Fragiskos D. Fragiskos

Oral Surgery

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With 1307 Figures, mostly in Color and 11 Tables

Springer

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Preface

It is my strong belief that writing a textbook constitutes an obligation for the academician towards his students, as well as towards his colleagues who are in search of continuing education.

Keeping this obligation in mind and given the developments in the field of oral and maxillofacial surgery and the recent impressive achievements in technology that have been noted, the writing of this book, which was based on the many years of experience of the author and contributors as well as the pertinent contemporary international bibliography concerning oral surgery, was considered imperative.

This book aims to give the dental student and the general practitioner practical guidance in the form of an atlas, which includes surgical procedures that may be performed in the dental office.

The practical format of this book has obliged us to limit the extent of theory and detailed description of techniques. Instead, we opted for numerous figures and a detailed step-by-step analysis employing illustrations of each surgical technique, keeping in mind that, in this type of book, a picture is undoubtedly more important than words.

The material is divided into 16 chapters which include: medical history; radiographic examination in oral surgery; principles of surgery; equipment, instruments and materials; simple tooth extraction; surgical tooth extraction; surgical extraction of impacted teeth; perioperative and postoperative complications; odontogenic infections; preprosthetic surgery; biopsy and histopathological examination; surgical treatment of radicular cysts; apicoectomy; surgical treatment of salivary gland lesions; osseointegrated implants; and prophylactic and therapeutic use of antibiotics in dentistry. Selective references are cited at the end of each chapter.

Distinguished colleagues have contributed to the writing of certain chapters relevant to their field of specialization. I would like to especially thank the following for their valuable contribution:

- Dr. H. Giamarellou, Professor in Internal Medicine and Infectious Diseases, School of Medicine, University of Athens, Greece, for her contribution as a co-author of Chap. 16 "Prophylactic and Therapeutic Use of Antibiotics in Dentistry."
- Dr. C. Alexandridis, Professor and Chairman, Department of Oral and Maxillofacial Surgery, School of Dentistry, University of Athens, Greece, for writing Chap. 12, "Surgical Treatment of Radicular Cysts" and his contribution as a co-author of Chap. 15, "Osseointegrated Implants."
- Dr. E. Stefanou, Associate Professor, Department of Oral Diagnosis and Radiology, School of Dentistry, University of Athens, Greece, for writing Chap. 2, "Radiographic Examination in Oral Surgery."
- Dr. A. Pefanis, Consultant in Internal Medicine and Infectious Diseases, School of Medicine, University of Athens, Greece, for his contribution as a co-author of Chap. 16, "Prophylactic and Therapeutic Use of Antibiotics in Dentistry."

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- Dr. A. Omar Abubaker, Professor and Chairman, Department of Oral and Maxillofacial Surgery, VCU School of Dentistry and VCU Medical Center and Dr. C. Skouteris, Associate Professor, Department of Oral and Maxillofacial Surgery, School of

The past two decades have witnessed significant advances in surgical techniques and instrumentation. However, the basic surgical principles upon which these advances owe their successful implementation and outcome have remained unchanged. Oral and maxillofacial surgery has its share of refinements and a pivotal role in the contemporary management of many pathologic, functional, and esthetic problems affecting the face and oral cavity. The majority of oral conditions that require surgical management fall within the realm of minor oral surgery. Hence, oral surgery constitutes an integral part of dental practice at both the undergraduate and professional level.

Over the years many oral surgery textbooks have served as recourses for useful information. This information, when coupled with appropriate training, has enhanced the skills of both the general dental practitioner and specialist. Following the tradition of other excellent oral surgical texts, Dr. Fragiskos has produced a well-written and amply illustrated text. Time-honored techniques and recent technical advances are presented in a well-balanced and succinct manner. In its present format this book can serve the reader as both a quick reference and a more in-depth resource of information on minor oral surgical techniques and related subjects.

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Foreword

Minor oral surgical procedures constitute a major part of the practice of dentistry. The majority of patients are in need of minor oral surgical procedures (e.g., extractions, implant placement, etc.) during the course of their dental management. Therefore, there is nothing "minor" about minor oral surgery.

Acquiring skills in oral surgical techniques is absolutely essential for today's dental practitioner. In this context, textbooks that can help in laying the grounds for such skills to blossom and flourish are an invaluable addition to the dental literature. Dr. Fragiskos has made a commendable effort to produce a well-structured, succinct, and superbly illustrated text. This book contains information on minor oral surgical procedures that is of great value to the dental student, general dental practitioner, and specialist.

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Medical History

1

F. D. Fragiskos

The medical history and clinical examination of the patient are deemed necessary in order to ensure the successful outcome of a surgical procedure, as well as a favorable postoperative healing process.

Investigation of the medical history is carried out with numerous questions pertaining to the presence of pathological conditions that may adversely influence the surgical procedure and endanger the patient's life.

There are various types of questionnaires that may be used by the dentist for gathering information about the general health of the patient. Table 1.1 presents the one that we feel fulfills the needs of the dental office.

Patients with underlying diseases should be given particular attention and all necessary preventive measures should be taken, in cooperation with the physician treating the patients, in order to avoid potential complications during and after the surgical procedure. This chapter refers to diseases and conditions that are included in the aforementioned medical history and which may cause problems at the dental office. The preventive measures that must be taken before and after the surgical procedure are also emphasized.

1.1
Congestive Heart Failure

Congestive heart failure is defined as the inability of the myocardium to pump enough blood to satisfy the needs of the body, so that the lungs and/or the systemic circulatory system are congested. The dentist treating patients with congestive heart failure must be especially careful, because any surgical procedure at the dental office may cause undue stress, resulting in cardiac dysfunction (workload increase of the heart, which surpasses the functional ability of the heart) followed by potential acute pulmonary edema.

Patients with this condition present with extreme dyspnea, hyperventilation, cough, hemoptysis (thin pinkish foamy expectoration), great difficulty in breathing, murmurs due to cardiac asthma, and cyanosis. The patient prefers the sitting position, is anx-

ious and might feel like he or she is choking and as if death is imminent.

The preventive measures that are deemed necessary before the surgical procedure for a patient presenting with congestive heart failure are the following:
- Written consent from the patient's cardiologist and consultation is desirable
- Oral premedication, e.g., 5–10 mg diazepam (Valium) or 1.5–3 mg bromazepam (Lexotanil), 1 h before the surgical procedure may be helpful
- Small amounts of vasoconstrictors in local anesthetic with particular importance of aspiration
- Short appointments, as painless as possible

1.2
Angina Pectoris

Angina pectoris is considered a clinical syndrome that is characterized by temporary ischemia in part of or all of the myocardium, resulting in diminished oxygen supply.

An episode of angina pectoris presents as brief paroxysmal pain posterior to the sternum, may be precipitated by fatigue, extreme stress, or a rich meal, and subsides within 2–5 min after rest and the use of vasodilators. The patient may describe the episode as painful discomfort in the chest, with a burning sensation, pressure, or tightness. Pain may be present in the cardiac area, radiating to the left shoulder, neck, left arm (with a numb sensation as well as tingling), sometimes down the chin and teeth of the mandible (usually the left side), or it may even be felt at the epigastrium, causing confusion in diagnosis.

Perspiration, extreme anxiety, and a feeling of imminent death often accompany these painful symptoms. Patients with a history of coronary heart disease have a greater chance of exhibiting angina pectoris during a dental appointment, due to the anxiety and stress of the upcoming procedure.

The preventive measures suggested in this case are:
- Written consent by the patient's cardiologist is desirable

Table 1.1. Medical history

Name _____

Age _____ Sex _____ Occupation _____

Address_____ Telephone _____

Name of physician _____

Questions pertaining to general condition of patient's health: ☐

1. Have you had any health problems during the last 5 years, so that you had to visit a physician or a hospital? ☐

2. Have you taken any medication for whatever reason during the last 2 years? ☐

3. Are you allergic to any substance or medication (e.g., antibiotics, local anesthetics, aspirin, etc.)? ☐

4. Have you taken any antibiotics during the last month? ☐

5. Did you ever have any prolonged bleeding that needed special treatment? ☐

6. Have you ever received radiotherapy in the neck or facial region for therapeutic purposes? ☐

7. Did you ever have, or do you have, a problem related to the following diseases or conditions? ☐

   ☐ Congestive heart failure   ☐ Prosthetic heart valve
   ☐ Angina pectoris   ☐ Surgically corrected cardiac disease
   ☐ Myocardial infarction   ☐ Heart pacemaker
   ☐ Rheumatic fever   ☐ Hypertension
   ☐ Heart murmur   ☐ Orthostatic hypotension
   ☐ Congenital heart disease   ☐ Cerebrovascular accident
   ☐ Cardiac arrhythmia

8. Have you ever been troubled by any other health problems other than the above? _____

_____

Notes _____

_____

_____

_____

(Date) _____ (Signature) _____

- Appropriate premedication, usually 5–10 mg diazepam (Valium) or 1.5–3 mg bromazepam (Lexotanil) orally, 1 h before the surgical procedure may be helpful
- Dental surgery in hospital, when the patient refers many episodes of angina pectoris
- Small amounts of vasoconstrictors in local anesthetic with particular importance of aspiration
- Short appointments, as painless as possible

1.3
Myocardial Infarction

Myocardial infarction refers to the ischemic necrosis of an area of the heart, usually due to complete blocking of some of the branches of the coronary arteries.

A myocardial infarction has a sudden onset with severe pain posterior to the sternum, which increases in severity rapidly and is characterized by a burning sensation, pressure, and extreme tightness. The pain is more severe compared to that of angina pectoris, lasting longer than 15 min and does not subside with rest or use of nitrates sublingually. Pain usually radiates (as in angina pectoris) to the left shoulder or towards the ulnar surface of the arm. It may also radiate towards the neck region, the mandible, teeth, midback region, epigastrium, and the right arm. The pain may also be associated with nausea, vomiting, perspiration, and dyspnea.

It is not always possible to treat patients in the dental office if they have suffered a myocardial infarction. It is considered prudent to avoid any routine dental surgery on patients with recent infarctions (within the last 6 months). In cases where treatment is deemed

absolutely necessary (acute infection, pain, etc.), management should take place in a hospital. Six months following the myocardial infarction, patients may also be treated in the dental office, as long as the dentist follows the same recommendations as those that were described in the case of angina pectoris.

1.4
Rheumatic Heart Disease

Patients with a history of rheumatic fever may have damage of the mitral and aortic valves, which may be described as stenosis, or insufficiency, or both.

Because patients with such a disease may develop clinical manifestations in the cardiovascular system years later, they must be evaluated very carefully before the surgical procedure is performed in order to determine if they can actually handle the stress involved.

It is also extremely important for the dentist to realize that transient bacteremia, which in healthy patients is nonthreatening and which may develop after invasive surgical procedures, is considered especially dangerous for patients belonging to this category. In this case, the endocardium generally presents great sensitivity to bacterial infection, and, as a result, any invasive procedure in the oral cavity without the use of antibiotics results in greater risk of bacterial endocarditis.

The preventive measures that are recommended are:
- Premedication before the surgical procedure can be helpful
- Avoidance of vasoconstrictors (or maximum concentration 1:100,000)
- Small amounts of vasoconstrictors in local anesthetic with particular importance of aspiration (see Chap. 16 for administration of antibiotic prophylaxis)

1.5
Heart Murmur

Heart murmurs are pathologic sounds (of longer duration and greater frequency than heartbeats) which are the result of vibrations caused by turbulence in the circulation through the vessels or chambers of the heart. Most heart murmurs are caused by valve defects, resulting from rheumatic disease and more rarely due to septic endocarditis, syphilis, or other diseases. They may also be due to congenital heart conditions.

Murmurs are described as:
a. Systolic murmurs:
　　1. Flow rate murmurs or outflow murmurs
　　2. Cardiac insufficiency murmurs
b. Diastolic murmurs:
　　1. Cardiac insufficiency murmurs
　　2. Congestive murmurs (via the mitral valve or tricuspid valve)
c. Continuous murmurs

Besides the murmurs mentioned above, which are due to organic cardiac defects, other murmurs are characterized as innocent or functional, which have a good prognosis.

From a dental point of view, when a patient reports a history of heart murmur, the dentist must establish whether the murmur is functional or pathologic. An antibiotic prophylaxis should be considered (see Chap. 16).

1.6
Congenital Heart Disease

Some congenital heart diseases (patent ductus arteriosus, atrial septal defects, ventricular septal defects, idiopathic pulmonary stenosis, tetralogy of Fallot, cyanotic heart disease, stenosis of pulmonary or aortic valve) are considered grave conditions, which must be evaluated carefully before the surgical procedure.

The preventive measures recommended in these cases are:
- Consultation with the physician treating the patient
- Premedication 1 h before the surgical procedure might be helpful
- If recommended by the cardiologist: administration of antibiotic prophylaxis, according to the regimen for rheumatic heart diseases involving valve damage (see Chap. 16)
- Use of vasoconstrictors at the smallest possible concentration
- Short appointments, as painless as possible

1.7
Cardiac Arrhythmia

Arrhythmia is any periodic variation in the normal rhythm of the heart, caused by disturbances of the excitability of the ventricles by the sinoatrial node.

Patients presenting arrhythmia, especially persistent arrhythmia despite antiarrhythmic management, require the following preventive measures:

- Consultation with treating physician
- In severe cases avoidance of local anesthetics containing vasoconstrictors or postponing of dental procedures
- Premedication before the surgical procedure can be of help
- Short appointments and pain control

1.8
Prosthetic Heart Valve

Patients who have undergone corrective surgery for various cardiac disorders with placement of prosthetic heart valves require antibiotic prophylaxis before the surgical procedure, because the endocardium associated with the artificial valve is particularly susceptible to microbial infection. The regimen recommended is the same as that for valve disease of rheumatic origin.

1.9
Surgically Corrected Heart Disease

Patients who have undergone surgery for heart disease in the past should be evaluated, with consultation with the treating physician, depending on the surgical procedure, the degree of cardiac or vascular defect, and the need for antibiotic prophylaxis (see Chap. 16).

1.10
Heart Pacemaker

Pacemakers are mainly used for the control of symptoms due to disturbances of the cardiac rhythm. Most modern types of pacemaker are able to maintain a relatively normal cardiac rhythm only when the need arises. The dentist must be aware of the following concerning pacemakers:

- The use of certain dental instruments increases the risk of abnormal activity of the pacemaker (monopolar electrosurgery, ultrasonic scalers, electronic dental anesthesia, etc.)
- Local anesthetics with vasoconstrictors may be used safely
- Antibiotic prophylaxis is not deemed necessary

1.11
Hypertension

Arterial pressure in healthy adult patients over 20 years of age is considered normal when diastolic blood pressure is under 90 mmHg and systolic blood pressure is under 140 mmHg.

Hypertension is the abnormal elevation of arterial pressure above the aforementioned values.

Arterial hypertension of unknown etiology exists in 95% of cases and is recognized as essential hypertension, whereas in 5% of cases the cause is known and is called secondary hypertension.

Measurement of blood pressure before any dental procedure is necessary in order to avoid many undesirable circulatory problems. Patients with blood pressure values ranging 140–160/90–95 mmHg may undergo dental surgery safely, whereas patients with blood pressure values ranging 160–190/95–110 mmHg will have to be given premedication half an hour to an hour before the surgical procedure, especially patients under stress. If the blood pressure values remain high even after premedication (e.g., over 180/110 mmHg) the dental session is postponed and the patient is referred to his/her physician for further treatment. Patients with blood pressure values over 190/110 mmHg are not allowed regular dental treatment. The patient's treating physician is consulted immediately and if there is an acute dental problem, the patient must be treated in a hospital, to prevent a possible sudden increase in arterial pressure, which is considered by many, erroneously, as a hypertensive crisis. Most patients considered to be suffering from a hypertensive crisis present intermittent elevation of arterial pressure, which is usually due to inadequate antihypertensive medication.

If no acute signs and symptoms of the target organs of hypertension (e.g., acute pulmonary edema, hypertensive encephalopathy) accompany the "peaks" of hypertension, no emergency therapeutic intervention is required. The patient must be referred to a physician for effective control of blood pressure. The sublingual administration of nifedipine (Adalat) may result in myocardial infarction or cerebrovascular accident, and so is not recommended. When acute signs and symptoms of the target organs accompany the "peaks" of hypertension, then the hypertension is termed malignant. This is characterized by severe hypertension (diastolic blood pressure >140 mmHg), along with papilloedema and/or retinal hemorrhage. The most serious complication is hypertensive encephalopathy,

the symptoms of which include severe headache, nausea, vomiting, confusion, convulsions, and coma.

Immediate management of hypertension is required very rarely, with intravenous administration of antihypertensive medication, targeting at a drop in blood pressure within a matter of minutes (e.g., hypertensive encephalopathy, acute weakening of left ventricle, encephalic hemorrhage, etc.), and should be carried out in a hospital. In actual practice, a dentist is not meant to administer emergency antihypertensive agents, except in cases of repeated acute pulmonary edema (rarely), whereupon the intravenous administration of furosemide (Lasix) is indicated.

To avoid uncontrollable blood pressure in hypertensive patients, certain preventive measures are necessary:

- Premedication before surgery often is helpful
- Blood pressure should be monitored before anesthesia and during the surgical procedure
- Preliminary aspiration to avoid intravascular administration, especially when the local anesthetic contains a vasoconstrictor
- Avoiding noradrenaline in patients receiving antihypertensive agents
- Short appointments, as painless as possible

1.12
Orthostatic Hypotension

Orthostatic hypotension is a sudden drop in blood pressure, which is noted as the patient is quickly returned to an upright position in the dental chair. This condition is due to disturbances of the autonomic nervous system, and is the second most frequently observed cause of transient loss of consciousness in the dental patient, after fainting.

The etiology of orthostatic hypotension is not entirely known, but there are predisposing factors. These factors include: diabetic neuropathy, antihypertensive agents or combinations of these, phenothiazines, sedatives, prolonged supine position, pregnancy, extreme fatigue, sympathectomy (due to the accumulation of large amounts of blood in the lower limbs), occasionally general infections, and severe psychological and physical exertion.

In the dental office, patients of any age may present with orthostatic hypotension if they are predisposed, or if they are hypotensive. As soon as these patients get out of the dental chair, their blood pressure drops suddenly, which is accompanied by dizziness, weakness, headache, loss of balance, sense of fainting, and finally loss of consciousness. There are usually no prodromal signs in the case of orthostatic hypotension, as there would be in the case of fainting (pallor, nausea, dizziness, and perspiration). That is why, based on the medical history, if the dentist deems that the patient is at risk for orthostatic hypotension, then he or she must support the patient as they get out of the dental chair, to protect them from a sudden fall, which may lead to serious injury.

To avoid an episode of orthostatic hypotension, the following preventive measures must be taken:

- Careful evaluation of medical history, especially concerning antihypertensive agents; also, fainting episodes, convulsions, etc.
- Blood pressure should be monitored in an upright and sitting position
- Administration of premedication for patients with severe psychological distress and physical exertion
- Avoidance of sudden changes in chair position during dental treatment, from the horizontal to the upright position (slow return), and not letting the patient get out of the chair suddenly, especially if he or she uses psychiatric drugs and antihypertensive agents or if the patient has a history of orthostatic hypotension

1.13
Cerebrovascular Accident

A cerebrovascular accident (stroke) is an acute neurologic disability secondary to deficit of a specific area of the brain. This deficit is due to focal necrosis of brain tissue, because of intracranial hemorrhage, cerebral embolism, or thrombosis.

The warning signs and symptoms include dizziness, vertigo, severe headache, perspiration, pallor, etc. These signs and symptoms may appear suddenly or gradually, while the patient may also present with loss of consciousness (apoplexy), upon which he or she rarely has time to mention anything at all. Other signs and symptoms include slow breathing, rapid pulse rate, partial or complete paralysis of one or both limbs of one side of the body, difficulty in swallowing, loss of expression or inability to move facial muscles, loss of tendon reflexes and an inability to rotate the head and eyes towards the side of cerebral damage (which is the opposite side of that which presents paresis) with dilation of the pupils, which do not react to light.

Patients with a history of a cerebrovascular accident must avoid surgical dental care for 6 months after the stroke. After this time, they may be treated, following consultation with their physician, after taking certain preventive measures:

- Blood pressure should be monitored before and during the surgical procedure (blood pressure must be controlled)
- Premedication 1 h before the surgical procedure can be helpful
- Adequate duration of local anesthesia and profound anesthesia
- Short appointment, as painless as possible, with gentle manipulations

If dental care is necessary within 6 months of the stroke, then it should be provided in a hospital. Patients who have suffered a cerebrovascular accident may be administered vasoconstrictors, in as low a dose as possible.

1.14
Anemia and Other Blood Diseases

Patients with a history of anemia must be evaluated carefully, because severe hemorrhage due to a tooth extraction or other surgical procedure in the oral cavity results in aggravation of the anemia, possibly endangering the patient's life.

Anemias that are of interest to the dentist include aplastic anemia, Biermer's megaloblastic anemia (a type of pernicious anemia), hypochromic anemias (iron deficiency anemia, thalassemia), and sickle cell anemia. Dentists should also be aware of patients with methemoglobinemia.

The following preventive measures are necessary for patients with a history of anemia and who need to have a tooth extracted:

- Hematocrit and hemoglobin levels must be as near normal as possible and consultation with the patient's hematologist is often necessary.
- Patients with sickle cell anemia in particular must avoid:
  - Pain and severe stress, otherwise a sickle cell crisis might result. Premedication and pain control with anesthetics that cause profound anesthesia are recommended.
  - Abrupt awkward manipulations during the extraction; due to osteoporosis caused by the disease, there is increased risk of fracture of the mandible.
- As far as local anesthetics are concerned, there are no contraindications for patients with anemia. However, methemoglobinemia, whether congenital or idiopathic, is a relative contraindication for the administration of two types of amide local anesthetics, articaine and prilocaine.

1.15
Leukemia

Leukemia is a pathologic condition of neoplastic nature, characterized by quantitative and qualitative defects of circulating white cells. Depending on the duration of the disease, it is classified as acute or chronic, and, according to the leukopoietic tissue that is involved, as myelogenous or lymphocytic.

Patients with leukemia must be treated with special care and always under consultation with the patient's hematologist, because these patients are susceptible to severe infection and postoperative hemorrhage. The preventive measures deemed necessary are:

- Avoidance of nerve block (only if anesthesia of the area is possible with local infiltration) because, due to the blood cell disorder, extensive hematoma may result.
- Surgical procedures (e.g., tooth extraction) may be performed in a hospital, except in the case of chronic leukemia in a state of remission, upon which management may take place in the dental office with administration of large doses of a broad-spectrum antibiotic. The patient must be handled with care, without abrupt movements, and with meticulous measures for the control of bleeding.
- Antibiotic prophylaxis should be administered.

1.16
Hemorrhagic Diatheses

These are pathologic conditions with hemorrhage, which may be spontaneous or the result of trauma.

Bleeding disorders are classified into three groups, according to their pathogenic mechanism:

a. Vascular disorders, which are due to alterations of the vascular wall, especially of the capillaries. These include hereditary hemorrhagic telangiectasia or Rendu–Osler disease, Ehlers–Danlos disease, von Willebrand disease (vascular hemophilia), and congenital bleeding diseases, scurvy, and purpura due to allergy.

b. Thrombocytic disorders, which are due to either decreased numbers of platelets (thrombocytopenia), or to congenital functional abnormality of the platelets. These include primary or idiopathic thrombocytopenia, Glanzmann's disease, and thrombocytosis or thrombocythemia.

c. Hemorrhagic diatheses because of disorders of coagulation, either due to deficiency of certain coagulation factors or the presence of anticoagulants in

the blood, which often occurs when the patient takes anticoagulant medication for years for therapeutic or preventive purposes. These include inherited disorders of coagulation (hemophilias and deficiency of other factors) and acquired disorders of the prothrombin complex (vitamin K deficiency), severe liver disease, and excessive use of various coagulation factors.

Patients with this type of disease are usually aware of their problem and always inform their dentist. The dentist should take the necessary precautionary measures before any surgical procedure, due to the risk of uncontrollable bleeding. The treating physician should be consulted, and, if deemed necessary, the surgical procedure must be carried out in a hospital with screening laboratory tests and medical management.

The preventive measures recommended for patients with hemorrhagic diathesis are the following:
- Designation of the time and place for the surgical procedure.
- Administration of medication by the treating hematologist, depending on the nature of the disease.
- Scheduling of surgical procedure for morning hours, so that there is ample time to control possible postoperative hemorrhage during the day.
- Limiting appointments that require therapy with replacement factors to as few as possible. Remove as many teeth needing extraction as possible at each session.
- Administration of both nerve block anesthesia and local infiltration anesthesia concurrently is thought to better control hemorrhage in the area with vasoconstrictors. Some people suggest that nerve block anesthesia should be avoided, especially in hemophilic patients, due to the risk of extensive hematoma resulting from injury to a large vessel if the patient has not taken the necessary medication.
- Local control of bleeding, which includes:
  - Smoothing of bone edges, so that the flap edges are as close as possible during suturing.
  - Packing the postoperative extraction alveolus with absorbable gelatin sponge or oxidized cellulose, and suturing of the wound.
  - Biting gauze at the extraction site for approximately an hour.
- Following postoperative recommendations, namely:
  - Continuation of administration of medication at the dose and time schedule as instructed by the hematologist.
  - Avoidance of administration of acetylsalicylic acid (aspirin) and other nonsteroidal anti-inflammatory drugs (indometacin), which produce

a tendency to bleeding. Acetaminophen, otherwise known as paracetamol, and ibuprofen are considered safer analgesics where bleeding is a problem.
  - Consumption of cold foods and liquids for the first few days and avoiding chewing hard foods for about a week.

1.17
Patients Receiving Anticoagulants

Patients who use anticoagulants should be treated after consultation with their treating physician. What basically concerns the dentist is the type of anticoagulant and the condition for which it is administered. Usually, anticoagulants are administered for long periods for various cardiovascular conditions (after acute myocardial infarction, vascular grafts, etc.), for certain types of cerebrovascular accidents, and for conditions involving veins (pulmonary embolism, venous thrombosis). They are given as special treatment for thrombo-embolic manifestations, as well as the prevention of recurrences.

The most commonly used anticoagulant drugs are coumarin drugs and heparin drugs, as well as anticoagulant derivatives of acetylsalicylic acid (aspirin).

Coumarin Drugs. These drugs are administered in doses sufficient to increase the prothrombin time to 2–2.5 times above the normal level (normal range: 11–12 s), thus delaying or preventing the intravascular coagulation of blood. This increase poses a major problem for blood coagulation, because of decreased plasma levels of factors II, VII, IX, and X. Therefore, if a surgical procedure is performed, there is an increased risk of prolonged postoperative bleeding, which is often difficult to control. For extensive surgical procedures there should be consultation with the hematologist so that the dose of the anticoagulant is reduced or even discontinued entirely before surgery, until the prothrombin time reaches the desired range (1.5 times the normal level, maximum). More specifically, the prothrombin time must be within a range of 17–19 s on the day of surgery, with gradual reduction of the therapeutic dosage at least 2 days beforehand.

After surgery, the prothrombin time is restored to the previous therapeutic levels with a gradual increase over a period of 2 days.

Today, the correct measurement of anticoagulation is based on the INR (International Normalized Ratio), which must be between 2 and 3 if the anticoagulation therapy is indicated for prophylaxis of venous throm-

bosis or atrial fibrillation, and range 2.5–3.5 if it is indicated for patients with prosthetic heart valves. Uncomplicated dental extractions or minor osteotomies can often be performed at an INR of 2.0–3.5. For extensive surgical procedures the INR should be 1.6–1.9, so that the risk of bleeding is reduced. A reduction of the oral anticoagulant should be weighed up against the risk of general complications together with the treating physician. The dentist must never reduce the oral anticoagulant without close consultation of the treating physician.

Heparin Drugs. Unfractionated heparin is usually only administered to hospitalized patients, because it is given parenterally. Its effect lasts approximately 4–8 h, but it may be prolonged for up to 24 h.

Heparin may be discontinued at least 4 h before the scheduled dental procedure. Postoperatively, if there is no profuse bleeding, heparin may be administered again the very same day, in dosages that have been adjusted accordingly.

Recently, heparin with low molecular weight (e.g., Clexane, Fraxiparine, etc.) has been widely used for the prevention of deep vein thrombosis. Patients under this type of medication do not need to adjust their dosages before any surgical procedure, nor do they require screening laboratory tests.

Aspirin-Containing Compounds (Aspirin). Patients who take aspirin for anticoagulant treatment for long periods must discontinue its use at least 2–5 days before the surgical procedure and may continue it 24 h later.

The aforementioned cases of discontinuing the anticoagulant treatment require the following screening laboratory tests on the morning of the scheduled surgical procedure:

a. Prothrombin time, for patients receiving coumarin drugs
b. Partial thromboplastin time, for patients receiving heparin (except for low molecular weight heparin)
c. Bleeding time and prothrombin time, for patients receiving salicylates for a prolonged period

Patients receiving anticoagulants because of artificial heart valves, severe venous thrombosis or vascular grafts who discontinued the therapy in order to have a tooth extracted must resume the anticoagulant drug as soon as possible, because of the increased risk of embolism due to thrombi. Tooth extractions in these patients must be performed in as few sessions as possible, so that the period without anticoagulant therapy is limited. If an emergency arises (acute dentoalveolar abscess) in a patient with heart disease who takes anticoagulants and it is not possible to measure the prothrombin time, the dental procedure must be performed in a hospital with meticulous local measures to control bleeding.

It has been suggested that reduction or discontinuation of the anticoagulant is not necessary for minor surgical procedures, if care is taken to control the bleeding and inhibitors of fibrinolysis are used (tranexamic acid), for at least 2 days postoperatively.

1.18
Hyperthyroidism

Hyperthyroidism is a condition that refers to an excess of thyroid hormones, due to hyperfunction of the thyroid gland.

Thyrotoxic patients present with anxiety, irritability, hyperactivity, profuse sweating, tremor of the hands, insomnia, weight loss because of increased metabolism, tachycardia, arrhythmia, increased blood pressure, weakness, and exophthalmos (71%).

In certain circumstances, thyrotoxic patients may develop thyrotoxic crisis, that is, acute worsening of the thyroid symptoms mentioned above. Patients with this condition have fever, marked tachycardia, arrhythmia, abdominal pain, profuse sweating, nausea, congestive heart failure, pulmonary edema and perhaps coma, which in a large number of patients results in death. Precipitating factors of a thyrotoxic crisis include severe stress, various infections, surgical procedures, trauma, pregnancy, diabetic ketoacidosis, drugs containing iodine, etc. Local anesthesia or surgical procedures may precipitate a thyrotoxic crisis, because of the stress they cause. Therefore, the administration of a sedative is deemed necessary to decrease the stress and fear a patient may have.

Consultation with a physician is important in the case of hyperthyroidism, because these patients usually suffer from cardiovascular disease, which must be taken into consideration by the dentist so that the treatment plan is altered accordingly. Surgical dental management should be postponed until function of the thyroid has been normalized by appropriate medical management.

These patients also present adverse interactions with catecholamines, therefore there is increased risk of having a severe reaction to vasoconstrictors, especially adrenaline and noradrenaline. Thus, if these patients, whose cardiovascular system is already stimulated by the hyperthyroidism, are given vasoconstrictors, e.g., adrenaline (which is a drug that

stimulates the heart), then acute arrhythmia, ventricular fibrillation or even thyrotoxic crisis may result.

Vasoconstrictors must be administered in the lowest concentration possible and definitely after preliminary aspiration. Felypressin is considered the safest vasoconstrictor.

1.19
Diabetes Mellitus

Diabetes mellitus is a syndrome characterized by alteration of the metabolism of carbohydrates, proteins, and lipids and is caused by abnormalities of the secretion mechanism and effect of insulin.

The dentist must be extremely careful about performing surgery on a diabetic patient, as far as the following are concerned.

Screening Tests. A recent blood glucose test is important. This test may be performed in the dental office before surgery using a glucometer, a portable piece of equipment that is battery operated. A drop of capillary blood from the fingertip is placed on the test strip after pricking with a special lancing device, and within 1 min a numerical value appears on the screen.

Scheduled Time of Surgery. In order to avoid the risk of a hypoglycemic reaction (insulin shock), it is best if surgery is performed in the morning, 1–1.5 h after breakfast (insulin's peak action is noted in the afternoon). This way, the patient comes to the dental office rested and without stress.

Diet. The diabetic's diet must not be altered before or after the surgical procedure. Before surgery, and particularly afterwards, the patient often neglects to eat their meal or cannot because of the pain and bleeding, with hypoglycemia resulting.

Postoperative Recommendations. Patients with controlled diabetes do not require preoperative or postoperative antibiotic prophylaxis. These people should be treated in the same way as nondiabetic dental patients.

Presence of Infection Before Surgery. All infections – especially those with fever and suppuration, by stimulating the release of catecholamines and glucagon – are considered risk factors for hyperglycemia and must be treated as quickly as possible. Antibiotics are administered in the case of acute dentoalveolar abscess, according to the regimen in Chap. 16, with incision and drainage procedures following.

Administration of Local Anesthetics. Local anesthetics must be administered with great care, because of the vasoconstrictor, whose concentration must be minimal. Adrenaline, which is one of the most commonly used vasoconstrictors, causes glycogenolysis, thus interacting with insulin. Noradrenaline has less of a glycogenolytic effect compared to adrenaline, and so is preferred in diabetics. Generally, though, the amount of vasoconstrictor in an ampoule is very small (the greatest concentration being 1:50,000) and so the risk is considered minor.

Administration of Other Drugs. Mild analgesics and sedatives containing acetaminophen (Tylenol) are used. Corticosteroids must be avoided because of their glycogenolytic action, as should salicylates (aspirin), due to potentiation of the hypoglycemic action of the antidiabetic tablets. The administration of an anxiolytic is recommended the previous afternoon and the morning before the surgical procedure.

Wound Healing. Surgical procedures in the oral cavity must be performed with gentle manipulations for optimal wound healing. Bone edges must be smoothed in order to avoid irritation of the gingiva. Suturing may be helpful.

Blood Glucose Level at the Time of Surgery. Generally, there is no specific blood glucose level that is prohibitive for emergency dental procedures. If surgery is not imperative, then it is better if it is postponed and the patient's blood glucose level is controlled.

Dental Office Supplies. For treatment of an emergency situation such as hyperglycemia or hypoglycemia, insulin, sugar or glucose solution, saline solution, glucose, etc. should be available at the dental office.

Diabetic hypoglycemia is most important, presenting when the blood glucose level is below 55 mg/100 ml. It appears rapidly and is characterized by hunger, distress, fatigue, sweating, vertigo, trembling, pallor, feelings of anxiety, headache, mental confusion, paresthesia, diplopia and blurred or decreased vision, convulsions and neurological disorders. In more severe cases, excessive perspiration, muscle hypertension, localized or generalized convulsions, and finally, loss of consciousness, coma, and death are observed.

Diabetic hyperglycemia develops slowly, is observed more rarely and is less dangerous than hypoglycemia. It is characterized by weakness, headache, nausea,

vomiting, diarrhea, xerostomia, dehydration, dyspnea, and, finally, lethargy resulting in a coma.

1.20
Renal Disease

The renal diseases that are of particular interest to the dentist are acute glomerulonephritis, chronic glomerulonephritis, and renal failure.

1.20.1
Acute Glomerulonephritis

This disease is characterized by acute, diffused inflammation of the glomeruli. It is more common in young people and it is caused by group A β-hemolytic *Streptococcus,* especially after upper respiratory infection (tonsillitis, otitis, pharyngitis). This is a severe condition and no surgical procedure is allowed in the oral cavity without consultation with the patient's treating physician. If deemed absolutely necessary, the surgical procedure must be performed in the hospital.

1.20.2
Chronic Glomerulonephritis

This disease presents without symptoms in the initial stages, the findings being proteinuria and the presence of hemorrhagic casts in the urine. Hypertension, headache, anemia, and polyuria are also observed. This disease develops slowly and eventually the renal parenchyma of both kidneys is destroyed, leading to renal retraction.

Patients with this disease may undergo surgery without prophylactic antibiotics. The following, however, are considered necessary:

- Consultation with the patient's treating physician
- Constant monitoring of blood pressure before and during the surgical procedure, because these patients are usually hypertensive

1.20.3
Chronic Renal Failure

This is a clinical syndrome characterized by permanent kidney damage, resulting in impaired glomerular and tubular function. Patients with chronic renal failure develop anemia, and, in advanced cases, hemor-

rhagic diatheses (thrombocytopenia in 50% of cases), as well as other metabolic disturbances.

The most common causes of the disease are glomerulonephritis, hypertensive nephrosclerosis, diabetes mellitus, and nephrotoxins.

When a surgical procedure is to be performed on the patient, the following preventive measures are necessary:

- Consultation with the patient's treating nephrologist
- In cases of severe anemia, the hematocrit must be at acceptable levels
- Preventive measures to avoid extensive hemorrhage due to hemorrhagic diatheses
- Local measures to control bleeding by placing gelatin sponge in the socket, as well as sutures for optimal healing of the wound
- Use of minimal amounts of vasoconstrictors, because hypertension is usually observed in chronic renal failure
- Use of minimal amounts of local anesthetics in order to avoid toxicity
- Avoidance of any dental procedure on the day of hemodialysis

1.21
Patients Receiving Corticosteroids

Patients who are to have oral surgery and who take corticosteroids must be managed in such a way to avert the possibility of acute adrenocortical insufficiency due to stress because of the imminent surgical procedure. There are, however, various opinions as to the criteria that determine which patients are at risk of developing acute adrenocortical insufficiency and which are not.

According to Glick's recommendations:

a. Patients who have received glucocorticoids during the last 30 days should be considered immunocompromised, and, as such, should be administered supplementation.

b. Patients who have received glucocorticoids in the past, but not during the last 30 days, are considered able to respond to stress and therefore do not need supplementation.

c. Patients who receive glucocorticoids on a long-term basis, using an alternate-day regimen, should have the surgery performed on the day they are not having therapy. These patients do not require an increase of their dosage of glucocorticoids.

d. Patients who receive glucocorticoids on a regular basis (daily), in doses greater than 10 mg predni-

sone (10 mg of Prezolon or 8 mg of Medrol), should be considered immunocompromised and do need supplementation.

Supplementation involves the administration of 100 mg hydrocortisone (Solu-Cortef) intramuscularly or intravenously, before surgery. If the surgical procedure proves to be particularly painful or prolonged, then the supplementary administration of 50–100 mg hydrocortisone is recommended 6 h later. It is recommended that the total dose administered does not exceed 250 mg.

Despite the aforementioned recommendations and adhering to the recommendations of the patient's physician, the dentist must be prepared to face the possibility of a crisis of acute adrenal insufficiency. Common findings of this condition include weakness, nausea, vomiting, hypotension, confusion, sleepiness, headache, dehydration and hyperpyrexia, and, if it is not treated rapidly, it may lead to coma and death of the patient.

1.22
Cushing's Syndrome

Apart from the cases of insufficient corticosteroid secretion, the patient may present with a pathologic condition characterized by hypersecretion of hormones from the adrenal cortex. Cushing's disease or hyperadrenalism causes this condition.

The preventive measures that are recommended for patients of this category who are to have dental surgery are the following:
- The surgical procedure should be performed in a hospital with the cooperation of the patient's physician
- Sedative medication must be administered
- In the case of a tooth extraction, manipulations must be performed carefully, because there is risk of fracture due to severe osteoporosis of the jaw

1.23
Asthma

This chronic condition, characterized by paroxysmal dyspnea with coughing, presents with stenosis of the duct of small bronchi and bronchioles, due to bronchoconstriction, edema of the mucosa, and viscous mucous production. Asthma affects children and adults, while 50% of the cases are due to allergy. Stress, allergy, and temperature changes, among other things,

may provoke paroxysmal attacks of asthma. The attack presents with expiratory dyspnea, which is accompanied by exertional nonproductive cough with wheezing. The patient's expression is anxious, their face is pale and cyanotic, and the patient has cold limbs and perspires.

An acute asthmatic attack is one of the most common respiratory problems encountered in the dental office. Immediate treatment is required, so that further deterioration of the patient's condition is avoided, which may otherwise lead to a condition called status asthmaticus. This condition is a severe form of paroxysmal asthma, and is refractory to the usual therapy for asthma.

As for patients with a history of asthma who are about to undergo surgery, the dentist must take all the appropriate precautions to prevent an attack during the dental procedure, as well as be prepared to deal with an asthma attack, should it occur for any reason.

The preventive measures that are recommended are the following:
- Take a detailed medical history of the patient, to determine the severity of the condition (frequency and duration of attacks)
- Administration of sedative medication for stress management, which is a precipitating factor in an asthmatic attack
- Control of pain (to avoid stress), with sufficient duration and depth of local anesthesia
- Short appointments, with gentle manipulations during surgical procedure

1.24
Tuberculosis

Tuberculosis is an infectious disease that is caused by *Mycobacterium tuberculosis,* otherwise known as Koch's bacillus, and may affect all organs, though the lung is the most common site. Unfortunately, recently there has been an increase in the number of infected persons internationally, generating fear of an even greater spread.

Clinical signs and symptoms include persistent cough, which becomes productive with sputum that is nonpurulent and may contain blood. Fever, anorexia, weight loss, and lassitude are also noted.

People as well as animals suffering from tuberculosis transmit disease. The mycobacterium enters the body by way of the respiratory system and more rarely via ingestion.

In the dental office, transmission of the disease may occur by way of droplets containing mycobacteria (mainly when the patient coughs during various dental procedures).

The following necessary precautionary measures to prevent spread of the disease must be taken in the dental office:

- Patients presenting with symptoms that suggest clinically active tuberculosis must be referred for a physical examination, to verify the current status.
- Dental treatment of patients with clinically active tuberculosis of the lungs or larynx should be postponed until it is confirmed that there is no danger of transmitting the disease.
- If emergency dental treatment is deemed necessary in a patient with active tuberculosis or if the patient has signs and symptoms suggestive of tuberculosis of the lungs or larynx, then the treatment should be rendered in a hospital. The dentist and staff who come into contact with these patients should take additional protection measures (e.g., surgical mask, disposable gown, etc.).

1.25
Infectious Diseases
(Hepatitis B, C, and AIDS)

AIDS and hepatitis B and C are infectious diseases that are worldwide health problems and are found in all social classes. Therefore, both the dentist and the patient need to be protected against transmission.

The medical history of the patient is significant and precautionary measures must be taken especially where high-risk groups are involved; namely, patients who undergo hemodialysis, drug-users, homosexuals, patients who have blood transfusions on a regular basis, and people who come from countries where the incidence and prevalence of these infectious diseases is high (Africa, Asia, etc.). The risk of transmission of an infectious disease from one patient to another basically involves the use of infected instruments during surgical procedures. The dentist is also at risk of infection after coming into contact with a carrier of the disease. Transmission of infectious disease occurs after direct contact with blood and saliva or after accidental puncture by an infected needle or other sharp dental instrument.

If the dentist establishes that the patient about to undergo surgery is a carrier of one the aforementioned viruses, rigid precautionary measures are deemed necessary. These include:

- Programming the surgical procedure as the last appointment of the day.
- Using two pairs of disposable gloves. Gloves protect the patient as well as the dentist and should be discarded immediately after use.
- Special protective glasses and disposable surgical mask.
- Special protective surgical gown and cap covering scalp hair.
- Disposable needles. Great care should be taken during their use, in order to avoid accidental puncture. Also, the plastic cover of the needle should be replaced with the special resheathing device only. This should be a standard technique for all patients.
- Discarding of surgical blades and disposable needles in a rigid sharps container, which is sealed when full and is removed from the dental office should also be a standard.
- Collecting all garbage (saliva ejectors, plastic cups, gloves, masks, gauze, etc.) in a tough nylon bag.
- After the surgical procedure, disinfection of certain objects with a virus-active disinfectant according to the local hygiene guidelines (exposed parts of the dental chair, the dentist's stool, spittoon, etc.).
- Sterilization of all instruments that were used in an autoclave, after they are cleaned and disinfected manually or preferably by an automat.

1.26
Epilepsy

Epilepsy is the clinical manifestation of abnormal electrical activity of the brain, which leads to motor activity and altered states of consciousness.

Epileptic patients are administered specific drug therapy and may present with epileptic seizures under certain circumstances. The main factors that precipitate such seizures include severe stress, alcoholic drinks, hypoglycemia, severe pain, administration of large doses of local anesthetics, and surgical procedures.

The clinical signs and symptoms of epilepsy involve periodical seizures, which present either abruptly or after some warning. The epileptic seizure usually presents in three phases: aura, convulsion phase, and postconvulsion phase. The aura involves prodromal symptoms, i.e., those that the patient feels before the seizure occurs. Presenting symptoms include tinnitus, yawning, dizziness, anxiety, and characteristic smells. The epileptic aura lasts a few seconds and the convulsion phase follows, which is characterized by persistent

spasmodic movements of the head, body, and limbs. Forcible jaw closing, rolling of the eyes upward or to the side, and pinkish froth from the mouth are also noted. Breathing may stop, the face becomes cyanotic, and fecal and urinary incontinence may occur. The convulsions then cease and, after a deep breath, the postconvulsion phase follows, which is characterized by disturbances of the consciousness state, pallor, and weakness. This phase has variable duration and may last 10–30 min, with the risk of airway obstruction by mucous secretion, vomit, or the tongue falling posteriorly against the posterior pharyngeal wall. After the epileptic seizure, the patient regains consciousness, but feels exhausted and may have a headache, but does not recall the seizure itself.

Certain epileptic patients may present with status epilepticus, which is characterized by repeated seizures lasting more than 30 min, without a recovery period. This condition is a medical emergency, because there is not enough time for the patient to breathe normally and to recover from the stress of the first seizure. The same problem exists when the seizure is prolonged and lasts for more than 10 min.

The preventive measures recommended for avoiding seizures during dental procedures in an epileptic patient are:

- Reduction of stress (e.g., with appropriate anxiolytic medication)
- Administration of small amounts of local anesthetic and always after preliminary aspiration (excessive amounts, especially intravascularly, may precipitate convulsions)
- Short appointments, as painless as possible
- Additional anticonvulsant drugs before the surgical procedure, always after consultation with the treating physician

1.27
Diseases of the Skeletal System

The main diseases of the skeletal system that the dentist must be aware of are: osteogenesis imperfecta, Marfan's syndrome, cleidocranial dysplasia, Down's syndrome, osteoporosis, idiopathic histiocytosis (formerly known as histiocytosis X), Gaucher's disease, Paget's disease, osteopetrosis, fibrous dysplasia of the jaws, and encephalotrigeminal angiomatosis (Sturge–Weber syndrome).

Because of the compromised substrate of the jawbones, there is risk of fracture even during a simple extraction and, in certain cases, hemorrhage and delayed healing due to potential postsurgical infection.

The aforementioned syndromes may be accompanied by heart disease, therefore these patients need special care when surgery is to be performed. Depending on the severity of the disease the necessary precautionary measures can be:

- Emergency surgical procedures performed only
- Avoidance of abrupt awkward manipulations during extraction
- Local measures to control bleeding when serious hemorrhage may result (Gaucher's disease, Paget's disease, Marfan's syndrome, encephalotrigeminal angiomatosis)
- Prophylactic administration of antibiotics to avoid development of infection in osteogenesis imperfecta, Down's syndrome, osteoporosis, osteopetrosis, and Marfan's syndrome

1.28
Radiotherapy Patients

Patients who have been treated recently with irradiation in the facial and neck area for therapeutic purposes present with increased risk of developing extensive bone infection if a tooth extraction or other surgical procedure in the mouth is performed. To avoid such a complication, the surgical procedure must be cautiously performed, after at least a year has passed without symptoms following the last radiotherapy session and the patient is given large doses of prophylactic antibiotics for several days. Wound closure is obligatory.

It is worth noting that when the extraction is performed before radiotherapy, 7–10 days must pass before the wound heals and radiotherapy begins. This period may be prolonged, depending on the patient's condition and the administered radiation dose.

1.29
Allergy

An allergic reaction, either during or after any dental procedure, is one of the most serious problems a dentist may encounter.

Drugs and other substances that may evoke allergic reactions are: local anesthetics, antibiotics, analgesics, anxiolytic drugs, as well as various other dental materials or products.

Local Anesthetics. Allergy that is caused by the use of local anesthetics is usually due to the preservatives in the ampoule, which act as germicides. The most

common preservatives used are the derivatives of paraben (methyl-, ethyl-, propyl-, and butyl-paraben). Today, most local anesthetics do not contain preservatives so as to avoid allergic reactions, resulting in a shorter shelf-life of the anesthetic solution.

Antibiotics. The antibiotic that interests the dentist most (as far as allergy is concerned) is penicillin, because it is considered the antibiotic of choice in most cases of dental procedure. The frequency of allergic reactions due to use of penicillin ranges from 2% to 10% and reactions manifest as mild, severe, or even fatal.

Analgesics. The analgesics that may be responsible, though infrequently, for allergic reactions are narcotics (codeine or pethidine), and acetylsalicylic acid (aspirin). Of the analgesics, aspirin is considered the drug responsible for most allergic reactions, which range from 0.2% to 0.9%. Allergic reactions due to aspirin vary from simple urticaria to anaphylactic shock. Sometimes symptoms of asthma or angioneurotic edema may appear.

Anxiolytic Drugs. Barbiturates are the anxiolytic drugs that cause allergic reactions most frequently. The people usually affected are those who report a history of urticaria, angioneurotic edema, and asthma. Allergic reactions are usually mild and are often limited to the appearance of skin reactions (urticaria).

Various Dental Materials or Products. Acrylic resins, certain antiseptics, radiograph processing solutions, and gloves may evoke allergy. Allergic reactions are usually mild and present with stomatitis (inflammatory erythema) and skin urticaria.

1.29.1
Classification of Allergic Reactions

Allergic reactions, based on the immunological mechanisms that cause them, are classified into four types:
a. Type I reaction (anaphylaxis)
b. Type II reaction (cytotoxic hypersensitivity)
c. Type III reaction (immune-complex-mediated hypersensitivity)
d. Type IV reaction (cell-mediated or delayed-type hypersensitivity)

1.29.2
Types of Allergic Reactions

The clinical manifestation of allergy is not always the same. Depending on the body's reaction, clinical symptoms appear whose seriousness varies from a simple rash to a medical emergency. These include:

Anaphylaxis. This is the most dangerous type of allergic reaction, which may cause the death of the patient within a few minutes. It involves acute respiratory and circulatory collapse, which presents with hoarseness of voice, dysphagia, anxiety, rash, burning, painful sensation, pruritus, dyspnea, cyanosis of the limbs, wheezing due to bronchospasm, vomiting, diarrhea, rapid irregular heart rate due to hypoxia, hypotension, and loss of consciousness. Anaphylaxis may prove fatal within 5–10 min.

Urticaria. This is the most common type of allergic reaction and is characterized by the appearance of vesicles of various sizes, which are due to the secretion of histamine and serotonin, resulting in an increased permeability of vascular structures. The vesicles induce pruritus and a burning sensation on the skin. The reaction may be limited or spread over the whole body. A severe reaction may cause a fall in blood volume and, as a result, anaphylaxis.

Angioneurotic Edema (Quincke's Edema). This appears suddenly, and is a well-defined swelling of the soft tissues, especially the lips, tongue, buccal mucosa, eyelids, and epiglottis. The patient's life is in danger because of obstruction of the upper respiratory tract, resulting in dyspnea and difficulty in swallowing, which, if not treated immediately, leads to death rapidly.

Allergic Asthma. This may appear as an isolated allergic reaction and presents as bronchospasm and respiratory dyspnea.

The most common precautionary measures that must be taken if a patient cites a history of any type of allergy are:
- Questions about the type of allergy and the drug or substance that caused the reaction.
- Referral of the patient to an allergist for testing, if the history shows allergy to local anesthetics in the past.
- Avoiding the administration of drugs to which the patient presents hypersensitivity. For example, in

the case of aspirin allergy, acetaminophen (Tylenol) may be prescribed, or in the case of allergy to penicillin, a macrolide may be administered.

- Patients with a history of atopic diseases, such as allergic rhinitis, asthma, and eczema, should be given particular consideration and attention.
- The dentist should be prepared to deal with an allergic reaction with drugs (adrenaline, hydrocortisone, antihistamines, and oxygen).

1.30
Fainting

Fainting is the sudden, but temporary loss of consciousness, where the functions of the cortex of the brain are inhibited, resulting in lack of communication of the patient with their surroundings. This condition is the most common complication encountered in dentistry and may occur in all persons regardless of age. It is usually seen between the ages of 15 and 35, especially males.

The most common causes of fainting are emotional states, severe pain, orthostatic hypotension, and hormone disorders.

The first symptoms of fainting include headache, feeling of anxiety, pallor of face, perspiration, tachycardia, weakness and malaise, increased temperature in the area of face and neck, nausea, vertigo, and imbalance. As fainting progresses, pupil dilation, yawning, and hyperpnea, as well as cold limbs may be noted. Blood pressure drops and just before loss of consciousness, there is bradycardia after the initial tachycardia, diminishing of eyesight, and severe dizziness. Lack of response to sensory stimuli and lack of protective reflexes characterize loss of consciousness. The patient may present with an irregular or regular respiratory rate, while total apnea rarely occurs. Bradycardia (50 beats/min), a drop in blood pressure, short but mild convulsions (especially when the patient is in a sitting position), and muscle relaxation, which may cause obstruction of the upper respiratory tract (tongue falls posteriorly against the posterior pharyngeal wall), also occur. Loss of consciousness does not usually last longer than 10–20 s. If the fainting episode lasts longer than 5 min, then the possibility that it has a more serious cause is greater, whereupon transferring the patient to a hospital is necessary.

Fainting episodes may be avoided most of the time, if the necessary precautionary measures are taken:
- Detailed medical history. What has to be evaluated is the patient's predisposition to fainting spells and if they are in a position to be subjected to the physi-

cal and psychological stress involved in a dental procedure. If it is ascertained that the patient feels extreme fear and anxiety or if factors that may precipitate a fainting episode are warranted, then sedative premedication must be administered, or, if possible, nitrous oxide–oxygen administered.
- Avoid causing pain. Before the administration of local anesthetics to very sensitive people, topical anesthetics should be used at the site of injection and deposition of the solution in the tissues should be as slow as possible.
- Placing the patient in an appropriate position. Chair position of the patient is very important in preventing fainting episodes. Regardless of the site of anesthesia and the surgical procedure in general, the patient must be in a semi-supine or supine position, because in this position (particularly supine), ischemia of the brain does not occur and, therefore, neither does the fainting spell.

1.31
Pregnancy

Pregnancy is not a disease, but a normal state of a woman's body; however, special treatment is required when the woman is about to undergo dental surgery, so that the developing embryo and the mother herself are not at risk. The most important risks are noted in the first trimester, because every intervention that may cause hypoxia may have a harmful effect on the embryo or be responsible for spontaneous abortion. Therefore, during the first and second trimesters, every surgical procedure in pregnant patients who cite previous spontaneous abortions in their history should be avoided. If, however, an emergency arises (e.g., acute dentoalveolar abscess), the patient should be managed after consultation with her obstetrician. During the second trimester, the patient with a problem-free history is not at risk, provided that the surgical procedure is short and as pain-free as possible. As far as the third trimester is concerned, every procedure should be avoided in the last days of pregnancy, because of the possibility of the baby being born during the dental procedure.

In all cases the patient's obstetrician should be consulted, who will determine if anxiolytic, analgesic, and antibiotic drugs are necessary, especially if the pregnant patient presents with systemic diseases that may render management in a hospital setting necessary.

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Radiographic Examination in Oral Surgery

2

E. Stefanou

The maxillofacial area presents exceptional difficulties as far as the radiographic examination is concerned. Even so, this examination is the most valuable and important diagnostic tool for oral surgeons, who have to chose the most appropriate radiographic technique among many, so that the information they gather will help them significantly in diagnosis and therapy. It is obvious, of course, that radiographs are taken only if necessary for diagnostic purposes and after meticulously scrutinizing the patient's history and the clinical examination of the patient.

Conventional radiographs are two-dimensional images, which depict three-dimensional anatomical areas. Therefore, correct interpretation of the radiographs is very important in diagnosing problems of the oral and maxillofacial area, and is achieved when:

- The radiographs are of good quality.
- The technique used for the various radiographs is known.
- The entire area that interests us is depicted.
- We are aware of the anatomy of the area and how various anatomical structures are depicted on radiographs.
- We are well aware of the various pathologic lesions that may present in the area and how they are depicted radiographically.

The diagnostic information obtained from a radiograph depends on the quality of the radiograph; the higher the quality of the image, the greater the probability of an accurate diagnosis.

Some pathologic conditions may require an increase or decrease of the technique factors involved in developing a radiograph. This is due to the pathologic lesion itself. When the lesion enhances bone density, the technique factors must increase. In contrast, when the lesion causes a decrease in bone density, then the technique factors decrease.

Generally, the main indications for radiographic examination are:

- Discovering a correlation between pathologic lesions and normal anatomical structures, e.g., the maxillary sinus, mandibular canal, nasal fossa, mental foramen, etc.
- Discovering impacted and supernumerary teeth, root remnants, etc.
- Evaluation of the degree of radiopenetration of a lesion.
- Identification of a lesion and its size, shape, and boundaries.
- The development of a lesion.
- The effect of a lesion on the bone cortex and the adjacent teeth.

The main radiographic techniques used in oral surgery are the following:

- Periapical projection.
- Occlusal projection.
- Panoramic radiograph.
- Lateral oblique projection of mandible.

More rarely, other extraoral projections of the face and jaw may be used, depending on the situation.

Periapical projections are advantageous in that they provide detailed information about the bone structure and aid us in the study of teeth that remain in the maxilla and mandible.

Occlusal projections have the same advantages as periapical radiographs, but they also depict larger areas. These projections provide the third dimension, used in conjunction with periapical or panoramic radiographs. They are also used for evaluating the arch of the jaw, bone quality and for examination of the greatest buccolingual dimension of the mandible.

A panoramic radiograph provides us with valuable information concerning the bone and its correlation to the mandibular canal, the maxillary sinus, and the nasal fossa. It also gives us an overall assessment of the dentoalveolar system and allows us to study the existing teeth, as well as the presence of bony lesions, root remnants, impacted teeth, etc.

2.1
Radiographic Assessment

Conventional radiographs have coherent limitations, since they depict a three-dimensional object as a two-dimensional image, therefore they present a disadvantage in determining the depth of the depicted images. In order to gather as much information as possible from a radiograph, a dentist must visualize the exact three-dimensional image of the anatomic areas of interest based on one or more of such two-dimensional images (radiographs).

The radiographic detection technique is basically used to locate:

- Foreign bodies, provided they are radiopaque.
- Root remnants and other tooth fragments that may have been displaced into the surrounding tissues.
- Impacted teeth and supernumerary teeth.
- Soft tissue calcifications.
- Fractures of the jaw.
- Expansion of the buccal or lingual wall of the jaw.
- Relationship of impacted teeth, roots, etc. to adjacent anatomical structures (nasal cavity, maxillary sinus, and inferior alveolar nerve).

Many times, clinical examination of the patient will reveal an impacted tooth, which is confirmed by a radiograph. An impacted tooth may also be discovered by chance on a radiograph.

Determining the position of impacted teeth on a horizontal level is important for the diagnosis and treatment plan, which entails either the extraction of the impacted tooth or its alignment in the arch with orthodontic therapy.

The impacted teeth that create the most localization problems are canines of the maxilla, which are often found palatally.

The techniques used to determine the position of the tooth are:

- Magnification technique.
- Two radiographs with different reference planes (right-angle or cross-section technique).
- Tube shift principle or parallax.
- Vertical transversal tomography of the jaw.
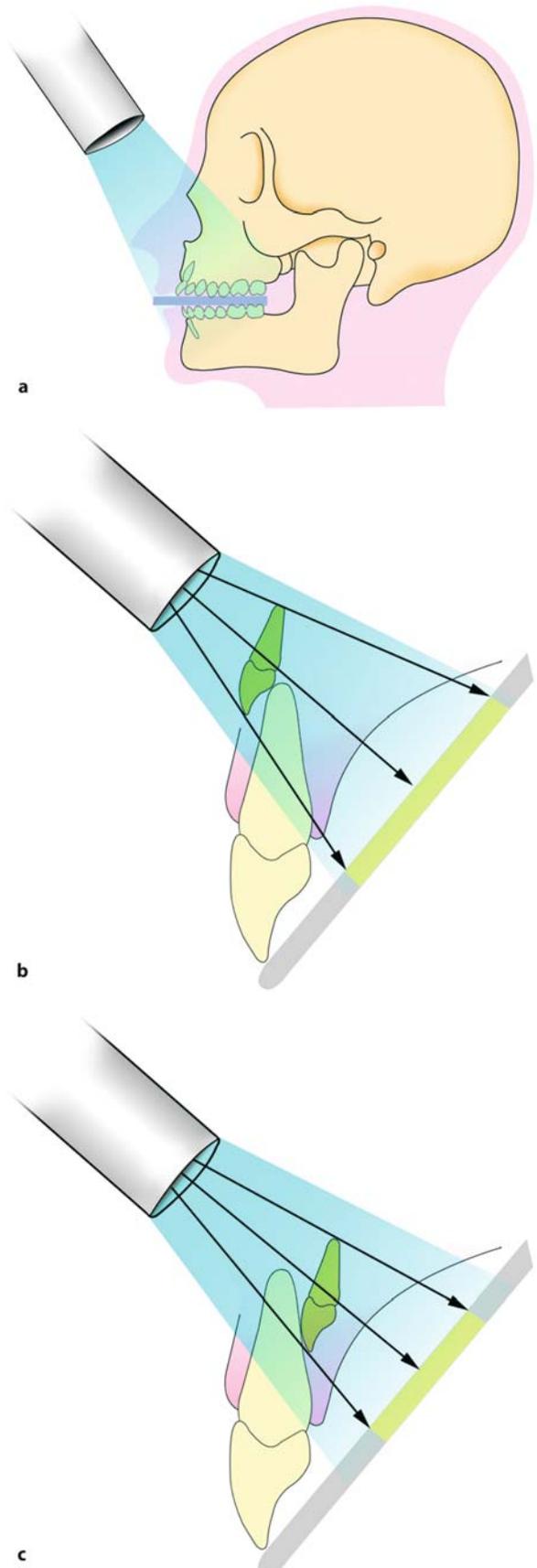
Fig. 2.1 a–c. **a** Positioning x-ray tube and x-ray film for taking a radiograph. **b** The impacted tooth, which is found buccally and further away from the film compared to the tooth in the dentition, is projected magnified. **c** The impacted tooth, which is found palatally and closer to the film compared to the tooth in the dentition, is projected as being a smaller size

2.2
Magnification Technique

This is based on the principle that, given a specific distance between an x-ray film and x-ray tube, the objects further away from the reference structures will be magnified to a greater degree compared to those that are closer to the film (Fig. 2.1a–c).

2.3
Two Radiographs
with Different Reference Planes

Localization with this method is based on taking two radiographs at right angles to each other or two radiographs with different reference planes, not quite at a right angle, but almost. The position of the foreign body in relation to the three dimensions is determined this way.

2.4
Tube Shift Principle

This is based on the following principle: when an observer looks at two objects and starts moving, they will notice that the object further away seems to move in the same direction, while the object closer to the observer seems to move in the opposite direction. Based on this principle, when we have two radiographs with different tube head positions, the impacted tooth will seem to move in the same direction as the tube head

when it is found palatally or lingually, and in the opposite direction compared to the tube head when it is found buccally (Fig. 2.2).

2.5
Vertical Transversal Tomography of the Jaw

This method provides transversal sections or slices of the jaw at the point of interest, thus determining the position of the impacted tooth easily, in relation to the rest of the teeth in the dentition (Fig. 2.3 a, b). Apart from axial (computed) tomography, vertical transversal tomography of the jaw is the only means of obtaining detailed information concerning the size and shape of the mandibular canal and its buccolingual relation to the impacted mandibular tooth. Computed axial tomography for the localization of impacted teeth should be used only if there is no other solution; in other words, rarely, and in exceptional cases, due to the very high doses the patient receives.

The magnification technique is unreliable, with a failure rate of 10%; therefore, its use must be indicative only. The other techniques may be used safely.

The combinations that may be used for radiographs with *different reference planes* are:
- Lateral cephalometric radiograph – anteroposterior cephalometric radiograph (Fig. 2.4 a, b).
- True occlusal radiograph – periapical radiograph (Fig. 2.5 a, b).
- True occlusal radiograph – panoramic radiograph (Fig. 2.6 a, b).
- Panoramic radiograph – lateral cephalometric radiograph (Fig. 2.7 a, b).
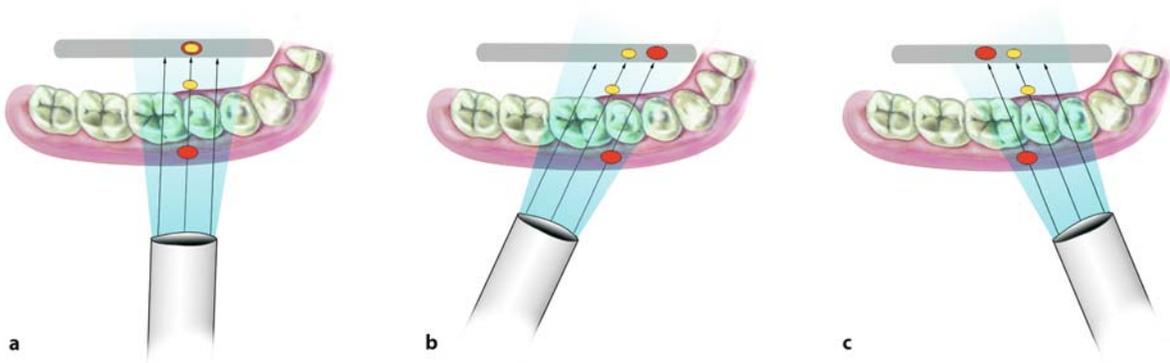
Fig. 2.2 a–c. Diagrammatic illustration of the radiographic method of localizing the buccal or lingual position of impacted teeth. Tooth movement depends on the proximal or distal shifting of the x-ray beam with regard to the initial position of the radiograph (homologous movement: palatal or lingual position, heterologous movement: buccal position)
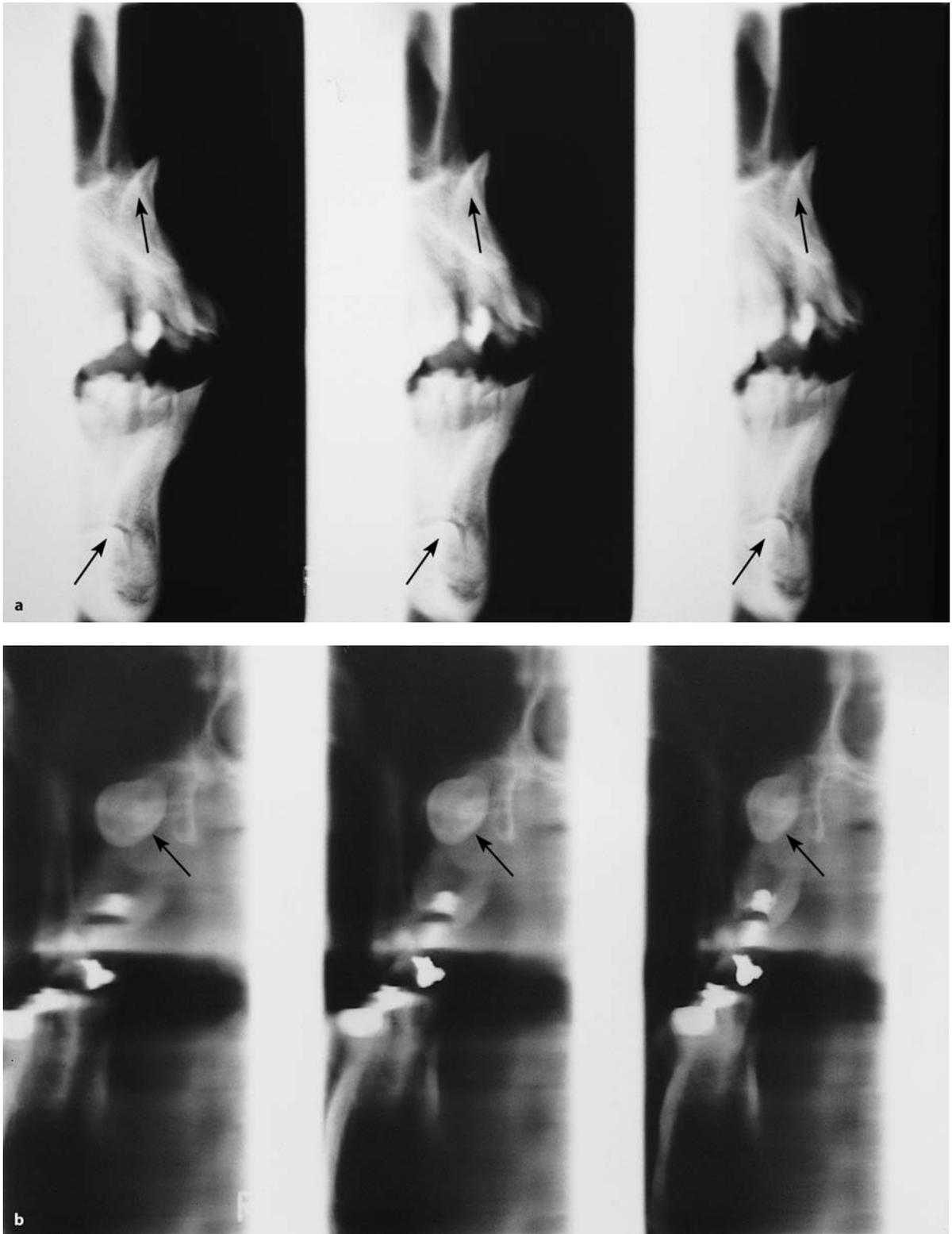
Fig. 2.3 a, b. a Vertical transversal tomography showing the buccal position of an impacted central incisor of the maxilla, as well as the position of the impacted canine of the mandible beneath and buccal to the roots of the anterior teeth. **b** Vertical transversal tomography, showing an impacted third molar buccal to the roots of the second molar

Fig. 2.4 a, b. a Lateral cephalometric radiograph showing a foreign body, whose position is determined on a sagittal and vertical plane. **b** Anteroposterior cephalometric radiograph on which a foreign body is located on a median and vertical plane
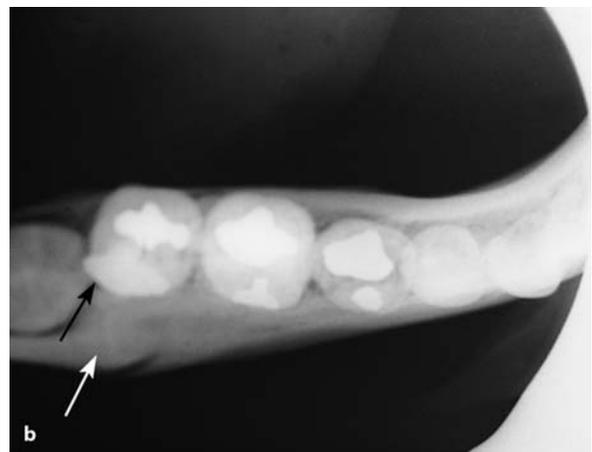
Fig. 2.5 a, b. a Periapical radiograph showing two impacted teeth (premolar and supernumerary). **b** True occlusal radiograph of the same area, showing the buccal position of the impacted premolar and the position of the supernumerary microdont between the impacted tooth and the crown of the second molar
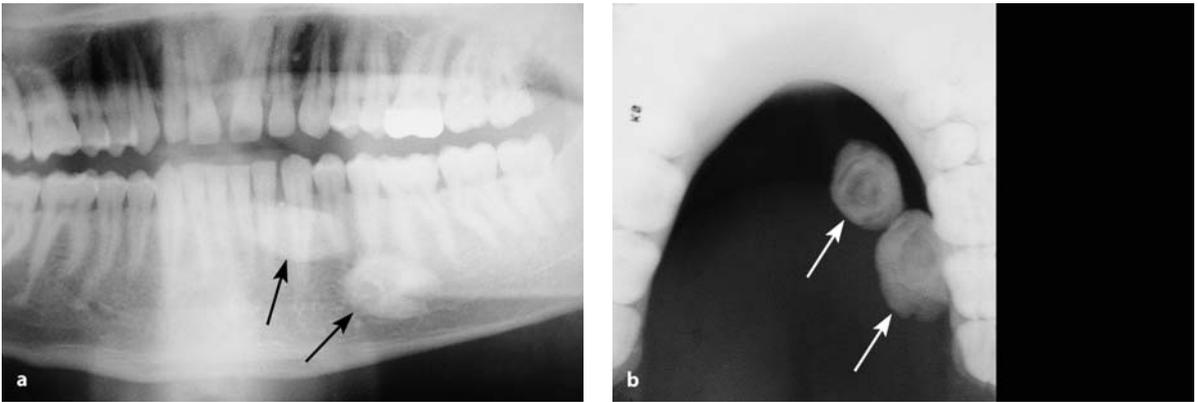
Fig. 2.6 a, b. a Panoramic radiograph showing radiopaque areas in the left side of the body of the mandible. **b** True occlusal radiograph of the mandible of the same case. The radiopacities are located lingually, in the floor of the mouth. These are sialoliths of the duct of the submandibular gland
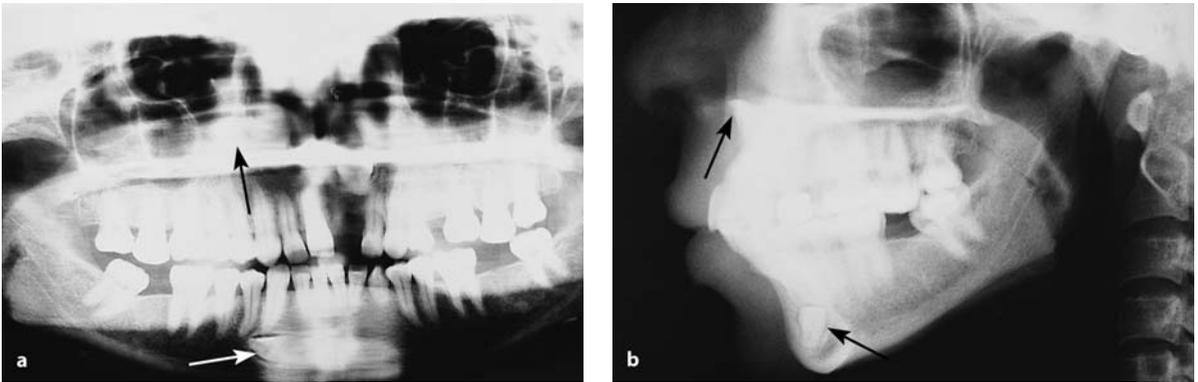
**Fig. 2.7 a, b. a** Panoramic radiograph showing two impacted teeth in the maxilla and mandible. **b** Lateral cephalometric radiograph of the same case. The impacted teeth are found buccal to the anterior teeth, in the respective areas

Fig. 2.8 a, b. a Periapical radiograph of the anterior maxilla. Two impacted supernumerary teeth (normal projection) are observed. **b** Periapical radiograph of the same area, with shifting of the tube to the right of the patient. The impacted teeth seem to move in the same direction as the tube, with the left central incisor used as the reference point. This means that the position of the impacted teeth is palatal

Fig. 2.9 a, b. a Periapical radiograph of the right maxilla, showing impacted canine. **b** Occlusal radiograph of the same area, showing shifting of the impacted tooth upwards with respect to the root of the lateral incisor (heterologous shifting: buccal location of tooth)
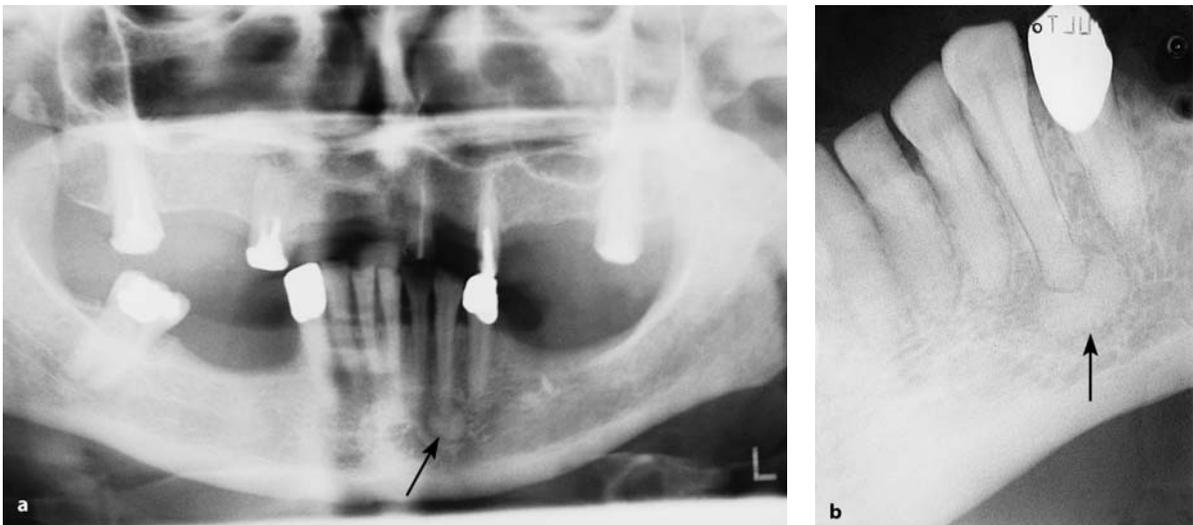
Fig. 2.10 a, b. a Panoramic radiograph showing radiopaque area at the root tip of the lateral incisor of the lower left jaw. **b** Periapical radiograph of the same area. The position of the lesion does not seem to change with respect to the root tip of the lateral incisor. The fact that the lesion does not seem to shift means that it is found exactly underneath the root tip of that particular tooth

The following combinations may be used with radiographs applying the *tube shift principle:*

- Two periapical radiographs with different angles (Fig. 2.8 a, b).
- Periapical radiograph – occlusal radiograph (Fig. 2.9 a, b).
- Periapical radiograph – panoramic radiograph (Fig. 2.10 a, b).
- Occlusal radiograph – panoramic radiograph (Fig. 2.11 a, b).

In order to be able to detect the position of the tooth using the tube shift principle, it is necessary to know the radiograph techniques well, so that combinations of the tube shift technique and the illusory shift of the impacted tooth can be interpreted (Fig. 2.12 a–c). Also, the greater the distance of the impacted teeth from the dentition, the greater the apparent shift in position.

As far as localization is concerned, it is important to use any available existing radiographs, to avoid purposeless irradiation of the patient. That way, together with the radiograph confirming the existence of the impacted tooth, only one more radiograph is required to show the localization of the impacted tooth.
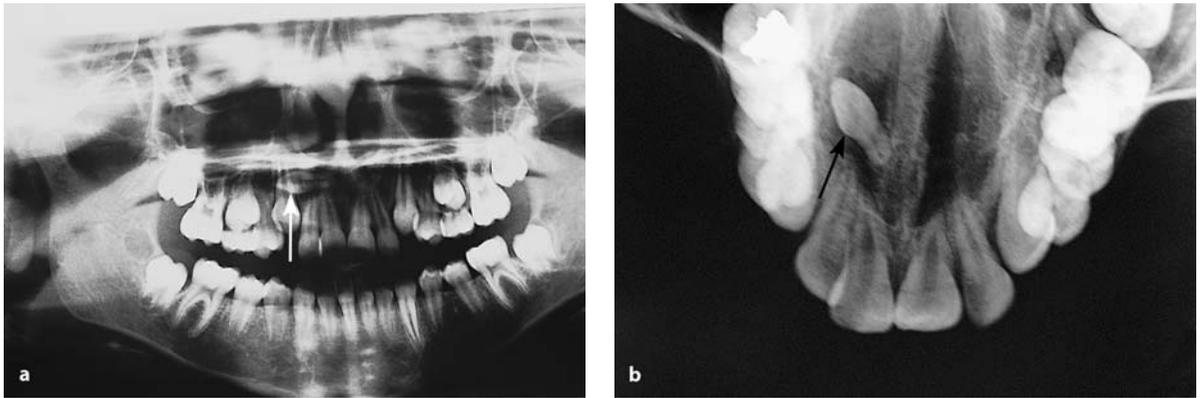
Fig. 2.11 a, b. a Panoramic radiograph showing an impacted tooth in the area of teeth 12–13 of the maxilla. **b** Occlusal radiograph of the same area, showing the shifting of the tooth upwards toward the roots of the lateral incisor and canine (homologous shifting: palatal location of tooth)
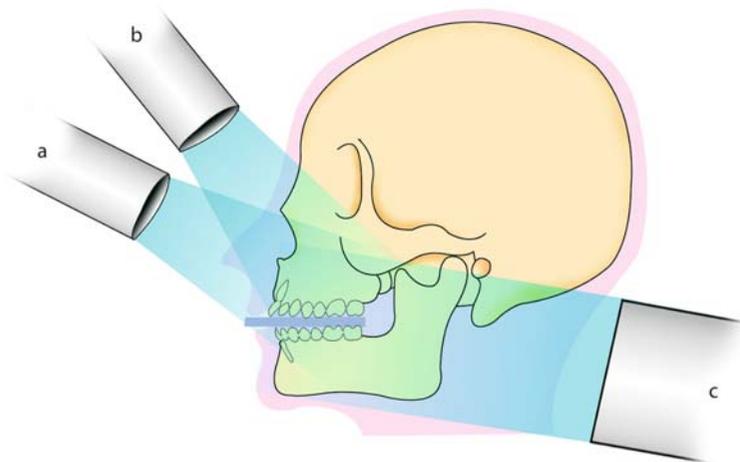
Fig. 2.12. Diagrammatic illustration of the position of the tube during periapical (*a*), occlusal (*b*), and panoramic (*c*) radiographs. These positions demonstrate the shifting of the tube

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Principles of Surgery

3

F. D. Fragiskos

The main concern of the dentist performing surgical procedures involves fundamental principles of surgery, asepsis and antisepsis, to prevent pathogenic microbes from entering the body as well as spread of certain infectious diseases from one patient to another. Sterilization of instruments, as well as preparation of the patient and dentist are therefore considered necessary.

Fig. 3.1. Special metallic container for sterilization of instruments. This container also ensures the maintenance of sterilization

3.1
Sterilization of Instruments

The basic methods used for sterilization of instruments are: dry heat, moist heat (autoclave), chemical means, and sterilization with ethylene oxide.

Sterilization of instruments is achieved in steel trays or the instruments are wrapped in drapes, which are placed either directly in the autoclave or in special metal containers, which have holes so that the steam may pass through during sterilization (Fig. 3.1). After sterilization, the holes of the container are sealed, so that whatever it contains remains sterilized until it is used. Wrapped instruments may also be sterilized with ethylene oxide (Fig. 3.2). This method is often used for plastic or metal instruments that are not heat resistant. Packages containing a full set of instruments necessary for each surgical procedure are considered very practical. The sterilized instruments these packages contain may be sealed and stored for a long period of time (Fig. 3.3). Packages which are opened and from which one or more instruments are removed repeatedly must be resterilized at least once a week.

All instruments and materials that are to be used for the surgical procedure are neatly arranged on the tray of the dental engine or surgery tray, after sterile drapes are placed to cover these surfaces.

Fig. 3.2. Ethylene oxide sterilizer

Fig. 3.3. Sterilized packages with a complete set of instruments necessary for surgery

Fig. 3.4. Covering of patient with sterile drapes

3.2
Preparation of Patient

After the patient is seated in the dental chair, the assistant attends to disinfecting the area to be operated on. The skin around the mouth is first disinfected with gauze impregnated with antiseptic solution, and then the mucosa of the oral cavity is disinfected. The patient is then covered with sterile drapes. Three sterile drapes are required for this, approximately 80 × 80 cm. The first sterile drape is placed on the upper part of the chair (back and headrest), where the patient lies. The second drape is folded in a triangle-shape and is placed on top of the first drape, where the patient will rest their head. The base of the triangle must be facing downwards, where the patient's nape of the neck is, when the patient's head is resting on the chair. The lateral corners of the triangular drape cover the head and are fastened with the aid of a towel clamp at the base of the nose. The third corner is lifted forward, over the scalp hair, and is also fastened at the base of the nose with the same towel clamp. The third drape is spread across the patient's chest, up to the neck, and is fastened at the sides of the triangular drape with two towel clamps, leaving the area of the nose, mouth and inferior border of the mandible exposed (Fig. 3.4).

3.3
Preparation of Surgeon

The preparation of the surgeon is necessary in all surgical procedures and includes the disinfection of hands and appropriate clothing. Before this procedure

Fig. 3.5. Cap covering scalp hair and surgical mask

though, the dentist must have put on shoe covers, a cap covering the hair, and a surgical mask (Fig. 3.5).

The disinfection procedure starts with cleaning the hands with soap. Scrubbing should be restricted to critically contaminated areas. For disinfection alcoholic solutions or alternatively disinfectant soaps are recommended. Depending on the detergent a total time of 3–5 min is recommended. First hands, arms and elbows, than hands and wrists and finally the hands only are disinfected (Fig. 3.6). Care should be taken so that no non-sterile areas above the elbows are touched during this procedure.

Fig. 3.6. Scrubbing up of hands with antiseptic detergent solution

After this procedure, the dentist wears the sterile gown, which is tied by the assistant, and then dons the gloves. The first glove is held by the right hand by the cuff and is placed on the left hand, while the second glove is held by its exterior surface by the gloved hand and is placed on the right (Figs. 3.7, 3.8).

3.4
Surgical Incisions and Flaps

The following fundamental rules apply to every surgical procedure, concerning the incision and flap:

- The incision must be carried out with a firm, continuous stroke, not interrupted strokes. During the incision, the scalpel should be in constant contact with bone. Repeated strokes at the same place, many times, impair wound healing.
- Flap design and incision should be carried out in such a way that injury of anatomic structures is avoided, such as: the mental neurovascular bundle, palatal vessels emerging from the greater palatine foramen and incisive foramen, infraorbital nerve, lingual nerve, submandibular duct, parotid duct, hypoglossal venous plexus, buccal artery (of concern when incision of an abscess of the pterygomandibular space is to be performed), facial nerve

Fig. 3.7. Gloving without an assistant. The first glove is donned on the left hand with the help of the washed right hand, holding it by the cuff

Fig. 3.8. Donning of glove in right hand. Left hand holds exterior of right glove, avoiding contact with skin of right hand

and facial artery and vein, which are of concern basically for the drainage of abscesses performed with extraoral incisions.
- Vertical releasing incisions should begin approximately at the buccal vestibule and end at the interdental papillae of the gingiva.
- Envelope incisions and semilunar incisions, which are used in apicoectomies and removal of root tips, must be at least 0.5 cm from the gingival sulcus.
- The elliptic incision, which is used for the excision of various soft tissue lesions, comprises two convex

incisions joined at an acute angle at each end, while the depth of the incision is such that there is no tension when the wound margins are coapted and sutured.

- The width of the flap must be adequate, so that the operative field is easily accessible, without creating tension and trauma during manipulation.
- The base of the flap must be broader than the free gingival margin, to ensure adequate blood supply and to promote healing.
- The flap itself must be larger than the bone deficit so that the flap margins, when sutured, are resting on intact, healthy bone and not over missing or unhealthy bone, thus preventing flap dehiscence and tearing.
- The mucosa and periosteum must be reflected together. This is achieved (after a deep incision) when the elevator is continuously kept and pressed firmly against the bone.
- When the incision is not made along the gingival sulcus, for esthetic reasons, and especially in people with broad smiles, the scar that will result must be taken into consideration, particularly on the labial surface of the front teeth.
- During the surgical procedure, excessive pulling and crushing or folding of the flap must be avoided, because the blood supply is compromised and healing is delayed.

3.5
Types of Flaps

Various types of flaps have been described in oral surgery, whose name is based mainly upon shape. The basic flap types are: trapezoidal, triangular, envelope, semilunar, flaps created by ⅄ and ✕ incisions, and pedicle flaps.

3.5.1
Trapezoidal Flap

The trapezoidal flap is created after a Π-shaped incision, which is formed by a horizontal incision along the gingivae, and two oblique vertical releasing incisions extending to the buccal vestibule. The vertical releasing incisions always extend to the interdental papilla and never to the center of the labial or buccal surface of the tooth. This ensures the integrity of the gingiva proper, because if the incision were to begin at the center of the tooth, contraction after healing would leave the cervical area of the tooth exposed (Fig. 3.9 a, b). A satisfactory surgical field is ensured when the incision extends at least one or two teeth on either side of the area of bone removal. The fact that the base of the resulting flap is broader than its free gingival margin ensures the necessary adequate blood supply for the healing process. The trapezoidal flap is suitable for extensive surgical procedures, especially when the triangular flap would not provide adequate access.

Advantages. Provides excellent access, allows surgery to be performed on more than one or two teeth, produces no tension in the tissues, allows easy reapproximation of the flap to its original position and hastens the healing process.

**Disadvantages.** Produces a defect in the attached gingiva (recession of gingiva).
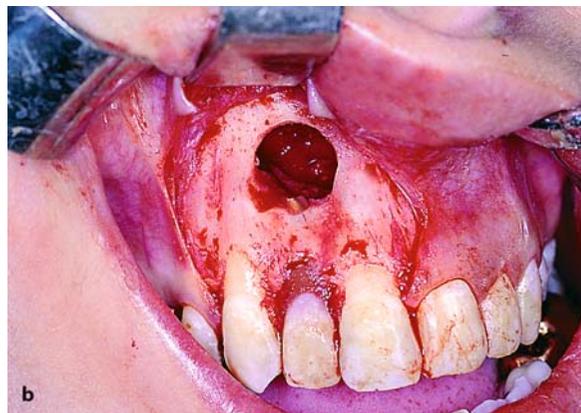
Fig. 3.9 a, b. Trapezoidal flap. **a** Diagrammatic illustration. **b** Clinical photograph. This type of flap is used in large surgical procedures, providing adequate access
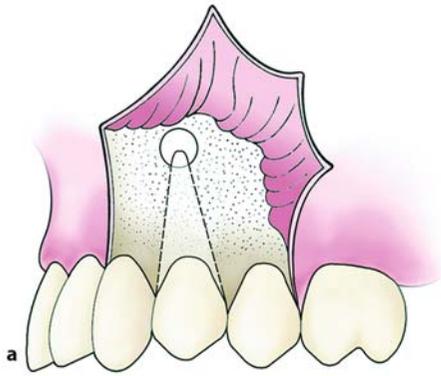
Fig. 3.10 a, b. Triangular flap resulting from L-shaped incision. **a** Diagrammatic illustration. **b** Clinical photograph. Indicated in surgical removal of root tips, small cysts and in apicoectomies
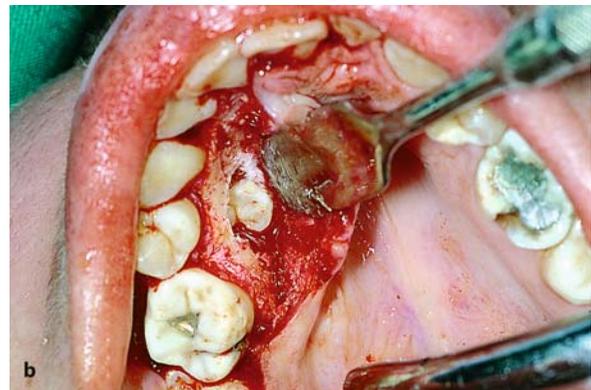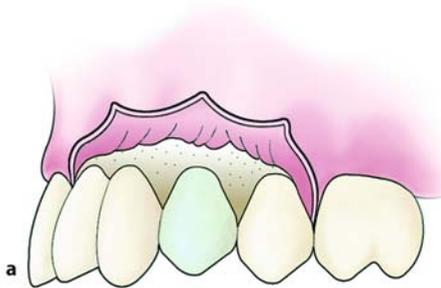
Fig. 3.11 a, b. Single-sided (envelope) flap created by a single horizontal incision along the cervical lines of the teeth. **a** Diagrammatic illustration (buccal). **b** Clinical photograph (palatal). It is primarily used in surgical procedures involv-

ing the cervical region of teeth buccally, and palatally in cases of removal of impacted teeth, as well as apicoectomies (palatal root of molar)

3.5.2
Triangular Flap

This flap is the result of an L-shaped incision (Fig. 3.10 a, b), with a horizontal incision made along the gingival sulcus and a vertical or oblique incision. The vertical incision begins approximately at the vestibular fold and extends to the interdental papilla of the gingiva. The triangular flap is performed labially or buccally on both jaws and is indicated in the surgical removal of root tips, small cysts, and apicoectomies.

Advantages. Ensures an adequate blood supply, satisfactory visualization, very good stability and reapproximation; it is easily modified with a small releasing incision, or an additional vertical incision, or even lengthening of the horizontal incision.

Disadvantages. Limited access to long roots, tension is created when the flap is held with a retractor, and it causes a defect in the attached gingiva.

3.5.3
Envelope Flap

This type of flap is the result of an extended horizontal incision along the cervical lines of the teeth. The incision is made in the gingival sulcus and extends along four or five teeth. The tissue connected to the cervical lines of these teeth and the interdental papillae is thus freed. The envelope flap is used for surgery of incisors, premolars and molars, on the labial or buccal and palatal or lingual surface (Fig. 3.11 a, b), and is usually indicated when the surgical procedure involves the cervical lines of the teeth
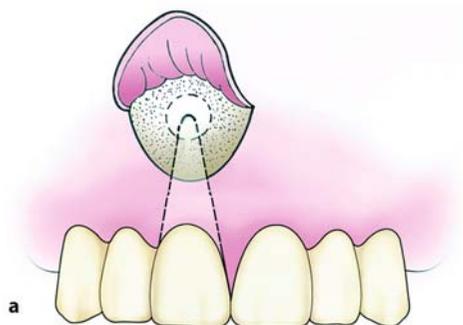
Fig. 3.12 a, b. Semilunar flap. **a** Diagrammatic illustration. **b** Clinical photograph. It is used in apicoectomies and removal of small cysts and root tips

labially (or buccally) and palatally (or lingually), apicoectomy (palatal root), removal of impacted teeth, cysts, etc.

Advantages. Avoidance of vertical incision and easy reapproximation to original position.

Disadvantages. Difficult reflection (mainly palatally), great tension with a risk of the ends tearing, limited visualization in apicoectomies, limited access, possibility of injury of palatal vessels and nerves, defect of attached gingiva.

3.5.4
Semilunar Flap

This flap is the result of a curved incision, which begins just beneath the vestibular fold and has a bowshaped course with the convex part towards the attached gingiva (Fig. 3.12). The lowest point of the incision must be at least 0.5 cm from the gingival margin, so that the blood supply is not compromised. Each end of the incision must extend at least one tooth over on each side of the area of bone removal. The semilunar flap is used in apicoectomies and removal of small cysts and root tips.

Advantages. Small incision and easy reflection, no recession of gingivae around the prosthetic restoration, no intervention at the periodontium, easier oral hygiene compared to other types of flaps.

Disadvantages. Possibility of the incision being performed right over the bone lesion due to miscalculation, scarring mainly in the anterior area, difficulty of

reapproximation and suturing due to absence of specific reference points, limited access and visualization, tendency to tear.

3.5.5
Other Types of Flaps

Other types of flaps are the result of a Y-shaped and an X-shaped incision. These flaps are used in surgical procedures of the palate, mainly for the removal of exostoses (torus palatinus).

Flap Resulting from Y-shaped Incision. An incision is made along the midline of the palate, as well as two anterolateral incisions, which are anterior to the canines (Fig. 3.13 a). This type of flap is indicated in surgical procedures involving the removal of small exostoses.

Flap Resulting from X-shaped Incision. This type of flap is used in larger exostoses, and is basically an extension of the Y-shaped incision (Fig. 3.13 b). The difference is that two more posterolateral incisions are made, which are necessary for adequate access to the surgical field. This flap is designed such that major branches of the greater palatine artery are not severed.

3.5.6
Pedicle Flaps

The three main types of pedicle flaps used for closure of an oroantral communication are: buccal, palatal, and bridge flaps.
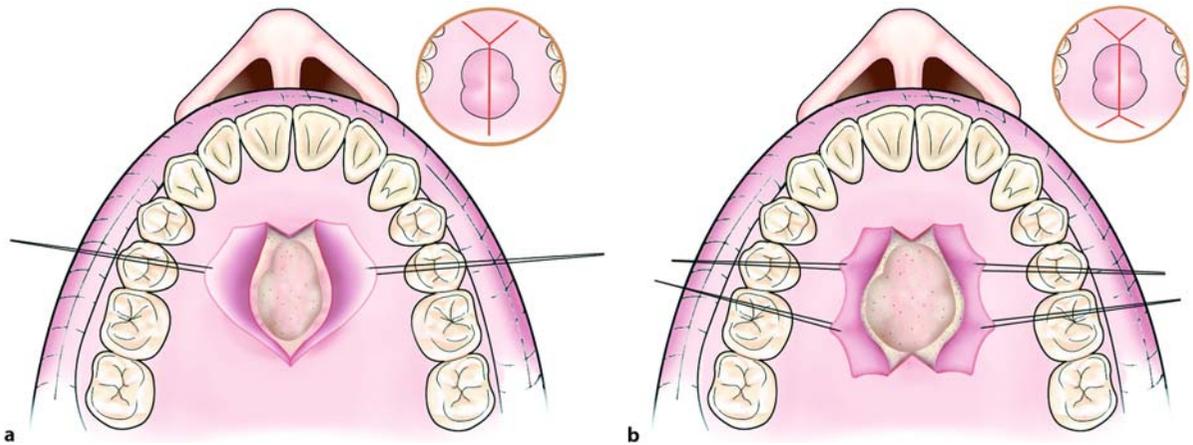
Fig. 3.13 a, b. Flaps created by **a** ⅄-shaped and **b** ⅄-shaped incisions. They are used for the removal of small and large palatal exostoses, respectively
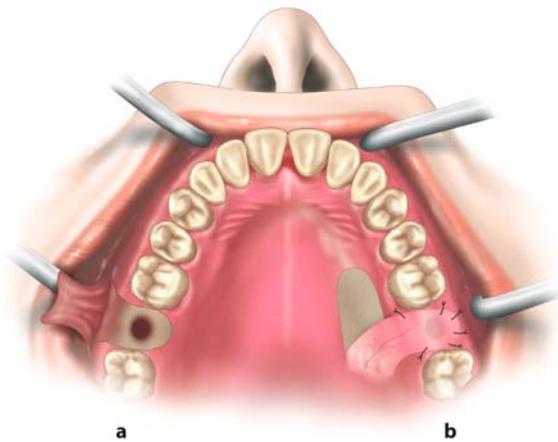

Fig. 3.14 a, b. Pedicle flaps. **a** Buccal. **b** Palatal. These techniques are suitable for closure of oroantral communication
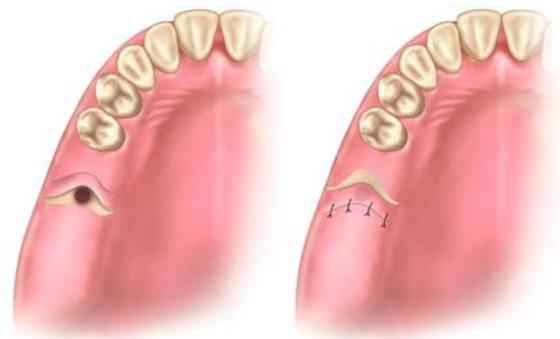
Fig. 3.15. Pedicle bridge flap, used for closure of oroantral communication

Buccal Flap. This is a typical trapezoidal flap created buccally, corresponding to the area which is to be covered, and is usually used on dentulous patients. It is the result of two oblique incisions that diverge upwards, and extend as far as the tooth socket (Fig. 3.14 a). After creating the flap, the periosteum is incised transversally, making it more elastic so that it may cover the orifice that results from the tooth extraction. The oblique buccal flap is a variation of the buccal flap. It is the result of an anteroposterior incision, so that its base is perpendicular to the buccal area, posterior to the wound. The flap is rotated about 70°–80° and is placed over the socket. Both cases require that, before placing the flap, the wound margins must be debrided.

Palatal Flap. This type of flap is used in edentulous patients so that the vestibular depth is maintained.

The resulting palatal mucoperiosteal flap is rotated posteriorly and buccally, always including the vessels that emerge from the corresponding greater palatine foramen (Fig. 3.14 b). After rotation, the flap is placed over the orifice of the socket, the wound margins are debrided, and the flap is sutured with the buccal tissues. A gingival dressing is applied for a few days at the void created and healing is achieved by secondary intention.

Pedicle Bridge Flap. This flap is palatobuccal and is perpendicular to the alveolar ridge (Fig. 3.15). After creation, the flap is rotated posteriorly or anteriorly, to cover the orifice of the oroantral communication, without compromising the vestibular fold. This type of flap is used only on edentulous parts of the alveolar ridge.
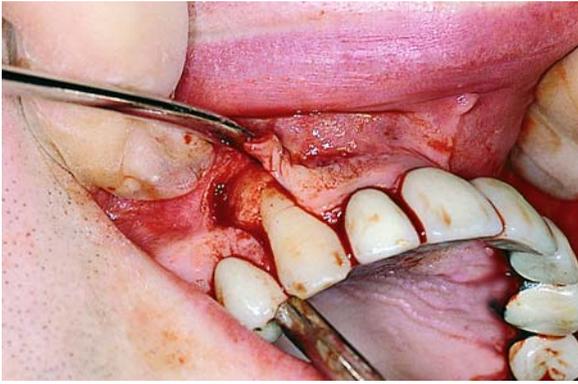
Fig. 3.16. Reflection of the mucoperiosteal flap after incision, with a periosteal elevator, which usually starts from the corner of the horizontal-vertical flap


**Fig. 3.17.** Suturing of wound. Suture is initially wrapped twice around the needle holder

3.6
Reflection of the Mucoperiosteum

Reflection is performed to separate the mucoperiosteal flap from the underlying bone. The elevator is in direct contact with bone and reflection starts at the incision, usually at an angle (Fig. 3.16), and is completed with gentle, steady strokes towards the labial or buccal vestibule, without damaging the tissues. When the attachment between bone and periosteum is strong or if symphysis occurs, then scissors or surgical blades may be used.

Fig. 3.18. The two ends of the suture are tightened to create a surgeon's knot over the wound (double knot)

3.7
Suturing

Suturing of the surgical wound is necessary, aiming at holding a flap over the wound, reapproximating the wound edges, protecting underlying tissues from infection or other irritating factors, and preventing postoperative hemorrhage. Suturing may also aid in the following:

- When hemorrhage is present deep in the tissues and ligation is required or for ligation of a large vessel
- For laceration of soft tissues in general
- In cases of severe hemorrhage where the suture holds the hemostatic plug in place
- For infections, after the incision, for stabilization of the rubber drain at the site of incision
- For immobilization of pedicle flaps in their new position, etc.

Stabilization of sutures is achieved with knots, which may be simple or a surgeon's knot, and are either tied with the fingers of both hands or with the help of the needle holder.

The technique applied for tying knots is as follows: after the needle passes through both wound edges, the suture is pulled, so that the needle-bearing end is longer. Afterwards, the long end of the suture is wrapped around the handle of the needle holder twice (Fig. 3.17). The short end of the suture (which is usually held by the assistant with anatomic forceps) is grasped by the needle holder and pulled through the loops. The suture is then tightened by way of its two ends, thus creating the first double-wrapped knot, which is called a surgeon's knot (Fig. 3.18). The flap is therefore replaced in the desired position. A single-wrap knot is then created, in the counterclockwise direction, which is named a safety knot (Figs. 3.19, 3.20). The
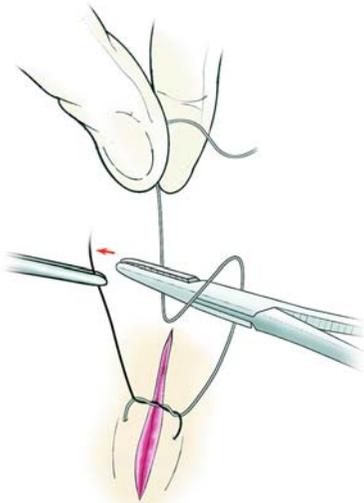
Fig. 3.19. Safety knot, created by the single wrap of the suture in the counterclockwise direction as opposed to Fig. 3.17
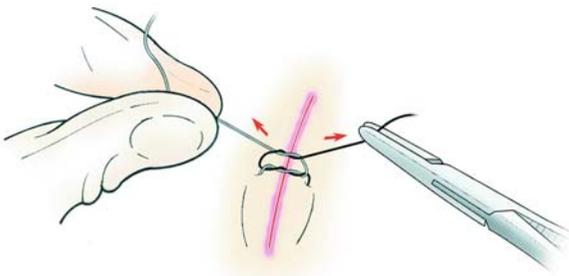

Fig. 3.20. Tightening of the safety knot over the initial surgeon's knot

knot must always be to the side and never on the incision itself. This makes tightening easier, irritates the wound less, and facilitates cutting and removing the suture.

Suturing Techniques

The main sutures used in oral surgery are the interrupted, continuous, and mattress sutures.

Interrupted Suture. This is the simplest and most frequently used type, and may be used in all surgical procedures of the mouth (Fig. 3.21). The needle enters 2–3 mm away from the margin of the flap (mobile tissue) and exits at the same distance on the opposite side. The two ends of the suture are then tied in a knot and are cut 0.8 cm above the knot. To avoid tearing the flap, the needle must pass through the wound margins one at a time, and be at least 0.5 cm away from the edges. Over-tightening of the suture must also be avoided (risk of tissue necrosis), as well as overlapping of wound edges when positioning the knot. The advantage of the interrupted suture is that when sutures are placed in a row, inadvertent loosening of one or even losing one will not influence the rest.

Continuous Suture. This is usually used for the suturing of wounds that are superficial but long, e.g., for recontouring of the alveolar ridge in the maxilla and mandible.

The technique applied is as follows: after passing the needle through both flap margins, an initial knot is made just as in the interrupted suture but only the
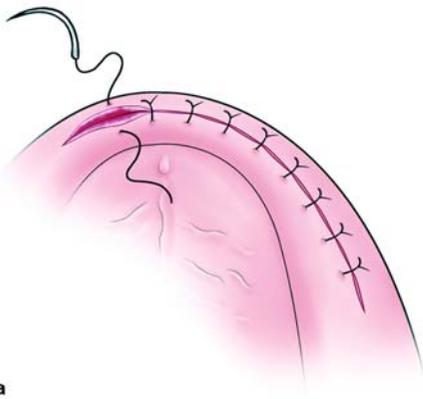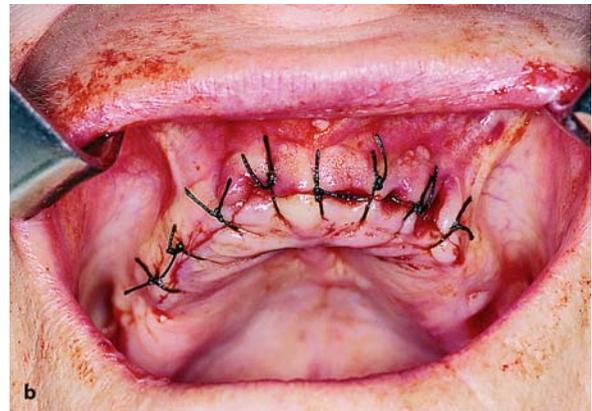
Fig. 3.21 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) of simple interrupted sutures. The distance between the sutures is 0.5 cm. The wound margins must coapt without overlapping
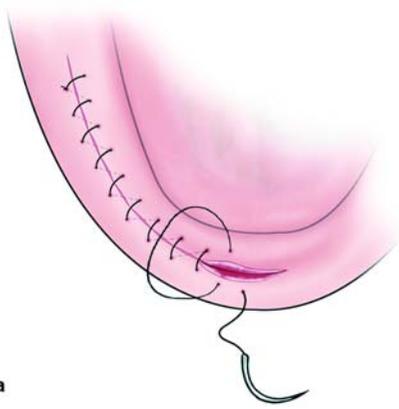
Fig. 3.22 a, b. Continuous simple suture. **a** Diagrammatic illustration. **b** Clinical photograph
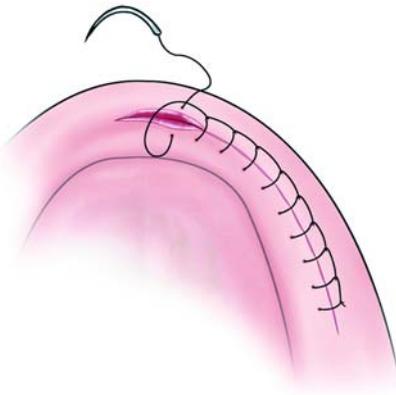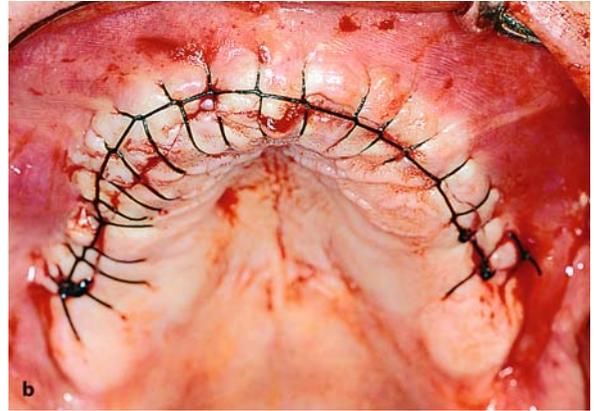

Fig. 3.23 a, b. Continuous locking suture. Wound margin approximation is achieved by successive loops

free end of the suture is cut off. The needle-bearing suture is then used to create successive continuous sutures at the wound margins (Fig. 3.22). The last suture is not tightened, but the loop created actually serves as the free end of the suture. Afterwards, the needle-bearing suture is wrapped around the needle holder twice, which grasps the curved suture (first loop), pulling it through the second loop. The two ends are tightened, thus creating the surgeon's knot.

The continuous locking suture is a variation of the continuous simple suture. This type of suture is created exactly as described above, except that the needle passes through every loop before passing through the tissues, which secures the suture after tightening. Suturing continues with the creation of such loops, which make up parts of a chain along the incision (Fig. 3.23). These loops are positioned on the buccal side of the wound, after being tightened.

The advantage of the continuous suture is that it is quicker and requires fewer knots, so that the wound margins are not tightened too much, thus avoiding the risk of ischemia of the area. Its only disadvantage is that if the suture is inadvertently cut or loosened, the entire suture becomes loose.

Mattress Suture. This is a special type of suture and is described as horizontal (interrupted and continuous) (Figs. 3.24, 3.25) and vertical (Fig. 3.26). It is indicated in cases where strong and secure reapproximation of wound margins is required. The vertical suture may be used for deep incisions, while the horizontal suture is used in cases which require limiting or closure of soft tissues over osseous cavities, e.g., postextraction tooth sockets. Reinforcement of the mattress suture is achieved with insertion of pieces of a rubber drain.

The technique used for the mattress suture is as follows: in the interrupted suture (horizontal and vertical), the needle passes through the wound margins at a right angle, and the needle always enters and exits
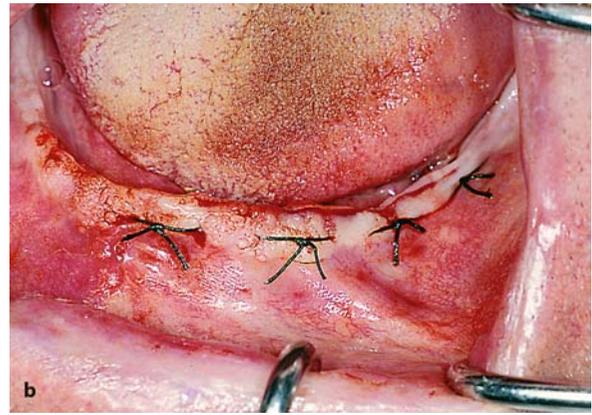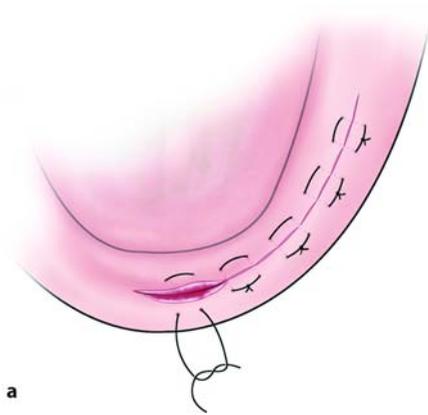
Fig. 3.24 a, b. Horizontal interrupted mattress suture. **a** Diagrammatic illustration. **b** Clinical photograph
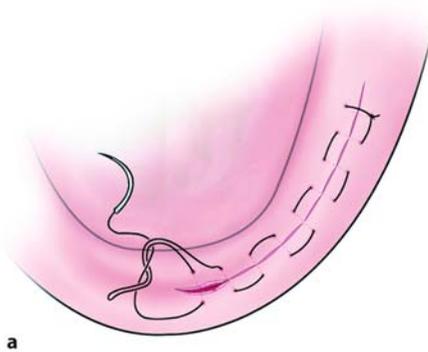
Fig. 3.25 a, b. Horizontal continuous mattress suture. **a** Diagrammatic illustration. **b** Clinical photograph. This type of suture is used where wound margins must coapt tightly (tissues with increased tension)
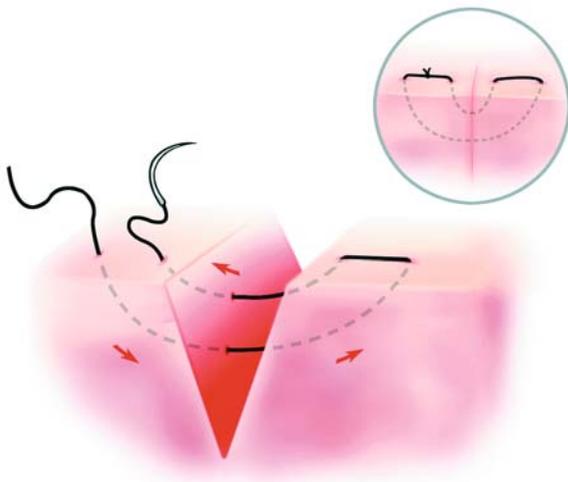

Fig. 3.26. Vertical mattress suture, used for deep incisions

the tissues on the same side. In the horizontal continuous suture, after creating the initial knot, the needle enters and exits the tissues in a winding maze pattern. The final knot is tied in the same fashion as in the continuous simple suture.

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Equipment, Instruments, and Materials

4

F. D. Fragiskos

This chapter describes the necessary armamentarium, that is equipment and instruments, as well as the rest of the materials the dentist may use in oral surgery.

4.1
Surgical Unit and Handpiece

The surgical unit includes the following:
- Surgical micromotor. This is a simple machine with quite satisfactory cutting ability.
- Technologically advanced machines, which function with nitrous dioxide or electricity (Fig. 4.1) and have a much greater cutting ability than the aforementioned micromotor.

The surgical handpiece is attached to the above unit, includes many types, and is manufactured to suit the needs of oral surgery (Fig. 4.2). Its advantages are as follows:
- It functions at high speeds and has great cutting ability.
- It does not emit air into the surgical field.
- It may be sterilized in the autoclave.
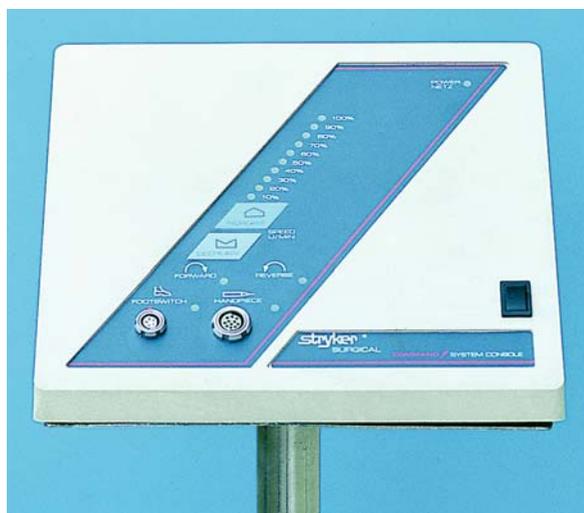
Fig. 4.1. Electric surgical micromotor with adjustable speed

Fig. 4.2. High-speed surgical handpiece

- The handpiece may receive various cutting instruments.

4.2
Bone Burs

The burs used for the removal of bone are the round bur and fissure bur (Fig. 4.3). A large bone bur similar to an acrylic bur may be used when the surgical procedure involves greater bone surface area (torus) or smoothing of bone edges of the wound.

4.3
Scalpel (Handle and Blade)

Handle. The most commonly used handle in oral surgery is the Bard–Parker no. 3. Its tip may receive different types of blades.

Blade. Blades are disposable and are of three different types (nos. 11, 12, and 15) (Fig. 4.4). The most common type of blade is no. 15, which is used for flaps and incisions on edentulous alveolar ridges. Blade no. 12 is indicated for incisions in the gingival sulcus and incisions posterior to the teeth, especially in the maxillary tuberosity area. Blade no. 11 is used for small incisions, such as those used for incising abscesses. The scalpel

Fig. 4.3. Various types of surgical burs

Fig. 4.4. Scalpel and various types of scalpel blades (nos. 11, 12, 15) commonly used in oral surgery
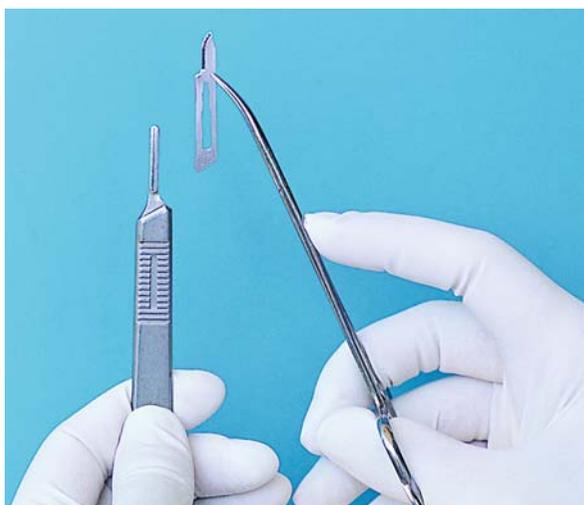
Fig. 4.5. Correct way to load the scalpel blade on the handle of the scalpel
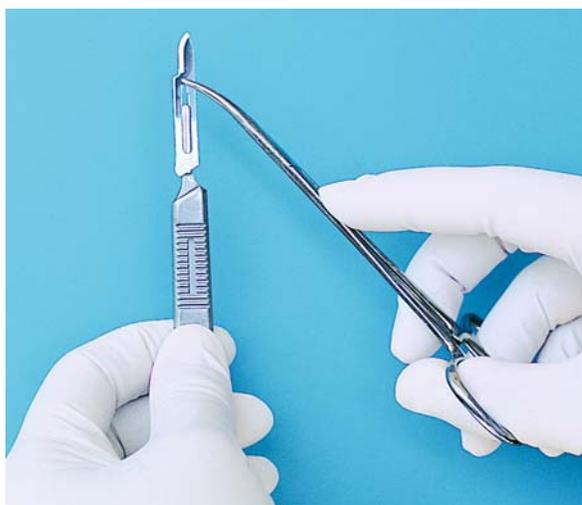
Fig. 4.6. Sliding of scalpel blade, with the male portion of the fitting facing upward, with the aid of a hemostat

blade is placed on the handle with the help of a needle holder, or hemostat, with which it slides into the slotted receiver with the beveled end parallel to that of the handle (Figs. 4.5, 4.6). The scalpel is held in a pen grasp and its cutting edge faces the surface of the skin or mucosa that is to be incised (Fig. 4.7).

Fig. 4.7. Scalpel is held in a pen grasp

4.4
Periosteal Elevator

This instrument has many different types of end (Fig. 4.8). The most commonly used periosteal elevator in intraoral surgery is the no. 9 Molt, which has

two different ends: a pointed end, used for elevating the interdental papillae of the gingiva, and a broad end, which facilitates elevating the mucoperiosteum from the bone. The Freer elevator is used for reflecting the gingiva surrounding the tooth before extraction. This instrument is considered suitable, compared to standard elevators, because it is easy to use and has thin anatomic ends.

The elevator may also be used for holding the flap after reflecting, facilitating manipulations during the surgical procedure. The Seldin elevator is considered most suitable for this purpose.

4.5
Hemostats

The hemostats used in oral surgery are either straight or curved (Fig. 4.9). The most commonly used hemostat is the curved mosquito type or micro-Halsted hemostat, which has relatively small and narrow beaks

Fig. 4.8 a–c. Various types of periosteal elevators. **a** Seldin. **b** Freer. **c** No. 9 Molt

Fig. 4.9 a, b. Micro-Halsted hemostats. **a** Straight. **b** Curved

Fig. 4.10 a, b. Surgical forceps.
a Standard. **b** Adson tissue forceps

Fig. 4.11 a, b. Anatomic dissecting
forceps. **a** Standard. **b** Adson dissecting
forceps

so that they may grasp the vessel and stop bleeding. Hemostats may also be used for firmly holding soft tissue, facilitating manipulations for its removal.

4.6
Surgical – Anatomic Forceps

Surgical forceps are used for suturing the wound, firmly grasping the tissues while the needle is passed. There are two types of forceps: the long standard surgical forceps, used in posterior areas, and the small, narrow Adson forceps, used in anterior areas (Fig. 4.10). The beak of the forceps has a wedge-shaped projection or tooth on one side, and a receptor on the other, which fit into each other when the handles are locked. This mechanism allows the forceps to grasp the soft tissues found between the beaks very tightly. Anatomic forceps (Fig. 4.11) do not have a wedge-shaped projection, but parallel grooves. This type of forceps is used to aid in the suturing of the wound, as well as grasping small instruments, etc., during the surgical procedure.

4.7
Rongeur Forceps

This instrument is used during intraoral surgery as well as afterwards, to remove bone and sharp bone spicules. The ends and sides of the sharp blades become narrow, so that when the handles are pressed, they cut the bone found in between without exerting particular pressure. There is a spring between the handles, which restores the handles to their original position every time pressure is applied for cutting bone. The most practical rongeur in oral surgery is the Luer–Friedmann, because its blades are both end-cutting and side-cutting (Fig. 4.12).

4.8
Bone File

This instrument has two ends: one small end and another with a large surface (Fig. 4.13). The cutting surface is made up of many small parallel blades, which are set in such a way that only pulling is effective. The bone file is used in oral surgery to smooth bone and not to remove large pieces of bone.

Fig. 4.12. Luer–Friedmann rongeur forceps with side-cutting/end-cutting edge

Fig. 4.13. Double-ended bone file with small and large ends
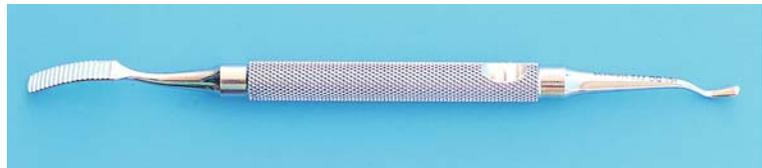
Fig. 4.14 a–c. Surgical mallet and chisels. **a** Partsch monobevel chisel. **b** Lucas chisel with concave end. **c** Lambotte bibevel chisel

4.9
Chisel and Mallet

Mallets are instruments with heavy-weighted ends. The surfaces of the ends are made of lead or of plastic so that some of the shock is absorbed when the mallet strikes the chisel.

The chisels used in oral surgery have different shapes and sizes. Their cutting edges are concave, monobeveled or bibeveled (Fig. 4.14). The bibevel chisel is used for sectioning multi-rooted teeth.

4.10
Needle Holders

Needle holders are used for suturing the wound. The Mayo–Hegar and Mathieu needle holders are considered suitable for this purpose (Fig. 4.15). The first type

Fig. 4.15 a, b. Needle holders.
a Mayo–Hegar needle holder.
**b** Mathieu needle holder
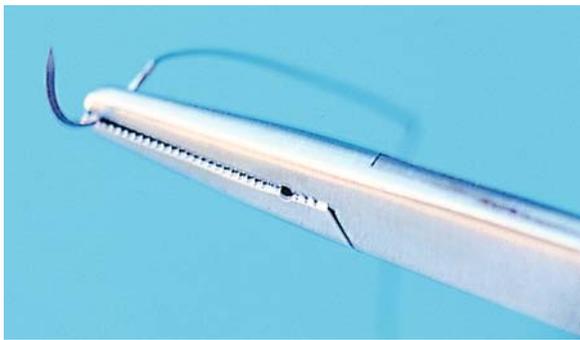
Fig. 4.16. Beak of the needle holder grasps a suture needle. The needle holder's beak face is crosshatched, ensuring stability of the needle during tissue penetration

looks similar to a hemostat and is preferred mainly for intraoral placement of sutures. The hemostat and needle holder have the following differences:

- The short beaks of the hemostat are thinner and longer compared to those of the needle holder.
- On the needle holder, the internal surface of the short beaks is grooved and crosshatched, permitting a firm and stable grasp of the needle (Fig. 4.16), while the short beaks of the hemostat have parallel grooves which are perpendicular to the long axis of the instrument.
- The needle holder can release the needle with simple pressure, because of the gap in the last step of the locking handle, whereas the hemostat requires a special maneuver, because it does not have that gap in the last step of the locking handle.
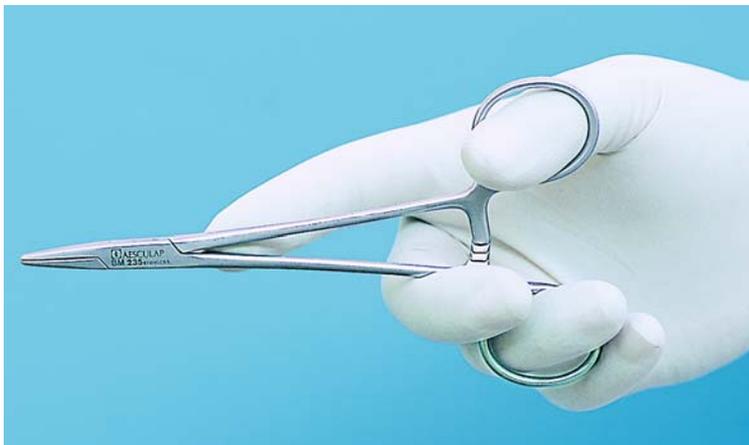
Fig. 4.17. Correct position of the fingers for holding the needle holder

Fig. 4.18 a, b. a Standard suture scissors. **b** Goldman–Fox soft tissue scissors

Fig. 4.19 a, b. a Blunt-nosed Metzenbaum soft tissue scissors. **b** Lagrange soft tissue scissors

The correct way to hold the needle holder is to place the thumb in one ring of the handle and the ring finger in the other. The rest of the fingers are curved around the outside of the rings, while the fingertip of the index finger is placed on the hinge or a little further up, for better control of the instrument (Fig. 4.17).

4.11
Scissors

Various types of scissors are used in oral surgery, depending on the surgical procedure. They belong to the following categories: suture scissors and soft tissue scissors (Figs. 4.18, 4.19). The most commonly used scissors for cutting sutures have sharp cutting edges, while Goldman–Fox, Lagrange (which have slightly upward curved blades), and Metzenbaum are used for soft tissue. Lagrange scissors are narrow scissors with sharp blades and are mainly used for removing excess

Fig. 4.20. Correct way to hold scissors


Fig. 4.21. Towel clamps

gingival tissue, while the Metzenbaum are blunt-nosed scissors and are suitable for dissecting and undermining the mucosa from the underlying soft tissues. Scissors are held the same way as needle holders (Fig. 4.20).

4.12
Towel Clamps

Towel clamps are mainly used for fastening sterile towels and drapes placed on the patient's head and chest, as well as for securing the surgical suction tube and the tube connected to the handpiece with the sterile drape covering the patient's chest (Fig. 4.21).

Fig. 4.22. Farabeuf retractors for retraction of the cheek and mucoperiosteal flap

Fig. 4.23. Kocher–Langenbeck retractors, used in the same way as Farabeuf retractors

Fig. 4.24. Minnesota retractors for retraction of the cheek and tongue

4.13
Retractors

Retractors are used to retract the cheeks and mucoperiosteal flap during the surgical procedure. The most commonly used retractors are Farabeuf, Kocher–Langenbeck, and Minnesota retractors (Figs. 4.22–4.24). Tongue retractors may be used to retract the tongue medially away from the surgical field, facilitating manipulations (Fig. 4.25).

**Fig. 4.25.** Weider retractor for retraction of tongue to the side during surgical procedure

Fig. 4.26. Rubber bite blocks for adults (**a**) and for children (**b**)


Fig. 4.27. Side action adjustable mouth props

4.14
Bite Blocks and Mouth Props

These instruments facilitate opening and keeping the mouth open when the surgical procedure requires this for prolonged periods and when patients cannot fully cooperate with the dentist. The types usually used are rubber bite blocks (Fig. 4.26), and the side action adjustable mouth prop (Fig. 4.27).

Fig. 4.28 a, b. a Fergusson suction tip with wire stylet used as a cleaning instrument. **b** Disposable suction tip

Fig. 4.29 a, b. a Special irrigation system for irrigating the surgical field with a steady stream of saline solution. **b** Regular plastic syringe used for the same purpose

4.15
Surgical Suction

There are a variety of designs and sizes of surgical suctions that are used for removing blood, saliva, and saline solution from the surgical field. Certain types of surgical suctions are designed so that they have several orifices, preventing injury to soft tissues (greatest danger for sublingual mucosa) during the surgical procedure. The standard surgical suction (Fig. 4.28) has a main orifice for suctioning and only one smaller orifice on the handle, for the reasons mentioned above. This orifice is usually covered when rapid suctioning of blood and saline solution from the surgical field is required.

4.16
Irrigation Instruments

Irrigating the surgical field with saline solution during bone removal is necessary and a plastic syringe or a special irrigation system with a steady stream of saline solution may be used for this purpose. In the first case, the syringe used is large, with a blunt needle that is angled (facilitating irrigation especially in posterior areas) with its end cut off so that it does not damage soft tissues. In the second case, the special irrigation system is directly connected to the bottle of saline solution, with a small tube. A knob stops the flow of solution (Fig. 4.29).

Fig. 4.30. Electrosurgical unit with various handpieces

4.17
Electrosurgical Unit

This is an electrical device, providing high-frequency radio waves for cauterization (hemostasis) of the vessels and incision of tissues (Fig. 4.30). Incising tissues with the help of electricity is called electrosurgery. The main parts of the electrosurgical unit are:

- The active electrode, to which the handpiece is usually connected. The end of the handpiece receives a metallic electrosurgical tip for incision or an electrosurgical ball for hemostasis. There are other designs of electrodes as well, such as loops and needles, which may be used according to the needs of the surgical procedure.
- The passive electrode, or ground plate, which is a separate electrode connected to the metallic plate, sized 30 × 20 cm. The metallic plate is placed in direct contact with the naked skin of the patient and is necessary for his or her safety.
- Foot pedal. This usually includes a separate switch for incising tissue and another one for electrocoagulation (hemostasis). On certain units, the handle of the positive cable controls this function.
- Switches. The main switches are: cauterization switch, voltage switch, switch for incising tissue, and a mixed switch for cauterization and incision. The last switch is found only on more modern units and is very useful, because the surgeon may alternately incise and cauterize, so that turning the switch back and forth from one function to the other is avoided.

There are also small portable electrosurgical units that are battery-operated and simple to use. They may be disposable or used more than once, depending on the model (Fig. 4.31).

4.18
Binocular Loupes with Light Source

This system is comprised of binocular loupes, which may be adapted to eyeglass frames or a headband, en-

Fig. 4.31 a, b. Portable electrosurgical units. **a** Disposable. **b** Unit that may be used many times

Fig. 4.32. Binocular loupes with light source, adapted to a headband

Fig. 4.33. Binocular loupes with light source, adapted to eyeglass frames

Fig. 4.34. Maxillary extraction forceps used for the six anterior teeth of the maxilla (superior and side view)
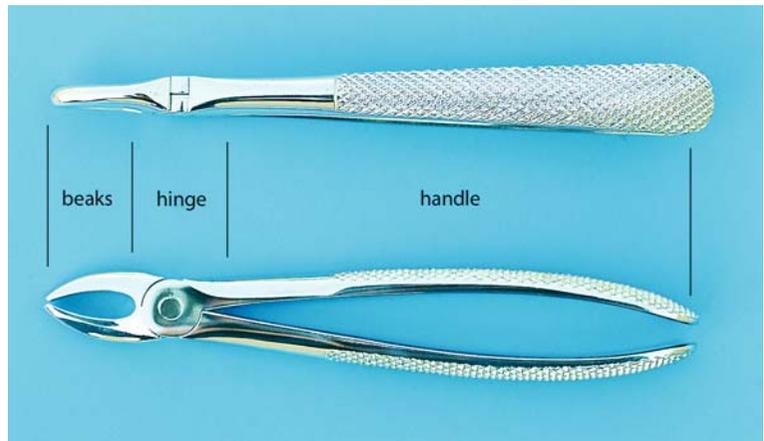
suring good vision of the surgical field (Figs. 4.32, 4.33). This system also has a light source that projects intense light into difficult areas of the surgical field (e.g., posterior teeth), where vision by means of standard lighting is not satisfactory.

4.19
Extraction Forceps

The simple intra-alveolar extraction is accomplished with the help of extraction forceps and elevators. Each extraction forceps is composed of two parts, which are crossed in such a way that they make up one instrument when used to extract a tooth. The basic components of the extraction forceps are the handle, which is above the hinge, and the beaks, which are below the hinge (Fig. 4.34). The instrument is held in the hand by the handle, upon which pressure is exerted during the extraction. The beaks are the functional component of the forceps and grasp the tooth at the cervical region and remove it from the alveolar socket.

Because tooth anatomy varies, extraction forceps with specially designed beaks have been manufactured, so that they may be used for specific teeth. So, according to the size and shape of the handles and beaks, the following types exist.

Maxillary Extraction Forceps for the Six Anterior Teeth of the Maxilla. Beaks that are found on the same level as the handles characterize these forceps, and the beaks are concave and not pointed (Fig. 4.34).

Fig. 4.35. Maxillary universal forceps or no. 150 forceps (mainly used for upper premolars)

Fig. 4.36. Maxillary right molar forceps, for the first and second upper molars of the right side

Fig. 4.37. Maxillary left molar forceps, for the first and second upper molars of the left side

Maxillary Universal Forceps or No. 150 Forceps. The forceps used for premolars have a slightly curved shape and look like an "S." Holding the forceps in the hand, the concave part of the curved part of the handle faces the palm, while the concave part of the beaks is turned upwards. The ends of the beaks of the forceps are concave and are not pointed (Fig. 4.35). These forceps may also be used for extraction of the six anterior teeth of the upper jaw.

Maxillary Molar Forceps, for the First and Second Molar. There are two of these forceps: one for the left and one for the right side. Just like the previously mentioned forceps, they have a slightly curved shape that looks like an "S" (Figs. 4.36, 4.37). The buccal beak of each forceps has a pointed design, which fits into the buccal bifurcation of the two buccal roots, while the palatal beak is concave and fits into the convex surface of the palatal root.

Fig. 4.38. Maxillary third molar forceps

Fig. 4.39. Maxillary root tip forceps

Maxillary Third Molar Forceps. These forceps have a slightly curved shape, just like the aforementioned forceps, and are the longest forceps, due to the posterior position of the third molar (Fig. 4.38). Because this tooth varies in shape and size, the beaks of the forceps are concave and smooth (without pointed ends), so that these forceps may be used for extraction of both the left and right third molar of the upper jaw.

Maxillary Cowhorn Molar Forceps. The upper cowhorn forceps are a variation of the maxillary molar forceps. The beaks of this type of forceps have sharply pointed ends, which fit into the trifurcation of the roots of the molars. They are primarily used for extraction of teeth with severely decayed crowns, because when they are used to extract intact teeth, they may fracture the buccal alveolar bone due to the large amount of force they generate.

Maxillary Root Tip Forceps. The handles of the root tip forceps are straight, while the beaks are narrow and angle-shaped. The ends of the beaks are concave and without a pointed design (Fig. 4.39).

Mandibular Forceps for Anterior Teeth and Premolars or Mandibular Universal Forceps or No. 151 Forceps. Unlike the maxillary forceps, the beaks and handles of these forceps face the same direction, creating an arch. When the forceps are held in the hand, the concave part of the arch of the handles faces the palm, while the beaks obviously face downward. The ends of the beaks are concave, without pointed ends (Fig. 4.40). The no. 151 forceps are used for extraction of the six anterior teeth and the four premolars of the lower jaw.

Mandibular Molar Forceps. These forceps are used for both sides of the jaw and have straight handles while the beaks are curved at approximately a right angle compared to the handles. Both beaks of the forceps have pointed ends, which fit into the bifurcation of the roots buccally and lingually (Fig. 4.41). These forceps are used for the removal of both the first and second molar of the right and left side of the lower jaw.

Fig. 4.40. Mandibular forceps for anterior teeth and premolars of the mandible or mandibular universal forceps or no. 151 forceps


Fig. 4.41. Mandibular molar forceps

Fig. 4.42. Mandibular third molar forceps

Mandibular Third Molar Forceps. These forceps also have straight handles, while the beaks, just like those of the first and second molar forceps, are curved at a right angle compared to the handles. The beaks are a little longer compared to the previous forceps, due to the posterior position of the third molar in the dental arch (Fig. 4.42). Because this tooth varies in size and shape and because there is usually no root bifurcation, the ends of the beaks of the forceps are concave without a pointed design.

Mandibular Cowhorn Molar Forceps. The lower cowhorn forceps or no. 23 forceps are a variation of the mandibular molar forceps (Fig. 4.43). In comparison to the standard forceps, the beaks have a semicircular shape with sharply pointed ends so that they can fit into the bifurcation of the roots and firmly grasp the tooth (Fig. 4.44). Owing to the function of these forceps, tooth extraction may be achieved quite easily as long as the roots are not curved. With the beaks of the forceps grasping the crown of the molar and the

Fig. 4.43. Mandibular cowhorn molar forceps for sectioning roots. They are used for extracting molars with intact crowns, and also when only sectioning of roots is necessary

Fig. 4.44. Mandibular cowhorn forceps adapted to molars

Fig. 4.45. English-style forceps with the hinge in the vertical direction
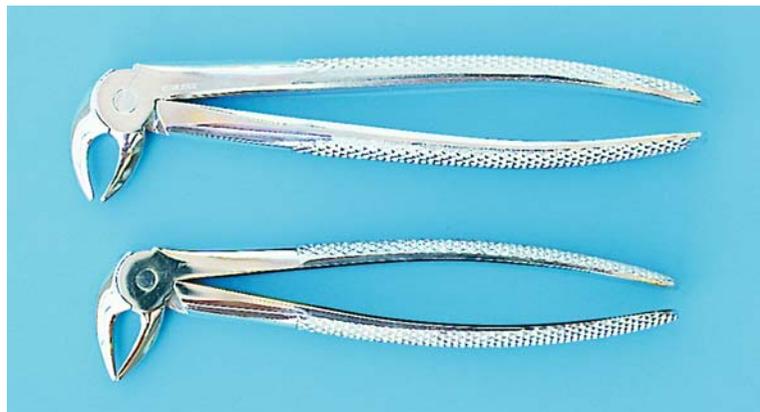
sharp ends fitting into the root bifurcation, the surgeon squeezes the handles and, using small buccolingual movements, slides the tooth out of the socket. Also, the cowhorn forceps are very useful for sectioning roots of posterior teeth in the lower jaw, when their crowns are severely decayed. After grasping the roots, the teeth are easily sectioned after applying pressure at the bifurcation point.

Vertical Hinge Forceps. These English-style forceps differ from the aforementioned forceps in that their hinges have a vertical direction (Fig. 4.45). Their use is limited, because large amounts of force can be generated during extraction with this type of forceps, so that if the bone is not elastic, there is increased risk of fracture of the alveolar bone.

Fig. 4.46. Mandibular root tip forceps

Mandibular Root Tip Forceps. The handles of the root tip forceps are straight, while the beaks are curved at a right angle. Their ends are very narrow and meet at the tip when the forceps are closed (Fig. 4.46).

4.20
Elevators

The elevator is the second most important instrument (after the extraction forceps) with which tooth extraction is achieved or aided. It is composed of three parts: the handle, the shank, and the blade. The shape of blade differs for each elevator type, and each is used as the need dictates. There are three main types of elevators used today in oral surgery: the straight elevator, the pair of elevators with T-shaped or crossbar handles, and the pair of double-angled elevators.

Straight Elevator. This is the most commonly used type of elevator for the removal of teeth and roots, in both the upper and lower jaws (Figs. 4.47, 4.48). As already mentioned, the elevator's components are the handle, shank, and blade. The handle is pear-shaped, and big enough to be held comfortably in the hand for the surgeon to apply pressure to the tooth to be luxated. The shank is narrow and long and connects the handle to the blade. The blade has two surfaces: a convex and a concave one. The concave surface is placed buccally, either perpendicular to the tooth or at an angle, and always in contact with the tooth to be luxated. The elevator is held in the dominant hand, and the index finger is placed along the blade almost reaching its end. The end of the blade is left exposed and is seated between the socket and the tooth to be luxated.

**Pair of Elevators with T-shaped or Crossbar Handles.** This type of elevator (Fig. 4.49) is used only in the lower jaw for removal of a root of a molar, after the other root has already been removed with the straight elevator. Each of these elevators is composed of the handle, shank, and blade. The shank is connected to the middle of the handle, giving the elevator a T-shaped appearance, while the connection of the shank to the blade is angled, and the blade end is sharp-tipped. The blades on this pair of elevators face in opposite directions, and the appropriate one is used according to the root that has to be removed. One elevator is used to remove the mesial root, and the other for the distal root, for each side of the lower jaw. Angled Seldin elevators are a variation of the elevators with T-shaped handles (Fig. 4.50).

In certain cases, the T-shaped elevator may be used to remove a whole third molar of the lower jaw. The tip of the elevator is placed into the root bifurcation buccal to the tooth, using the external oblique ridge as a fulcrum.

Pair of Double-Angled Elevators. Double-angled elevators are mainly used to remove root tips in both jaws. They are also very useful instruments for the extraction of impacted third molars of the upper jaw (Fig. 4.51). Their handle is similar to that of the straight elevator. The shank has a double angle, so that the instrument may enter the socket, and the two elevators face in opposite directions. The blade has a convex and concave surface, ending in a sharp point. There are also double-angled elevators with narrow blades and very sharp ends, which may easily remove small broken root tips.

Fig. 4.47. Straight Bein elevator

Fig. 4.48. Straight White elevator with slightly curved blade, suitable for extracting posterior maxillary teeth

**Fig. 4.49.** Pair of elevators with crossbar or T-shaped handles

Fig. 4.50. Pair of angled Seldin elevators suitable for extracting roots in the mandible

Fig. 4.51. Pair of double-angled elevators

Fig. 4.52 a, b. Chompret elevators; **a** straight, and **b** curved

Fig. 4.53. Sharp-tipped angled elevators suitable for removal of root tips

4.21
Other Types of Elevators

Straight Chompret Elevator. The narrow blade of this instrument means that this type of elevator may also be used as a straight elevator (Fig. 4.52 a). The straight Chompret elevator may only be used this way

when the width of the straight elevator blade prevents its correct placement for the luxation of the tooth or root.

Curved Chompret Elevator (Fig. 4.52 b) and **Double-angled Elevators with Narrow Blades and Sharp-Tipped Ends** (Fig. 4.53). These instruments are used by the dentist as the need dictates.

Fig. 4.54 a, b. a Special instrument for removing roots below the margin of alveolar bone. **b** Bur for widening the root canal

Fig. 4.55. Periapical curettes with ends of different sizes
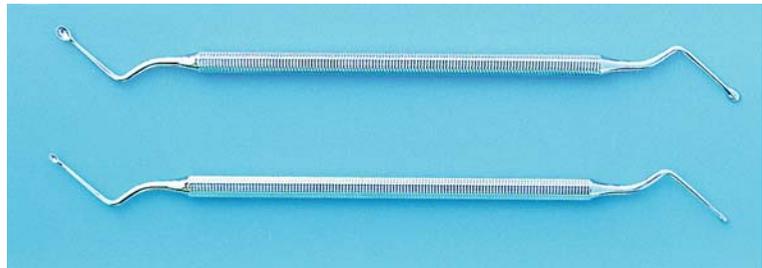
Fig. 4.56 a, b. Desmotomes. **a** Straight. **b** Curved

4.22
Special Instrument for Removal of Roots

The instrument in Fig. 4.54 is used to remove broken roots found below the alveolar crest. The spiral end of the instrument is placed inside the extraction socket, and, after screwing the instrument into the root canal of the broken root, traction is used to remove the root from the socket (see Chap. 5).

4.23
Periapical Curettes

These are angled double-ended, spoon-shaped instruments (Fig. 4.55). The most commonly such used instrument is the periapical curette, whose shape facilitates its entry into bone defects and extraction sockets. The main use of this instrument is the removal of granulation tissue, small cysts, bone chips, foreign bodies, etc.

4.24
Desmotomes

These instruments are used to sever the soft tissue attachment, and are either straight or curved (Fig. 4.56 a, b). The straight desmotome is used for the anterior teeth of the upper jaw and the curved desmotome for the rest of the teeth of the upper jaw as well as all of the teeth of the lower jaw.

Fig. 4.57. Set of instruments necessary for simple tooth extraction

Fig. 4.58. Set of instruments necessary for surgical tooth extraction

4.25
Sets of Necessary Instruments

For practical reasons, sterilized and packaged full sets of instruments for the most common surgical procedures must always be available. These sets include:

a. Set for simple tooth extraction (Fig. 4.57)[1]:
  1. Local anesthesia syringe, needle, and ampule.
  2. Desmotome or Freer elevator.
  3. Retractor or mouth mirror.
  4. Extraction forceps
     (depending on the tooth to be removed).

  5. Surgical or anatomic forceps.
  6. Elevators.
  7. Sterile gauze.
  8. Periapical curette.
  9. Suction tip.
  10. Towel clamp.
  11. Needle holder.

b. Set for surgical tooth extraction (Fig. 4.58):
  1. Local anesthesia syringe, needle, and ampule.
  2. Scalpel and blade.
  3. Periosteal elevators.
  4. Elevators.
  5. Bone chisel.
  6. Mallet.
  7. Rongeur forceps.
  8. Bone file.
  9. Periapical curette.
  10. Bone burs.
  11. Hemostat.

---

1) Disposable materials (e.g., needles for anesthesia, gauze, sutures, etc.) shown in Figs. 4.57–4.60 are not included in the set at the time of sterilization. These are usually placed on the surgery tray afterwards together with the rest of the instruments.

Fig. 4.59. Set of instruments necessary for soft tissue specimen sampling by biopsy

Fig. 4.60. Set of instruments necessary for incision and drainage of abscesses

12. Retractors.
13. Needle holder.
14. Surgical forceps and anatomic forceps.
15. Scissors.
16. Towel clamps.
17. Disposable plastic syringe.
18. Suction tip.
19. Straight handpiece.
20. Bowl for saline solution.
21. Sutures.
22. Sterile gauze.

c. Set of instruments for surgical biopsy
   (bone and soft tissue) (Fig. 4.59):
   1. Local anesthesia syringe, needle, and ampule.
   2. Scalpel and blade.
   3. Periosteal elevator.
   4. Scissors.
   5. Surgical forceps and anatomic forceps.
   6. Periapical curette.
   7. Needle holder.

8. Hemostats.
9. Rongeur forceps.
10. Towel clamps.
11. Suction tip.
12. Sutures.
13. Sterile gauze.
14. Retractors.

d. Set of instruments for incision and drainage
   of abscess (Fig. 4.60):
   1. Local anesthesia syringe, needle, and ampule.
   2. Scalpel and blade.
   3. Hemostats.
   4. Surgical and anatomic forceps.
   5. Scissors.
   6. Needle holder.
   7. Suction tip.
   8. Towel clamps.
   9. Sutures.
   10. Sterilized Penrose rubber drain 1/4 in.
   11. Sterile gauze.

Fig. 4.62. Nonresorbable surgical sutures made of silk

Fig. 4.61 a, b. Different types of resorbable sutures made from gut tissue and synthetic material

4.26
Sutures

Great progress in sutures has been made since 1865, when disinfection and sterilization first started being used in surgery. There is a big variety in the size of surgical sutures available today, and two basic categories: (1) resorbable, and (2) nonresorbable sutures.

Resorbable Sutures. These sutures are resorbed after a certain time, which usually coincides with healing of the wound. These sutures are made of gut or vital tissue (catgut, collagen, fascia, etc.) and are plain or chromic, or of synthetic material, e.g., polyglycolic acid (Dexon) (Fig. 4.61). Plain catgut sutures are resorbed postsurgically over 8 days, chromic sutures in 12–15 days, and synthetic (Dexon) sutures in approximately 30 days. These types of sutures are used for flaps with little tension, children, mentally handicapped patients, and generally for patients who cannot return to the clinic to have the sutures removed.

Nonresorbable Sutures. These sutures remain in the tissues and are not resorbed, but have to be cut and removed about 7 days after their placement. They are fabricated of various natural materials, mainly surgical silk (monofilamentous or multifilamentous, in many diameters and lengths) and surgical cotton suture. Silk sutures are the easiest to use and the most economical, and have a satisfactory ability to hold a knot (Fig. 4.62).

The most commonly used suture sizes are 4–0 and 3–0 for resorbable sutures, and 3–0 and 2–0 for nonresorbable sutures. These kinds of sutures are sold in sterilized packages with pre-attached atraumatic needles or in bundles without needles.
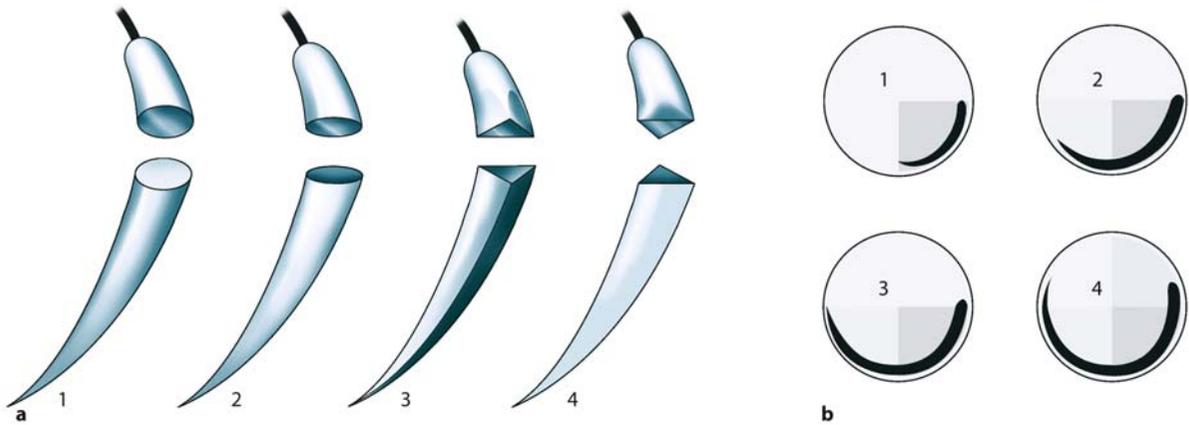
Fig. 4.63 a, b. Cross-sectional view of needles. **a** Round tapered (*1*), oval tapered (*2*), cutting (*3*, triangular with one of the three cutting edges on the inside of the semicircle), reverse-cutting (*4*, triangular with two cutting edges on the inside of the semi-circle). **b** Size of needle compared to regular circle: one-quarter of a circle (*1*), three-eighths of a circle (*2*), half a circle (*3*), three-quarters of a circle (*4*)

4.27
Needles

A variety of needles are available in oral surgery, and they may differ in shape, diameter, cross-sectional view, and size (Fig. 4.63). They are usually made of stainless steel, which is a strong and flexible material. The needles preferred by surgeons today are *atraumatic disposable needles* with pre-attached sutures on their posterior ends. *Needles that may be used and sterilized many times* are also available, with an eye or groove in the needle, through which the suture is passed.

Needles with Round or Oval Cross-Sectional View. These are considered atraumatic and are mainly used for suturing thin mucosa. Their disadvantage is that great pressure is required when passing through the tissues, which may make suturing the wound harder.

Triangular Needles. These needles have sharp cutting edges and are preferred for suturing thicker tissues. When they are used for thin mucosa, care is required because they may tear the tissues. The most suitable needles are semicircular or three-eighths of a circle and 19–20 mm long, in both cases.

4.28
Local Hemostatic Drugs

These drugs are suitable only for local use and can stop heavy bleeding, which is due to injury of capillaries or arterioles. The main hemostatic drugs are listed below.

Fig. 4.64. Hemostatic powder suitable for stopping capillary bleeding

Alginic Acid. This is sold in powder form in special 5-mg packages (Fig. 4.64). It is placed on the bleeding surface, creating a protective membrane that applies pressure to the capillaries and helps hold the blood clot in place.

Natural Collagen Sponge. This is a white sponge material, nonantigenic and fully absorbable (Fig. 4.65). Its hemostatic ability is due to promotion of platelet aggregation. Also, it activates coagulation factors XI and XIII. It is used for patients who are prone to hemorrhage after dental surgical procedures.

Fig. 4.65. Absorbable hemostatic natural collagen sponges. These are indicated in cases of postextraction bleeding

Fig. 4.66. Gelatin sponges. These are used to treat postextraction bleeding

Fibrin Sponge. The fibrin sponge is nonantigenic, and is prepared from bovine material that has been processed in order to avoid allergic reactions. It is used locally in the bleeding area and especially in the postextraction socket. It promotes coagulation, creating a normal hemostatic blood clot, but it also functions as a plug over the edges of the bleeding area. The fibrin sponge is fully absorbed by the tissues within 4–6 weeks.

Gelatin Sponge. This is a relatively spongy material, nonantigenic and fully absorbable (Fig. 4.66). Its hemostatic action and application are the same as that of the fibrin sponge.

Oxidized Cellulose. This is an absorbable hemostatic material, which is manufactured by controlled oxidation of cellulose by nitrous dioxide. It is available in gauze form or pellet form (Fig. 4.67). It is used topically as a hemostatic material, because it releases cytotoxic acid, which has significant affinity for hemoglobin. Its attachment to the walls of the postextraction socket for the treatment of bleeding is quite satisfactory and therefore it is considered superior to various other hemostatic sponges, which have a tendency to expel the material from the socket.

Bone Wax. Bone wax is a sterilized, nonabsorbable mix of waxes, and is composed of white beeswax, paraffin wax, and an isopropyl ester of palmitic acid

Fig. 4.67. Oxidized cellulose in pellet form

(Fig. 4.68). It is white and available as a solid rectangular plate weighing 2.5 g. It is used to control bleeding that originates in bone or chipped edges of bone. Before its application, bone wax is first warmed with the fingers, so that the desirable consistency is reached. Its hemostatic action is brought about through mechanical obstruction of the osseous cavity, which contains the bleeding vessels.

Fig. 4.68. Surgical bone wax for treatment of bone hemorrhage

Fig. 4.70. Iodoform gauze for the treatment of fibrinolytic alveolitis (dry socket)

Fig. 4.69. Petrolatum (Vaseline®) gauze in a sterile container

Fig. 4.71. Surgical gingival dressing for protection of an exposed postoperative field, until healing by secondary intention occurs

4.29
Materials for Covering or Filling a Surgical Wound

Petrolatum Gauze. Petrolatum (Vaseline®) gauze is available in sterilized packages and is used mainly for covering exposed wounds, for tamponade of bone cavities after marsupialization of cysts, for surgical procedures in the maxillary sinus, etc. Before its application, the excess petrolatum must be removed and the gauze saturated with antibiotic ointment (oxytetracycline) (Fig. 4.69), if deemed necessary.

Iodoform Gauze. This gauze has antiseptic, analgesic and hemostatic properties. Its indications for use are the same as for petrolatum gauze, although it may remain in place for longer. The iodoform gauze is also available in small-sized packages (Fig. 4.70), for the treatment of dry socket.

Surgical Dressing. This is an autopolymerized putty-like paste, available in sterilized packaging. It is used in periodontology and oral surgery as a temporary protective covering of intraoral wounds after surgical procedures (Figs. 4.71, 4.72).
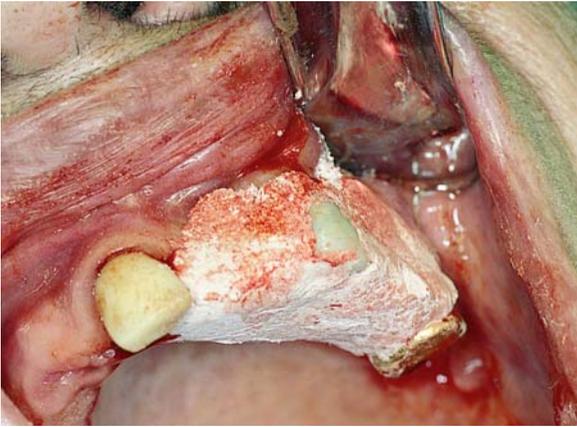
Fig. 4.72. Clinical photograph showing closure of the operative field with surgical dressing

4.30
Materials for Tissue Regeneration

Sometimes during surgical procedures (removal of cysts, extraction of impacted teeth, etc.) large bony defects are created, which cause problems associated with esthetics, function, and the healing process, or they may even affect the stability of the jaw bone. Recently, application of a variety of materials in oral surgery to the area around these bony defects aids bone regeneration and eliminates the defect or limits its size. These materials may also prove useful in the regeneration of periodontal tissues, for the filling of bone defects around an implant, or for augmentation of a deficient alveolar ridge, etc. The most commonly used such materials are membranes and bone grafts.

Membranes. These may be absorbable or nonabsorbable. Synthetic polymer and collagen membranes are absorbable (Fig. 4.73a). Nonabsorbable membranes include those reinforced with titanium, as well as metallic titanium network membranes. The main disadvantage of nonabsorbable membranes is the need to perform a second surgical procedure for their removal.

Bone Grafts. These belong to four categories:
1. Autografts, which are composed of tissues from the actual patient.
2. Allografts, which are composed of tissues from another individual.
3. Heterografts, which are composed of tissues from various animals (Fig. 4.74).

Fig. 4.73 a, b. **a** Absorbable collagen membrane used for guided bone regeneration. **b** Clinical photograph showing stabilization of the membrane in an area of bone deficit after surgical extraction

Fig. 4.74 a, b. Heterografts of bovine bone (Bio-Oss) for the regeneration of large osseous defects; **a** in compact form, and **b** in granules

4. Alloplastic grafts, which are composed of synthetic bone substitutes, e.g., hydroxylapatite (Fig. 4.75), phosphoric calcium ceramics, and oily calcium hydroxide in cream form (Fig. 4.76).

Fig. 4.75 a, b. a Synthetic bone substitute (hydroxylapatite) in granules. **b** Clinical photograph of transplantation of lateral incisor of the maxilla. The area of osseous defect is filled with hydroxylapatite
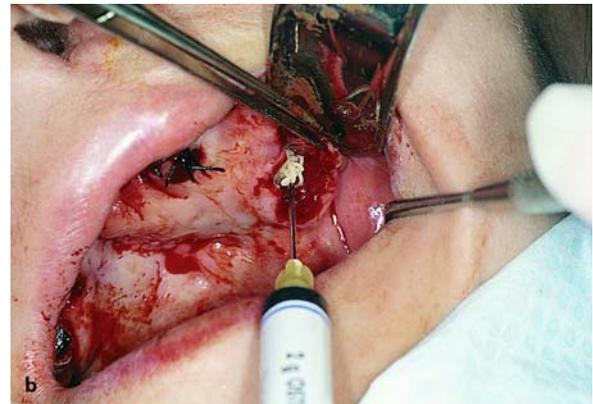
Fig. 4.76 a, b. a Oily calcium hydroxide in cream form used for bone regeneration. **b** Postextraction socket with buccal loss of bone. The area is filled with synthetic material

Fig. 4.77. Amelogenin (base and catalyst) used for tissue regeneration

Other materials that contain amelogenin as the active ingredient, amelogenin being one of the proteins associated with tooth enamel (Fig. 4.77), may also promote tissue regeneration.

Of all the grafts, bone autografts give the best results. In spite of that, their use of limited, because a second concurrent surgical procedure is required. For this reason, the aforementioned synthetic substitute materials are used today instead, and bone regeneration in areas with large bone defects is accomplished satisfactorily.

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Simple Tooth Extraction

5

F. D. Fragiskos

This chapter describes the fundamental principles and techniques involved in tooth extraction. A tooth or root may be removed with either the closed or the open technique. The closed technique is also known as the simple technique or forceps technique, while the open technique is also known as a surgical extraction or flap technique (see Chap. 6).

The simple technique is that which is used most often in everyday practice. In contrast, the surgical technique is employed only in cases where the tooth or root extraction is not possible with the simple technique.

The basic requirements for a successful outcome in simple tooth extraction are as follows:

- Informing and reassuring the patient, so that stress and fear levels are minimized, and so to ensure desirable cooperation during the procedure.
- Knowing tooth anatomy well, which can be variable.
- Detailed clinical and radiographic examinations, since these provide important information pertaining to procedure planning and selecting the appropriate technique.

- Preparation of the patient, which includes: (1) rinsing the oral cavity with various antiseptic solutions, and (2) correct positioning of the dental chair.

5.1
Patient Position

To ensure adequate visualization and comfort during the various manipulations required for the tooth extraction, the dental chair must always be positioned correctly. For the extraction of a maxillary tooth, the patient's mouth must be at the same height as the dentist's shoulder and the angle between the dental chair and the horizontal (floor) must be approximately 120° (Fig. 5.1a). Also, the occlusal surface of the maxillary teeth must be at a 45° angle compared to horizontal when the mouth is open. During mandibular extractions, the chair is positioned lower, so that the angle between the chair and the horizontal is about 110° (Fig. 5.1b). Furthermore, the occlusal surface of the mandibular teeth must be parallel to the horizontal when the patient's mouth is open. The position of
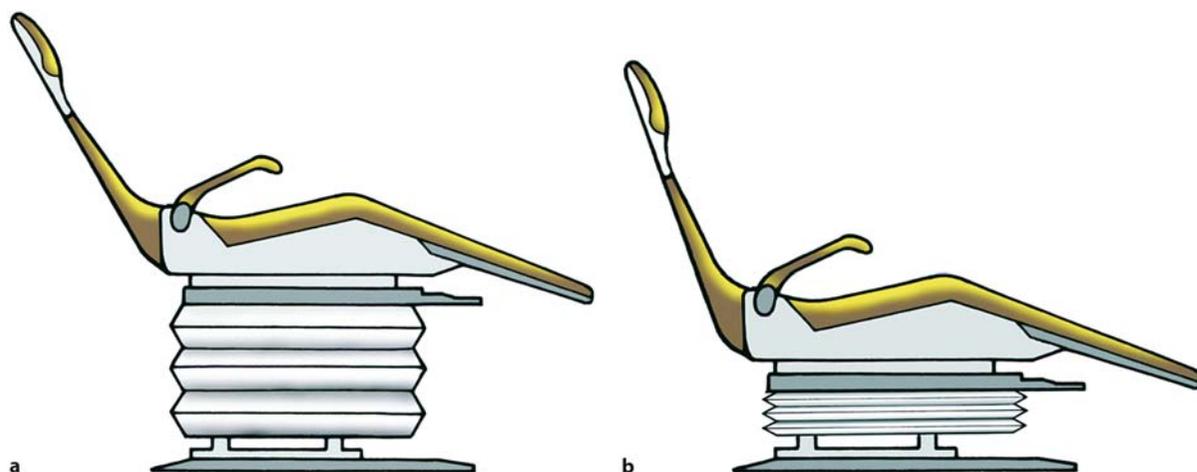
Fig. 5.1 a, b. Position of dental chair during extraction. **a** Maxilla: angle between dental chair and the horizontal (floor) is 120°. **b** Mandible: angle between dental chair and the horizontal (floor) is 110°

Fig. 5.2. Position of dentist during extraction. In this and all other figures, positions for right-handed dentists are illustrated. For all maxillary teeth and posterior mandibular teeth, the dentist is to the front and right (and to the left, for left-handed dentists) of the patient. For the anterior mandibular teeth (teeth 33–42 for right-handed, and teeth 32–43 for left-handed, dentists), the dentist is positioned in front of or behind and to the right (or to the left, for left-handed dentists) of the patient

right-handed dentists during extraction using forceps is in front of and to the right of the patient; left-handed dentists should be in front of and to the left of the patient. For the extraction of anterior mandibular teeth right-handed dentists should be positioned in front of the patient, or behind them and to their right; left-handed dentists should be in front of them or behind them and to their left (Fig. 5.2).

5.1.1
Extraction

The extraction itself is accomplished in two stages. During the first stage, the tooth is separated from the soft tissues surrounding it using a desmotome or elevator; during the second stage, the tooth is elevated from the socket using forceps or an elevator.

5.2
Separation of Tooth from Soft Tissues

5.2.1
Severing Soft Tissue Attachment

The first step in removing a tooth using the simple technique is to sever or loosen the soft tissue attachment surrounding the tooth. Two instruments are re-
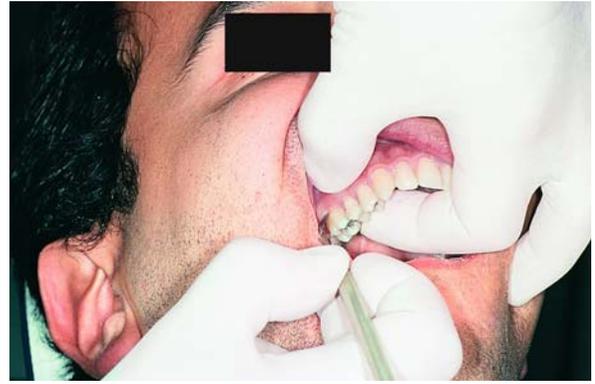
Fig. 5.3. Severing the soft tissue attachment in maxillary right teeth (teeth 13–18). Placement of fingers of the non-dominant hand: index finger is palatal, thumb is buccal

quired to sever the soft tissue attachment: the straight and curved desmotomes (Fig. 4.56). The straight desmotome is used for the six maxillary anterior teeth, while the curved desmotome is used for the rest of the maxillary teeth and all the mandibular teeth.

The desmotome is held in the dominant hand, with a pen grip and, after being positioned at the bottom of the gingival sulcus, it is used to sever the periodontal ligament. This is accomplished in one continuous motion, beginning at the distal surface of the tooth and moving toward the mesial surface, first buccally and then lingually or palatally.

While severing the soft tissue attachment, the index finger and thumb of the nondominant hand are positioned buccally and palatally or the index finger and middle finger are placed buccally and lingually, to protect the soft tissues from injury (tongue, cheeks and palate). More specifically for right-handed dentists, in the right maxilla, from the canine and posterior to the canine teeth (teeth 13–18), the index finger is placed palatally and the thumb buccally (Fig. 5.3), while for the rest of the teeth (anterior teeth and teeth on the left side, teeth 12–28), the index finger is positioned buccally and the thumb palatally (Figs. 5.4, 5.5). In the mandible, the fingers are positioned differently. The fingers usually used are the index finger and middle finger of the nondominant hand. More specifically, from the left third molar until the right lateral incisor (teeth 38–42), the index finger is placed buccally and the middle finger lingually (Figs. 5.6, 5.7), while for the rest of the teeth of the right side (teeth 43–48), the index finger is positioned lingually and the middle finger buccally (Fig. 5.8). For left-handed dentists, from the canine and posterior to the canine teeth (teeth 23–28) in the left maxilla, the index finger is placed palatally and the thumb buccally, while for the

Fig. 5.4. Severing the soft tissue attachment in anterior maxillary teeth. Placement of fingers of the nondominant hand: index finger is labial, thumb is palatal

Fig. 5.5. Severing the soft tissue attachment in maxillary left teeth. Placement of fingers of the nondominant hand: index finger is buccal, thumb is palatal

Fig. 5.6. Severing the soft tissue attachment in mandibular left teeth. Placement of fingers of the nondominant hand: index finger is buccal, middle finger is lingual

Fig. 5.7. Severing the soft tissue attachment in anterior mandibular teeth. Placement of fingers of the nondominant hand: index finger is labial, middle finger is lingual

Fig. 5.8. Severing the soft tissue attachment in mandibular right teeth (teeth 43–48). Placement of fingers of the nondominant hand: middle finger is buccal, index finger is lingual

rest of the teeth (anterior teeth and teeth on the right side, teeth 22–18), the index finger is positioned buccally and the thumb palatally. In the mandible, the fingers are positioned differently. The fingers usually used are the index finger and middle finger of the nondominant hand. More specifically, from the right third molar until the left lateral incisor (teeth 48–32), the index finger is placed buccally and the middle finger lingually, while for the rest of the teeth of the left side (teeth 33–38), the index finger is positioned lingually and the middle finger buccally.

5.2.2
Reflecting Soft Tissues

Reflecting the gingiva surrounding the tooth is accomplished with two instruments called Chompret elevators. Depending on the shape of the blade,

the Chompret elevator is either straight or curved (Figs. 4.52 a, b). These elevators are used to push or slightly reflect the gingiva around an intact tooth, to allow the extraction forceps to grasp the tooth beneath the cervical line of the tooth as apically as possible. Some people suggest that reflecting the soft tissues is not necessary since severing them is sufficient, while others consider that reflecting is a more appropriate procedure compared to severing the soft tissue attachment. The fact remains that severing the soft tissue attachment is a less traumatic procedure compared to reflecting.

Chompret elevators are also used to expose destroyed teeth that are covered by hyperplastic gingivae, enabling positioning of the appropriate instrument for their removal. Reflecting (positioning of fingers and movements) is done in exactly the same way as severing the soft tissue attachment, with a slightly different motion, which is applied with slight pressure and in an outward direction.

Chompret elevators may also be used as dental elevators to remove roots and broken root tips. It is worth noting that in the case of an intact tooth, the Freer periosteal elevator (Fig. 4.8), being a very narrow instrument and easy to handle, is considered more suitable for reflecting the soft tissue attachment compared to the previously mentioned instruments (Figs. 4.52 a, b).

5.3
Extraction Technique Using Tooth Forceps

The extraction technique using tooth forceps is based on certain guidelines to ensure that the tooth is extracted with maximum skill. These guidelines involve the correct way to hold the forceps and the tooth itself, the forces applied to the tooth, and the direction of movement during the extraction.

The extraction forceps are held in the dominant hand, while the thumb is simultaneously placed between the handles directly behind the hinge, so that pressure applied to the tooth is controlled (Figs. 5.9, 5.10). The nondominant hand also plays an important role in the extraction procedure. More specifically:

- It reflects the soft tissues of the cheeks, lips, and tongue, so that there is adequate visualization of the surgical field.
- It supports the alveolar process of the maxilla and aids in stabilizing the patient's head. It also controls the expansion of the alveolar bone by way of feel, as well as luxation of the tooth during the various maneuvers.

Fig. 5.9. The correct way to hold maxillary extraction forceps

Fig. 5.10. The correct way to hold mandibular extraction forceps

- It supports and stabilizes the mandible, counteracting the forces applied by the extraction forceps, which, when very great, may injure the temporomandibular joint.

After reflecting of the gingiva, the beaks of the forceps are positioned at the cervical line of the tooth, parallel to its long axis, without grasping bone or gingivae at the same time. The initial extraction movements applied are very gentle. More specifically, the dentist applies slow steady pressure to move the tooth buccally at first, and then palatally or lingually. Movements must become greater gradually and the buccal pressure is greater than the corresponding palatal or lingual pressure, because the labial or buccal bone is thinner and more elastic compared to that of the palate. If anatomy of the root permits (single, conical roots), rotational force may be applied in addition to buccopalatal or buccolingual pressure. These movements expand the alveolar bone and also sever all the periodontal fibers. Slight traction is also employed at the same time, facilitating the tooth extraction. Dur-

ing the final extraction phase, traction is not permitted, because there is risk of damage due to sudden removal of the tooth and the risk of the forceps knocking the teeth of the opposite arch. To avoid such a possibility, the final extraction movement must be labial or buccal, and in a curved direction that is outwards and upwards for the maxilla, and outwards and downwards for the mandible.

Before the tooth is delivered from the socket, the soft tissue between the tooth and the gingiva must be examined for a possible attachment. If this is the case, the gingiva must be completely severed from the tooth, because there is a risk of greatly tearing the tissues.

5.3.1
Extraction of Maxillary Central Incisors

Instruments. Extraction forceps for six anterior maxillary teeth or maxillary universal forceps (no. 150).
In order to extract maxillary central incisors, righthanded dentists must be positioned in front of and to the right of the patient, and left-handed dentists in front of and to the left of the patient. The index finger of the nondominant hand is then placed labially, and the thumb palatally, firmly holding the alveolar process next to the tooth to be extracted. The beaks of the forceps are adapted to the tooth, and the beaks must be parallel to the long axis of the tooth. The initial extraction movements are gentle, first in a labial direction, and then palatal. After the initial force is applied to the tooth, motions gradually become greater and the final extraction force is applied labially (Fig. 5.11). Because the root of the central incisor is conical in shape, its removal may also be achieved using rotational forces. More specifically, the tooth is rotated first in one direction and immediately afterwards in the other direction, until the periodontal fibers are completely severed. The tooth is then delivered from the socket using slight traction.

5.3.2
Extraction of Maxillary Lateral Incisors

Instruments. Extraction forceps for six anterior maxillary teeth or maxillary universal forceps (no. 150).
In order to extract maxillary lateral incisors, righthanded dentists must be positioned in front of and to the right of the patient, and left-handed dentists in front of and to the left of the patient. The fingers of the nondominant hand are placed in exactly the same way as for the central incisors.

The extraction movements for removal of the lateral incisor are labial and palatal. Because the lateral incisor has a thin root and there is usually curvature of the root tip distally, rotational force is not allowed. Slight rotational motions may be employed only in the final stage, with simultaneous traction of the tooth from the socket.

5.3.3
Extraction of Maxillary Canines

Instruments. Extraction forceps for six anterior maxillary teeth or maxillary universal forceps (no. 150 forceps).
Maxillary canines present some degree of difficulty due to: (1) their firm anchorage in alveolar bone, and (2) their long roots and frequent curvature of the root tip. Also, the labial surface of the tooth's root is covered by thin alveolar bone, and if due consideration is not given during movements, there is a risk of fracturing the alveolar process.

In order to extract maxillary canines, right-handed dentists must be positioned in front of and to the right (left-handed dentists should be in front of and to the left) of the patient, whose head should be turned towards the dentist. For the right-handed dentist, the fingers of the nondominant hand are placed as follows: for the right side, the thumb is placed labially and the index finger palatally, while for the left side, the index finger is placed labially and the thumb palatally. For the left-handed dentist, the fingers of the nondominant hand are placed as follows: for the right side, the thumb is placed palatally and the index finger labially, while for the left side, the index finger is placed palatally and the thumb labially. The extraction movements are labial and palatal, with gradually increasing intensity. Because the canine has a flattened root and the root tip is usually curved distally, rotational motions are not permitted, or if they are used, they must be done so very gently and with alternating buccopalatal pressure. The final extraction movement is labial.

5.3.4
Extraction of Maxillary Premolars

**Instruments.** Maxillary universal forceps (no. 150).
In order to extract maxillary premolars, the dentist should be positioned in front of and to the right (or to the left for left-handed dentists) of the patient. For right-handed dentists, the fingers of the nondominant hand are placed as follows: for the right side, the index
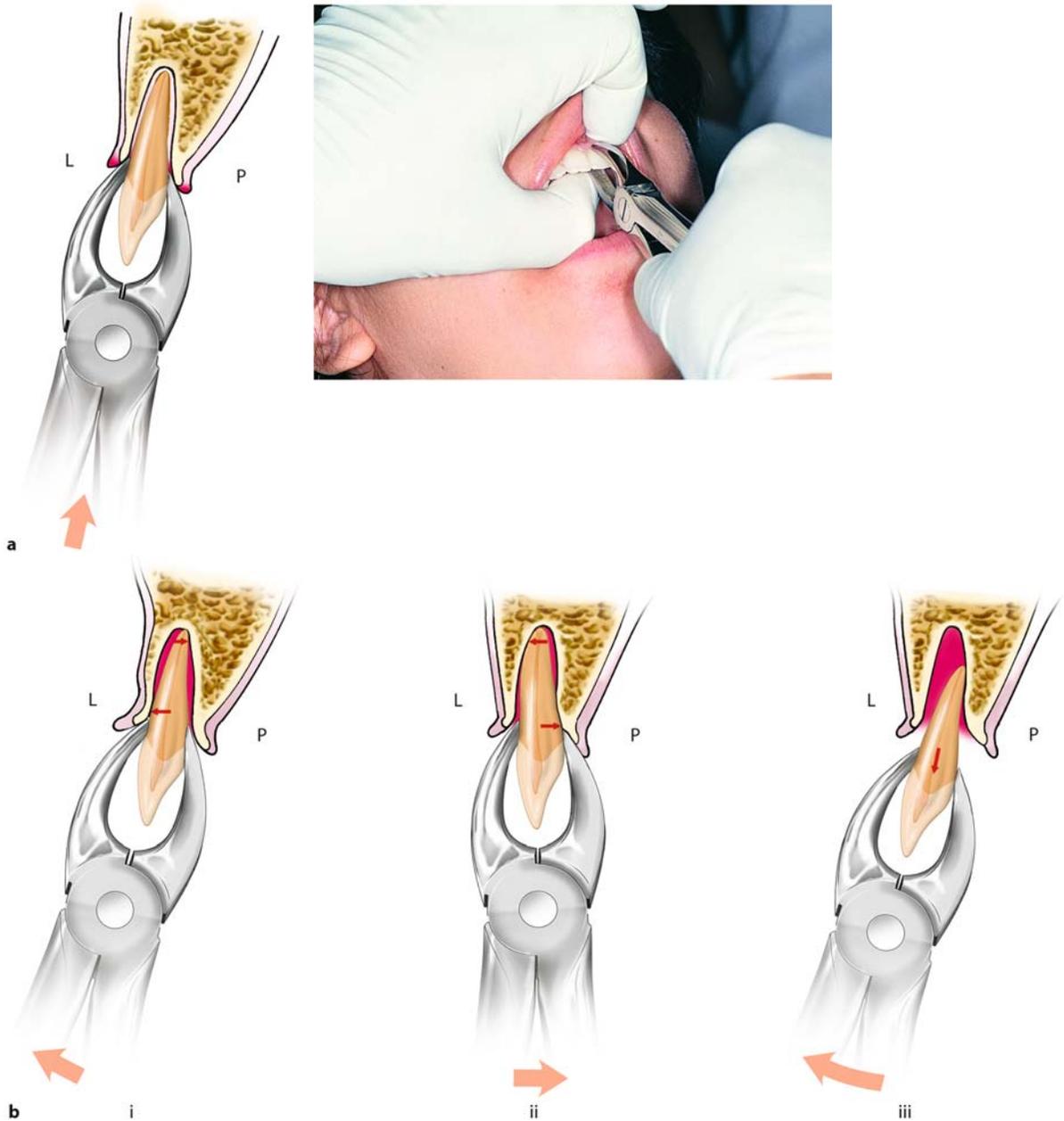
Fig. 5.11 a, b. a Extraction of a maxillary anterior tooth (central incisor). Forceps grasps the tooth and fingers of the nondominant hand support the alveolar process. **b** Extraction movements: initial labial (*L*) pressure (*i*); the tooth is brought back to its original position, with direction of motion continuing to the palatal (*P*) side (*ii*); the final extraction movement is curved, with the concave part facing upwards (*iii*)

finger is placed palatally and the thumb buccally, while for the left side, the index finger is placed buccally and the thumb palatally. For left-handed dentists, the fingers of the nondominant hand are placed as follows: for the right side, the index finger is placed buccally and the thumb palatally, while for the left side, the index finger is placed palatally and the thumb buccally. As for the first premolar, because it usually has two roots, buccal and palatal pressure should be gentle and slight (Figs. 5.12, 5.13). If movements are vigorous and abrupt, there is a risk of fracturing the root tips. If one of the root tips does break, it may be removed easily,

Fig. 5.12 a, b. Extraction of maxillary left tooth (first premolar). **a** Diagrammatic illustration and **b** clinical photograph, which show how to hold the tooth with forceps and support the alveolar process with fingers of the nondominant hand. (*B* Buccal, *P* palatal)
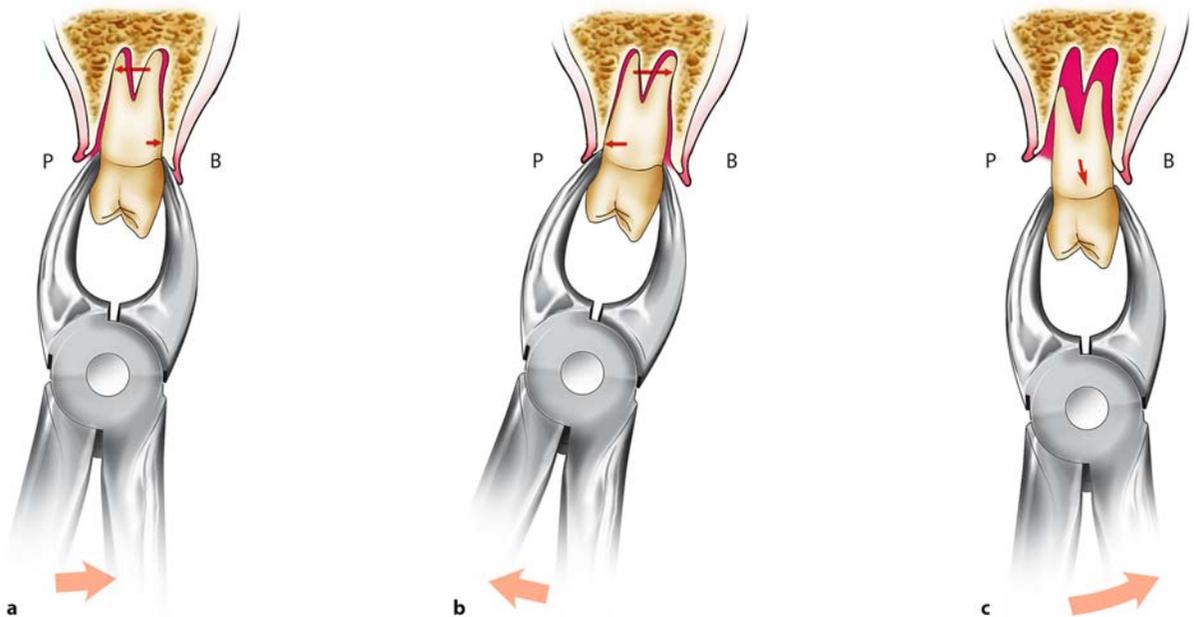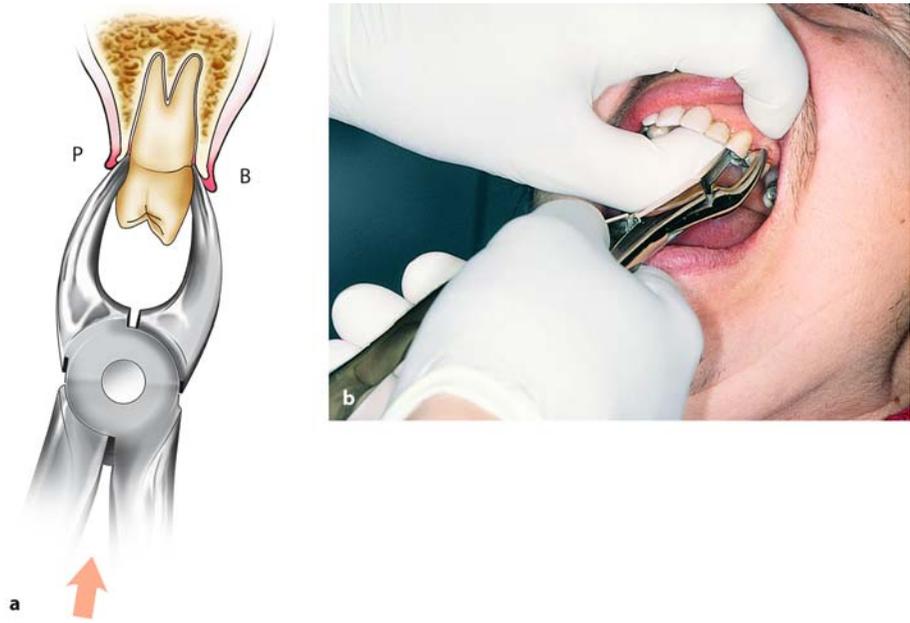
Fig. 5.13 a–c. Extraction movements: **a** buccal (*B*), **b** palatal (*P*), **c** final extraction movement according to the legend for Fig. 5.11

since they are not very curved and the tooth has already been mobilized during the extraction attempt. Rotational motions are not allowed due to the tooth's anatomy.

Extraction of the second premolar is easier, because the tooth has one root. Movements are the same as those for the first premolar. The final movement for both teeth is buccal.

5.3.5
Extraction of Maxillary First and Second Molars

Instruments. Maxillary right molar forceps, maxillary left molar forceps.

In order to extract maxillary molars, the dentist must be positioned in front of and to the right (or to the left, for left-handed dentists) of the patient. The fingers of the nondominant hand are placed in exactly the same way as for maxillary premolars. The appropriate forceps are chosen, depending on the tooth to be extracted. The right and left maxillary molar forceps differ in that their buccal beaks have a pointed end at the center, which adapts to the root bifurcation.

The maxillary first molar has three diverging roots: the palatal, which is the largest and most widely divergent toward the palate, and the two buccal roots, which are often curved distally. The tooth is firmly anchored in the alveolar bone and its buccal surface is reinforced by the extension of the zygomatic process. This tooth therefore requires the application of strong force during its extraction, which may cause fracture of the crown or root tips. To avoid this from happening, initial movements must be gentle, with buccopalatal pressure and an increasing range of motion, especially buccally, where resistance is less. The final extraction movement is a buccal upwards curved motion, following the direction of the palatal root. Because the root tips are close to the maxillary sinus, their removal requires careful consideration, due to the risk of oroantral communication.

Extraction of the maxillary second molar may be accomplished in the same way as for the maxillary first molar, because the teeth have similar anatomy. Extracting the second molar, however, is considered to be easier than extracting the first molar, because there is less resistance from the buccal alveolar process and relatively little divergence of the roots. Quite often the roots of this tooth are fused together in a conical shape. In this case, extraction of the tooth is even easier.

5.3.6
Extraction of Maxillary Third Molar

Instruments. Maxillary third molar forceps.

In order to extract maxillary third molars, the dentist must be positioned in front of and to the right (or to the left, for left-handed dentists) of the patient. The fingers of the nondominant hand are placed in exactly the same way as for maxillary premolar extraction. The maxillary third molar is the smallest of all molars and varies greatly in size, number of roots, and root morphology. It has three to eight roots. It most commonly has three roots just like the other maxillary molars, but smaller and converging. They are usually fused together in a conical shape, curved distally. Extraction of the tooth depends on its location, as well as on the number and shape of the roots. If the third molar has erupted completely and its roots are fused (conical shape), its extraction does not usually present any difficulty and it may be removed with only buccal pressure. The risk of fracturing the palatal alveolar process is avoided this way, which would otherwise occur if force were applied palatally (the palatal bone is thinner and lower than the buccal bone). When the tooth has three or more roots, though, its extraction is accomplished by applying buccal pressure and very gentle palatal pressure.

The final extraction movement must always be buccal. Root anatomy of the third molar permitting, extraction is easily accomplished using the straight elevator. The elevator is positioned between the second and third molars and the tooth is luxated according to the direction of its roots.

5.3.7
Extraction of Mandibular Anterior Teeth

Instruments. Mandibular universal forceps or no. 151 forceps.

In order to extract mandibular anterior teeth 33–42, right-handed dentists may be positioned in front of and to the right of the patient, or behind and to the right of the patient, with their left hand placed around the patient's head. Left-handed dentists may be positioned in front of and to the left of the patient to extract mandibular anterior teeth 32–43, or behind and to the left of the patient, with their right hand placed around the patient's head. The mandible is stabilized with the four fingers, which are placed on the submandibular area, and the thumb is placed on the occlusal surfaces of the teeth.

Mandibular incisors have narrow flattened roots, which are not very firmly anchored in the alveolar bone. These teeth have one root and are curved at the root tip, especially the lateral incisor. Their extraction is easy, due to their morphology and the thin labial alveolar bone surrounding the root.

Extraction pressure is applied labially and lingually, gradually increasing in intensity. Due to the flattened roots of the teeth, only slight rotational force is permitted (Figs. 5.14, 5.15).

Fig. 5.14 a, b. Extraction of anterior mandibular tooth (central incisor). **a** Diagrammatic illustration and **b** clinical photograph showing how to hold the tooth with forceps and support the mandible with fingers of the nondominant hand. (*B* Buccal, *L* lingual)
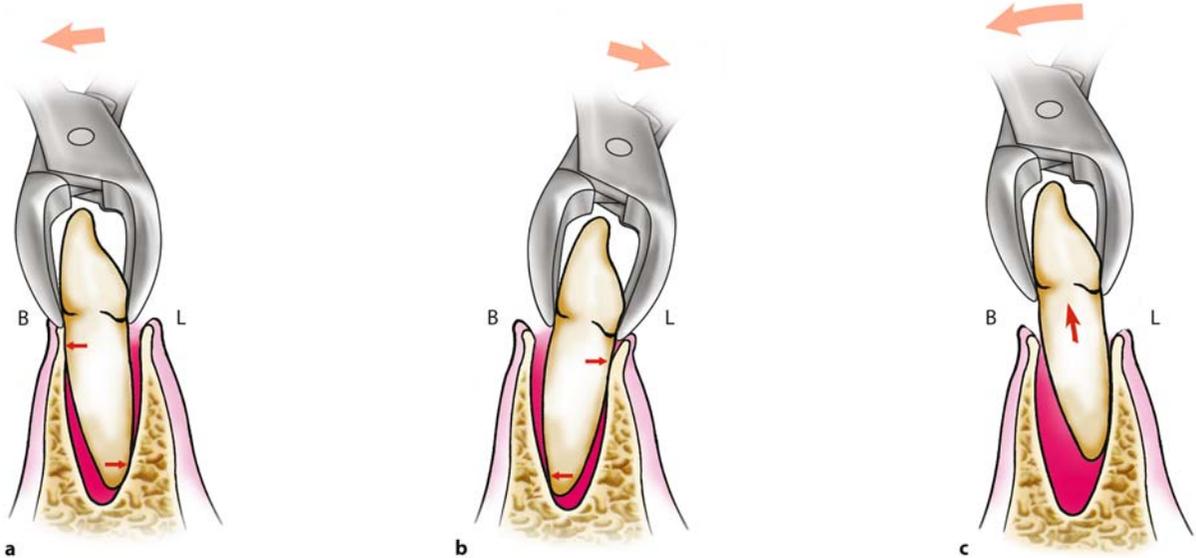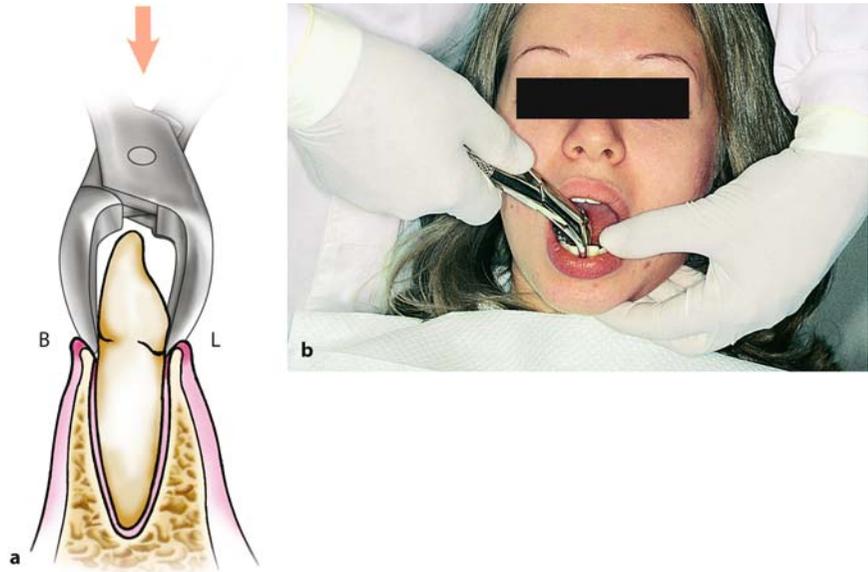
Fig. 5.15 a–c. Extraction movements: **a** buccal (*B*), **b** lingual (*L*), and **c** final extraction movement, which is curved, with the concave part of the arch facing downwards (that is, the opposite direction compared to the extraction of maxillary teeth)

Mandibular canines usually have only one root. Seventy per cent of these teeth have a straight root, while 20% present distal curvature. Compared to incisors, canines are more difficult to extract, due to the long root and frequent curvature of the root tip. Extraction movements are the same as those employed for central and lateral incisors.

The final extraction movement for all anterior teeth is labial, curved outwards and downwards. Damage of maxillary teeth by the forceps is thus avoided.

5.3.8
Extraction of Mandibular Premolars

Instruments. Mandibular universal forceps or no. 151 forceps.

In order to extract mandibular premolars, the dentist must be positioned in front of and to the right (or to the left, for left-handed dentists) of the patient. For mandibular left (right for left-handed dentists) premolars, the mandible is stabilized by the four fingers on the submandibular area and the thumb on the incisor
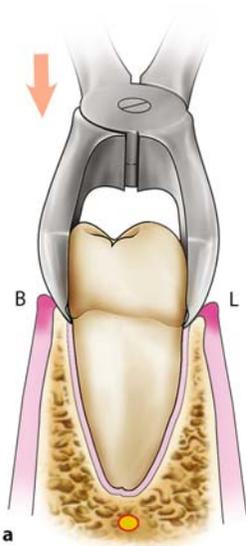
Fig. 5.16 a, b. Extraction of a mandibular left posterior tooth (first molar). **a** Diagrammatic illustration and **b** clinical photograph showing how to hold the tooth with forceps and support the mandible with the nondominant hand. (*B* Buccal, *L* lingual)
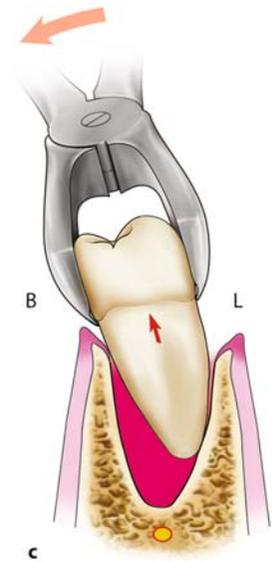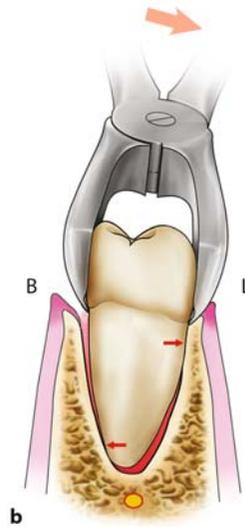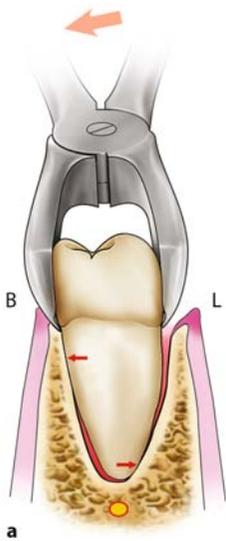
Fig. 5.17 a–c. Extraction movements: **a** buccal, **b** lingual, **c** final extraction movement, always towards the buccal side, outwards and downwards

surface of the incisors, while for mandibular right (left for left-handed dentists) premolars, only the position of the thumb differs, which is placed on the occlusal surface of the molars of the same side.

Even though mandibular premolars are generally surrounded by dense, hard bone, their extraction is considered quite easy because their roots are straight and conical, although sometimes they may be thin or the root tip may be large. Buccolingual force is applied for extraction of these teeth. Gentle rotational force may also be applied when extracting the second premolar. The final extraction movement is outwards and downwards.

5.3.9
Extraction of Mandibular Molars

Instruments. Mandibular molar forceps.

In order to extract mandibular molars, the dentist must be positioned in front of and to the right (or to the left, for left-handed dentists) of the patient. The mandible is stabilized by the four fingers on the submandibular area, while the thumb is placed on the incisor surface of the incisors for the left side (right side for left-handed dentists), or on the occlusal surface of the premolars for the right side (left side for left-hand-

ed dentists). The mandibular first molar usually has two roots, a mesial and a distal one. The mesial root is larger, more flattened than the distal root and usually is curved distally. The distal root is straighter and narrower than the mesial root, and more rounded.

The mandibular second molar has a morphology similar to that of the first molar. Even though this tooth is surrounded by dense bone, it is removed more easily than the first molar, because its roots are smaller and less divergent, and they are often fused together.

The extraction technique is the same for both molars. More specifically, the forceps are adapted to the tooth as apically as possible, beneath the cervical line of the tooth, with the beaks parallel to the long axis of the tooth. Initially the movements are gentle with buccal and lingual pressure. After the tooth is slightly mobilized, force is gradually increased and the final extraction movement is buccal, taking care not to damage the maxillary teeth with the forceps (Figs. 5.16, 5.17).

5.3.10
Extraction of Mandibular Third Molar

Instruments. Mandibular third molar forceps.

In order to extract the third molar, the mandible is stabilized in the same way as for the first and second molar, or the thumb may be placed more posteriorly. The mandibular third molar usually has two roots, whose morphology is similar to that of the other molars. They are smaller, though, and usually are fused in a conical shape, widely diverging distally. Buccolingual pressure is applied and the range of motion depends on the morphology of the buccal and lingual alveolar bone. The lingual alveolar bone is very thin compared to the buccal alveolar bone, which is unyielding in the third molar area; therefore, the force that mobilizes the tooth must be applied in the lingual direction. Afterwards, pressure must be applied very carefully, so as to avoid fracture of both the tooth, due to excessive buccal force, and the lingual plate of bone. If the third molar has one root or if the roots converge and are curved in the same direction, the extraction may be accomplished using the straight elevator alone. In this case the elevator is positioned at the mesial surface of the tooth, which is delivered according to the direction of curvature of the roots.

Fig. 5.18. Deciduous mandibular molar with subjacent permanent tooth
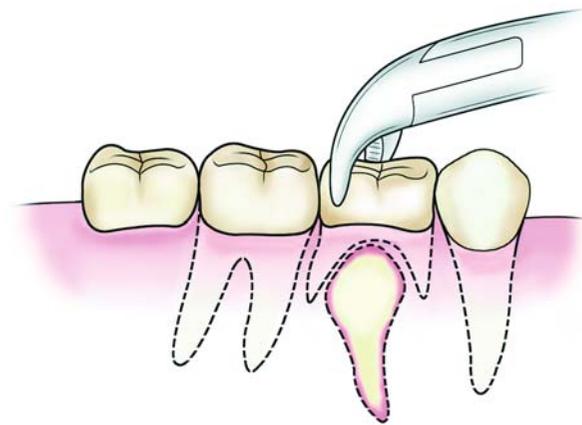
Fig. 5.19. Extraction of deciduous molar with forceps. Forceps are positioned mesially or distally on the crown and not the center of the tooth

5.3.11
Extraction of Deciduous Teeth

Instruments. The forceps used to extract deciduous teeth are small and have narrow beaks, so that they can be adapted accordingly to the cervical region of the tooth to be extracted.

The extraction technique for deciduous teeth is similar to that used for permanent teeth. The dentist must pay particular attention when extracting deciduous molars because of the risk of simultaneously extracting the bud of the subjacent permanent tooth (Fig. 5.18). More specifically, because the crown of the deciduous molar is short, the beaks of the forceps may accidentally grasp the crown of the bud of the underlying permanent tooth as well and remove both. This is why the beaks of the forceps must be positioned on the mesial or the distal area of the tooth and not the center (root bifurcation), underneath which is the permanent tooth (Fig. 5.19).

When the roots of the deciduous tooth embrace the crown of the subjacent premolar, the deciduous tooth must be removed by surgical extraction (see Chap. 6).

If the root of the deciduous tooth breaks during the extraction procedure, it may be removed using narrow elevators, taking care to avoid contact with the permanent tooth. Extraction of deciduous teeth is much easier than that of permanent teeth, especially if their roots are resorbed. Deciduous teeth are difficult to extract when root resorption is incomplete. The subjacent tooth then erupts partially, causing thinning of the roots instead of total resorption. These thin root remnants are interposed between the crown of the permanent tooth and the bone, and fracture easily during the attempt to extract the deciduous tooth. This extraction is deemed necessary because the deciduous tooth is not shed spontaneously due to incomplete resorption of the root or roots.

Fig. 5.20. Correct way to hold straight elevator. Index finger is placed near the blade

5.4
Extraction Technique Using Root Tip Forceps

The root tip forceps are used in exactly the same way as the tooth forceps. In order to use this instrument, the root must protrude out of the gingivae, so that it can be firmly grasped. If the root is at the same level as, or a little beneath, the alveolar margin, a small portion of the root must be exposed before the dentist is able to grasp the root with the root tip forceps. This is accomplished after carefully reflecting a small portion of the gingivae and removing part of the buccal and palatal alveolar bone. As for the dentist's position, placement of fingers of the nondominant hand and extraction movements, they are no different than those described for intact teeth.

5.5
Extraction Technique Using Elevator

5.5.1
Extraction of Roots and Root Tips

A variety of elevators may be used to extract roots and root tips. The most commonly used elevator is the straight elevator. This elevator, besides root extractions, may also be used to remove intact teeth – especially the maxillary and mandibular third molars, root anatomy permitting. There is no doubt that the straight elevator is the ideal instrument in everyday dentistry, as long as it is used correctly. Otherwise, it may cause a number of undesirable complications. In order to

Fig. 5.21. Placement of gauze between finger and lingual side, for protection from injury in case the elevator slips

avoid such situations, certain basic rules must be followed:

- The straight elevator must be held in the dominant hand and the index finger placed along the blade, leaving its anterior end exposed, which is used to luxate the tooth or root (Fig. 5.20).
- This instrument must always be used buccally, and never on the lingual or palatal side.
- The concave surface of the blade must be in contact with the mesial or distal surface of the tooth to be extracted, and be seated between the tooth and alveolar bone.
- When the instrument is placed between the maxillary posterior teeth, it must be perpendicular to their long axis. As for the rest of the teeth of both the maxilla and mandible, it may be perpendicular, parallel, or at an angle.
- During luxation, a cotton roll or gauze should be placed between the finger and palatal or lingual side, to avoid injury of the finger or tongue in case the elevator slips (Fig. 5.21).

a

b

c
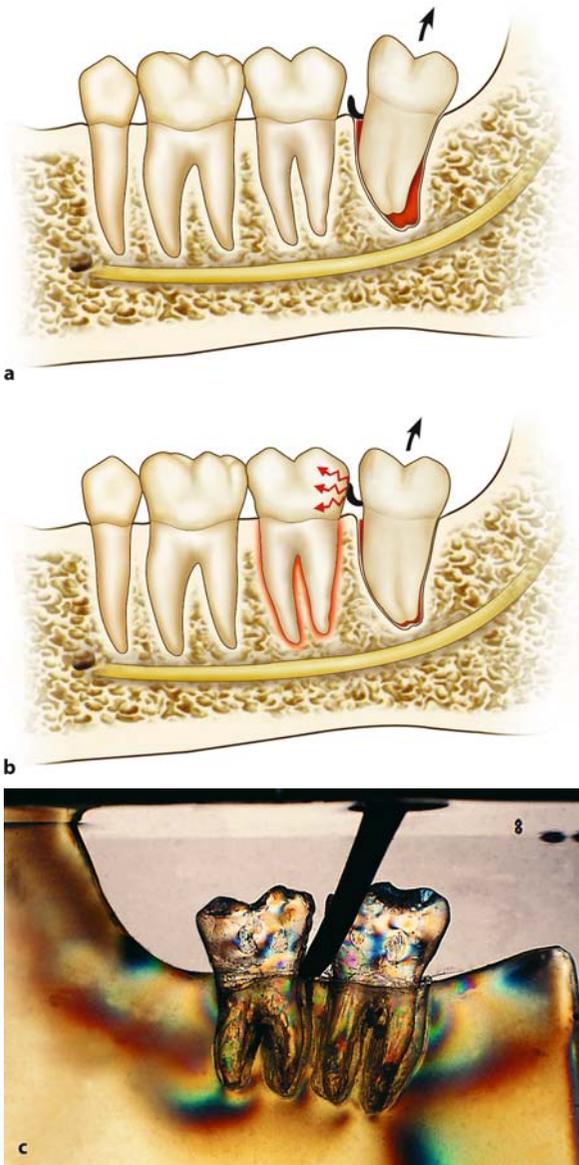
Fig. 5.22 a–c. a During luxation of a tooth, the alveolar ridge is used as a fulcrum, not the adjacent tooth. **b** Incorrect placement of the instrument. **c** Photoelastic model showing extraction of the third mandibular molar using a straight elevator. Using the adjacent tooth (second molar) as a fulcrum creates great tension around the tooth, with a risk of injury to tissues surrounding the root

- During luxation, the adjacent tooth should not be used as a fulcrum, but only the alveolar bone. Otherwise, there is a risk of damaging the periodontal ligament fibers (Fig. 5.22 a–c).
- The straight elevator should not be used to extract multi-rooted teeth, because there is a risk of fracturing their roots if they have not been sectioned previously.
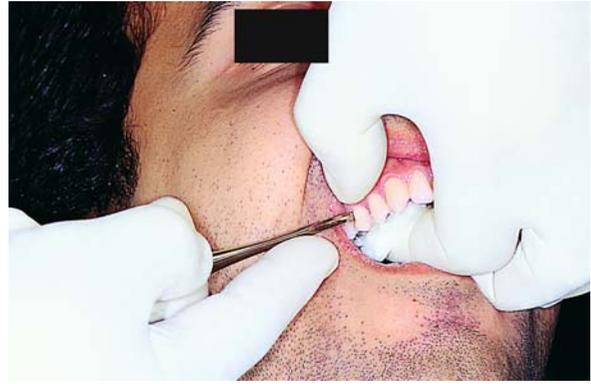
Fig. 5.23. Extraction of maxillary right posterior tooth using straight elevator. Correct way to hold the instrument and alveolar process (thumb is buccal, index finger is palatal)

Fig. 5.24. Extraction of maxillary left posterior tooth using straight elevator. Correct way to hold the instrument and alveolar process (index finger is buccal, thumb is palatal)

During the luxation attempt using the straight elevator, the fingers of the nondominant hand must be in a certain position.

- More specifically for right-handed dentists:
  Maxilla: From the right premolar up to the right third molar (teeth 14–18), the index finger is placed palatally and the thumb is placed buccally (Fig. 5.23). From the right canine up to the left third molar (teeth 13–28), the index finger is placed labially or buccally and the thumb is placed palatally (Fig. 5.24).
  Mandible: From the right first premolar up to the right third molar (teeth 44–48), the nondominant hand embraces the patient's head and the index finger is placed buccally, while the thumb is placed lingually (Fig. 5.25). From the right canine up to the left third molar (teeth 43–38), the index finger is placed lingually and the thumb is placed labially or buccally (Fig. 5.26).

Fig. 5.25. Extraction of mandibular right posterior tooth using straight elevator. Correct way to hold the instrument and alveolar process (index finger is buccal, thumb is lingual)

Fig. 5.26. Extraction of mandibular left posterior tooth using straight elevator. Correct way to hold the instrument and alveolar process (thumb is buccal, index finger is lingual)

● More specifically for left-handed dentists:
Maxilla: From the left premolar up to the left third molar (teeth 24–28), the index finger is placed palatally and the thumb is placed buccally (Fig. 5.23). From the left canine up to the right third molar (teeth 23–18), the index finger is placed labially or buccally and the thumb is placed palatally (Fig. 5.24).
Mandible: From the left first premolar up to the left third molar (teeth 34–38), the nondominant hand embraces the patient's head and the index finger is placed buccally, while the thumb is placed lingually (Fig. 5.25). From the left canine up to the right third molar (teeth 33–48), the index finger is placed lingually and the thumb is placed labially or buccally (Fig. 5.26).

5.5.2
Extraction of Single-Rooted Teeth with Destroyed Crown

The removal of single-rooted teeth whose crown has been destroyed is accomplished with the help of the straight elevator. More specifically, the blade of the elevator is seated between the root and alveolar bone (perpendicular or at an angle), with the concave surface of the blade in contact with the mesial or distal surface of the root. Using the alveolar bone as a fulcrum, rotational forces are applied around the axis of the elevator, in the mesial and distal area, resulting in displacement of the root and elevation from the socket (Figs. 5.27–5.29).

If the root is broken beneath the alveolar margin and its removal presents difficulty, the special instrument for removal of roots mentioned in Chap. 4
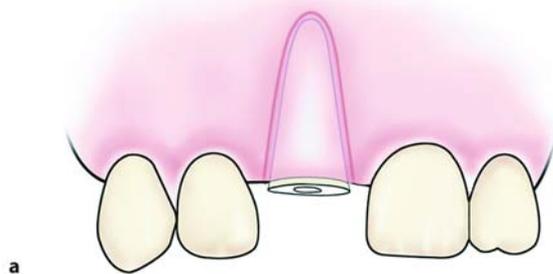
Fig. 5.27 a, b. a Root of maxillary central incisor. **b** The use of an elevator is indicated for its removal
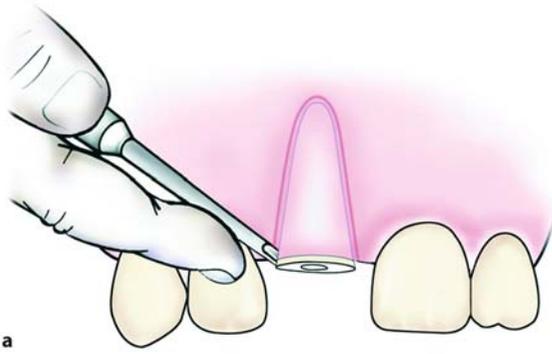
Fig. 5.28 a, b. Positioning of straight elevator on the distal surface of the root, either perpendicular to, or at an angle to, the root
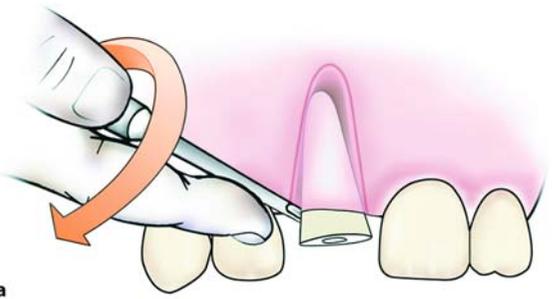
Fig. 5.29 a, b. Luxation of the root of maxillary central incisor with straight elevator
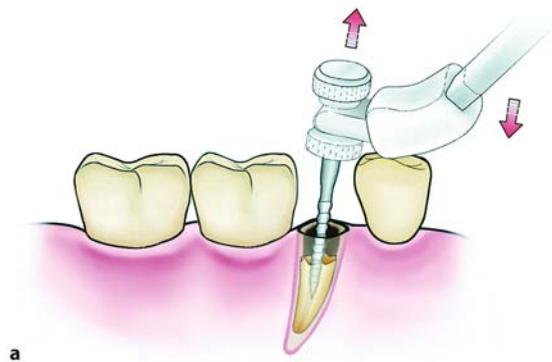
Fig. 5.30 a, b. Removal of the root of mandibular premolar with the special instrument (endodontic file-based action) for root extraction

(Fig. 4.54) may be used. More specifically, after slight mobilization of the root using an elevator, a bur is used to widen the root canal and the special instrument is screwed into the root.

The root is then removed from the socket (Fig. 5.30), using the occlusal surface of the adjacent tooth as a fulcrum.
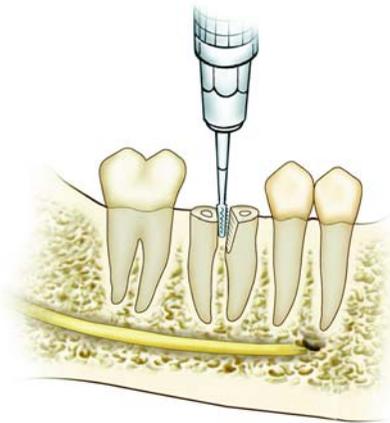
Fig. 5.31 a,b. Separation of roots of the mandibular first molar with fissure bur

5.5.3
Extraction of Multi-Rooted Teeth with Destroyed Crown

The extraction of roots of multi-rooted teeth whose crown is destroyed is impossible using extraction forceps or root tip forceps. In such cases, removal is accomplished after separating the roots using the procedure described below.

If the roots are above the alveolar bone, the roots are sectioned and separated after creating a deep perpendicular buccolingual groove using a fissure bur, which reaches the intraradicular bone (Fig. 5.31). The roots are then removed separately one at a time, using either root tip forceps or an elevator.

Sectioning may also be accomplished using the straight elevator, after placing its blade in the root bifurcation, with the concave surface of the instrument in contact with the distal root. At the same time, the fingers are placed as described for the extraction using an elevator, protecting the tissues from the sharp end of the blade in case the instrument slips (Figs. 5.32–5.34). The roots are separated employing rotational movements, while at the same time the distal root is elevated relatively easily from its socket (Figs. 5.35, 5.36). The mesial root may then be removed using the elevator with T-bar handles or the angled Seldin elevator. The elevator is placed so that the blade is positioned in the empty socket with its end facing the root. The intraradicular bone is removed first (if it is higher than the root) and then the tip of the elevator comes into contact with the root, which is removed after carefully applying rotational pressure upwards (Figs. 5.37, 5.38).

Fig. 5.32. Roots of mandibular first molar. Extraction is accomplished by sectioning roots using a straight elevator

Fig. 5.33. Clinical photograph of the radiograph shown in Fig. 5.32
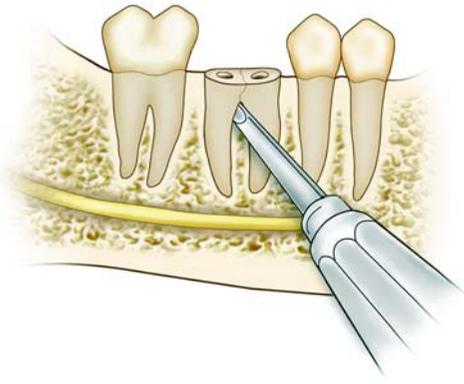
Fig. 5.34 a, b. Positioning of the elevator and the fingers of the left hand for separation of molar roots
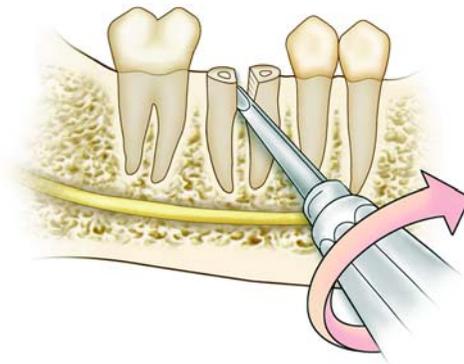
Fig. 5.35 a, b. Separation of roots with seating and rotation of the elevator at the bifurcation point
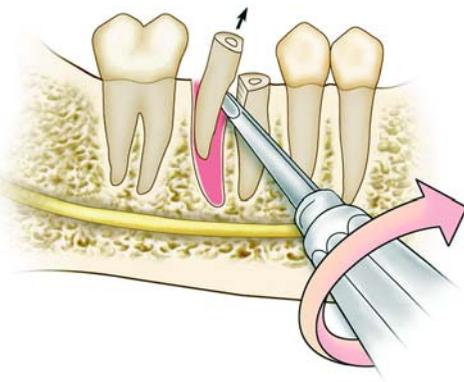
Fig. 5.36 a, b. Removal of distal root using a straight elevator
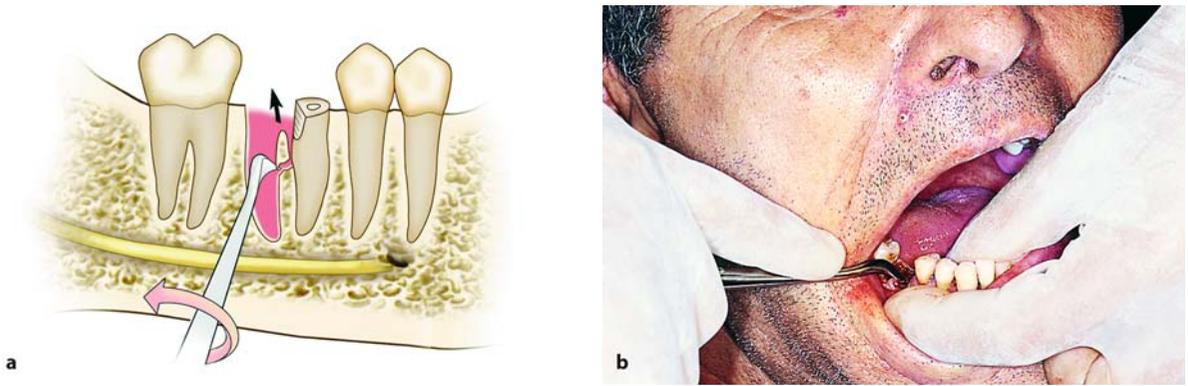
Fig. 5.37 a, b. Using an elevator with T-shaped handles to remove intraradicular bone
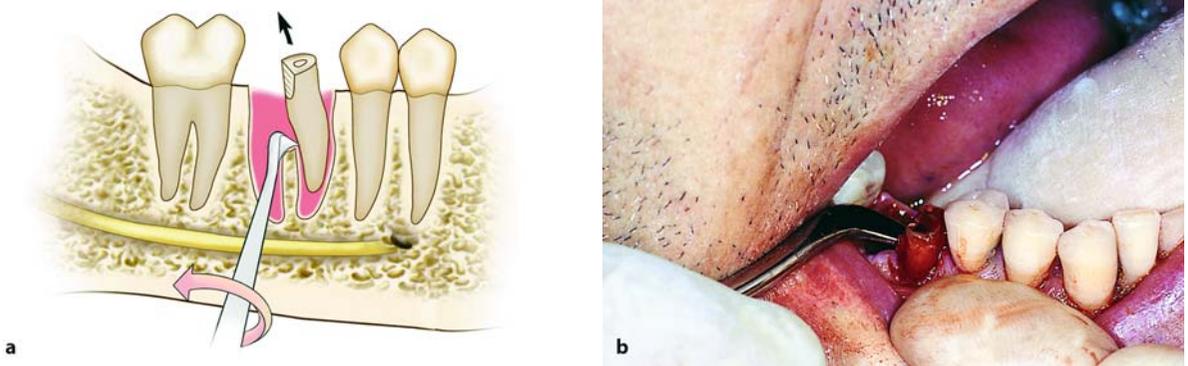
Fig. 5.38 a, b. Luxation of root with rotation of the elevator upwards

5.5.4
Extraction of Root Tips

In order to extract root tips from the maxilla and mandible, double-angled elevators are considered the most appropriate instruments, due to their sharp tip, which fits easily between the root tip and the alveolar bone, first mobilizing and then luxating the root tip from the socket (Fig. 5.39 a, b). In these cases, especially useful instruments are those that have very narrow blades of various shapes (straight, hooked, etc.). Their use is indicated for the removal of small root tips remaining at the bottom of the socket, since they may be placed in that area more easily than standard elevators.

The procedure for extracting a root tip is now described. When the root tip is very small and deep in the socket, a narrow angled elevator is placed between the alveolar bone and the root tip, and the instrument is pushed forward gently as apically as possible. Luxation is then attempted until the root tip is mobilized. If the root tip is not mobilized at all, attempts are continued on the mesial and distal aspects of the socket until the root tip is fully mobilized, upon which its removal is very easy. When the extraction involves a root tip of a maxillary or mandibular molar and the extraction proves difficult, part of the intraradicular bone is removed from inside the socket with a round bur or sharp instrument, creating room that will facilitate its luxation (Figs. 5.40 a, b, 5.41 a, b). If the root tip belongs to the palatal root, even though the extraction may be accomplished using the same procedure, the dentist must be especially careful, because there is an increased risk of displacing the root tip into the maxillary sinus. The root tip may also be removed with the aid of an endodontic file, which is first positioned inside the socket and then screwed into the root canal, upon which the root tip is delivered either by hand or with a needle holder (Fig. 5.42). When a needle holder is used, a protective gauze may be placed between it and the occlusal surface of the teeth on which it rests (Fig. 5.42 b).
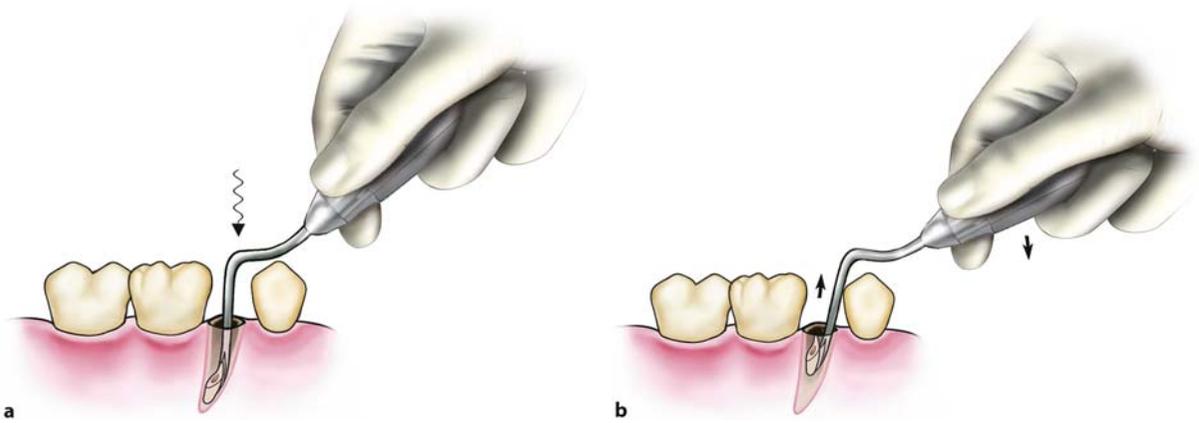
Fig. 5.39 a, b. Diagrammatic illustrations showing luxation of the root tip of the mandibular second premolar, using double-angled elevators
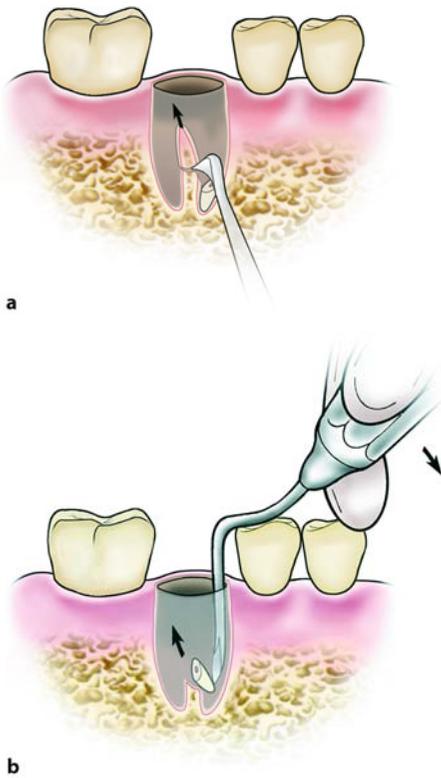
Fig. 5.40 a, b. Technique for removing the tip of a mesial root of a mandibular molar. Removal of intraradicular bone and luxation of the root tip using a double-angled elevator
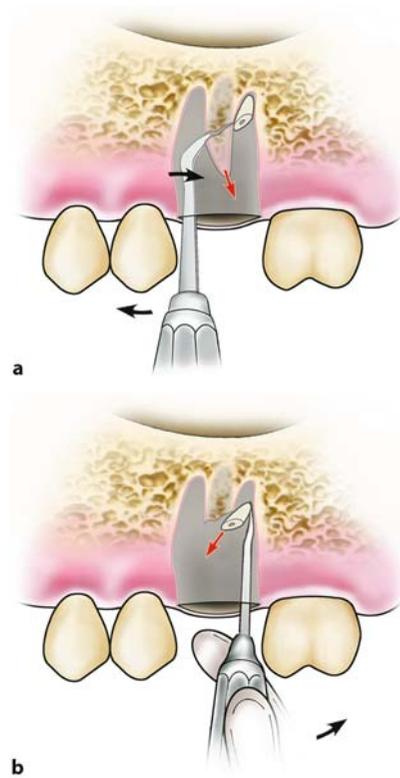
Fig. 5.41 a, b. Removal of the tip of the distal root of a maxillary molar, employing technique similar to that shown in Fig. 5.40
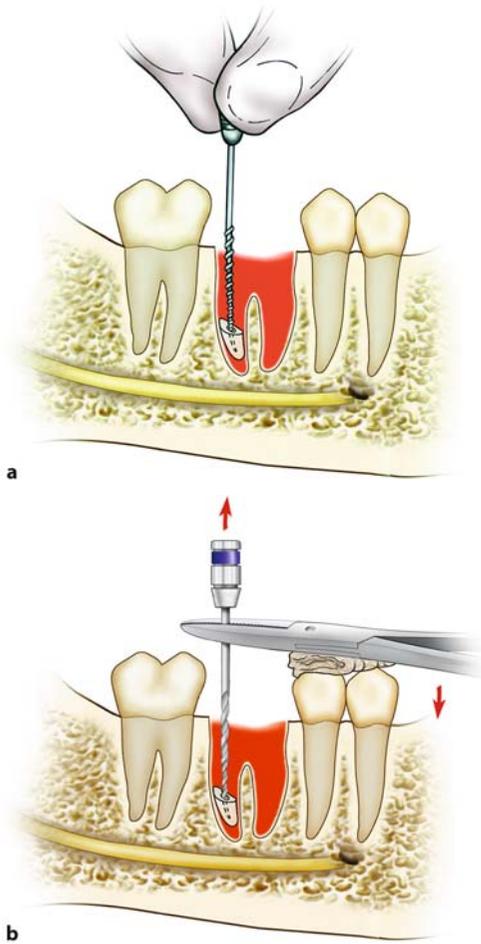
Fig. 5.42 a, b. Removal of the root tip using an endodontic file. After the endodontic file enters the root canal, the root tip is drawn upwards by hand (**a**), or with a needle holder (**b**)

Fig. 5.43. Curettage of the socket after tooth extraction for removal of the periapical lesion

Fig. 5.44. Root, together with firmly attached lesion at tip of root, right after extraction

5.6
Postextraction Care of Tooth Socket

After extraction of the tooth, the bottom of the socket is curetted (as long as the tooth is nonvital) with a periapical curette, to remove any periapical lesion from the area (Fig. 5.43). Curetting must be done carefully, because if any remnants of granulation tissue remain in the socket, there is a chance they will develop into a cyst, because a large percentage contain epithelial cells. Sometimes the lesion is firmly attached to the root tip of the tooth and is extracted together with the tooth (Fig. 5.44). Even in this case, the socket must be inspected, but only in the apical region. When the lesion is large and the entire lesion cannot be removed through the socket alone, then surgery is required.

Afterwards, and only if considered necessary (e.g., there are sharp bone edges), the alveolar margin is smoothed using rongeur forceps or a bone file, and then the lingual and buccal plates are compressed using finger pressure. This is done to restore the expansion of the socket caused by the extraction, and also for initial control of hemorrhage. Hemostasis is also aided by the patient applying pressure on gauze placed over the socket for 30–45 min.

5.7
Postoperative Instructions

After finishing the surgical procedure, oral and written instructions are given to the patient, concerning exactly what to do in the next few days. These instructions normally include the following:

- *Rest*: After surgery, the patient should stay at home and not go to work for 1 or 2 days, depending on the extent of the surgical wound and the patient's physical condition.
- *Analgesia*: Take a painkiller (but not salicylates, aspirin), every 4 h, for as long as the pain persists.
- *Edema*: After the surgical procedure, the extraoral placement of cold compresses (ice pack wrapped in a towel) over the surgical area is recommended. This should last for 10–15 min at a time, and be repeated every half hour, for at least 4–6 h.
- *Bleeding*: The patient must bite firmly on gauze placed over the wound for 30–45 min. In case bleeding continues, another gauze is placed over the wound for a further hour.
- *Antibiotics*: These are prescribed only if the patient has certain medical conditions or inflammation (see Chaps. 1 and 16).
- *Diet*: The patient's diet on the day of the surgical procedure must consist of cold, liquid foods (pudding, yogurt, milk, cold soup, orange juice, etc.).
- *Oral hygiene*: Rinsing the mouth is not allowed for the first 24 h. After this, the mouth may be rinsed with warm chamomile or salt water, three times a day for 3–4 days. The teeth should be brushed with a toothbrush and flossed, but the patient should avoid the area of surgery.
- *Removal of sutures*: If sutures were placed on the wound, the patient must have them removed a week later.

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Surgical Tooth Extraction

6

F. D. Fragiskos

Surgical extraction is the method by which a tooth is removed from its socket, after creating a flap and removing part of the bone that surrounds the tooth. This technique is relatively simple and within a general practitioner's scope if the basic principles of the surgical technique are followed.

6.1
Indications

The main indications for performing a surgical extraction are:

- Teeth of the maxilla or mandible that present unusual root morphology (Fig. 6.1). In such cases, a surgical extraction is performed preventively, because their removal is impossible with the simple technique without complications arising (e.g., root breaking, fracture of alveolar bone, etc.).
- Teeth with hypercementosis of root and root tip, presenting large bulbous roots (Figs. 6.2, 6.3).
- Teeth with dilaceration of root tips (Fig. 6.4).
- Teeth with ankylosed roots or with abnormalities, e.g., dens in dente (Fig. 6.5).
- Impacted and semi-impacted teeth (Fig. 6.6). The extraction of these teeth is accomplished employing a surgical technique, depending on the type and

localization of the impacted or semi-impacted tooth (see Chap. 7).

- Teeth fused with an adjacent tooth (Fig. 6.7a, b) or teeth fused with an adjacent tooth in the apical area (Fig. 6.8). If extraction were to be attempted using the simple technique in these unusual cases, then part of the alveolar process could be fractured or removed together with the teeth.
- Broken root tips that have remained in the alveolar bone (Fig. 6.9) and are involved in osteolytic lesions, or are in such a position that, in the case of denture placement, they could create problems in the future.
- Maxillary posterior teeth, whose roots are included in the maxillary sinus (Fig. 6.10). When the maxillary sinus extends as far as the alveolar ridge, the bone found in the posterior area of the maxilla is also weakened. This increases the risk of fracture of the maxillary tuberosity if the extraction involves a firmly anchored tooth (molar), because with the simple technique great forces are generated during its removal.
- Roots of teeth found below the gumline, when their removal is impossible any other way (Figs. 6.11, 6.12).
- Roots with periapical lesions, whose entire removal through the tooth socket would not be possible with curettage alone (Figs. 6.13–6.15).

Fig. 6.1. Teeth with unusual root morphology. Surgical technique is indicated for removal

Fig. 6.2. Radiograph showing maxillary premolar with hypercementosis at root tip

Fig. 6.3. Hypercementosis of root of mandibular second premolar

Fig. 6.4. Root tips of first and second premolar, with nearly right-angle curvature compared to long axis of teeth

Fig. 6.5. Dens in dente of maxillary left canine

Fig. 6.6. Semi-impacted mandibular third molar. Surgical technique is indicated for removal

Fig. 6.8. Maxillary second molar for which the surgical technique is indicated for removal. During the procedure the third molar would be removed as well, due to fusion of the two teeth in the apical area

Fig. 6.9. Radiograph showing root tips of mandibular third molar, which are close to the mandibular canal

Fig. 6.7 a,b. a Panoramic radiograph, showing fusion of two mandibular premolars. **b** The same fused teeth after their removal

- Deciduous molars whose roots embrace the crown of the subjacent premolar. If the simple extraction technique were to be attempted, there is a great risk of concurrent luxation of the premolar (Fig. 6.16).
- Posterior teeth with supraeruption. It is well known that when the antagonist is missing, these teeth present supraeruption to a great degree, which is accompanied by the dragging down of the alveolar process. As such, the extraction must be carried out using the surgical technique with concurrent re-contouring of the alveolar process of the area (see Chap. 10).

Fig. 6.10. Pneumatization of the maxillary sinus into the alveolar process of the edentulous area corresponding to the maxillary first molar

Fig. 6.11. Radiograph showing the mesial root of the mandibular first molar, entirely covered by bone
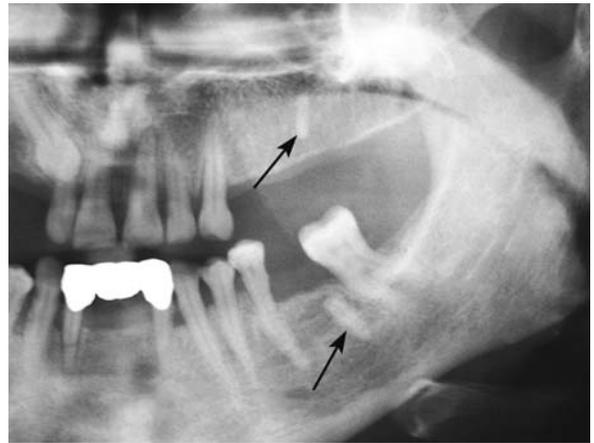
Fig. 6.12. Roots of maxillary and mandibular molars completely covered by bone

Fig. 6.13. Radiograph showing roots with large periapical lesions. Their removal is only possible with the surgical technique
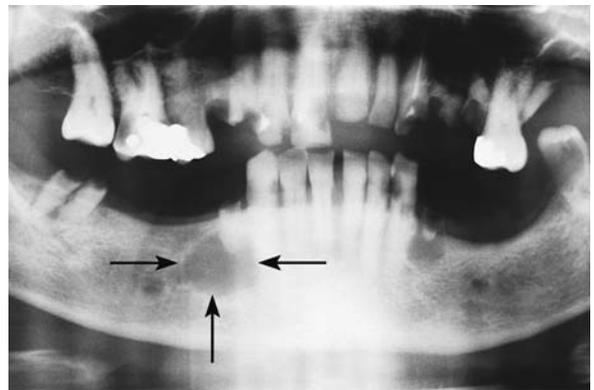
Fig. 6.14. Root of mandibular left first premolar, with extensive periapical lesion

Fig. 6.15. Root of 44 displaced into pathologic lesion, after unsuccessful removal attempt

Fig. 6.16. Deciduous mandibular molar, whose roots embrace the crown of the succedaneous premolar. Risk of concurrent luxation with the simple extraction technique

6.2
Contraindications

The contraindications for a surgical extraction are as follows:

- Asymptomatic fractured root tips, whose pulp was vital, located deep in the socket. The extraction of such root tips should not be considered, especially in older patients, when:
  - There is a risk of serious local complications, such as the dislodging of a root tip into the maxillary sinus or injury of the inferior alveolar nerve, mental nerve, or lingual nerve.
  - A large part of the alveolar process needs to be removed.
  - There are serious health problems present. If a patient with health problems needs to have a surgical extraction, then it must be performed with the cooperation of the treating physician and only if the general status of the patient has improved; the necessary preventive measures must also be taken.

6.3
Steps of Surgical Extraction

The surgical extraction techniques for single-rooted and multi-rooted teeth are similar, and include the following steps:

1. Creation of a flap.
2. Removal of bone and exposure of an adequate part of the root.
3. Extraction of the tooth or root with elevators or forceps.
4. Postoperative care of wound and suturing.

The surgical extraction involves teeth with intact crowns, roots and root tips, and presents certain characteristics in each of these cases.

6.4
Surgical Extraction of Teeth with Intact Crown

6.4.1
Extraction of Multi-Rooted Tooth

The removal of a single-rooted or multi-rooted tooth with an intact crown is achieved with the simple extraction technique and is usually very easy. There are certain situations, though, when the extraction requires a surgical approach, in order to avoid undesirable complications. The procedure for these cases is as follows. When the extraction involves a multi-rooted maxillary tooth, an envelope flap is created and the buccal plate is removed using a round bur, as far as the root bifurcation. The two buccal roots are sectioned after a groove is created using a fissure bur, and the crown together with the palatal root is then removed (Fig. 6.17). The two other roots are then removed separately, preferably using a straight elevator or root tip forceps.

6.4.2
Extraction of an Intact Tooth with Hypercementosis of the Root Tip

If an extraction is indicated for a tooth that has hypercementosis at the root tip, then it must be performed using the surgical technique. Otherwise, as already mentioned, fracture of the root tip is inevitable. The procedure used for such cases generally is described below:

- When the tooth to be extracted is single-rooted (Fig. 6.18 a), an L-shaped flap is initially created, and the bone covering the buccal surface of the root is then removed. The extraction is performed easily towards the buccal side that is no longer covered by bone, using forceps or elevators (Fig. 6.18 b).
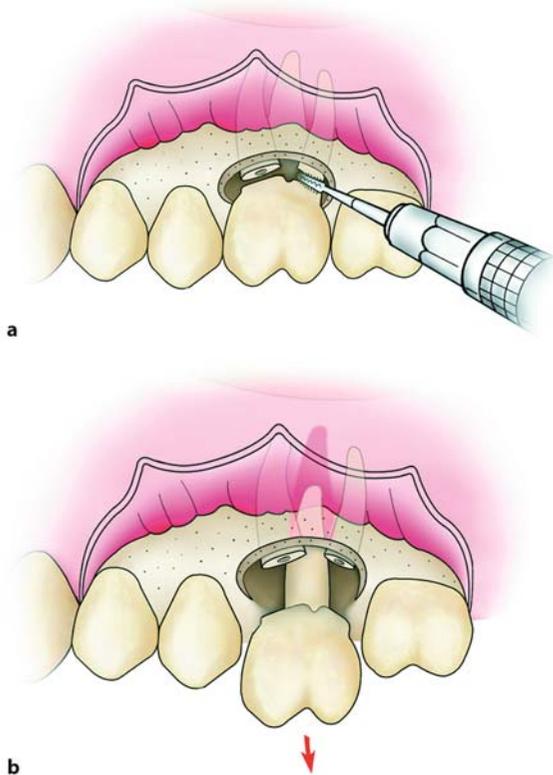
Fig. 6.17 a, b. Steps in the surgical extraction of an intact maxillary first molar. Reflection of the envelope flap, sectioning of two buccal roots from the crown (**a**), removal of the crown together with the palatal root, and then finally removal of the mesial and distal roots (**b**)

Fig. 6.18 a, b. Diagrammatic illustrations showing the steps in the surgical extraction of a single-rooted tooth with hypercementosis at the root tip. An L-shaped incision is made and the flap is reflected. The buccal plate covering the surface of the root is removed, and the tooth is extracted using forceps

● When the tooth to be extracted is multi-rooted with hypercementosis at the root tip (Fig. 6.19 a), at first an envelope flap is created, and the buccal bone is removed to just below the root bifurcation. The roots are separated, after a vertical groove is created on the crown of the tooth using a fissure bur, which extends as far as the intraradicular bone (Fig. 6.19 b). After this procedure, the mesial part is removed first (root and crown) using forceps or an elevator (Fig. 6.20). Afterwards, the intraradicular bone is removed using a round bur, and the socket is widened along the length of the root (Fig. 6.21). After this widening, the distal part, which includes the bulbous root tip, is easily removed using forceps, a straight elevator or an elevator with T-shaped handles (Fig. 6.22).

a

Fig. 6.20. Extraction of the mesial portion of the tooth, which includes the crown and root
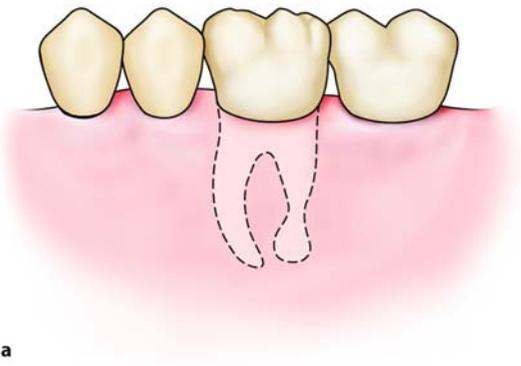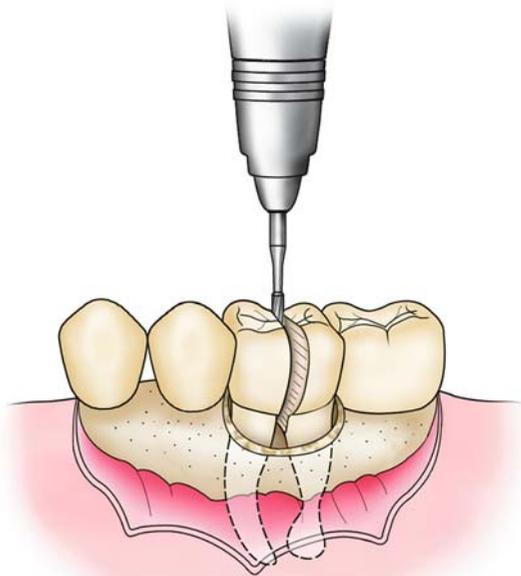
b

Fig. 6.19 a, b. Surgical extraction of a mandibular molar with hypercementosis at the distal root tip. The envelope flap is reflected, part of the buccal plate is removed, and the tooth is sectioned buccolingually at the crown as far as the intraradicular bone
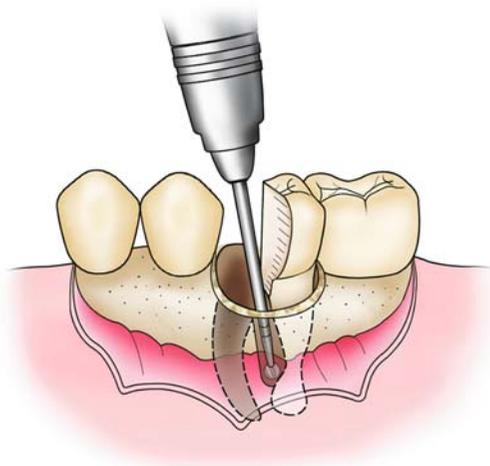
Fig. 6.21. Widening of the alveolus with a round bur, so that removal of the root is possible without fracturing the bulbous root tip
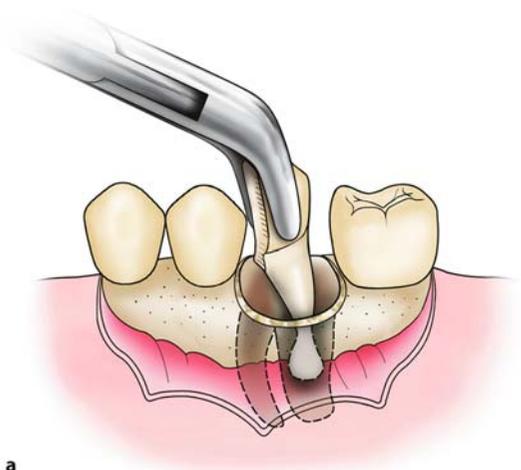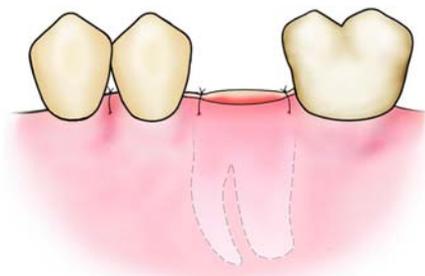
Fig. 6.22 a, b. a Extraction of the distal portion of the tooth using forceps after creating a pathway for removal. **b** Suturing of the flap using interrupted sutures

a

b

6.4.3
Extraction of Deciduous Molar that Embraces Crown of Permanent Tooth

If an extraction is indicated for a deciduous molar and if examination of the radiograph reveals that the roots of the deciduous molar embrace the crown of the succedaneous premolar (Fig. 6.23), it must be removed surgically using the following steps. First an envelope flap is created and then buccal bone is removed as far as the root bifurcation using a round bur (Fig. 6.24). Afterwards, the roots are separated with a vertical deep groove on the crown of the tooth using a fissure bur, and the distal part of the tooth is first removed using forceps, and then the mesial part (Figs. 6.25–6.27). The flap is repositioned and sutured using interrupted sutures (Fig. 6.28).

Fig. 6.23. Deciduous molar, whose roots embrace the crown of the succedaneous premolar
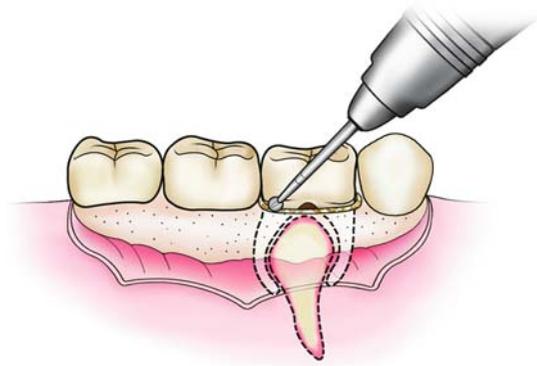
Fig. 6.24. Envelope flap created and bone removed as far as the root bifurcation
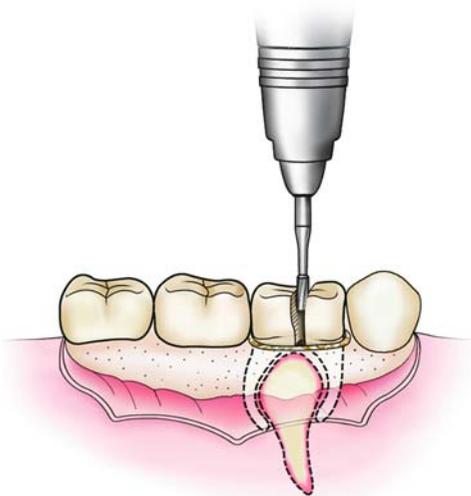
Fig. 6.25. Roots of the molar sectioned with a perpendicular groove on the crown, which extends as far as the intraradicular bone
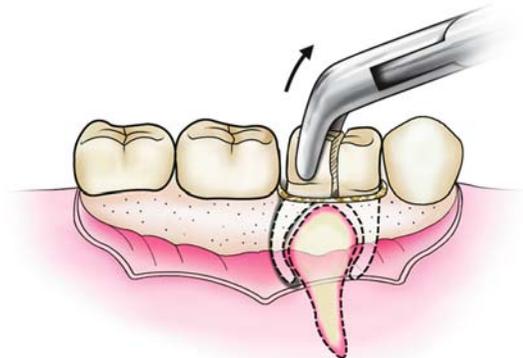
Fig. 6.26. Removal of the distal portion of the tooth, which includes the crown and root, using forceps
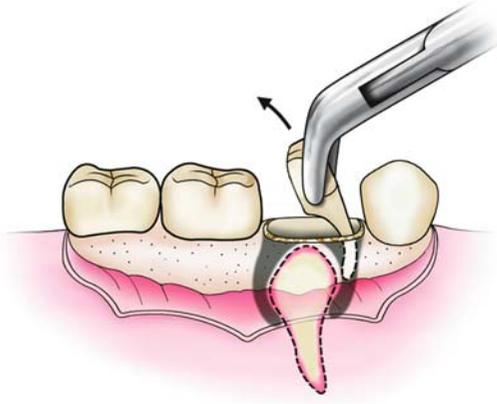
Fig. 6.27. Removal of the mesial portion of the tooth, which includes the crown and root

Fig. 6.28. Suturing of the flap with interrupted sutures

6.4.4
Extraction of Ankylosed Tooth

In the case of ankylosis of the tooth, and especially if dental dysplasia is also present (e.g., dens in dente), as shown in Fig. 6.29, the simple technique to extract the tooth must not be attempted, because there is a risk of fracturing a large part of the buccal alveolar bone. The technique used to remove the tooth is usually as follows. After the creation of a trapezoidal flap, the buccal bone is removed around the tooth using a fissure bur. Using a chisel, the tooth is then carefully removed together with the ankylosed portion of the buccal alveolar bone. The socket is cared for and suturing of the flap follows (Figs. 6.30–6.33).

Fig. 6.29 a,b. Radiograph (**a**) and clinical photograph (**b**) of a maxillary canine with dens in dente. A surgical technique is indicated for its removal

Fig. 6.30. A trapezoidal flap is created, which extends from the lateral incisor as far as the distal aspect of the maxillary first premolar
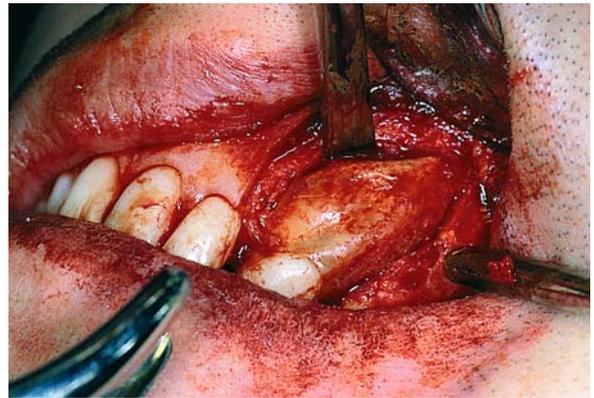
Fig. 6.31. Use of a chisel to remove the tooth, together with the ankylosed portion of the labial plate
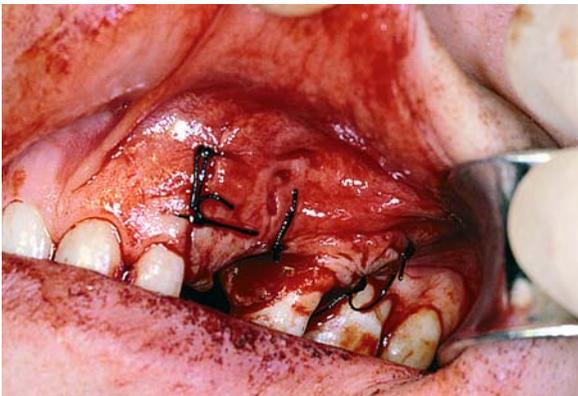
Fig. 6.32. Operation site after placement of sutures

Fig. 6.33. Tooth after removal, with a portion of bone on the labial surface

6.5
Surgical Extraction of Roots

There are various surgical techniques for root removal, as listed below:

- Removal of part of the buccal bone for luxation of the root buccally.
- The opening of a window on the buccal bone for removal of the root through the socket or through the window itself.
- Creation of a groove on the surface of the root (to be used as a purchase point for positioning the elevator), after removal of a small amount of buccal bone.
- Creation of a groove between the root and bone, which allows for positioning of the elevator.

Each of the aforementioned techniques is described in detail below.

6.5.1
Root Extraction After Removal of Part of the Buccal Bone

When the tooth is single-rooted and the level of the root is below the margin of alveolar bone (Figs. 6.34, 6.35), an L-shaped incision is made (Fig. 6.36), the flap is reflected (Fig. 6.37), and a large part of the buccal bone is removed using a round bur until the root is exposed (Figs. 6.38a, b). The root is then luxated using a straight elevator, which is placed palatally in the gingival sulcus (when it involves the maxilla). The root is mobilized easily, using rotational movements with the elevator and applying a small amount of pressure outwards (Figs. 6.39, 6.40). After smoothing the bone margins, the surgical field is irrigated with saline solution and, after repositioning the flap, the wound is sutured (Figs. 6.41, 6.42).
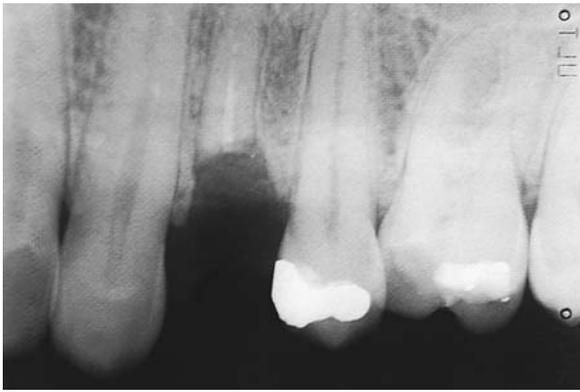
Fig. 6.34. Radiograph of the root of a maxillary first premolar. The surgical technique is indicated for its removal

Fig. 6.35. Clinical photograph of the case shown in Fig. 6.34
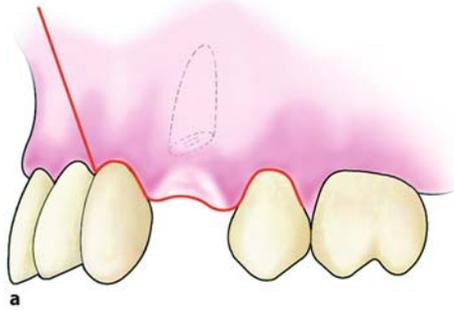
Fig. 6.36. Creation of an L-shaped incision, which extends from the mesial aspect of the canine as far as the distal aspect of the second premolar
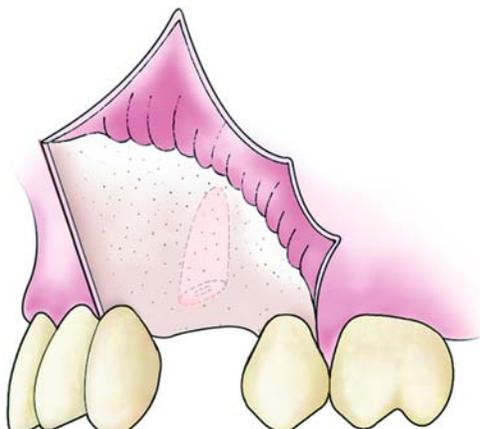
Fig. 6.37 a, b. Reflection of the flap. **a** Diagrammatic illustration. **b** Clinical photograph
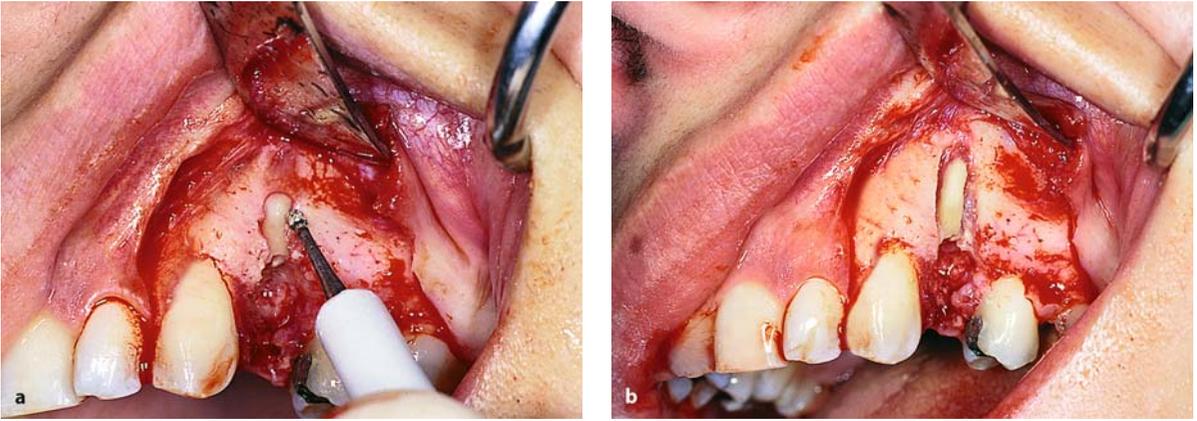
Fig. 6.38 a, b. a Removal of the buccal plate along the length of the root using a round bur. **b** The root is exposed after bone removal. This technique is employed in cases where ankylosis is present along the entire root surface
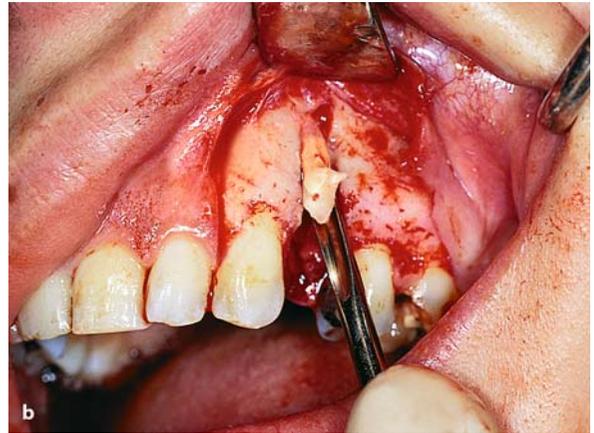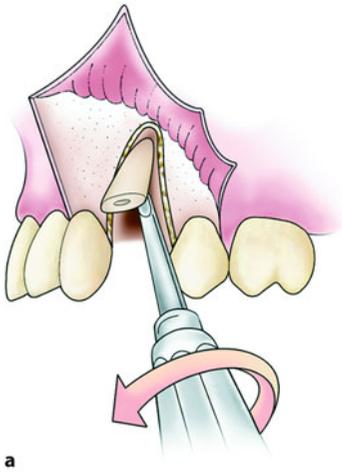
Fig. 6.39 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) of luxation of the root in the outward direction using a straight elevator

Fig. 6.40. Surgical field at the end of the operation

Fig. 6.41. Smoothing of bone margins of the wound using a bone file
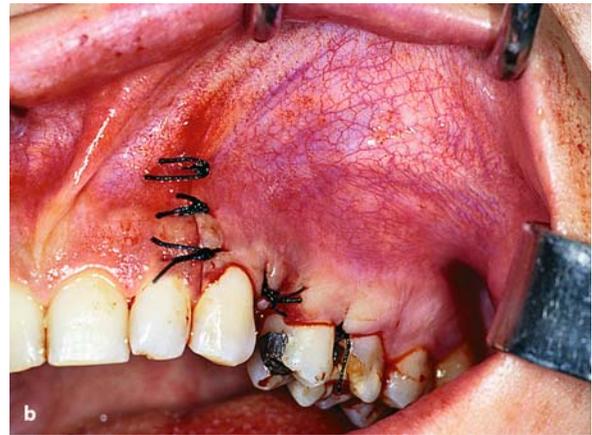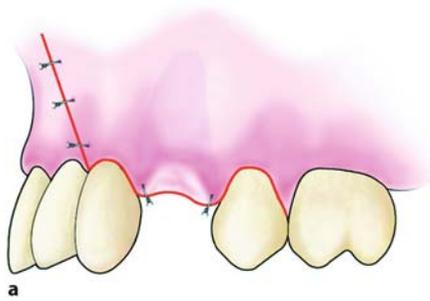
Fig. 6.42 a, b. Operation site after suturing. Diagrammatic illustration (**a**) and clinical photograph (**b**)
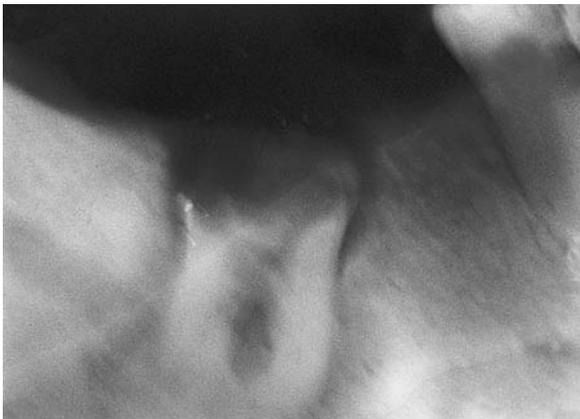
Fig. 6.43. Radiograph of roots of the mandibular first molar. The surgical technique is indicated for their removal

Fig. 6.44. Clinical photograph of the case shown in Fig. 6.43. The roots are located at the point shown by the *arrow*

When the tooth has two roots and the roots are below the level of the margin of the alveolar process without being separated (Figs. 6.43, 6.44), the extraction is performed as follows. First an envelope flap is created, one or two teeth at most, beyond the root to be removed (Figs. 6.45 a, b). Then part of the buccal bone is removed using a round bur, until the root bifurcation is exposed. The roots are sectioned using a fissure bur and are removed with a straight elevator (Figs. 6.46 a, b, 6.47). The socket is then cared for accordingly and sutures are placed.
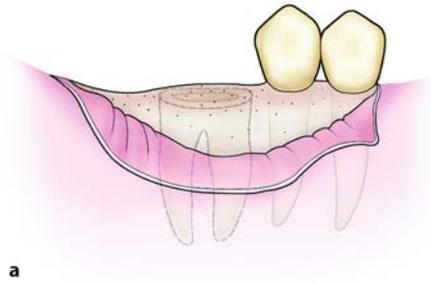
Fig. 6.45 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) showing the creation of an envelope flap to expose the roots
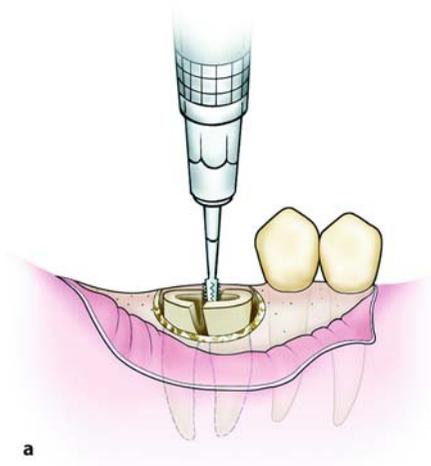
Fig. 6.46 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) showing the removal of the buccal plate as far as the root bifurcation. Roots are separated using a fissure bur in the buccolingual direction
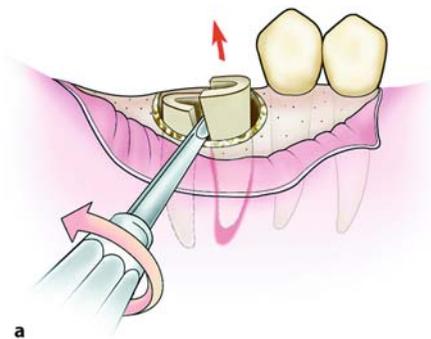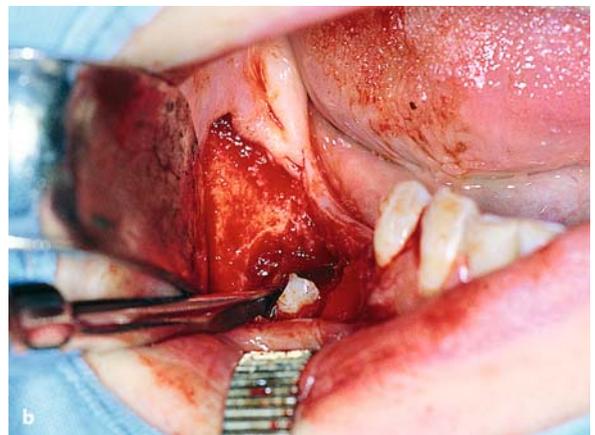
Fig. 6.47 a,b. Luxation of roots after sectioning. **a** Diagrammatic illustration. **b** Clinical photograph

6.5.2
Extraction of Root after a Window is Created on Buccal Bone

This technique is indicated for the removal of roots immediately after their fracture (Figs. 6.48, 6.49), so that the buccal bone remains intact. The procedure in this case is as follows. After making an L-shaped incision, the flap is reflected and a small window is created, using a round bur, with constant irrigation using saline solution, on the buccal bone, corresponding to the tip of the fractured root (Figs. 6.50–6.52). The window is then enlarged, and enough of the root is exposed to allow its displacement from the socket us-

ing a narrow-angled elevator (Figs. 6.53, 6.54). After removal of the root, the socket is cared for and interrupted sutures are placed (Fig. 6.55).

The root may also be removed though the window itself that was created on the buccal bone using the previously mentioned technique. Depending on the case, a trapezoidal or semilunar flap is created and complete or partial exposure of the root follows (Figs. 6.56–6.60). The root is then removed from the bone deficit without difficulty, preferably using a narrow-angled elevator (Figs. 6.61–6.64). This technique is usually used in cases of fractured small roots, which were not removed during the extraction procedure but remained in the socket for a long time and were eventually totally covered by bone.

Fig. 6.48. Radiograph of the root of a maxillary first premolar. The open window technique on buccal alveolar bone is indicated for its extraction

Fig. 6.49. Clinical photograph of the case shown in Fig. 6.48, immediately after fracture of the root
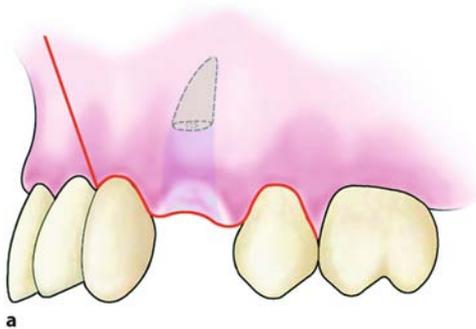
Fig. 6.50 a, b. L-shaped incision, which extends from the mesial aspect of the canine as far as the distal aspect of the second premolar. **a** Diagrammatic illustration. **b** Clinical photograph
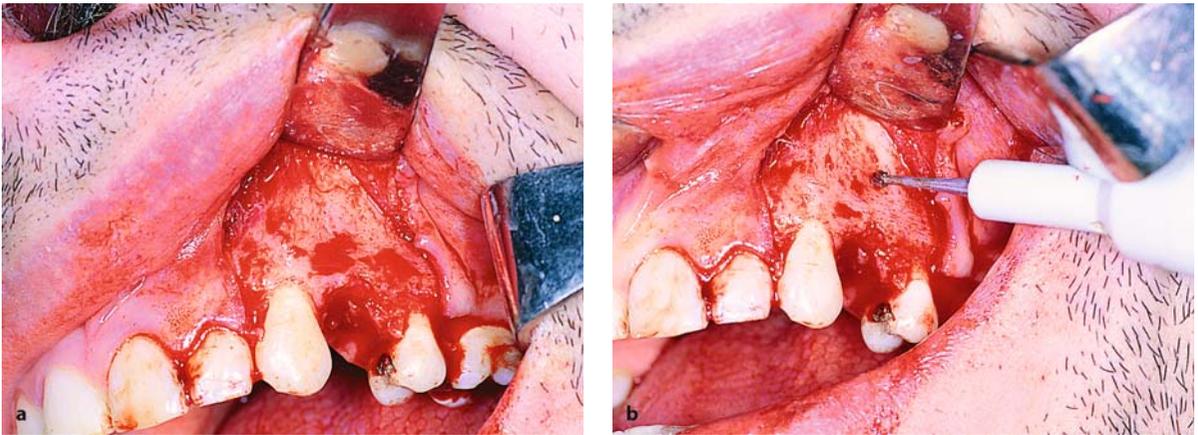
Fig. 6.51 a, b. Reflection of the flap (**a**) and removal of bone at the apex of the tooth (**b**)
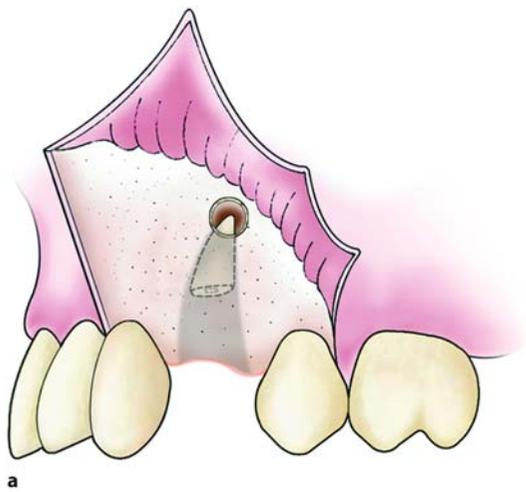
Fig. 6.52 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**). Removal of bone and part of the apex of the tooth are shown
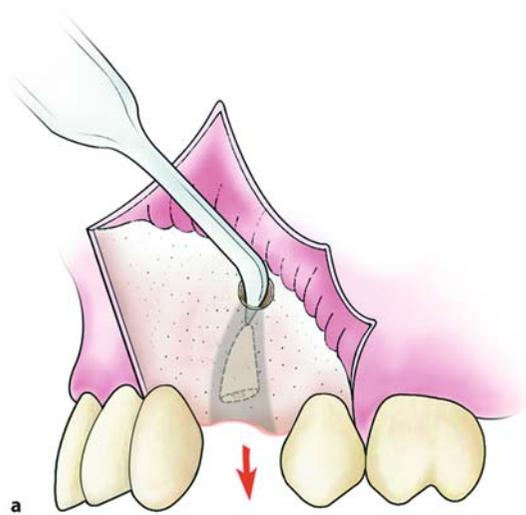
Fig. 6.53 a, b. Elevator positioned at the tip of the root, which is delivered from the socket. **a** Diagrammatic illustration. **b** Clinical photograph
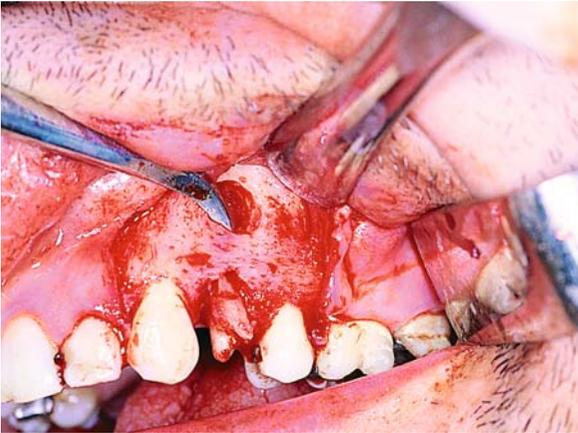
Fig. 6.54. Final step in root extraction from the socket

Fig. 6.55. Operation site after placement of sutures

Fig. 6.56. Periapical radiograph of the root of the maxillary first premolar. A surgical extraction is indicated due to complete osseous coverage

Fig. 6.57. Clinical photograph of the case shown in Fig. 6.56
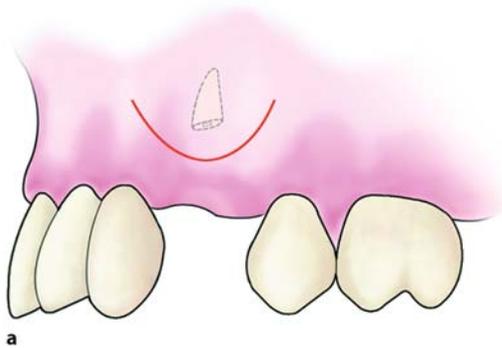
Fig. 6.58 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) of the semilunar incision created between the canine and first premolar
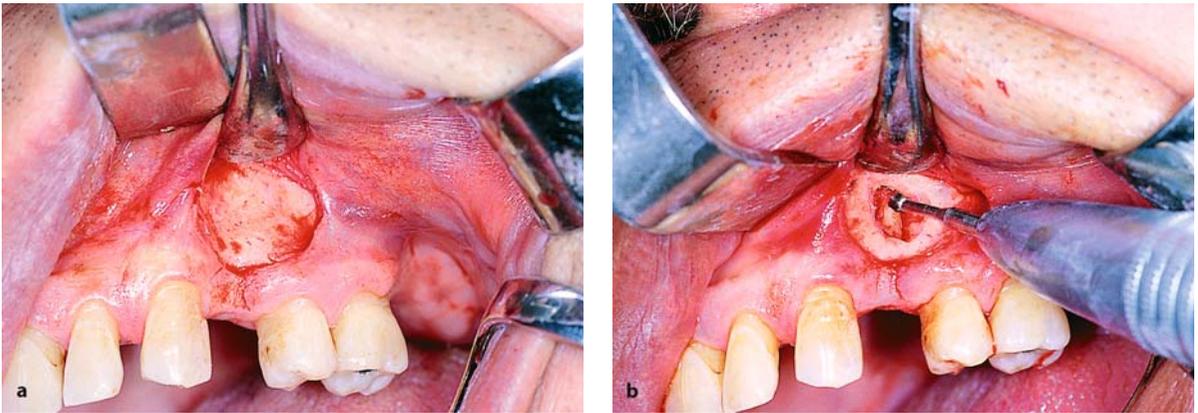
Fig. 6.59 a, b. Creation of flap (**a**) and removal of part of the buccal plate (**b**), corresponding to the area where the root is located
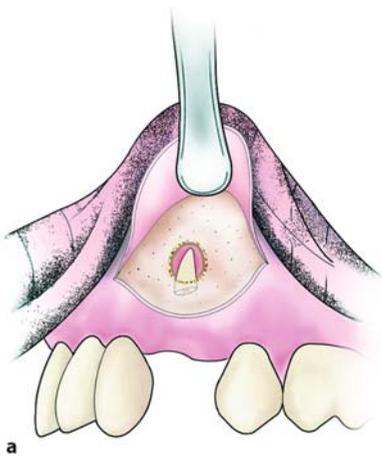
Fig. 6.60 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) after removal of the buccal plate and exposure of the root
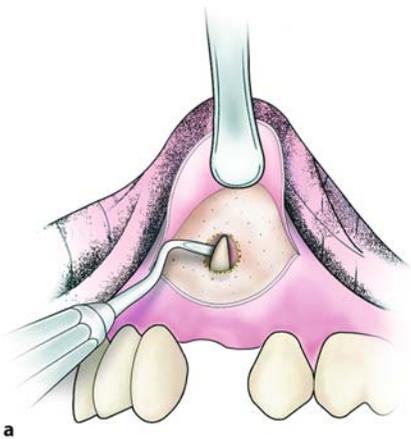
Fig. 6.61 a, b. Removal of the root from the osseous window using double-angled elevator. **a** Diagrammatic illustration. **b** Clinical photograph
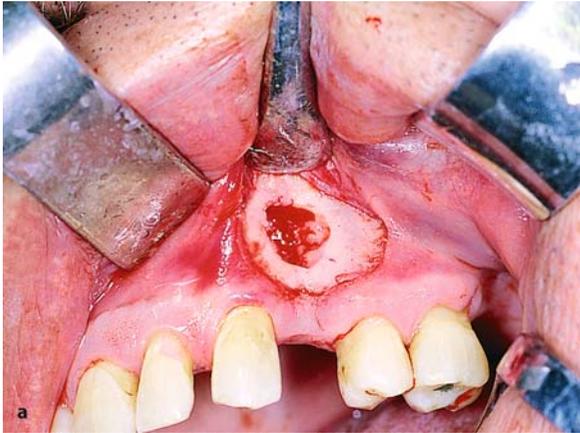
Fig. 6.62 a, b. **a** Surgical field at the end of the operation. **b** Root after removal

Fig. 6.63. Stabilization of the flap in its initial position with placement of the first suture at the center of the semilunar incision
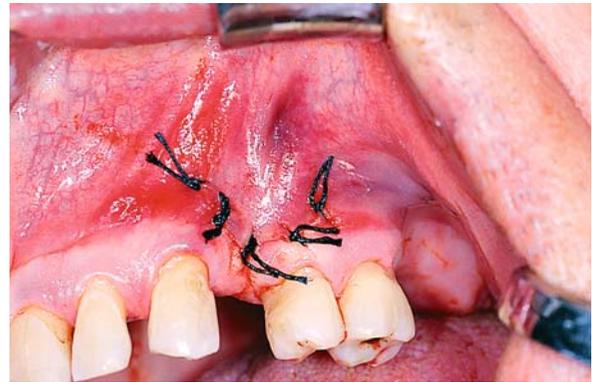
Fig. 6.64. Operation site after suturing

6.5.3
Creation of Groove on Surface of Root, after Removal of Small Amount of Buccal Bone

This technique is used for roots beneath the margin of the alveolar process. First, an envelope flap is reflected and a small amount of buccal bone is removed, until part of the root is exposed. A groove is then created on its surface, which serves as a purchase point for positioning of the blade of the double-angled elevator, to luxate the root outwards with appropriate movements (Fig. 6.65 a, b). This technique is used primarily in the mandible, where the buccal bone, which in this case serves as a fulcrum, is dense and able to withstand applied pressure, as opposed to the maxilla.

6.5.4
Creation of a Groove Between Root and Bone, Which Allows Positioning of the Elevator

This technique is used for the roots of posterior mandibular teeth, where the buccal bone, because of the external oblique ridge, is dense and hard. After reflecting an envelope flap in these cases, a groove is created using a round bur between the buccal bone and the root, which makes enough room to allow for the positioning of the elevator. The blade of the T-shaped elevator or of the Seldin elevator is then seated in the groove, which luxates the root upwards, using the external oblique ridge as a fulcrum (Fig. 6.66 a, b).
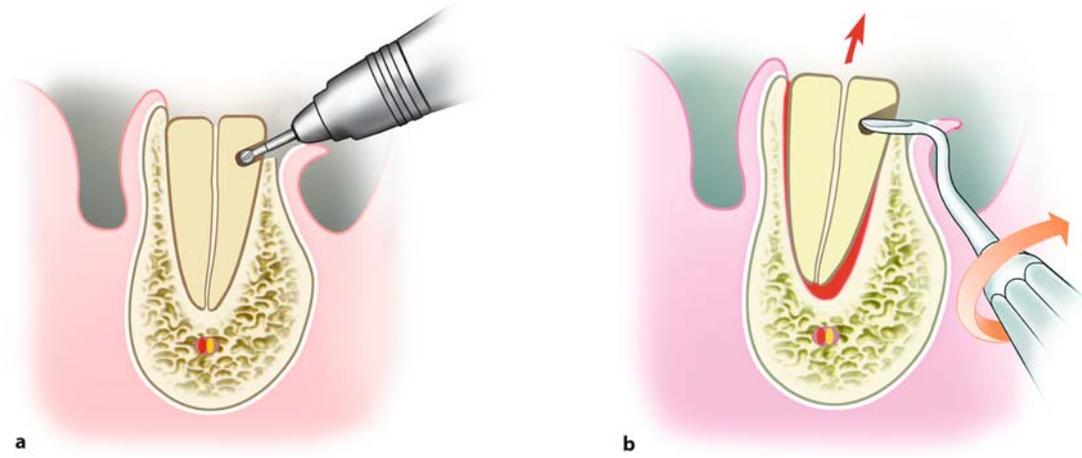
Fig. 6.65 a, b.   a Small portion of the buccal plate is removed and a groove created at the surface of the root, at a 45° angle to the long axis of the tooth. **b** Placement of the double-angled elevator in the purchase point of the root for luxation
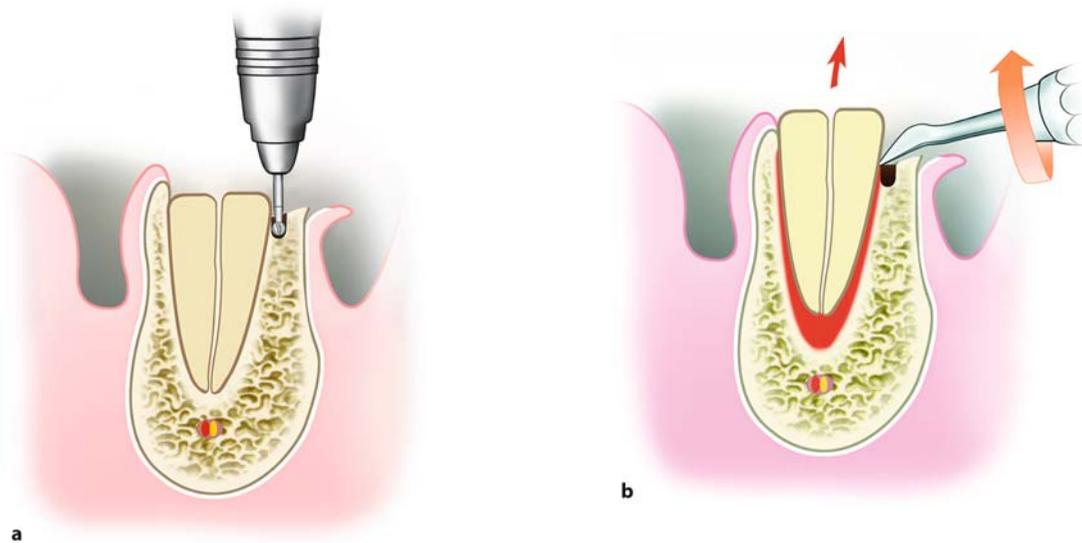
Fig. 6.66 a, b.   a Groove created between the root and buccal bone for elevator placement. **b** Luxation of the root with angled Seldin elevator

6.6
Surgical Extraction of Root Tips

When a root tip is fractured deep in the socket and is impossible to remove with simple luxation, its removal may be accomplished using one of the aforementioned techniques for removal of roots, depending on the situation.

The dentist must pay particular attention when removing root tips that have been dislodged towards the maxillary sinus.

When a root or root tip of a posterior maxillary tooth is fractured and displaced into the maxillary sinus during the luxation attempt, it is a serious complication and must be dealt with as soon as possible. In order to avoid such a possibility, before any extraction of a posterior maxillary tooth, radiographs must be examined carefully to determine how close the root tips are to the maxillary sinus.

This close proximity is usually observed when the maxillary sinus is pneumatized into the alveolar process between the root tips of molars and especially when there are periapical lesions that are in contact with the lower surface of the maxillary sinus. In cases

such as these, if a root tip is fractured, it may be displaced into the maxillary sinus fairly easily if movements during the luxation attempt are not gentle and if special narrow instruments are not used.

6.6.1
Surgical Technique

If the root tip has actually been displaced into the maxillary sinus, the patient is informed at once about the situation and a new appointment is scheduled so that removal of the root tip and closure of the oroantral communication are accomplished in the same session. If the dentist doubts his or her ability to treat the complication, then the patient should be referred to a special surgeon. The procedure in this case is as follows. After radiographic confirmation and precise localization of the root tip in the maxillary sinus (Figs. 6.67, 6.68), a straight incision is made, which begins at the canine and ends in a trapezoidal shape, including the postextraction socket (Fig. 6.69). After reflection of the flap, access to the maxillary sinus is accomplished by opening a window at the buccal bone (Figs. 6.70, 6.71). The mucosa of the maxillary sinus is then incised using a scalpel, and after the root tip is localized following inspection of the area, the root tip is removed using the suction or anatomic forceps (Figs. 6.72, 6.73). If there is granulation tissue in the area of the fistula, it is removed using a periapical curette through the aperture in the maxillary sinus and through the socket itself (Fig. 6.74). Immediately after removal of the root tip, closure of the oroantral communication follows. More specifically, the existing
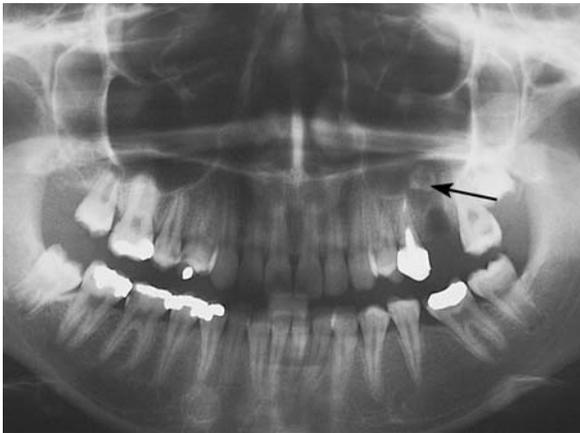
Fig. 6.67. Panoramic radiograph showing the root tip of the first molar displaced into the maxillary sinus

Fig. 6.68. Clinical photograph of the case shown in Fig. 6.67
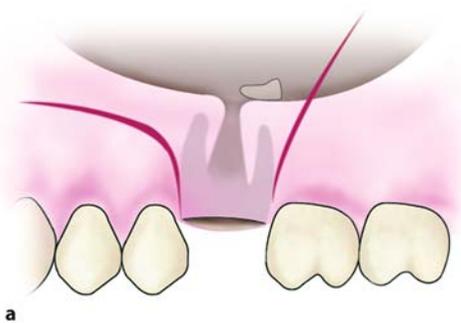
Fig. 6.69 a, b. Surgical procedure for removal of a root tip from the maxillary sinus and closure of the oroantral communication in the same surgical session. Incision for creation of the appropriate flap. **a** Diagrammatic illustration. **b** Clinical photograph
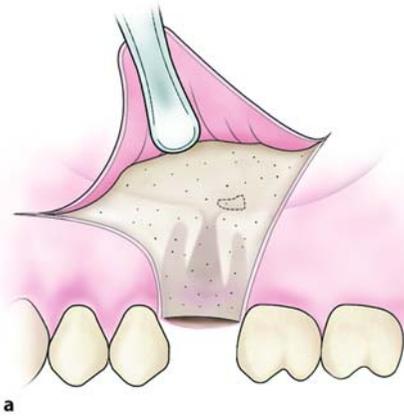
Fig. 6.70 a, b. Reflection of flap and removal of bone to allow access to the maxillary sinus. **a** Diagrammatic illustration. **b** Clinical photograph
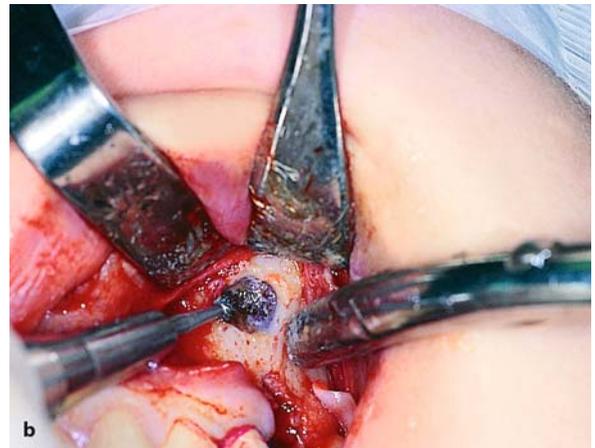
Fig. 6.71 a, b. Access to the maxillary sinus above the postextraction socket. The antral mucosa is revealed through the created aperture. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 6.72 a, b. Maxillary sinus opened with incision in mucosa. **a** Diagrammatic illustration. **b** Clinical photograph
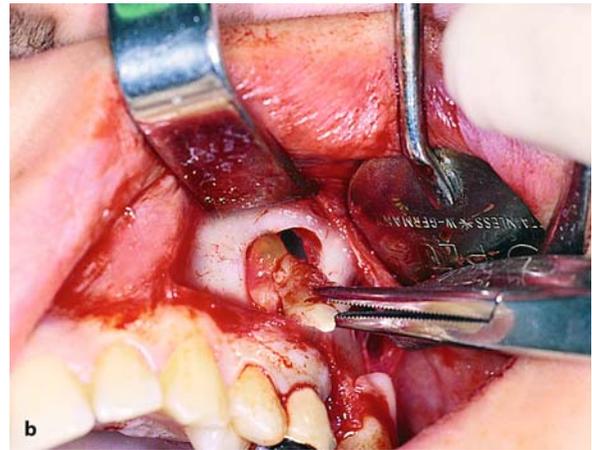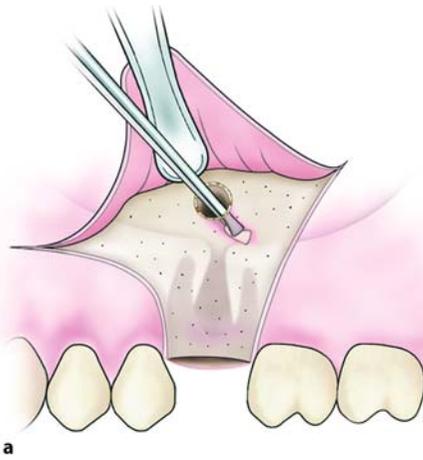
Fig. 6.73 a, b. Removal of root tip from the maxillary sinus together with a portion of mucosa found above and around the orifice of the communication. **a** Diagrammatic illustration. **b** Clinical photograph
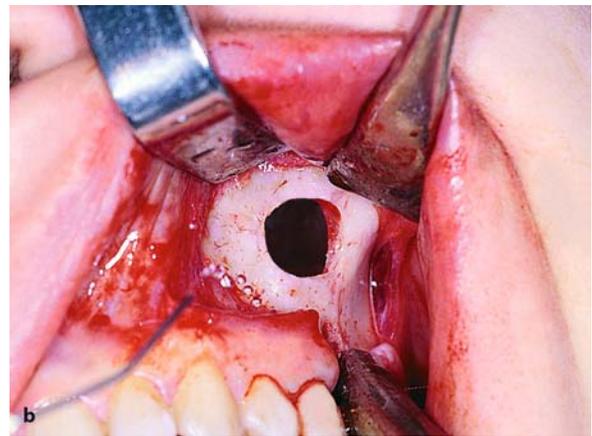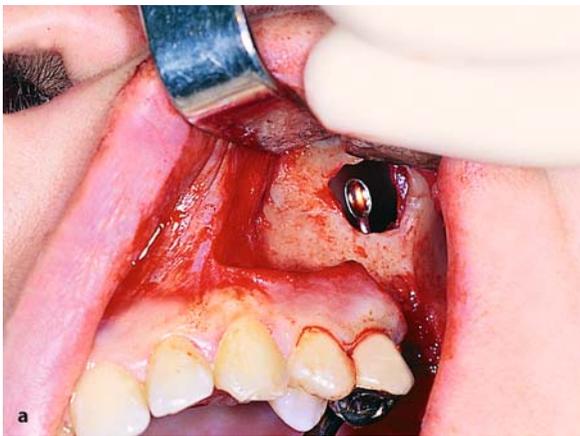
Fig. 6.74 a, b. **a** Periapical curette used to examine if inflammatory tissue has been removed from the area through the socket. **b** Surgical field at the end of the operation
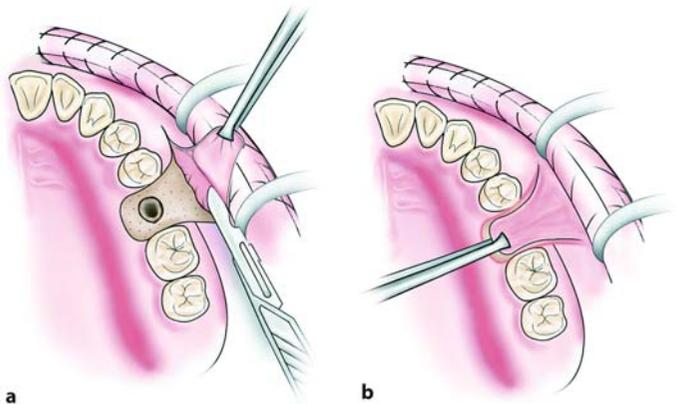
Fig. 6.75 a, b. **a** Horizontal incision of the periosteum at the base and center of the flap to ensure elasticity, so that it is adequate to cover the fistula. **b** Examination of the flap's elasticity with traction towards the suturing position

trapezoidal flap is lengthened with a horizontal incision of the periosteum at the middle and the base of the flap, so that the flap is big enough to cover the fis-

tula (Fig. 6.75 a, b). The bone edges of the wound are then smoothed and the flap is repositioned and sutured with the palatal soft tissues, which have already
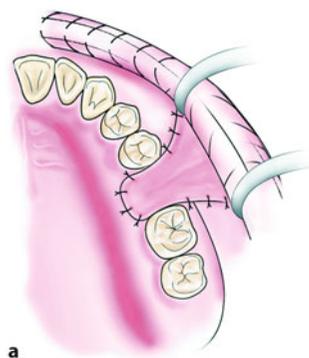
Fig. 6.76 a, b. Stabilization of the flap over the postextraction socket with sutures. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 6.77 a, b. Clinical photograph (**a**) and radiograph (**b**) 2 months after the surgical procedure

been reflected and debrided (Fig. 6.76). Postoperative care includes administration of broad-spectrum antibiotics and decongestants of the nasal mucosa (0.1% xylometazoline spray or solution) for approximately 1 week. The sutures are removed 10 days after the surgical procedure and the patient returns for a postoperative check-up about 2 months later (Fig. 6.77 a, b).

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Surgical Extraction of Impacted Teeth

7

F. D. Fragiskos

Of the surgical procedures performed in the oral cavity, the removal of impacted and semi-impacted teeth is the most common. The extraction of these teeth, depending on their localization, may prove to be relatively easy or extremely difficult and laborious. Regardless of the degree of difficulty of the surgical procedure though, its success primarily depends on correct preoperative evaluation and planning, as well as on the treatment of complications that may arise during the procedure, or the management of complications that may present after the surgical procedure. For these reasons, a medical history, clinical examination of the patient, and radiographic evaluation of the area surrounding the impacted tooth are deemed necessary.

7.1
Medical History

A detailed medical history is necessary because, based on the information provided in Chap. 1, useful information may be found concerning the general health of the patient to be operated on. This information determines the preoperative preparation of the patient, as well as the postoperative care instructions.

7.2
Clinical Examination

During the intraoral clinical examination, the degree of difficulty of access to the tooth is determined, especially concerning impacted third molars. When the patient cannot open his or her mouth, because of trismus that is mainly due to inflammation, the trismus is treated first, and extraction of the third molar is performed at a later date. In certain cases of impacted teeth, especially canines, buccal or palatal protuberance may be observed during palpation or even inspection, which suggests that the impacted tooth is located underneath. Also, the adjacent teeth are examined and inspected (extensive caries, large amalgam restorations, prosthetic appliance, etc.) to ensure their integrity during manipulations with various instruments during the extraction procedure.

7.3
Radiographic Examination

The radiographic examination provides us with all the necessary information to program and correctly plan the surgical removal of impacted teeth. This information includes: position and type of impaction, relationship of impacted tooth to adjacent teeth, size and shape of impacted tooth, depth of impaction in bone, density of bone surrounding impacted tooth, and the relationship of the impacted tooth to various anatomic structures, such as the mandibular canal, mental foramen, and the maxillary sinus. These aforementioned data may also be provided by periapical radiographs and panoramic radiographs, as well as occlusal radiographs (see Chap. 2).

7.4
Indications for Extraction

Specialists have divergent points of view concerning the necessity to extract impacted teeth.

Certain people suggest that the removal of impacted teeth is necessary as soon as their presence is confirmed, which is usually by chance. They even believe that it must be done as soon as possible, as long as there is no possibility that the impacted tooth may be brought into alignment in the dental arch using a combination of orthodontic and surgical techniques. On the other hand, others suggest that the preventive removal of asymptomatic impacted teeth, besides subjecting the patient to undue discomfort, entails the risk of causing serious local complications (e.g., nerve damage, displacement of the tooth into the maxillary sinus, fracture of the maxillary tuberosity, loss of support of adjacent teeth, etc.). As far as impacted teeth that have already caused problems are concerned,
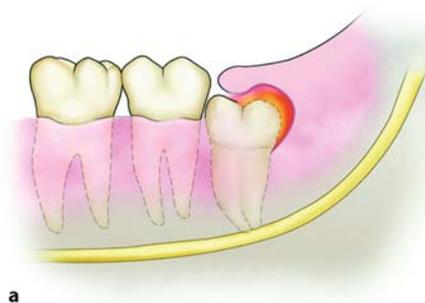
Fig. 7.1 a, b. Pericoronitis in a semi-impacted mandibular third molar. **a** Diagrammatic illustration showing inflammation under the operculum and distal to the crown of the tooth. **b** Clinical photograph. Characteristic swelling of the operculum due to constant biting from the antagonist

everyone agrees that they should be removed, regardless of the degree of difficulty of the surgical procedure. The most common of these problems are now given.

Localized or Generalized Neuralgias of the Head. Impacted teeth may be responsible for a variety of symptoms related to headaches and various types of neuralgias. If this is the case, the pain may be due to pressure exerted by the impacted tooth where it comes into contact with many nerve endings. Many people suggest that the symptoms may subside after the removal of the offending tooth, which basically involves ectopic impacted teeth.

Pericoronitis. This is an acute infection of the soft tissues covering the semi-impacted tooth and the associated follicle (Fig. 7.1). This condition may be due to injury of the operculum (soft tissues covering the tooth) by the antagonist third molar or because of entrapment of food under the operculum, resulting in bacterial invasion and infection of the area. After inflammation occurs, it remains permanent and causes acute episodes from time to time. It presents as severe pain in the region of the affected tooth, which radiates to the ear, temporomandibular joint, and posterior submandibular region. Trismus, difficulty in swallowing, submandibular lymphadenitis, rubor, and edema of the operculum are also noted. A characteristic of pericoronitis is that when pressure is applied to the operculum, severe pain and discharge of pus are observed. Acute pericoronitis is often responsible for the spread of infection to various regions of the neck and facial area.

Production of Caries. Entrapment of food particles and bad hygiene, due to the presence of the semi-impacted tooth, may cause caries at the distal surface of the second molar, as well as on the crown of the impacted tooth itself (Figs. 7.2, 7.3).

Decreased Bone Support of Second Molar. The well-timed extraction of a semi-impacted tooth presenting a periodontal pocket ensures the avoidance of resorption of the distal bone aspect of the second molar, which would result in a decrease of its support (Fig. 7.4).

Obstruction of Placement of a Partial or Complete Denture. The impacted teeth of edentulous patients can erupt towards the residual alveolar ridge, creating problems when applying a prosthesis (Fig. 7.5). The localization of the tooth is often observed after its communication with the oral cavity and the presence of pain and edema.

Obstruction of the Normal Eruption of Permanent Teeth. Impacted teeth and supernumerary teeth often hinder the normal eruption of permanent teeth, creating functional and esthetic problems (Figs. 7.6, 7.7).

Provoking or Aggravating Orthodontic Problems. Lack of room in the arch is possibly the most common indication for extraction, primarily of impacted and semi-impacted third molars of the maxilla and mandible.
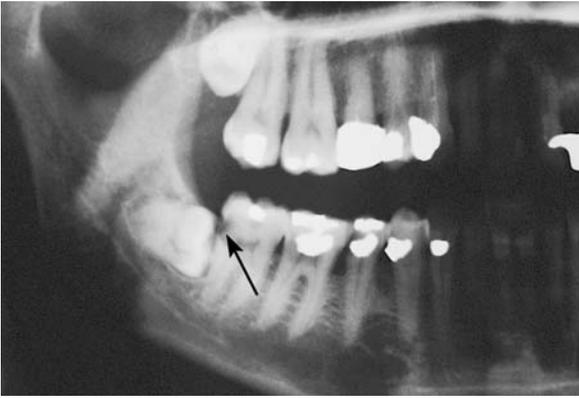
Fig. 7.2. Caries on the distal surface of the second molar, caused by a semi-impacted mandibular third molar
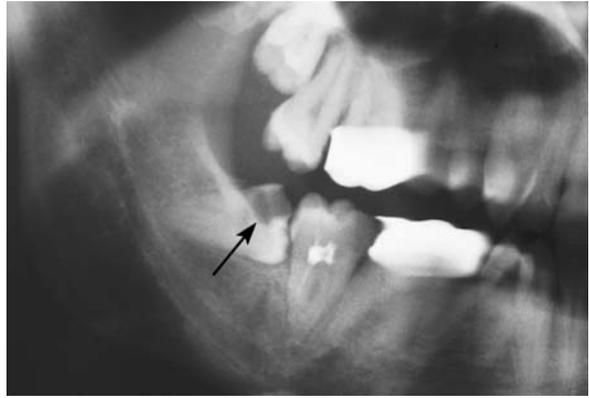
Fig. 7.3. Caries in the distal area of the crown of semi-impacted third molar, due to entrapment of food and bad hygiene
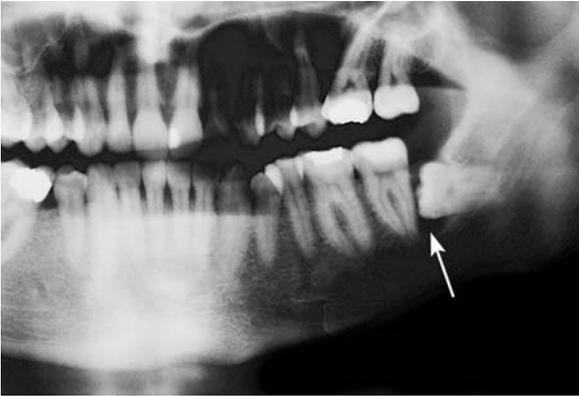
Fig. 7.4. Bone resorption at the distal surface of the root of a mandibular second molar, resulting in a periodontal pocket

Fig. 7.5. Impacted mandibular third molar in edentulous area, which erupted after placement of a partial denture

Fig. 7.6. Obstruction of the eruption of a mandibular second molar because of an impacted third molar

Fig. 7.7. Impacted maxillary central incisor, whose eruption was obstructed because of a supernumerary tooth
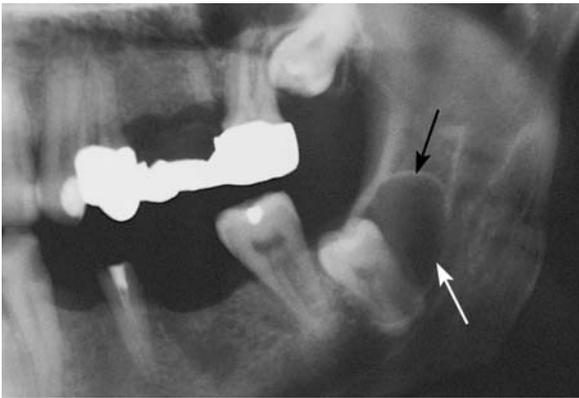
Fig. 7.8. Impacted mandibular third molar with well-defined radiolucency at the distal area
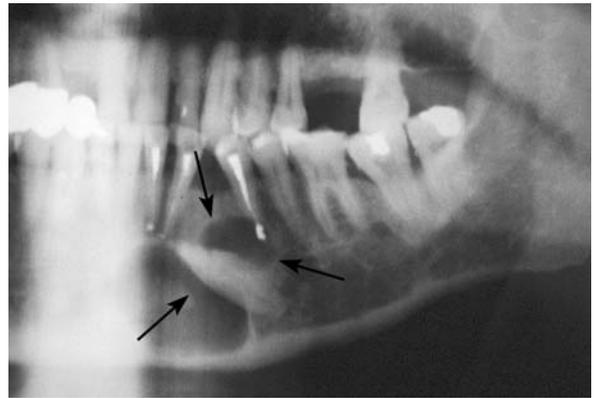
Fig. 7.9. Impacted mandibular canine that is surrounded by a lesion
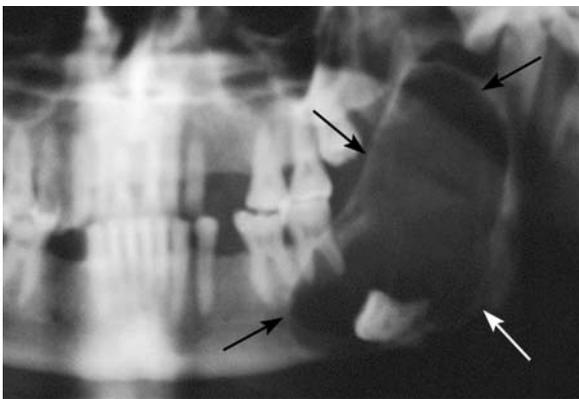
Fig. 7.10. Extensive radiolucent lesion in the posterior area of the mandible, occupying the ramus. The impacted tooth has been displaced to the inferior border of the mandible
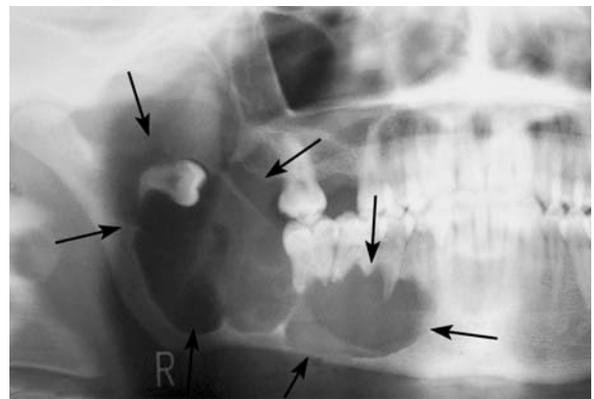
Fig. 7.11. Extensive radiolucent lesion in the mandible, extending from the mandibular notch as far as the canine. The impacted tooth has been displaced to an area high in the ramus of the mandible

Participation in the Development of Various Pathologic Conditions. The coexistence of an impacted tooth and various pathologic conditions is not an uncommon phenomenon. Often cystic lesions develop around the crown of the tooth and are depicted on the radiograph as different-sized radiolucencies (Figs. 7.8, 7.9). These cysts may be large and may displace the impacted tooth to any position in the jaw (Figs. 7.10, 7.11). When the presence of such osteolytic lesions is verified radiographically, they must be removed together with the associated impacted tooth.

Destruction of Adjacent Teeth Due to Resorption of Roots. Resorption of the roots of adjacent teeth is another undesirable situation that may be caused by the impacted tooth; the effect is brought about through pressure. This case primarily involves the posterior teeth of the maxilla and mandible. It begins with resorption of the distal root and, eventually, may totally
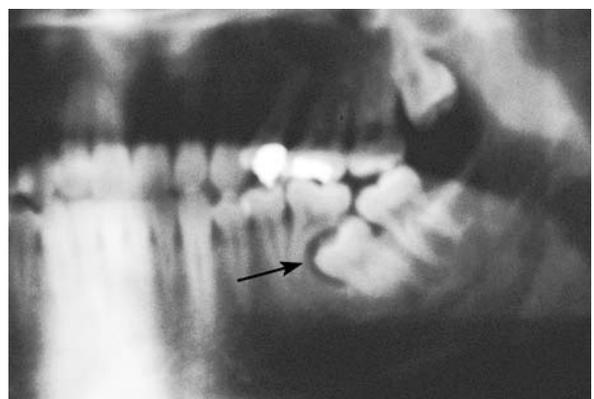
Fig. 7.12. Complete resorption of the distal root of the left mandibular first molar, due to an impacted second molar
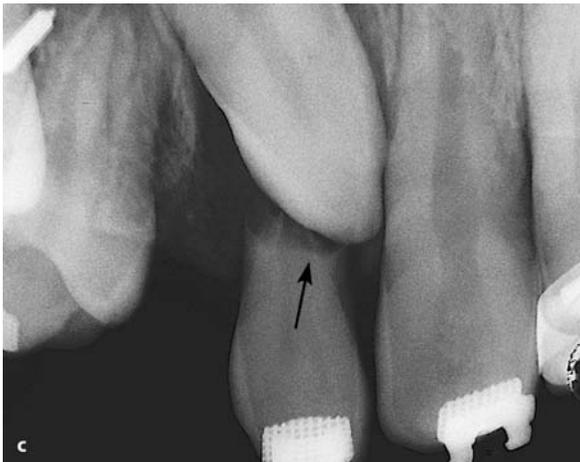
Fig. 7.13 a–c. **a** Extensive resorption of the roots of maxillary and mandibular second molars due to impacted third molars. Tooth 17 was also removed during the attempt to extract tooth 18, because preservation of the tooth in the dental arch was deemed impossible. **b** Maxillary second molar (shown in **a**) after its removal, showing resorption of the distal root. **c** Complete resorption of the root of the right lateral incisor due to an impacted maxillary canine

destroy the tooth (Figs. 7.12, 7.13 a, b). The resorption of roots may also be observed in other areas of the dental arch and may involve dental surfaces other than those mentioned above (Fig. 7.13 c).

Having mentioned the undesirable situations that are associated with impacted teeth, and given the fact that no one can guarantee that an asymptomatic impacted tooth will not create problems in the future, the choice of removing or preserving the impacted tooth must be made after considering all the possibilities.

7.5
Appropriate Timing for Removal of Impacted Teeth

If the impacted tooth is to be removed, the most suitable time to do so is when the patient is young, thus avoiding the aforementioned complications and undesirable situations that could get worse with time. Also, younger patients generally deal with the overall surgical procedure and stress well, and present fewer complications and faster postsurgical wound healing compared with older patients. Furthermore, it is easier to remove bone from these patients compared to older patients, whose bone is usually dense and hard.

7.6
Steps of Surgical Procedure

The surgical procedure for the extraction of impacted teeth includes the following steps:
1. Incision and reflection of the mucoperiosteal flap
2. Removal of bone to expose the impacted tooth
3. Luxation of the tooth
4. Care of the postsurgical socket and suturing of the wound

The main factors for a successful outcome to the surgical procedure are as follows:
- Correct flap design, which must be based on the clinical and radiographic examination (position of tooth, relationship of roots to anatomic structures, root morphology).
- Ensuring the pathway for removal of the impacted tooth, with as little bone removal as possible. This is achieved when the tooth is sectioned and removed in segments, which causes the least trauma possible.
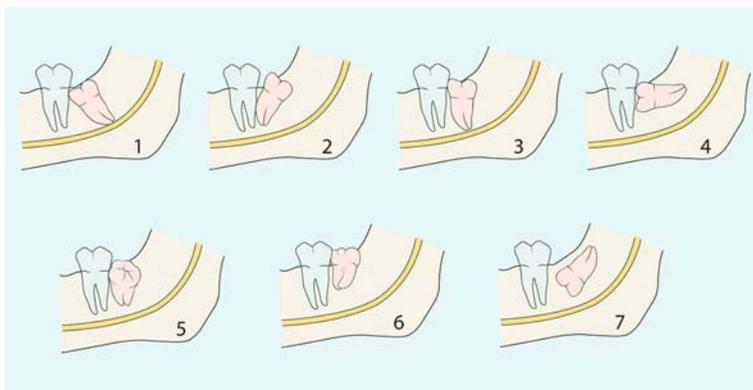
Fig. 7.14. Classification of impaction of mandibular third molars, according to Archer (1975) and Kruger (1984). (*1* Mesioangular, *2* distoangular, *3* vertical, *4* horizontal, *5* buccoangular, *6* linguoangular, *7* inverted)
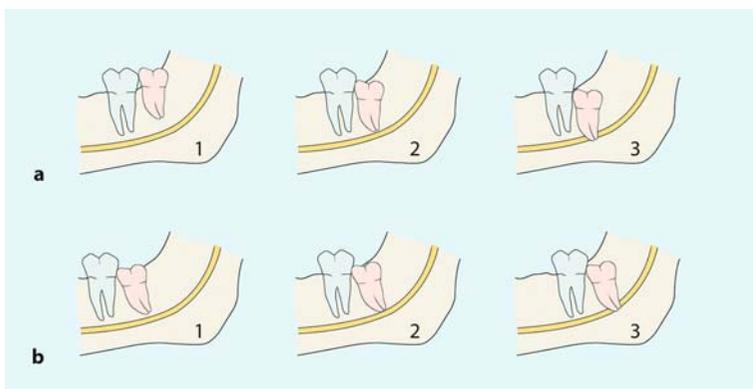
Fig. 7.15 a, b. Classification of impacted mandibular third molars according to Pell and Gregory (1933): **a** according to the depth of impaction and proximity to the second molar; **b** their position according to the distance between the second molar and the anterior border of the ramus of the mandible

7.7
Extraction of Impacted Mandibular Teeth

7.7.1
Impacted Third Molar

Classification. The impacted mandibular third molar may present with various positions in the bone, and so the technique for its removal is determined by its localization. The classic positions of the tooth, depending on the direction of the crown of the tooth, are (according to Archer 1975; Kruger 1984): mesioangular, distoangular, vertical, horizontal, buccoangular, linguoangular, and inverted (Fig. 7.14). Impacted teeth may also be classified according to their depth of impaction, their proximity to the second molar, as well as their localization in terms of the distance between the distal aspect of the second molar and the anterior border of the ramus of the mandible. As far as the depth of impaction is concerned, mandibular third molars may be classified (according to Pell and Gregory 1933) as belonging to three categories (Fig. 7.15):

Class A: The occlusal surface of the impacted tooth is at the same level as, or a little below that of, the second molar (Fig. 7.15 a, 1).
Class B: The occlusal surface of the impacted tooth is at the middle of the crown of the second molar or at the same level as the cervical line (Fig. 7.15 a, 2).
Class C: The occlusal surface of the impacted tooth is below the cervical line of the second molar (Fig. 7.15 a, 3).

As for the distance to the anterior border of the ramus of the mandible, impacted teeth may be classified as belonging to one of the following three categories:
Class 1: The distance between the second molar and the anterior border of the ramus is greater than the mesiodistal diameter of the crown of the impacted tooth, so that its extraction does not require bone removal from the region of the ramus (Fig. 7.15 b, 1).
Class 2: The distance is less and the existing space is less than the mesiodistal diameter of the crown of the impacted tooth (Fig. 7.15 b, 2).

Fig. 7.16. Impacted right mandibular third molar, completely embedded at great depth in bone. Its extraction is considered difficult, because a large part of the bone must be removed and there is a risk of injury to the inferior alveolar nerve
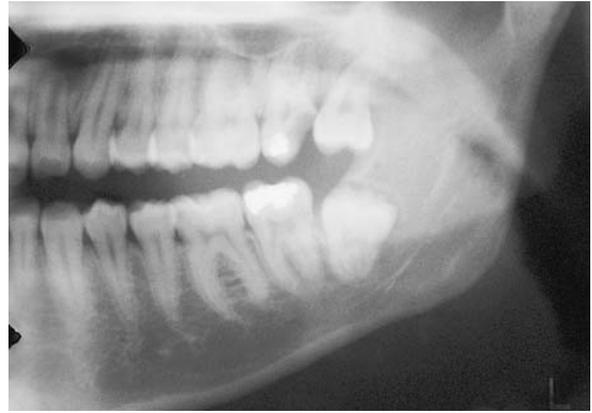
Fig. 7.17. Impacted mandibular third molar, with the greatest part of the crown in the ramus of the mandible. Its extraction is considered difficult, because access through the anterior border of the ramus is difficult

Fig. 7.18 a, b. Incision for the creation of a triangular flap, which is indicated in certain cases of extraction of impacted mandibular third molars. **a** Clinical photograph. **b** Diagrammatic illustration

Class 3: There is no room between the second molar and the anterior border of the ramus, so that the entire impacted tooth or part of it is embedded in the ramus (Fig. 7.15 b, 3).

The above classification methods refer to all of the aforementioned positions of the impacted tooth. Furthermore, the number of roots of the impacted tooth and their relationship to the mandibular canal are taken into consideration. It is obvious that the cases belonging to Class 3 present more difficulty during the surgical procedure, because the extraction of the tooth requires removal of a relatively large amount of bone and there is a risk of fracturing the mandible and damaging the inferior alveolar nerve (Figs. 7.16, 7.17).

Types of Flaps. Two types of flaps may be used when surgically removing impacted mandibular third molars: the triangular and the envelope flap. The choice depends on the evaluation of the various data pertaining to the case (e.g., depth of impaction, position, etc.).

Triangular flap:

The incision for this type of flap begins at the anterior border of the ramus (external oblique ridge) with special care for the lingual nerve and extends as far as the distal aspect of the second molar, while the vertical releasing incision is made obliquely downwards and forward, ending in the vestibular fold (Fig. 7.18). In certain cases, e.g., when impaction is deep, to ensure a satisfactory surgical field or when the impacted tooth conceals the roots of the second molar, the incision may continue along the
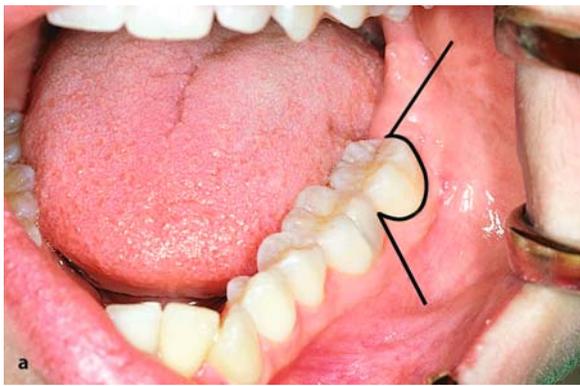
Fig. 7.19 a, b. Variation of incision shown in Fig. 7.18 (vertical releasing incision is distal to the first molar). The mesial extension of incision is necessary due to the position of the third molar compared to the second molar
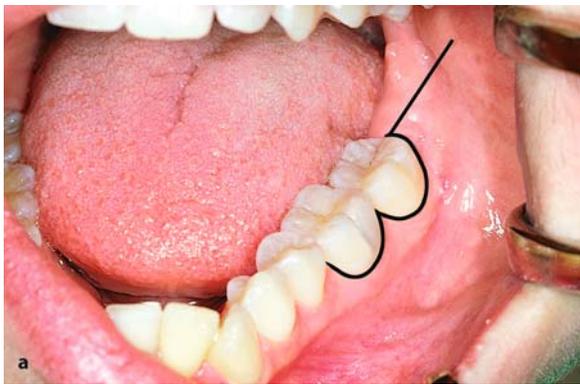
Fig. 7.20 a, b. **a** Clinical photograph and **b** diagrammatic illustration showing incision for envelope flap

cervical line of the last tooth while the vertical incision begins at the distal aspect of the first molar (Fig. 7.19).

Horizontal (envelope) flap:

The incision for the flap also begins at the anterior border of the ramus and extends as far as the distal aspect of the second molar, continuing along the cervical lines of the last two teeth, and ending at the mesial aspect of the first molar (Fig. 7.20). This type of flap is usually used in cases where impaction is relatively superficial.

Anesthesia. Anesthesia in cases of impacted mandibular third molars is achieved by: inferior alveolar nerve block, buccal nerve block, lingual nerve block, and local infiltration for hemostasis in the surgical field.

7.7.1.1
Removal of Bud
of Impacted Mandibular Third Molar

The following procedure is used to remove a bud of an impacted mandibular third molar (Fig. 7.21):

After a triangular incision is made using a scalpel with a no. 15 blade (Figs. 7.22, 7.23), the mucoperiosteal flap is reflected from the distal aspect of the second molar, continuing along the incision posteriorly as far as the anterior border of the ramus. The bone covering the tooth is removed using a round bur, until the entire crown is exposed (Figs. 7.24, 7.25). If the roots of the tooth have not yet developed, the tooth will roll around inside the alveolar crypt during the elevation attempt, so that the extraction is relatively difficult. That is why a pathway for removal must be ensured, by removing sufficient bone from the buccal
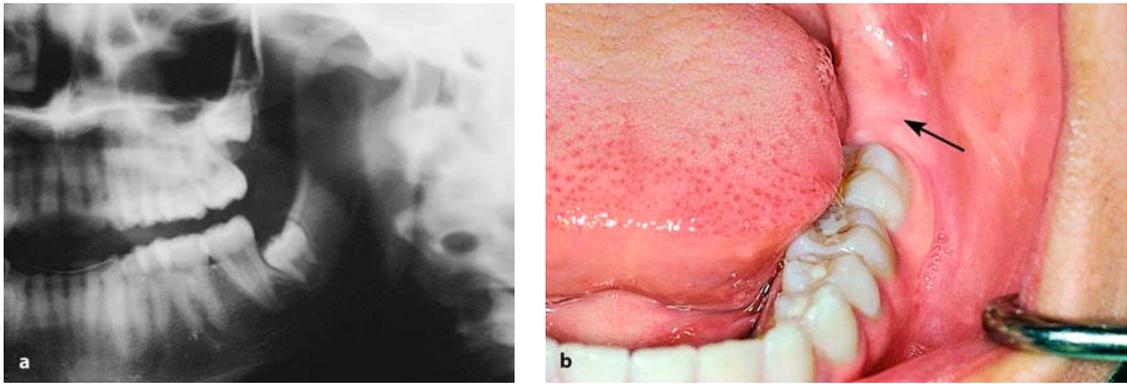
Fig. 7.21 a, b. Bud of mandibular third molar. **a** Radiograph and **b** clinical photograph of the relevant area
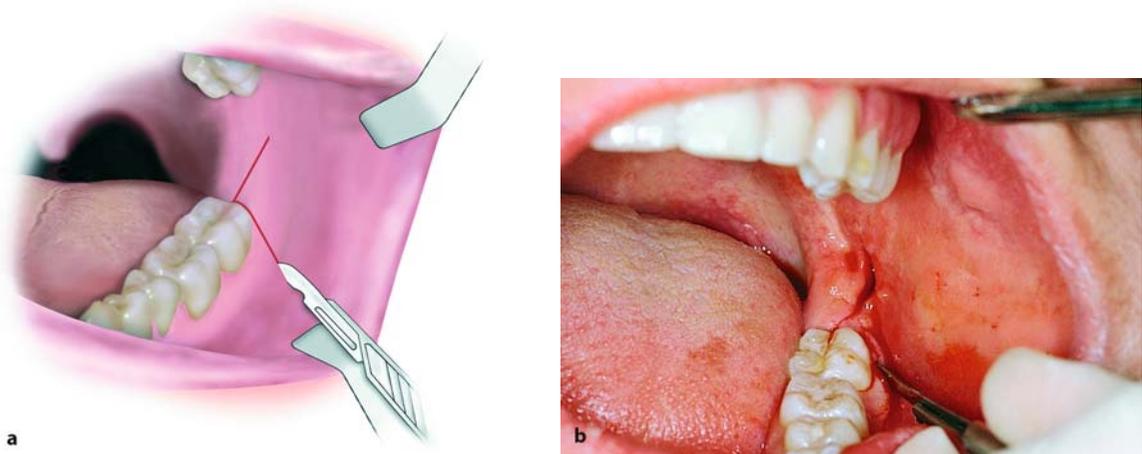
Fig. 7.22 a, b. Triangular incision using a scalpel with a no. 15 blade. **a** Diagrammatic illustration. **b** Clinical photograph
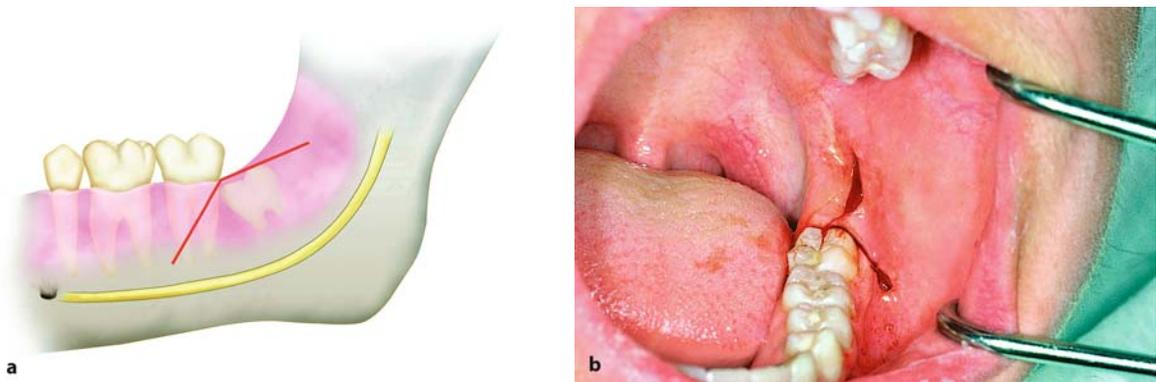
Fig. 7.23 a, b. Triangular incision completed. **a** Diagrammatic illustration. **b** Clinical photograph

and distal aspects of the crown of the tooth (guttering technique)[1] (Fig. 7.26), so that its elevation from the socket is not hindered. After exposing the impacted tooth sufficiently, the straight elevator is placed in the mesial region and the tooth is elevated with a rotational movement distally (Figs. 7.27, 7.28).

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1) The guttering technique involves the removal of bone by creating a groove on the buccal and distal aspects of the crown of the tooth, ensuring a pathway for removal that will facilitate its luxation. Extensive bone removal is thus avoided.
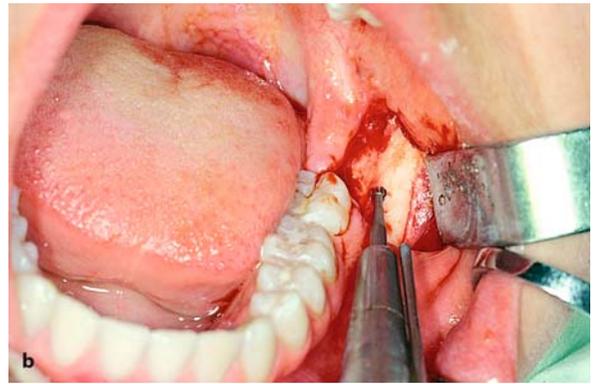
Fig. 7.24 a, b. Reflection of the flap and use of a surgical handpiece to remove part of the bone over the crown of the impacted tooth. **a** Diagrammatic illustration. **b** Clinical photograph
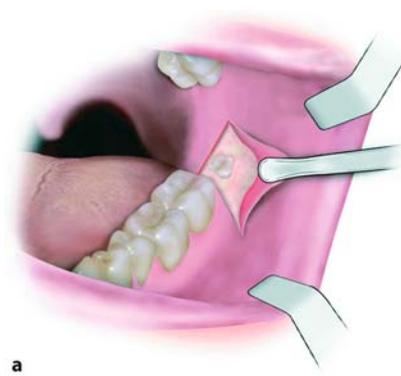
Fig. 7.25 a, b. Exposure of the crown of an impacted tooth. **a** Diagrammatic illustration. **b** Clinical photograph
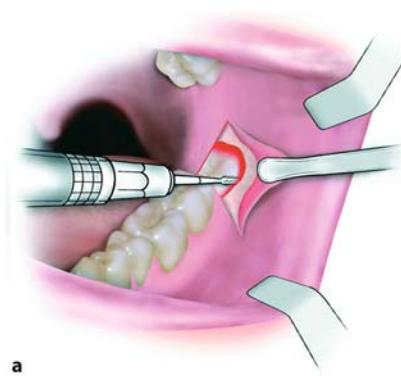
Fig. 7.26 a, b. Removal of bone from the buccal and distal aspects of the crown of an impacted tooth, to ensure a withdrawal pathway that will facilitate luxation (pathway of removal)

When the extraction of the impacted tooth is complete, the follicular sac, which is usually on the distal aspect of the second molar, as well as bone fragments that may be present in the socket are removed (Figs. 7.29 a, 7.30). The bone margins are then examined to ascertain if there are any sharp edges. If so, then a bone file or a special bur may be used to smooth the bone (Fig. 7.29 b). After this procedure, the area is irrigated with saline solution and the wound is sutured. The first suture is placed at the corner of the
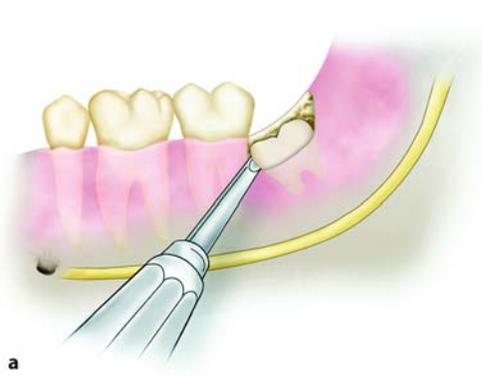
Fig. 7.27 a, b. Placement of the straight elevator between the mesial aspect of the impacted tooth and alveolar bone. **a** Diagrammatic illustration. **b** Clinical photograph
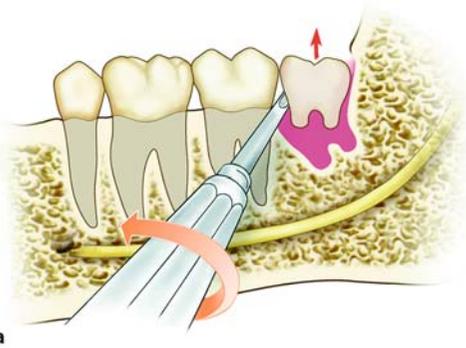
Fig. 7.28 a, b. Luxation of a tooth with rotational movement distally. Contact between the elevator and the distal surface of the second molar is avoided. **a** Diagrammatic illustration. **b** Clinical photograph
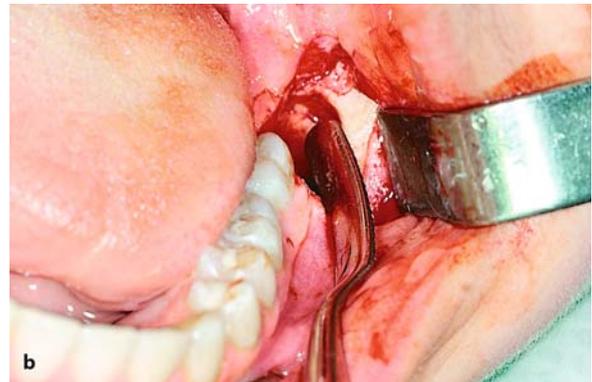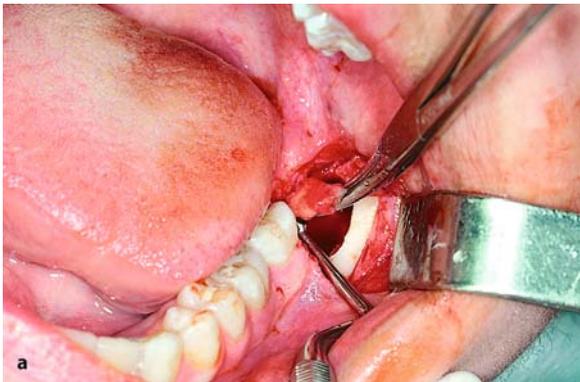
Fig. 7.29 a, b. **a** Removal of follicle using a hemostat and periapical curette. **b** Smoothing of bone edges of the wound using a bone file

flap to ensure correct repositioning of the flap, while the rest are placed along the posterior and vertical incisions (Fig. 7.31). After completing the surgical procedure, oral and written postoperative instructions are given to the patient, and the sutures are removed 8 days later.

The procedure for care of the wound is the same as that for all cases of impacted teeth.

Fig. 7.30. Tooth and follicle after removal

Fig. 7.31. Operation site after suturing

7.7.1.2
Extraction of Impacted Third Molar in Horizontal Position

The extraction of an impacted third molar in a horizontal position is considered quite difficult and must be treated with particular care. This tooth may be superficial or deep in the bone and frequently its crown is close to the distal aspect of the second molar. The surgical procedure used to extract the impacted tooth, especially if the tooth is not deep in the bone (Fig. 7.32), is as follows. After making a horizontal incision, the mucoperiosteal flap is reflected (Figs. 7.33, 7.34). The bone covering the tooth is removed using a round bur, and the area is irrigated with a steady stream of saline solution, until the crown is entirely exposed (Fig. 7.35). A groove is then created vertically to the long axis of the tooth using a fissure bur, at the cervical line of the tooth, to separate the crown from the root (Fig. 7.36). The groove created by the bur should not be deep, since the mandibular canal is often found in close proximity to the tooth and there is a risk of injuring or severing the inferior alveolar nerve. The straight ele-

vator is used, after being placed in the groove created earlier, to separate the crown from the root with a rotational movement (Fig. 7.37). The crown is removed separately, using the same elevator, with a rotational movement upwards, and the root is then easily removed, using a straight or angled elevator, whose blade end is placed in a purchase point created on the buccal aspect of the root (Figs. 7.38, 7.39). After smoothing the bone, the area is irrigated with saline solution and sutures are placed. The first suture is placed at the distal aspect of the second molar and the rest are placed at the interdental papillae and the posterior end of the incision (Figs. 7.40 a, b).
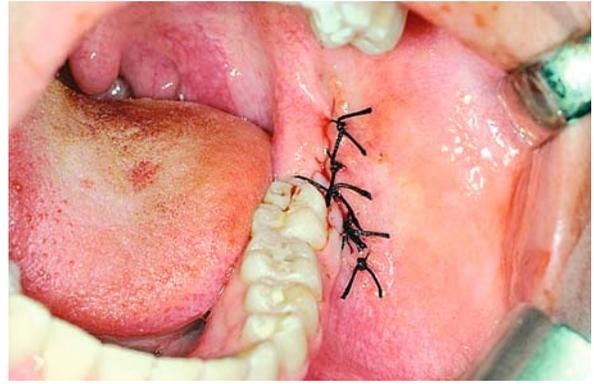
If the tooth has two roots, sectioning and removal of the crown are done as described above. Afterwards, if the roots of the impacted tooth have been separated during sectioning of the crown, they are easily removed one at a time, first the distal root and then the mesial root. If separation is not achieved at the beginning, then it must be carried out later. If not, during the attempt to extract both roots at the same time, there is a risk of fracturing the root tips, especially if they present curvature.
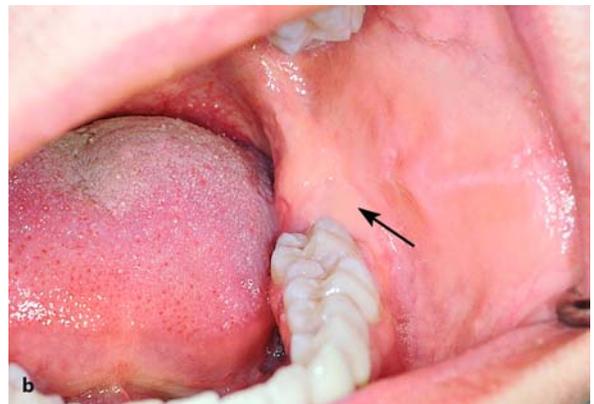
Fig. 7.32 a, b. a Radiograph showing impacted mandibular third molar in the horizontal position. **b** Clinical photograph of the area of the impacted tooth

Fig. 7.33 a, b. Horizontal incision using a scalpel with a no. 15 blade. **a** Diagrammatic illustration. **b** Clinical photograph
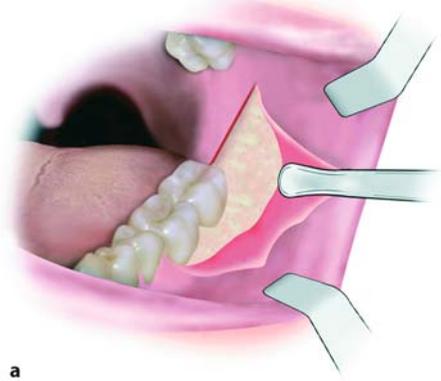
Fig. 7.34 a, b. Reflection of flap and retraction with the broad end of a periosteal elevator. **a** Diagrammatic illustration. **b** Clinical photograph
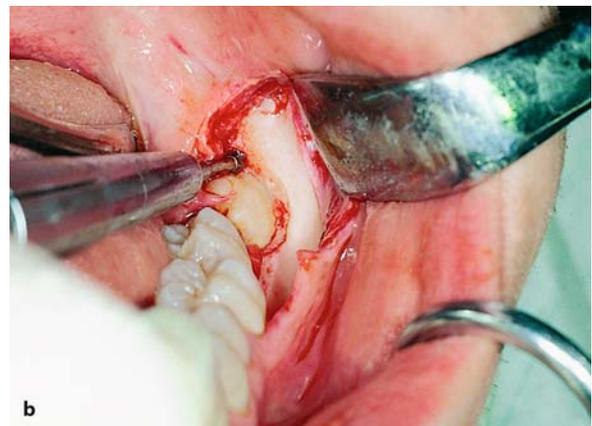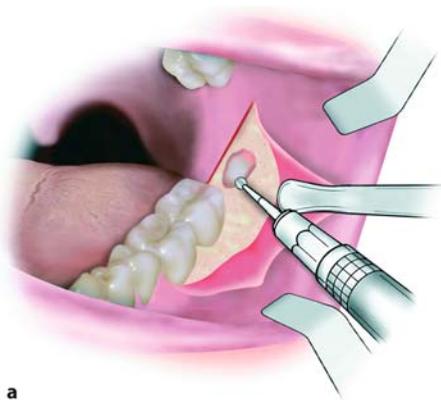

Fig. 7.35 a, b. Removal of bone using a round bur, to expose the crown of the impacted tooth
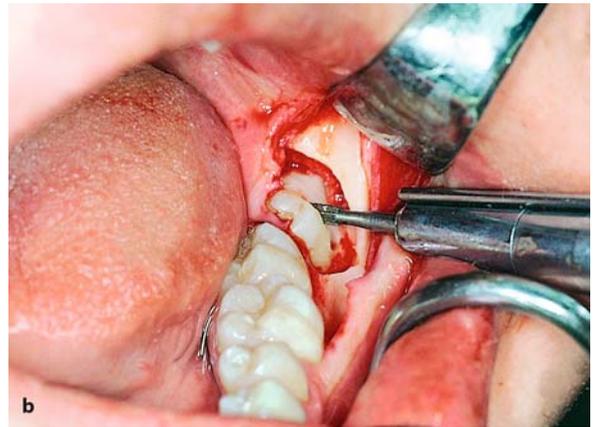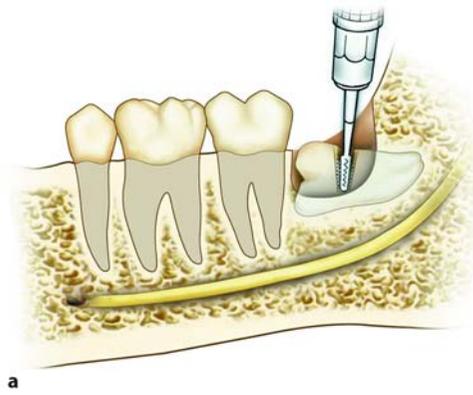
Fig. 7.36 a, b. Sectioning tooth at the cervical line using a fissure bur. The diagrammatic illustration (**a**) shows the position beyond which the bur must not proceed, to avoid injury of the inferior alveolar nerve
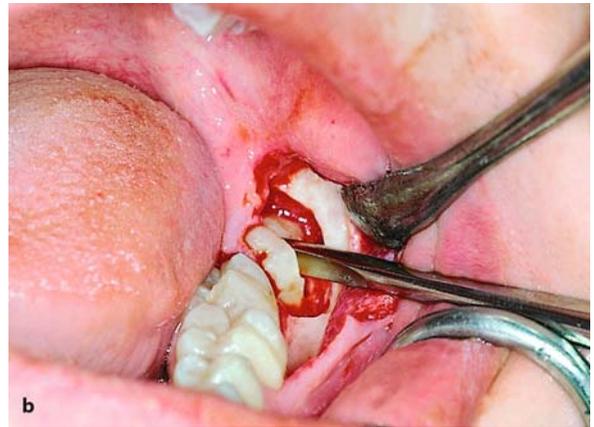
Fig. 7.37 a, b. Separation of crown from the root, with rotation of the elevator in a groove created on the impacted tooth
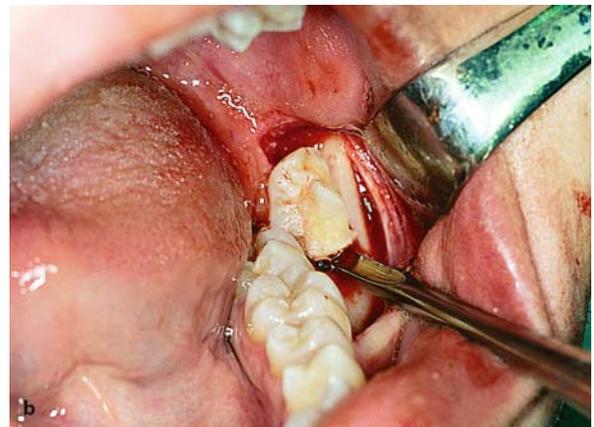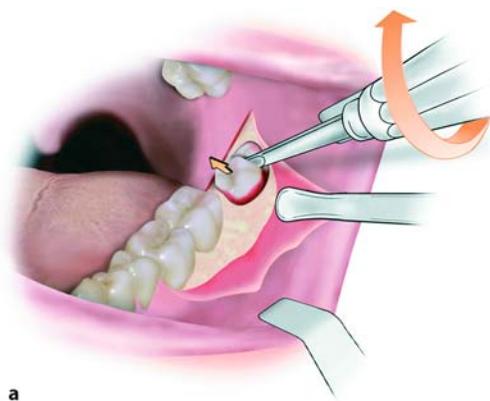
Fig. 7.38 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) showing removal of the crown of the tooth using a straight elevator
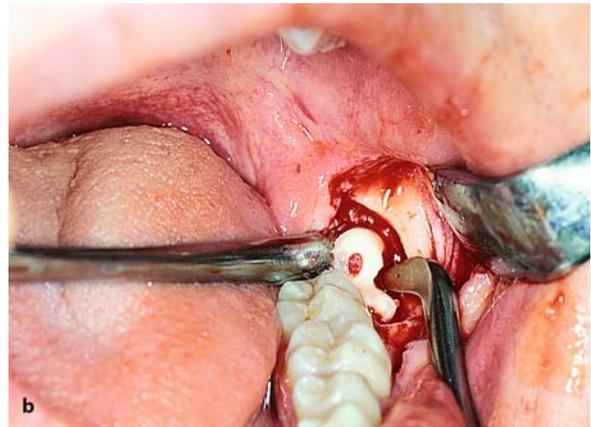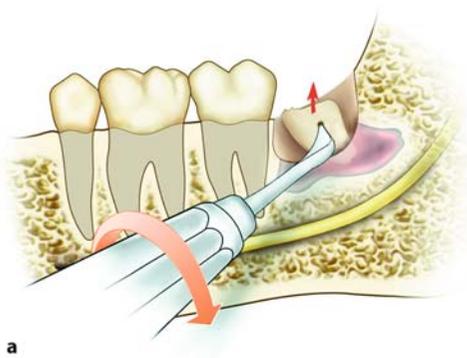
Fig. 7.39 a, b. Luxation of the root of an impacted tooth using an angled Seldin elevator
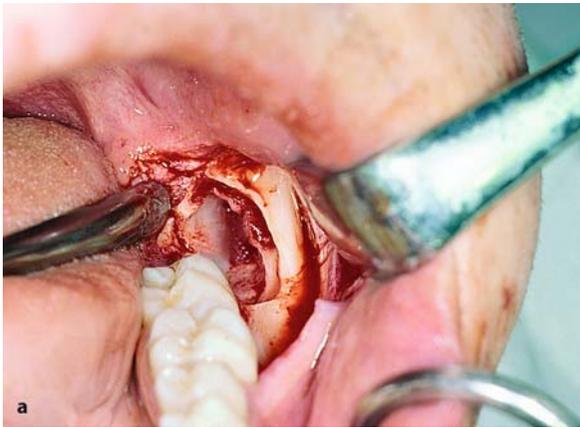
Fig. 7.40 a, b. **a** Operation site after removal of tooth. **b** Surgical field after suturing

7.7.1.3
Extraction of Third Molar
with Mesioangular Impaction

This tooth presents inclination of the crown mesially, to a greater or lesser degree, so that the mesial cusps are in contact with the distal aspect of the second molar. Often, for the extraction of such an impacted tooth, sectioning is considered necessary in addition to bone removal. The most common case requiring sectioning of the tooth is when it has mesioangular impaction and the crown is just below or below the cervical line of the second molar (Fig. 7.41). In this case, the technique used for its removal is as follows:

After creating a horizontal incision (Figs. 7.42, 7.43), the mucoperiosteal flap is reflected. Reflection begins at the interdental papilla at the mesial aspect of the first molar and continues posteriorly, along the incision as far as the anterior border of the ramus (Fig. 7.44).

The bone covering the tooth is removed using a round bur, until the entire crown is exposed (Fig. 7.45). Afterwards, using a fissure bur, sufficient bone is removed using the guttering technique, on the buccal and mainly the distal aspect of the tooth (Fig. 7.46). If the tooth is single-rooted, to facilitate its removal, the mesial portion of the tooth is removed first, while the remaining portion is then luxated. If the tooth has two roots, the roots may be separated and each root may be extracted in the easiest direction, depending on its curvature. More specifically, a deep vertical groove is made on the crown of the tooth using a fissure bur, approximately as far as the intraradicular bone (Fig. 7.47). Sectioning is achieved using a straight elevator, which, after being placed in the groove already created, is rotated and separates the roots (Figs. 7.48, 7.49). This separation of the tooth allows for limited bone removal, thus causing less trauma and faster completion of the surgical procedure.
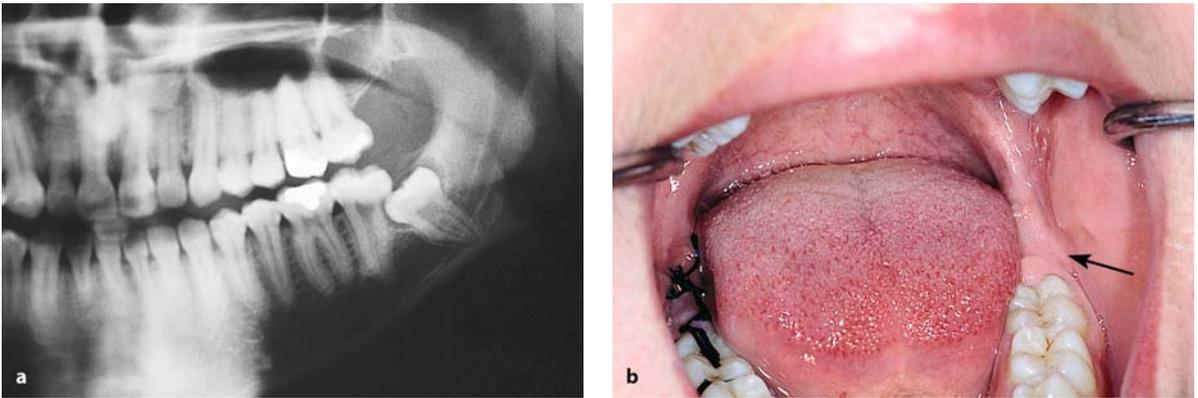
Fig. 7.41 a, b. **a** Radiograph showing impacted mandibular third molar (partial bone impaction) with mesioangular position. **b** Clinical photograph of area of impaction
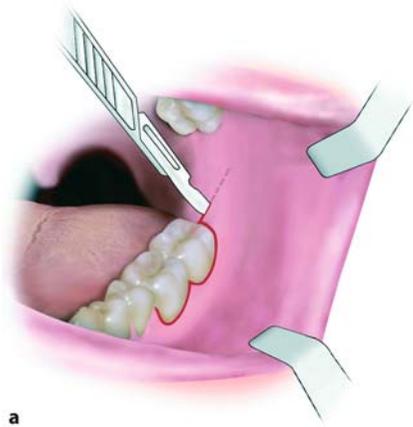

Fig. 7.42 a, b. Horizontal incision (for envelope flap) using a scalpel with a no. 15 blade. **a** Diagrammatic illustration. **b** Clinical photograph
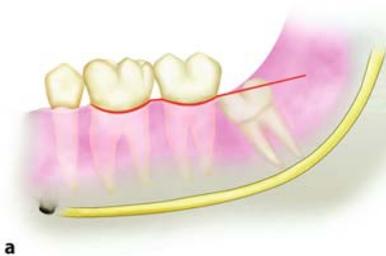

**Fig. 7.43 a, b.** Diagrammatic illustration (**a**) and clinical photograph (**b**) after completion of incision
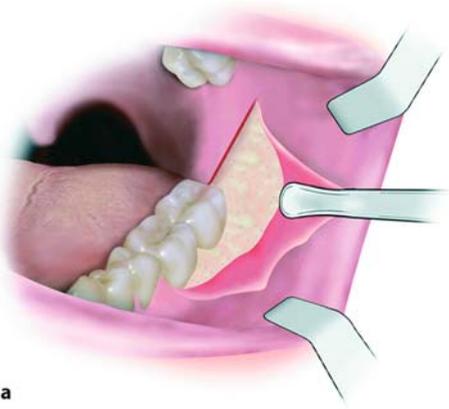
Fig. 7.44 a, b. Reflection of flap and retraction using the broad end of the periosteal elevator
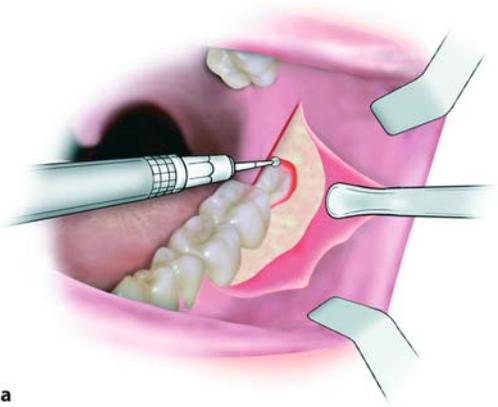
Fig. 7.45 a, b. Exposure of the crown of the tooth using a round bur. **a** Diagrammatic illustration. **b** Clinical photograph
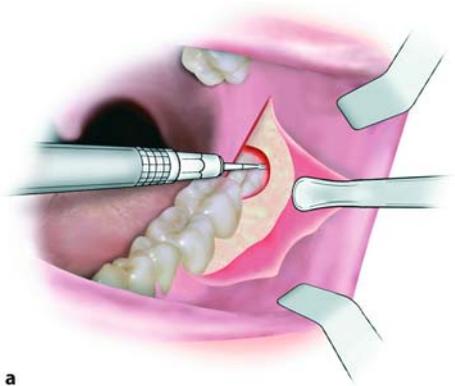
Fig. 7.46 a, b. Removal of bone using the guttering technique. A groove is created buccally, which extends distally to the crown of the tooth, creating room that will facilitate its luxation
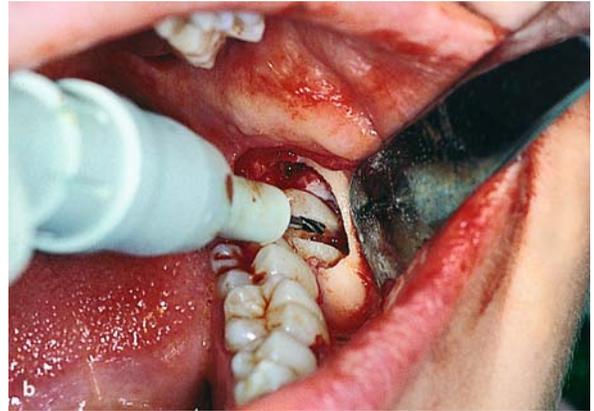
Fig. 7.47 a, b. Sectioning of the crown of an impacted tooth, in the buccolingual direction, which extends as far as the intraradicular bone. **a** Diagrammatic illustration. **b** Clinical photograph
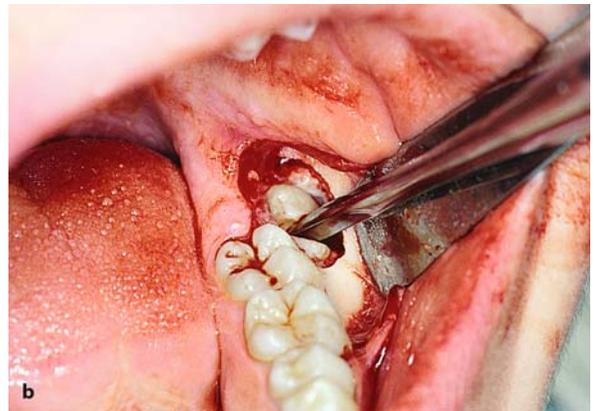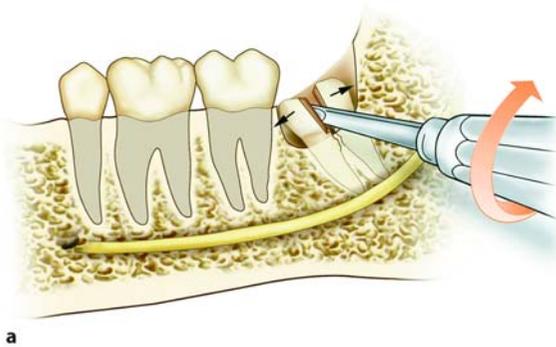
Fig. 7.48 a, b. Separation of tooth with positioning and rotation of straight elevator in created groove
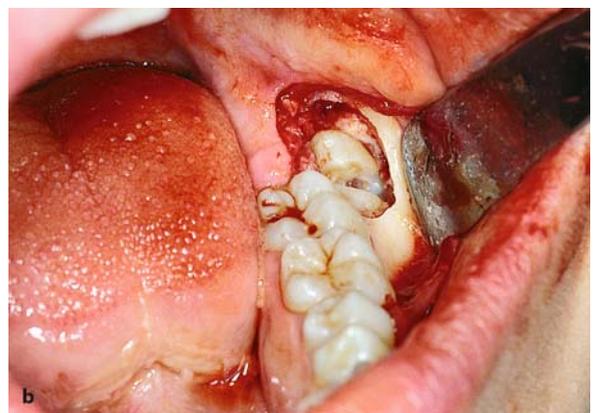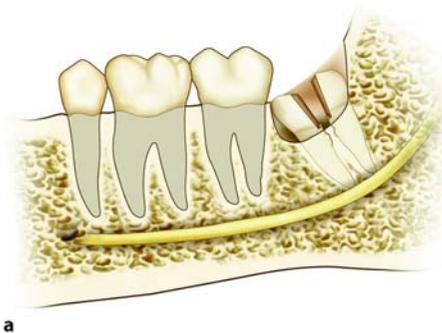
Fig. 7.49 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) of the impacted tooth after separation

The tooth is removed in two steps. First the distal root is elevated together with part of the crown (Fig. 7.50), and then, after placing the blade of the elevator on the mesial aspect of the tooth, the other root is removed with rotational movement distally (Figs. 7.51, 7.52). Care of the socket follows, as does
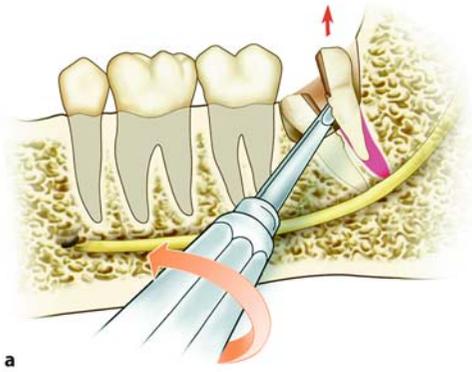
Fig. 7.50 a, b. Luxation of the distal segment of the tooth with rotation of the elevator distally. **a** Diagrammatic illustration. **b** Clinical photograph
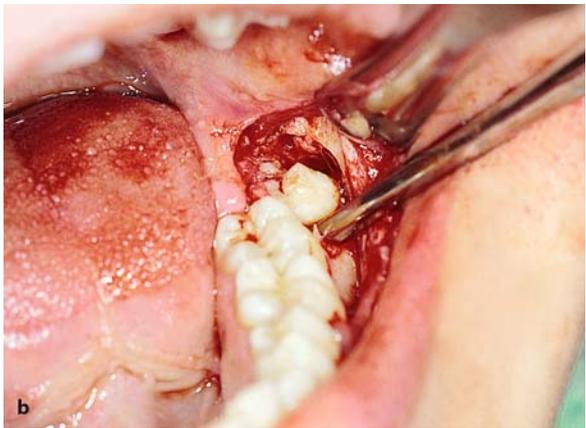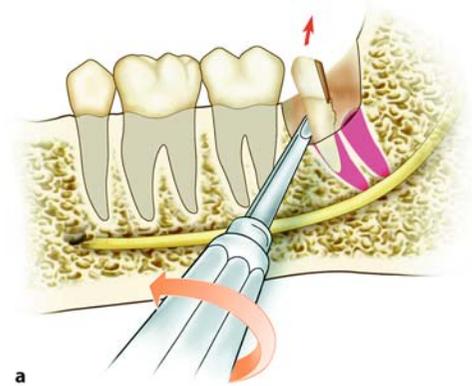
Fig. 7.51 a, b. Luxation of the mesial segment of an impacted tooth using a straight elevator. **a** Diagrammatic illustration. **b** Clinical photograph

**Fig. 7.52.** Segments of tooth after removal

Fig. 7.53. Empty socket after extraction of tooth

suturing of the wound, which is performed in exactly the same way as in other cases of impacted teeth (Figs. 7.53, 7.54 a, b).

Fig. 7.54 a, b. a Removal of follicle using a hemostat and periapical curette. **b** Surgical field after placement of sutures

7.7.1.4
Extraction of Third Molar
with Distoangular Impaction

Removal of this tooth is considered quite difficult, since it is located beneath the anterior border of the ramus with a fair amount of bone above its crown, while its roots are inclined somewhat near the distal root of the second molar (Fig. 7.55). Therefore, it is impossible to remove the tooth in one piece, unless a large amount of bone is removed.

The technique for creating the flap and removing bone is similar to that mentioned for the tooth with mesioangular impaction (Figs. 7.56–7.59). The only difference is the separation of the tooth, which is performed so that its removal can be achieved with minimal bone removal. More specifically, the distal portion of the crown is sectioned using a fissure bur, and removed, while the remaining segment of the tooth is then luxated, after placing the elevator at the mesial aspect of the tooth (Figs. 7.60–7.63). Care of the socket and suturing of the flap are carried out exactly as in other cases of impacted teeth (Fig. 7.64).
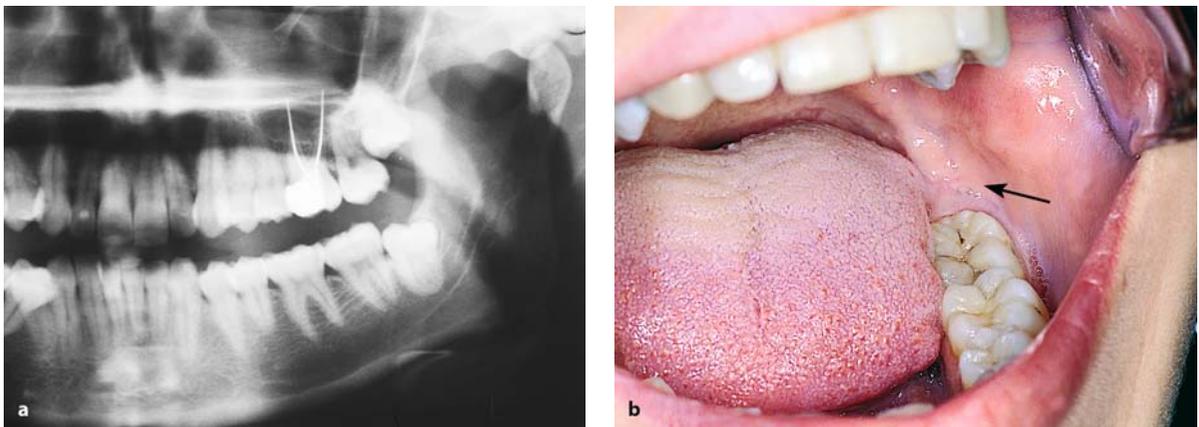
Fig. 7.55 a, b. a Radiograph showing impacted mandibular third molar (partial bone impaction) with a distoangular position. **b** Clinical photograph of the area of impaction
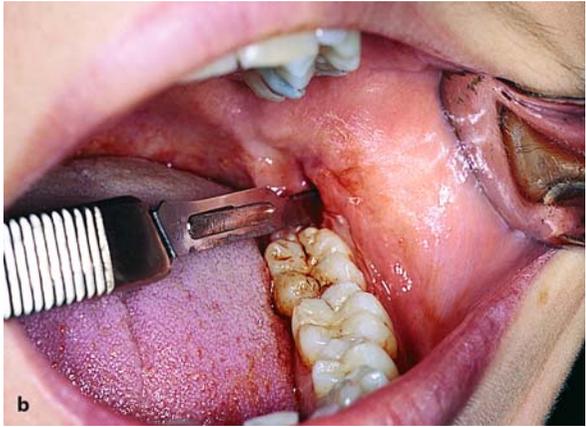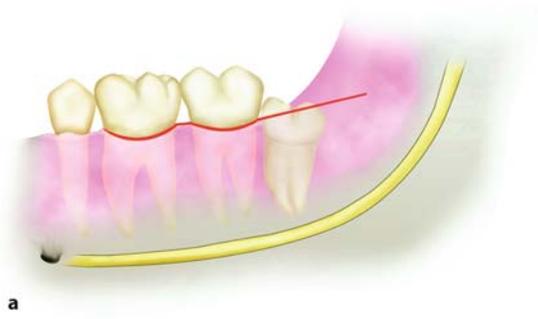
Fig. 7.56 a, b. The horizontal incision extends as far as the mesial aspect of the first molar. **a** Diagrammatic illustration. **b** Clinical photograph
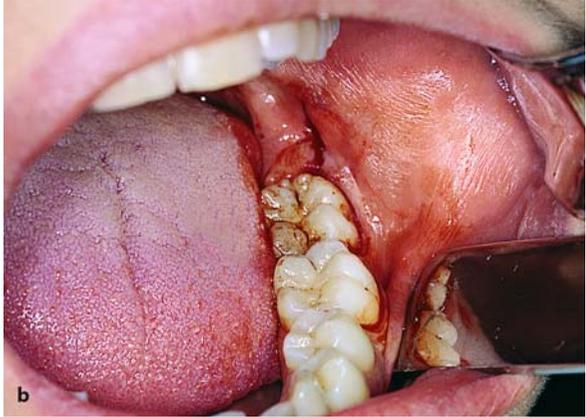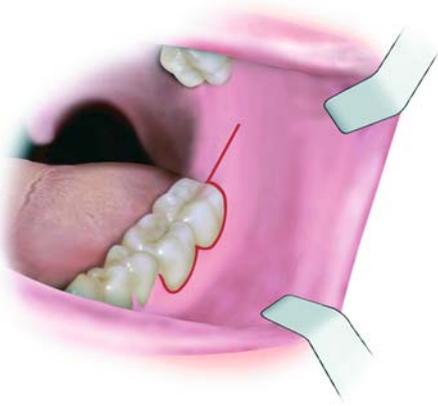

Fig. 7.57 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) showing the horizontal incision upon completion
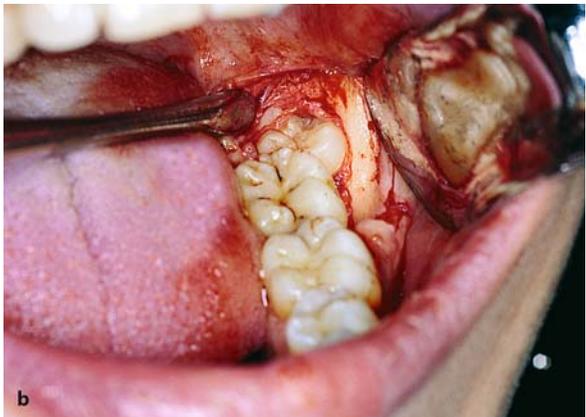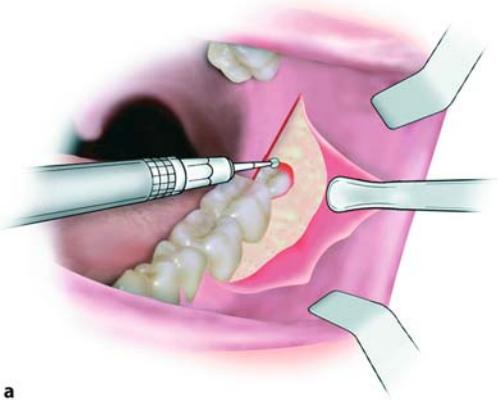
Fig. 7.58 a, b. Reflection of the mucoperiosteal flap, and partial exposure of the crown of the impacted tooth. **a** Diagrammatic illustration. **b** Clinical photograph
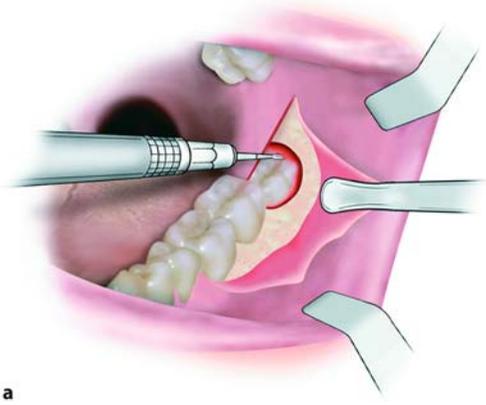
Fig. 7.59 a, b. Removal of bone on the buccal and distal aspects of the crown of the tooth. The groove is created to facilitate luxation. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 7.60 a, b. Sectioning of the distal portion of the crown of the impacted tooth using a fissure bur. **a** Diagrammatic illustration. **b** Clinical photograph
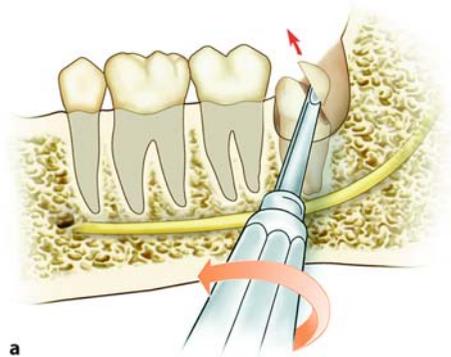

Fig. 7.61 a, b. Removal of the distal part of the crown using a straight elevator. **a** Diagrammatic illustration. **b** Clinical photograph
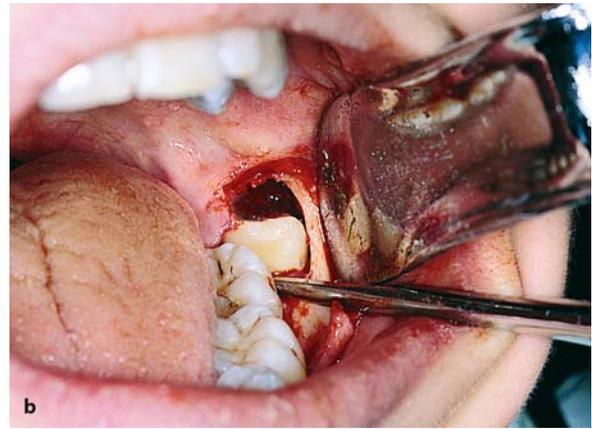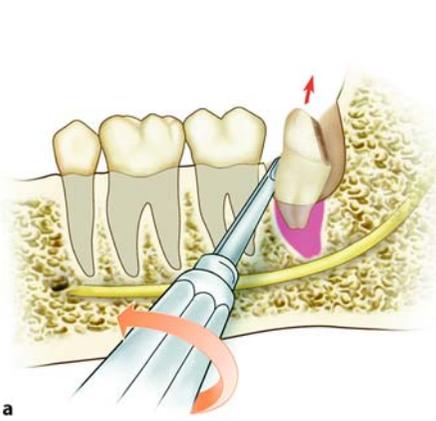
Fig. 7.62 a, b. Luxation of the impacted tooth in the distal direction, after creating a pathway for removal. **a** Diagrammatic illustration. **b** Clinical photograph


Fig. 7.63. Tooth after removal
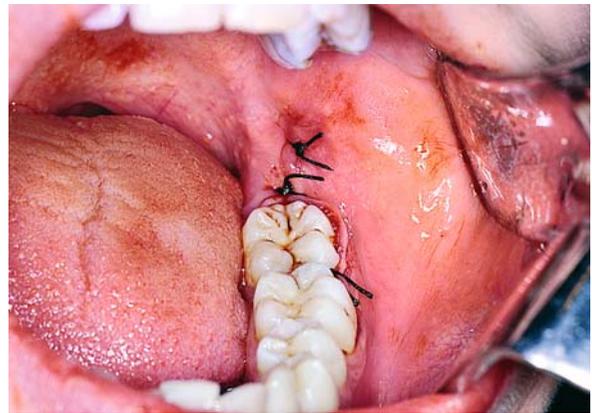
Fig. 7.64. Surgical field after suturing

7.7.1.5
Extraction of Impacted Third Molar in Edentulous Patient

One of the major problems faced in surgery of impacted mandibular third molars in dentulous patients is the second molar, which often hinders manipulations during the operation. Therefore, the surgical extraction of the third molar in edentulous patients is much easier and faster compared to dentulous patients, if the surgeon adheres to the rules regarding the surgical technique. The techniques for creation of the flap and removal of bone are the same as those used for other cases of impacted teeth. The second molar is often missing; therefore, tooth sectioning is not necessary because it may easily be extracted using either the elevator or tooth forceps, after the bone surrounding the tooth has been removed (Figs. 7.65–7.71).

Fig. 7.65. Radiograph showing impacted right mandibular third molar in an edentulous area
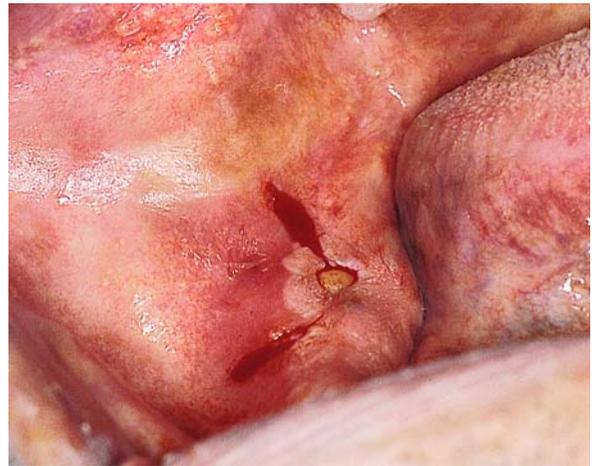

Fig. 7.66. Incision created for the removal of an impacted tooth
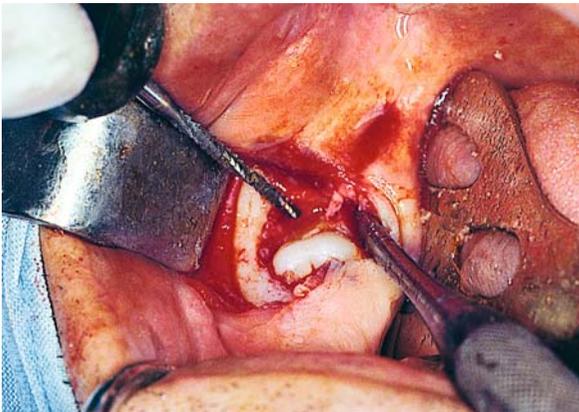
Fig. 7.67. Creation of flap and removal of bone from the buccal and distal aspects of the crown of the tooth
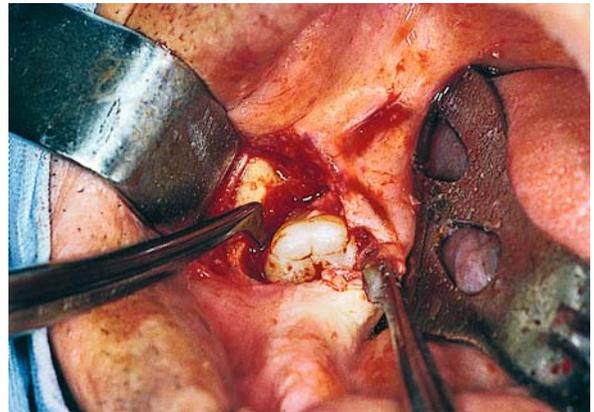
**Fig. 7.68.** Positioning of elevator with T-shaped handles for luxation of the impacted tooth
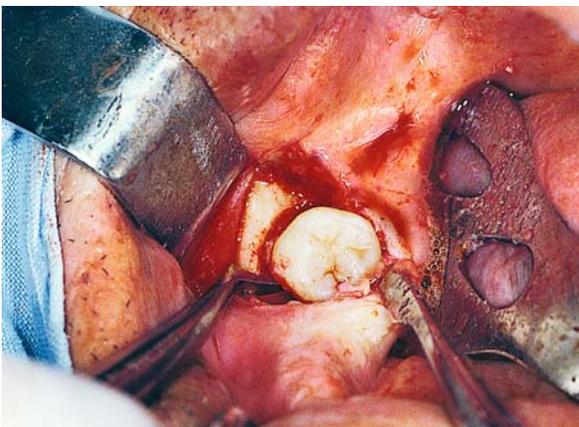
**Fig. 7.69.** Removal of tooth with rotation of elevator upwards
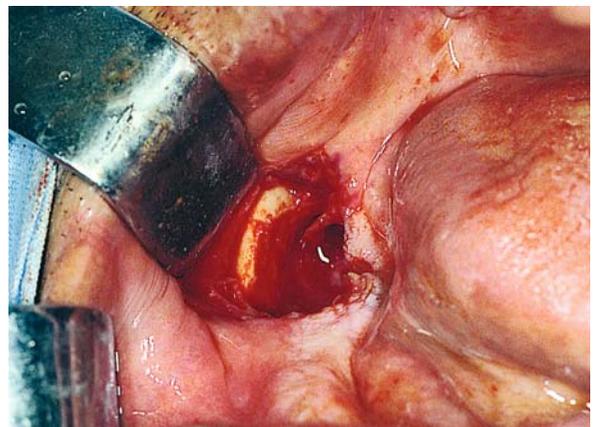
**Fig. 7.70.** Surgical field after removal of tooth
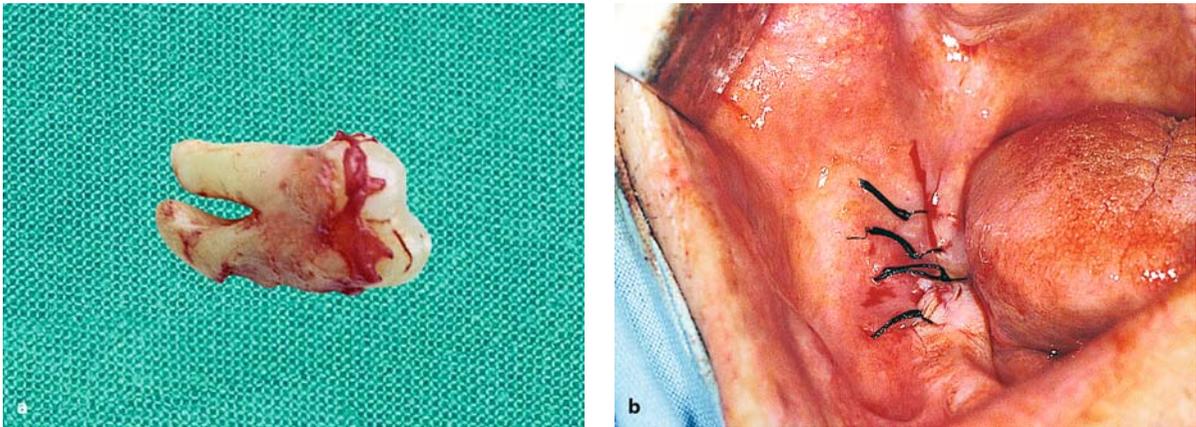
Fig. 7.71 a, b. a Tooth after removal from socket. **b** Surgical field after placement of sutures

7.7.2
Impacted Premolar

Impacted mandibular premolars may be localized lingually or buccally, in a vertical position, and with their crowns often wedged underneath adjacent teeth.

When localization is buccal (Fig. 7.72), a trapezoidal flap is created very carefully, making the vertical incisions some way from the mental foramen, to avoid injuring the mental neurovascular bundle.

After creating the flap (Fig. 7.73), bone is removed along the impacted tooth taking care not to injure the adjacent teeth (Figs. 7.74, 7.75). A fissure bur is used to section the tooth at approximately the cervical line and the crown is separated from the root using the straight elevator (Figs. 7.76, 7.77). Afterwards, the crown is removed from between the teeth (Figs. 7.78, 7.79). Extraction of the root is achieved using an angled elevator, whose blade tip is placed in the purchase point created on the buccal aspect of the root. The root is thus easily luxated upwards and removed from the socket (Figs. 7.80–7.84).

Fig. 7.72 a, b. a Radiograph showing impacted mandibular second premolar. **b** Clinical photograph of area of impaction
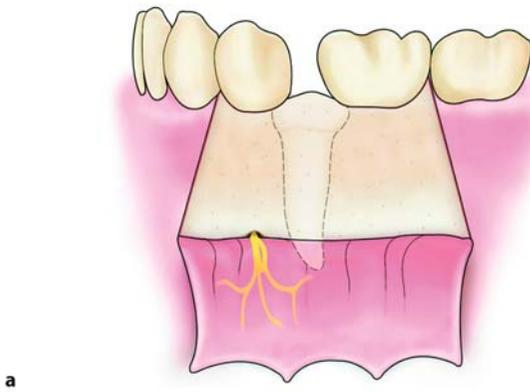
Fig. 7.73 a, b. Creation of trapezoidal flap for removal of an impacted tooth. The course of the mental nerve after emerging from the mental foramen is shown in *yellow*. **a** Diagrammatic illustration. **b** Clinical photograph
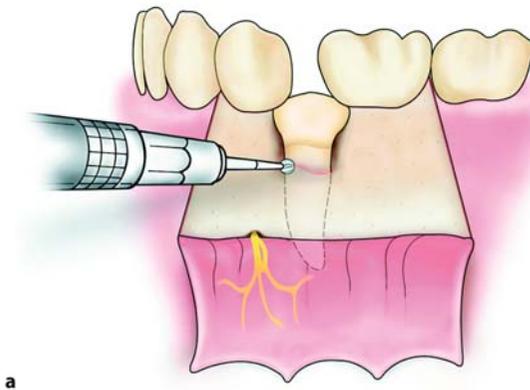

Fig. 7.74 a, b. Removal of buccal bone to expose tooth. **a** Diagrammatic illustration. **b** Clinical photograph
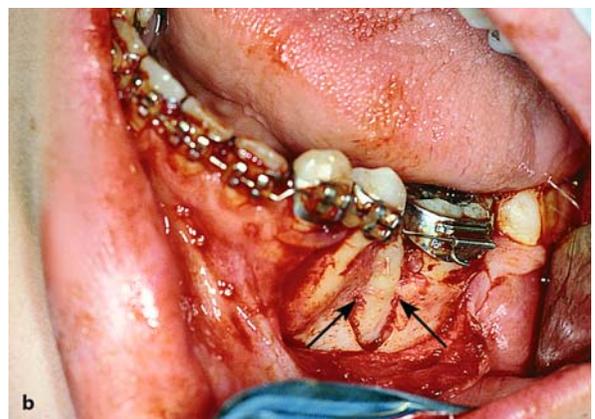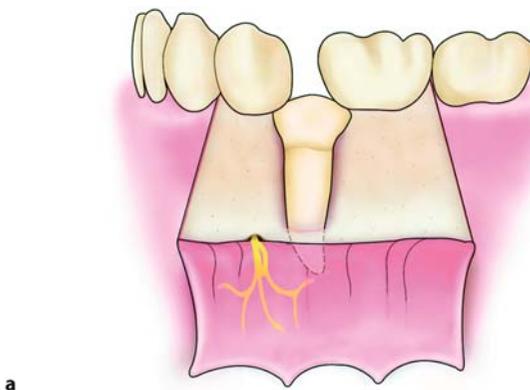

Fig. 7.75 a, b. Exposure of part of the buccal aspect of the root, after removal of a large amount of buccal bone. **a** Diagrammatic illustration. **b** Clinical photograph
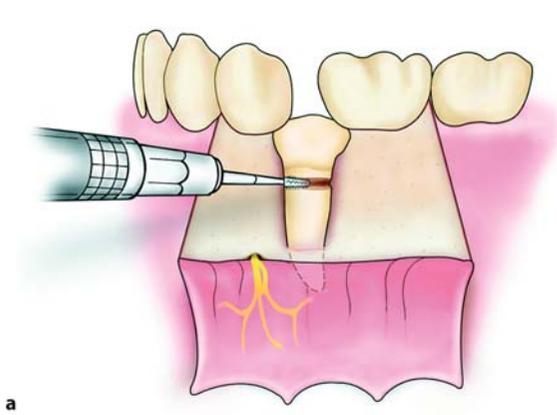
Fig. 7.76 a, b. Partial sectioning of the crown from the root of the tooth using a bur, in the buccolingual direction. **a** Diagrammatic illustration. **b** Clinical photograph
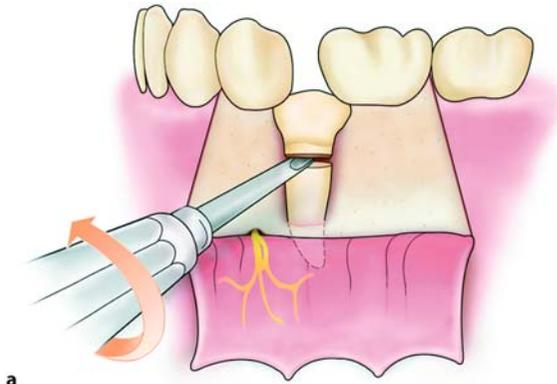
Fig. 7.77 a, b. Separation of the impacted tooth into two segments using the straight elevator. **a** Diagrammatic illustration. **b** Clinical photograph
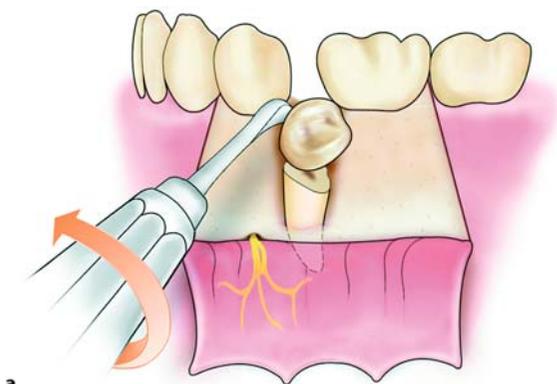
Fig. 7.78 a, b. Removal of the crown using Seldin elevator or elevator with T-shaped handles. **a** Diagrammatic illustration. **b** Clinical photograph
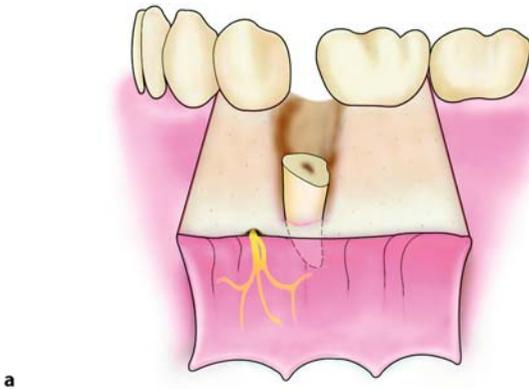
Fig. 7.79 a, b. Portion of remaining root after removal of the crown. **a** Diagrammatic illustration. **b** Clinical photograph
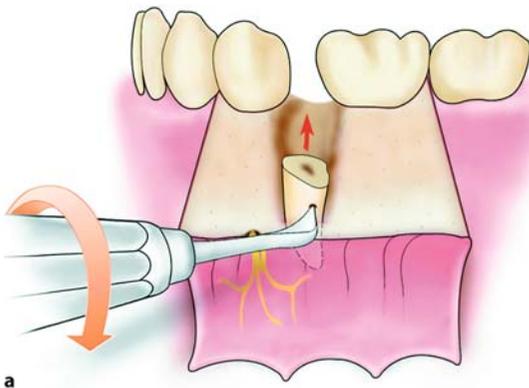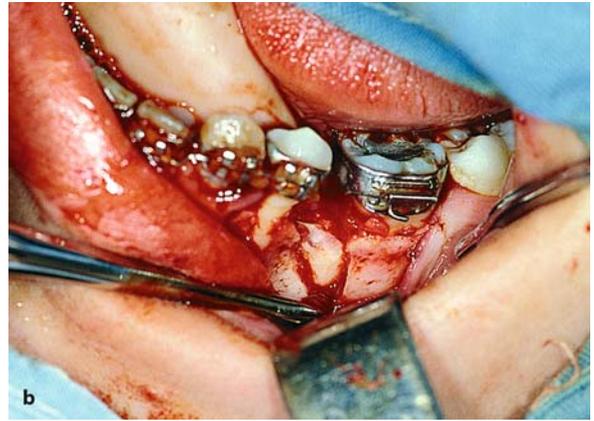
**Fig. 7.80 a, b.** Positioning of angled elevator in the purchase point of the root, for luxation
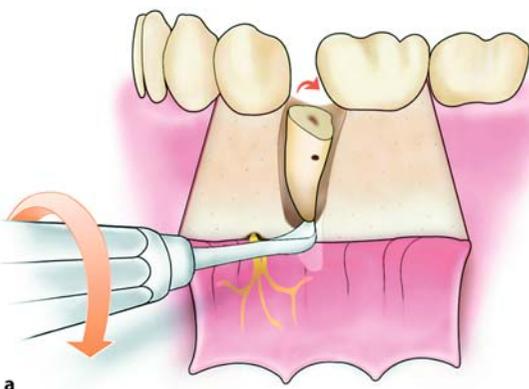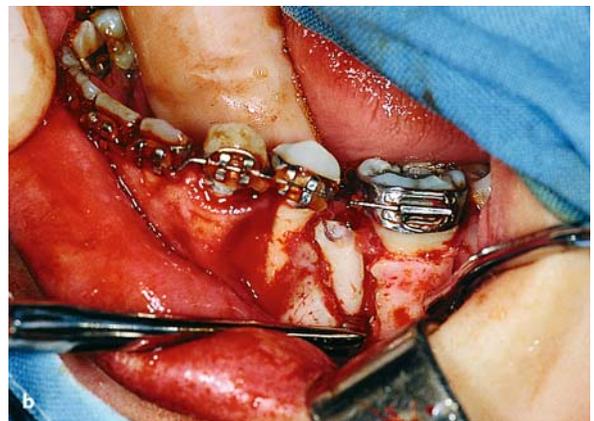
Fig. 7.81 a, b. Final step in removal of the root from the socket using the angled Seldin elevator. **a** Diagrammatic illustration. **b** Clinical photograph
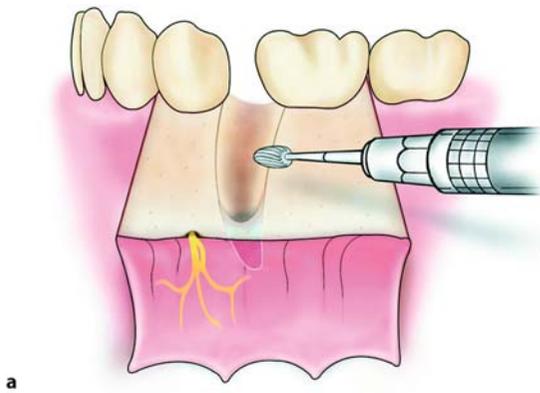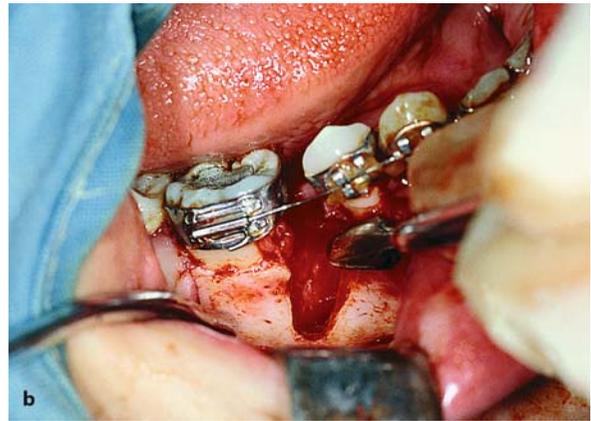
Fig. 7.82 a, b. Smoothing of bone edges of the wound using a surgical bur. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 7.83. Surgical field after placement of sutures

Fig. 7.84. Impacted premolar with groove on the surface of the root

7.7.3
Impacted Canine

Impacted mandibular canines are usually localized buccally and generally next to or underneath the roots of the incisors, in a vertical, horizontal, or oblique position.

The case presented involves an impacted canine in a vertical position, and the surgical procedure was performed with concurrent removal of odontomas found nearby (Fig. 7.85). First a trapezoidal flap is cre-

ated that ensures a satisfactory surgical field and access, which is also necessary because of the presence of the odontomas (Figs. 7.86, 7.87). The crown of the impacted tooth is exposed using a round bur, while a fissure bur is used to remove bone around the crown to permit positioning of the elevator (Fig. 7.88). After this procedure, the tooth is luxated mesially and distally and the odontomas are then removed using a narrow angled elevator, after being exposed using a narrow round bur (Figs. 7.89, 7.90). After care of the wound, the flap is repositioned and interrupted sutures are placed (Figs. 7.91, 7.92).
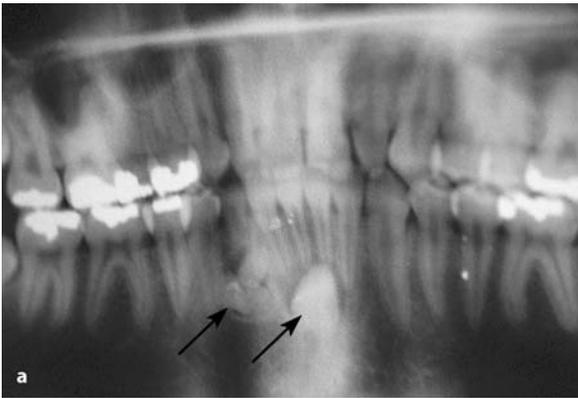
Fig. 7.85 a, b. a Panoramic radiograph showing an impacted mandibular canine and odontomas in the anterior area of the mandible. **b** Clinical photograph of the radiograph shown in **a**, showing the deciduous canine, which remained in the dental arch due to impaction of the permanent canine and the presence of odontomas

Fig. 7.86 a, b. Trapezoidal incision extending from the left lateral incisor as far as the first premolar of the opposite side of the mandible. **a** Diagrammatic illustration. **b** Clinical photograph
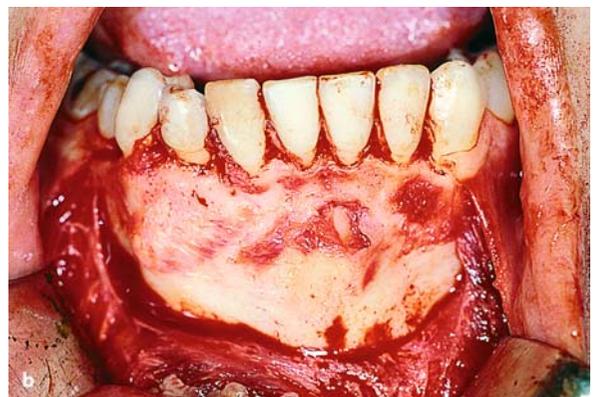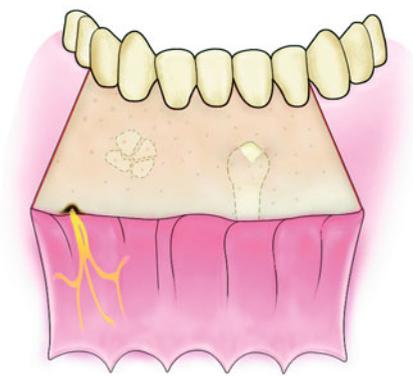
Fig. 7.87 a, b. Reflection of the flap, which ensures satisfactory access to the surgical field, necessary due to the presence of odontomas, other than the impacted tooth. **a** Diagrammatic illustration. **b** Clinical photograph
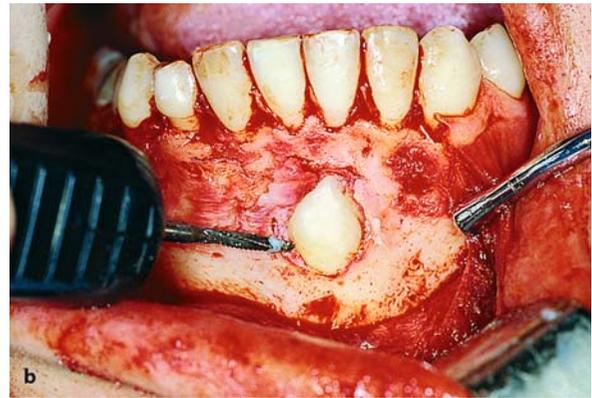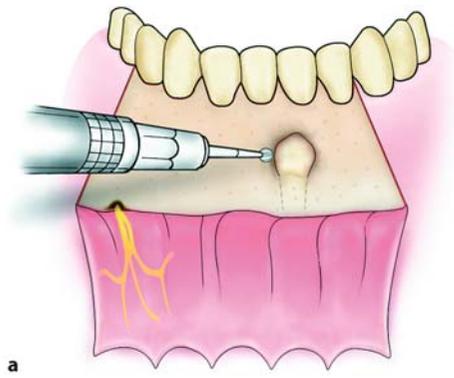
Fig. 7.88 a, b. Exposure of the crown of the impacted tooth using a surgical bur. **a** Diagrammatic illustration. **b** Clinical photograph
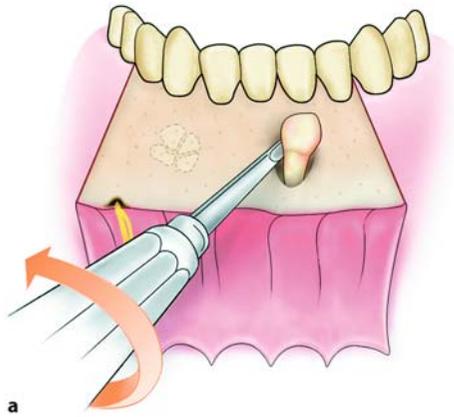
Fig. 7.89 a, b. Luxation using the blade of the elevator alternately on the mesial and distal aspects of crown of tooth. **a** Diagrammatic illustration. **b** Clinical photograph
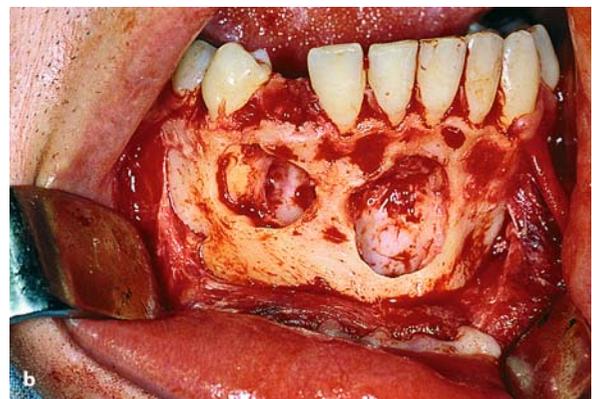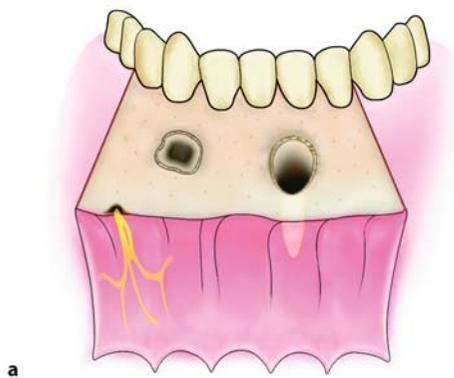
Fig. 7.90 a, b. Surgical field after removal of the impacted tooth and odontomas. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 7.91. Surgical field after suturing

Fig. 7.92. Canine and odontomas after removal

7.7.4
Premolar with Deep Impaction

When the impacted premolar is deep in the bone (Fig. 7.93), the procedure for its removal is generally as follows. First a trapezoidal incision is made (Fig. 7.94), and the mucoperiosteal flap is reflected, which, due to the position of the impacted tooth, must be done very carefully, until the mental foramen and the emerging neurovascular bundle are visible (Fig. 7.95).

When this procedure is complete, the bone covering the crown and part of the root is removed (Fig. 7.96). The straight elevator is then placed on the mesial or distal aspect, and using alternate movements, the tooth is luxated buccally (Figs. 7.97–7.99).

Fig. 7.93 a, b. **a** Radiograph showing the mandibular second premolar with complete bone impaction. **b** Clinical photograph of the area of impaction
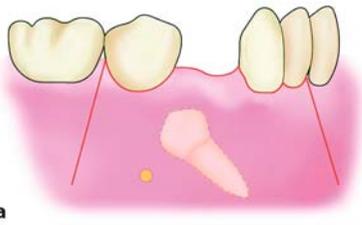
Fig. 7.94 a, b. Completed trapezoidal incision. **a** Diagrammatic illustration. **b** Clinical photograph. The area of the mental foramen (*yellow circle* in **a**) is avoided at vertical releasing incision
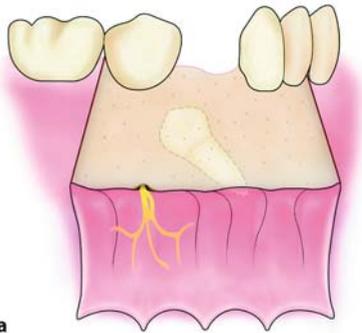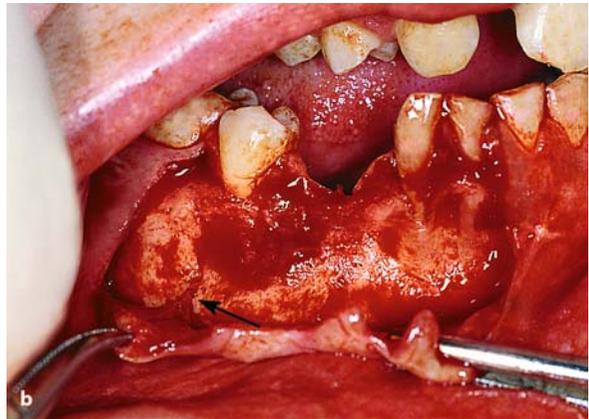
Fig. 7.95 a, b. Flap reflection. *Arrow* points to the mental nerve, which was prepared to avoid injury. **a** Diagrammatic illustration. **b** Clinical photograph
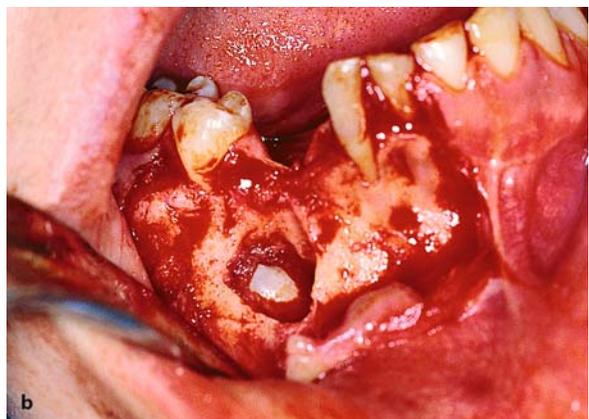
Fig. 7.96 a, b. Removal of buccal bone to expose the crown of the impacted tooth. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 7.97 a, b. Luxation of the tooth using rotational movements in the mesial direction. **a** Diagrammatic illustration. **b** Clinical photograph
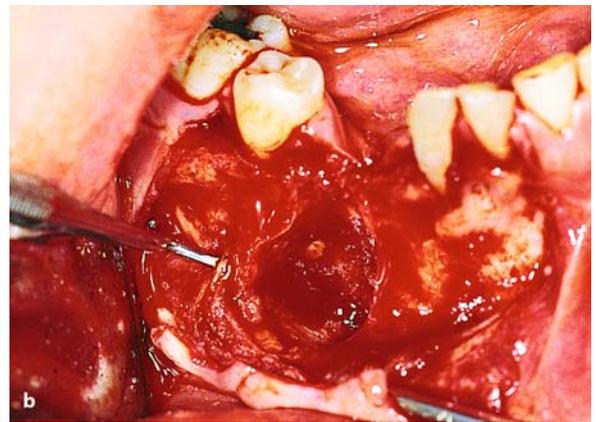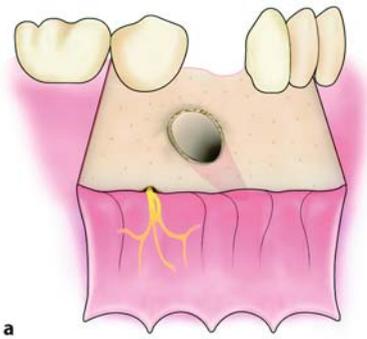
Fig. 7.98 a, b. Surgical field after removal of the impacted tooth. **a** Diagrammatic illustration. **b** Clinical photograph
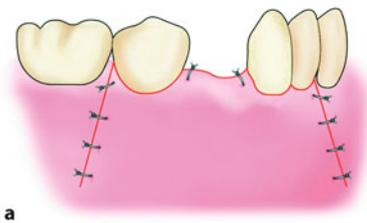
Fig. 7.99 a, b. Surgical field after suturing. **a** Diagrammatic illustration. **b** Clinical photograph

7.8
Extraction of Impacted Maxillary Teeth

7.8.1
Impacted Third Molar

Removal of an impacted maxillary third molar is difficult, because of insufficient visualization of the area and limited access. Furthermore, other factors (reduced aperture of the mouth, close proximity of the impacted tooth to the maxillary sinus, etc.) may make the surgical procedure even more difficult.

Classification. Impaction of the maxillary third molar (according to Archer 1975) may be classified as: mesioangular, distoangular, vertical, horizontal, buccoangular, linguoangular, or inverted (Fig. 7.100). The tooth usually presents with a mesial or distal inclination, with the occlusal surface positioned buccally.

Impacted maxillary third molars may also be classified (Archer 1975), according to the depth of impaction compared to the second molar, into three categories:

Class A: The occlusal surface of the impacted tooth is at approximately the same level as the occlusal surface of the second molar (Fig. 7.101 a).

Class B: The occlusal surface of the impacted tooth is at the middle of the crown of the adjacent second molar (Fig. 7.101 b).

Class C: The occlusal surface of the crown of the impacted tooth is below the cervical line of the adjacent molar or even deeper, contiguously or even above its roots (Figs. 7.101 c–e).

Impacted teeth belonging to the third category are very difficult cases, because their extraction entails the removal of large amounts of bone, limited access, and the risk of displacing the impacted tooth into the maxillary sinus (Fig. 7.102).
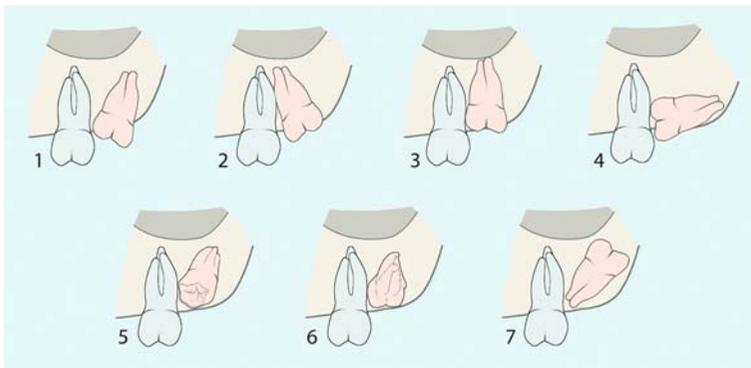
Fig. 7.100. Classification of impaction of maxillary third molars according to Archer (1975). (*1* Mesioangular, *2* distoangular, *3* vertical, *4* horizontal, *5* buccoangular, *6* linguoangular, *7* inverted)
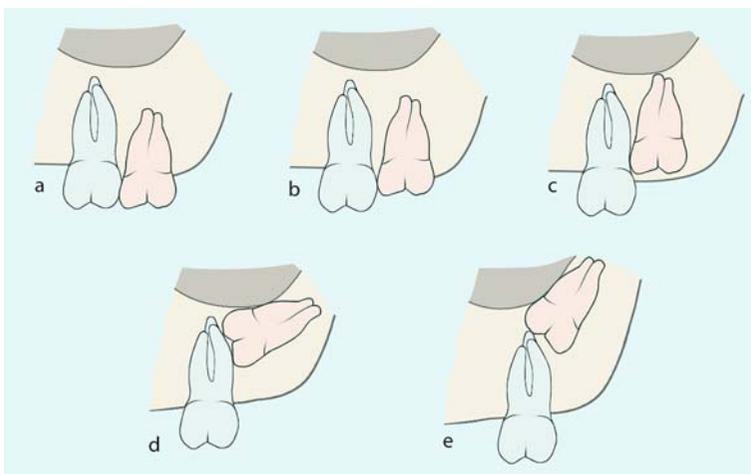
Fig. 7.101 a–e. Classification of impacted maxillary third molars according to Archer (1975), depending on the depth of impaction compared to the adjacent second molar
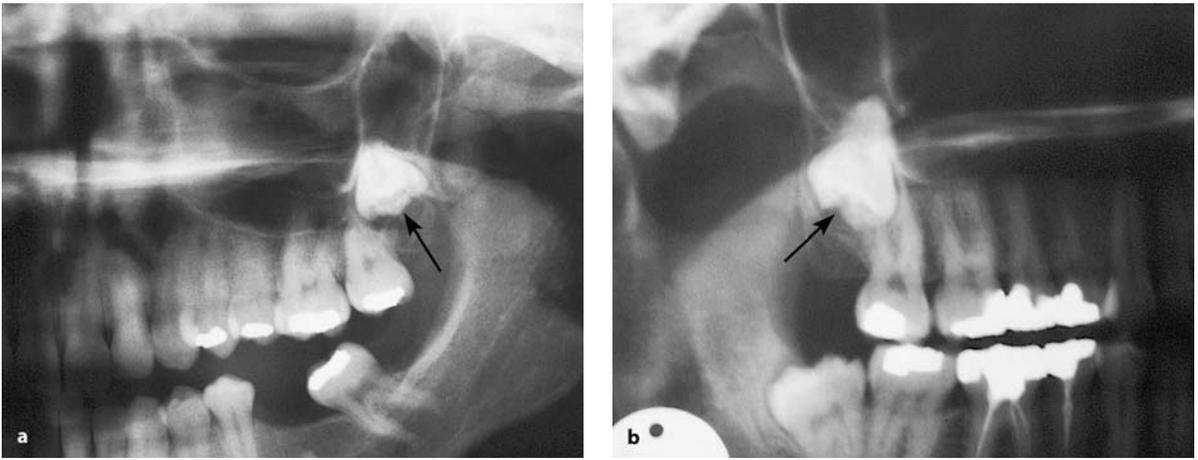
Fig. 7.102 a, b. Maxillary third molars with deep, complete bone impaction. Their removal is considered difficult, because of the closeness to the maxillary sinus and insufficient visualization of the area

Types of Flaps. The types of flaps used are triangular and horizontal:

Triangular flap:

The incision for creating the flap begins at the maxillary tuberosity and extends as far as the distal aspect of the second molar, continuing obliquely upwards and anteriorly (vertical incision) to the vestibular fold (Fig. 7.103). In rare cases, when impaction is deep and a satisfactory surgical field is necessary or when the impacted tooth covers the roots of the second molar buccally, then the vertical incision may be made at the distal aspect of the first molar (Fig. 7.104).

Incisions and Types of Flaps for Extraction of Impacted Third Molar
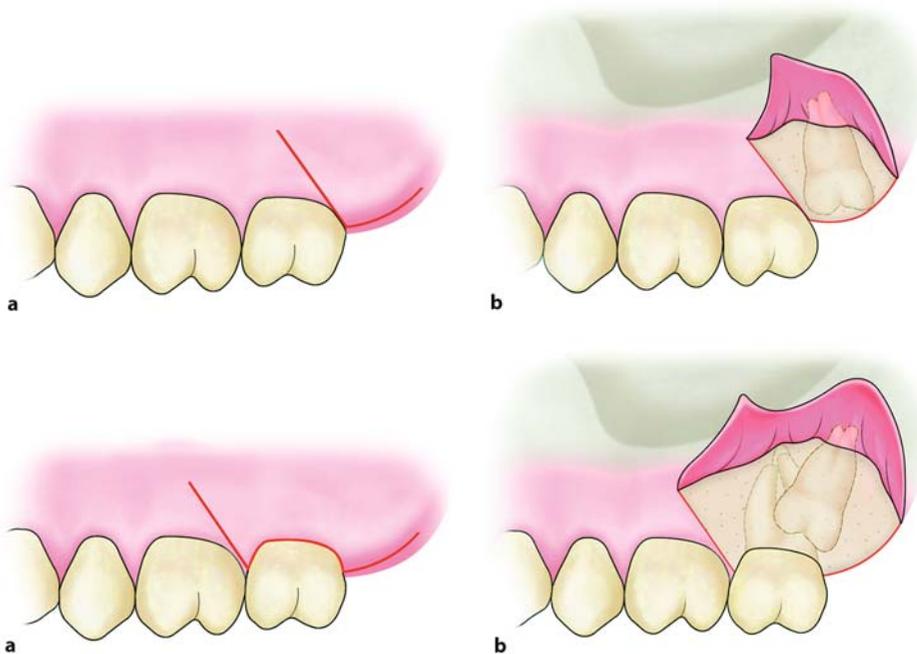
Fig. 7.103 a, b. Diagrammatic illustrations showing the triangular incision (**a**) and reflection of the flap (**b**), indicated in certain cases of extraction of impacted maxillary third molars

Fig. 7.104 a, b. Variation of the triangular incision and flap shown in Fig. 7.103 (the vertical incision extends as far as the distal aspect of the first molar). The mesial extension of the incision is necessary due to the position of the third molar compared to the second molar

Fig. 7.105 a, b. Diagrammatic illustrations showing the horizontal incision (**a**) and envelope flap (**b**), for removal of impacted maxillary third molars
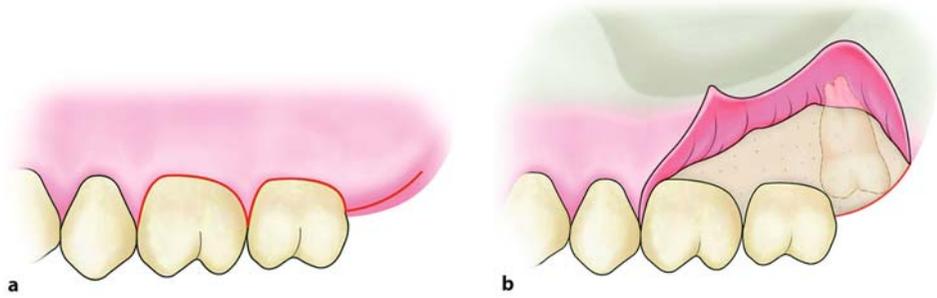
Horizontal (envelope) flap:

The incision for creation of this flap also begins at the maxillary tuberosity and extends as far as the distal aspect of the second molar, continuing buccally along the cervical lines of the last two teeth, and ending at the mesial aspect of the first molar (Fig. 7.105).

Removal of Bone. Often, after reflection of the flap, part of the crown of the impacted tooth is visible or there is bone protuberance over the crown. Because the bone in this case is thin and spongy, it may be removed from the buccal surface using a sharp instrument. If the buccal bone is dense and thick, then its removal is achieved using a surgical bur.

7.8.1.1
Extraction of Impacted Third Molar

The procedure for removing the impacted third molar (Fig. 7.106) is as follows.

After making a triangular incision (Fig. 7.107), the mucoperiosteal flap is reflected (Fig. 7.108) and the buccal bone is then removed until the entire crown of the impacted tooth and part of its roots are exposed. Because extraction of the tooth in segments is not indicated, sufficient space must be created around its crown to be able to luxate the tooth. Thus, using a straight or double-angled elevator on the mesial aspect of the tooth, always buccally, the tooth is luxated carefully, posteriorly, outwards and downwards (Figs. 7.109, 7.110). Care of the wound and suturing are performed in the same way as described for all other cases of impacted teeth (Fig. 7.111).

Fig. 7.106 a, b. **a** Radiograph showing a maxillary third molar with distoangular impaction. **b** Clinical photograph of the case shown in **a**
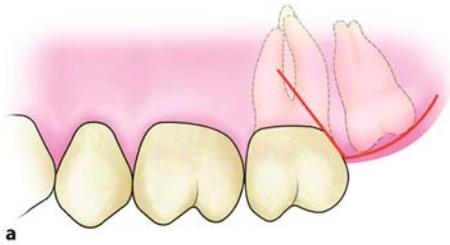
Fig. 7.107 a, b. Triangular incision completed. **a** Diagrammatic illustration. **b** Clinical photograph
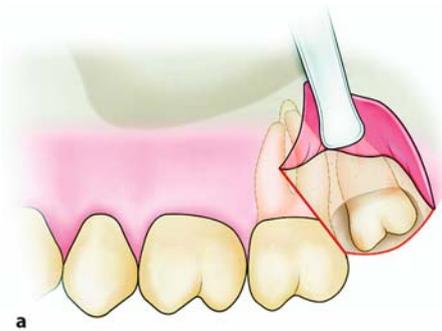
Fig. 7.108 a, b. Reflection of the flap and exposure of the crown of the impacted tooth. Placement of the broad end of the periosteal elevator in the posterior position is indicated to protect the tooth from becoming accidentally displaced into the infratemporal fossa or into soft tissues. **a** Diagrammatic illustration. **b** Clinical photograph
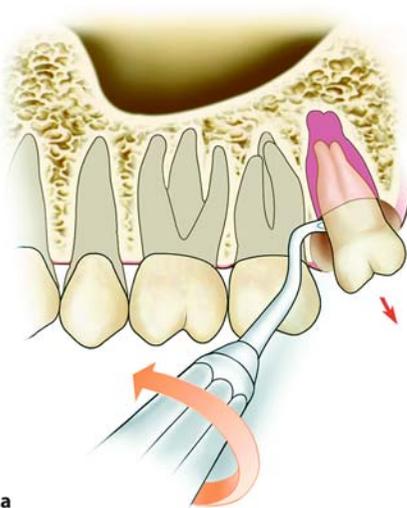
Fig. 7.109 a, b. Luxation of the impacted tooth using double-angled elevator. Extraction movements depend largely upon the relationship between the tooth and the maxillary sinus. **a** Diagrammatic illustration. **b** Clinical photograph
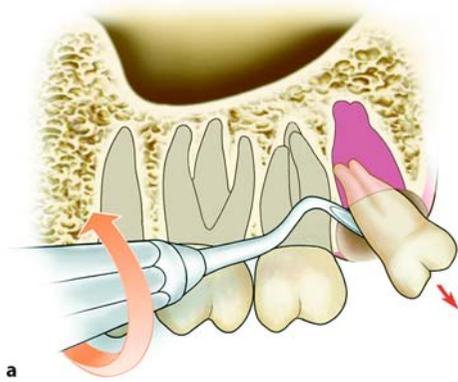
Fig. 7.110 a, b. Final luxation of the tooth. **a** Diagrammatic illustration. **b** Clinical photograph
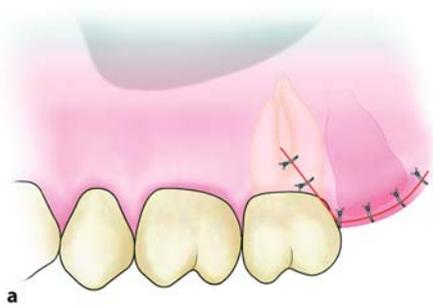
Fig. 7.111 a, b. Surgical field after placement of sutures. **a** Diagrammatic illustration. **b** Clinical photograph

7.8.2
Impacted Canines

Impacted maxillary canines are quite common, and approximately 12%–15% of the population present with impacted canines. They are localized palatally more often than labially.

Even though positions vary, the impacted canine presents five basic localizations (contralateral or ipsilateral and deep in the bone) as follows:
1. Palatal localization
2. Palatal localization of crown and labial localization of root
3. Labial localization of crown and palatal localization of root
4. Labial localization
5. Ectopic positions

In young people aged 20 years or slightly older, impacted maxillary canines may be correctly aligned in the dental arch after surgical exposure and orthodontic treatment. In older patients, especially after the age of 30 years, the above procedure is not a method of choice, because the risk of failure is greater. In such cases, surgical removal is preferred, if deemed necessary of course.

The technique for removing impacted canines depends on the position of impaction (palatal or labial), the relationship of the impacted tooth to adjacent teeth, as well as the inclination of its crown. These factors should be assessed before planning the surgical procedure.

The localization of impacted canines is achieved using various radiographic techniques together with careful clinical examination. The most commonly used intraoral projections are occlusal projections, periapical radiographs and panoramic radiographs, while the technique employed for exact localization of the labial or palatal position of the impacted tooth is based on the tube shift principle, as described in Chap. 2. As far as the clinical examination is con-

cerned, a palpable protuberance of the area designates the position of the tooth quite accurately. Based on the data from the clinical and radiographic examination, the surgical removal of impacted canines may be performed in three ways: with the labial approach, the palatal approach or a combination of the two.

7.8.2.1
Extraction Using Labial Approach

If the impacted tooth is localized labially and is entirely covered by bone (Figs. 7.112, 7.113), the procedure for its removal is as follows. First a trapezoidal incision is created and the mucoperiosteum is then re-

flected (Figs. 7.114, 7.115). The bone covering the tooth is removed using a round bur, with a steady stream of saline solution, until the entire crown of the tooth and part of the root are exposed (Figs. 7.116, 7.117). A groove is then created at the cervical line using a fissure bur, in order to separate the crown from the root (Figs. 7.118, 7.119). Separation is achieved using a straight elevator, which is placed in the groove. Upon rotation, the instrument separates the tooth into two segments. The crown is removed first and the root is then luxated, after creating a purchase point on the surface of the root for placement of the tip of the elevator blade (Figs. 7.120–7.126). After smoothing the bone, the area is thoroughly irrigated with saline solu-

Fig. 7.112. Radiograph showing impacted maxillary canines. Right canine is located labially while left canine is located palatally

Fig. 7.113. Clinical photograph of the labial area where the right canine of the case shown in Fig. 7.112 is localized

Fig. 7.114. Surgical procedure for removal of right impacted canine. A trapezoidal incision is created buccally

Fig. 7.115. Reflection of the mucoperiosteal flap

tion, and the wound is sutured (Figs. 7.127–7.129). When the impacted tooth is not entirely covered by bone, but the crown of the tooth is covered by overly-ing soft tissues, removal of the tooth is easier, since it does not have to be sectioned into two pieces (Figs. 7.130–7.138).

Fig. 7.116. A round bur is used to remove the bone covering the crown of the tooth

Fig. 7.117. Complete exposure of the crown of the tooth and part of the root

Fig. 7.118. Sectioning of the crown–root at the cervical line of the tooth, using a fissure bur
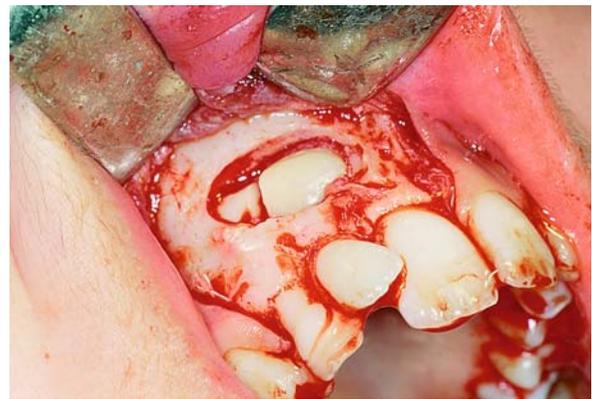
Fig. 7.119. Tooth after sectioning

Fig. 7.120. Removal of the crown of the impacted tooth using a straight elevator

Fig. 7.121. Root of the tooth after removal of the crown
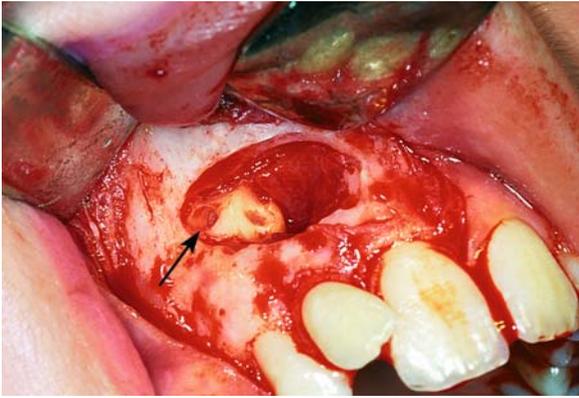
Fig. 7.122. Purchase point created on the root for placement of the elevator blade

Fig. 7.123. Luxation of the root using a curved Chompret elevator
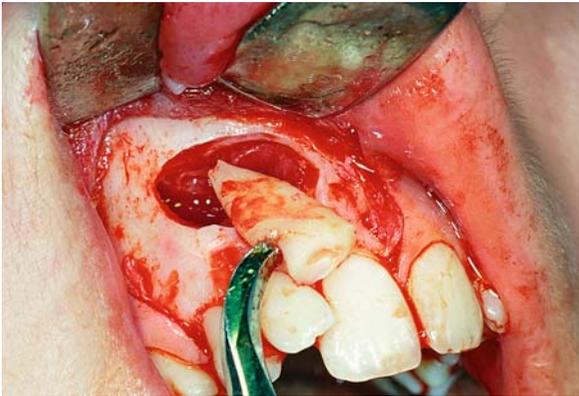
Fig. 7.124. Final step of root extraction
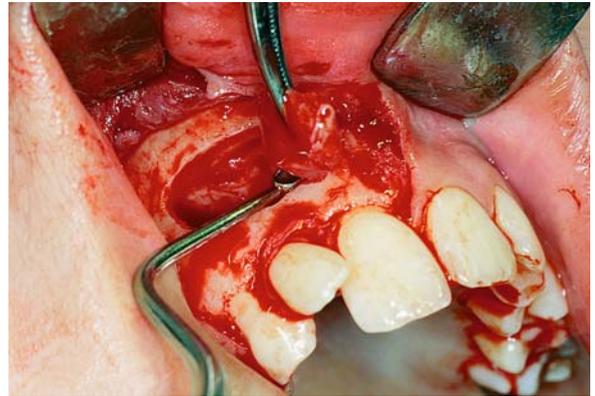
Fig. 7.125. Removal of follicle using a hemostat and periapical curette

Fig. 7.126. The two segments of tooth after removal
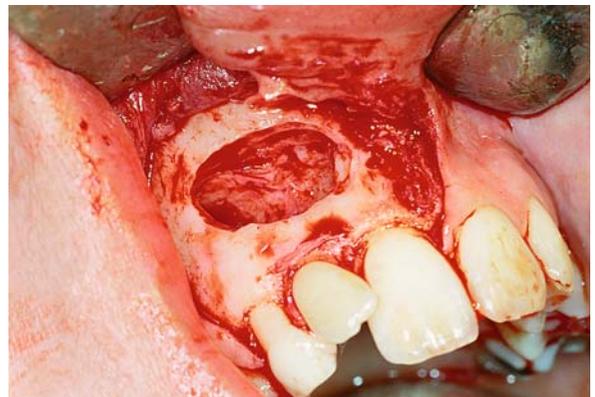
Fig. 7.127. Surgical field after removal of the tooth
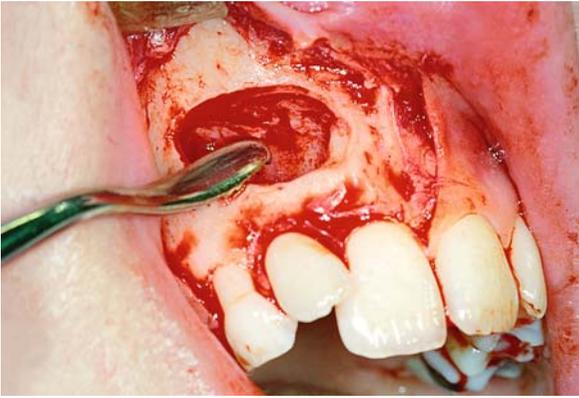
Fig. 7.128. Smoothing of the bone edges of the wound using a bone file

Fig. 7.129. Surgical field after suturing

Extraction of Impacted Canine with Partial Bone Impaction

Fig. 7.130. Radiograph showing an impacted maxillary canine with a labial localization

Fig. 7.131. Clinical photograph of the area of impaction. The ischemic protuberance, shown by *arrows*, indicates the position of the crown of the impacted tooth

Fig. 7.132. Trapezoidal incision and reflection of the mucoperiosteal flap

Fig. 7.133. Reflection of the flap and exposure of the crown of the impacted tooth, which was not covered by bone
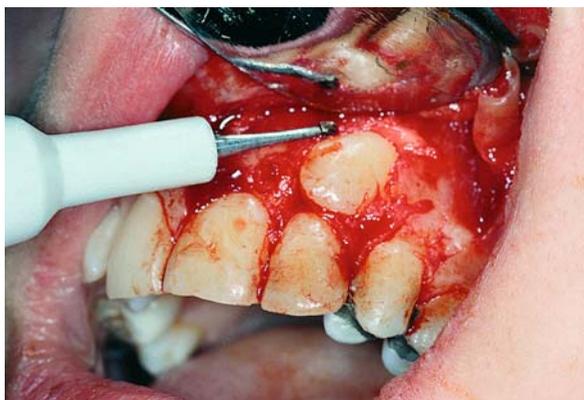
Fig. 7.134. Creation of a groove between the crown and bone, allowing for positioning of the elevator

Fig. 7.135. Placement of the straight elevator in a groove created for tooth luxation

Fig. 7.136. Removal of the tooth in a mesial, upward and outward direction

Fig. 7.137. Smoothing of bone edges of the wound using a bone file

Fig. 7.138. Surgical field after placement of sutures

7.8.2.2
Extraction Using Palatal Approach

When the impacted tooth is positioned palatally (Fig. 7.139), the approach is achieved using a bilateral palatal flap. The incision for creation of the flap begins at the first or second ipsilateral premolar and, after continuing along the cervical lines of the teeth, ends at the first premolar on the contralateral side (Fig. 7.140).

After careful reflection of the mucoperiosteum, part of the crown of the tooth may be exposed, or the entire crown may be covered by bone, resulting in protuberance at that site (Fig. 7.141). Either way, enough

bone must be removed to expose the entire crown, so that the tooth may be extracted using forceps or an elevator (Fig. 7.142). If the tip of the crown is positioned between the roots of the lateral and central incisors, there is a risk of injuring their roots during the exposure attempt. That is why extraction of the canine must be achieved using the technique of separating the crown from the root. More specifically, a groove is created on the cervical line of the tooth using a fissure bur (Fig. 7.143) and, after placing the elevator blade in the groove created, the instrument is rotated until the crown is separated from the root (Fig. 7.144). The crown is then removed, and, after using the round bur to create a purchase point on the root for placement of the angled elevator's tip, the root is elevated from its bed (Figs. 7.145, 7.146). After this procedure, the bone edges are smoothed, and the area is thoroughly irrigated with saline solution, while the flap is repositioned and sutured with interrupted sutures (Figs. 7.147, 7.148).
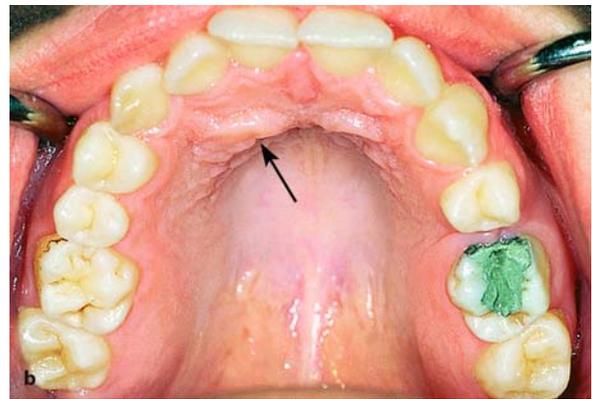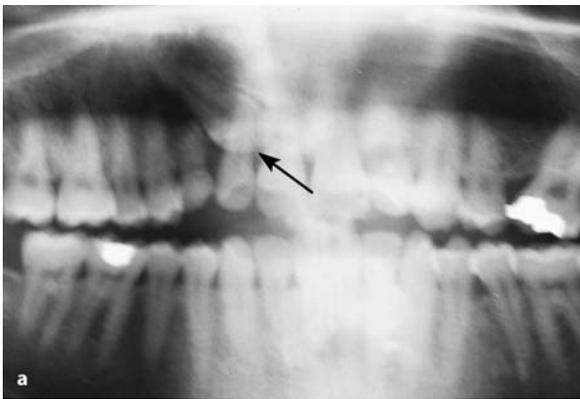
Fig. 7.139 a, b. a Radiograph showing an impacted maxillary canine with palatal localization. **b** Clinical photograph of the area of impaction
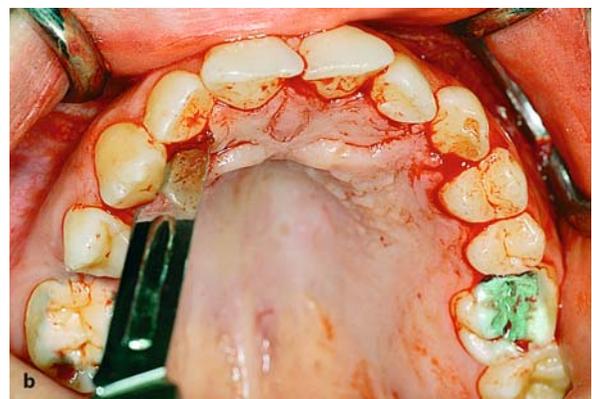
Fig. 7.140 a, b. Palatal incision along the cervical lines of the teeth. **a** Diagrammatic illustration. **b** Clinical photograph
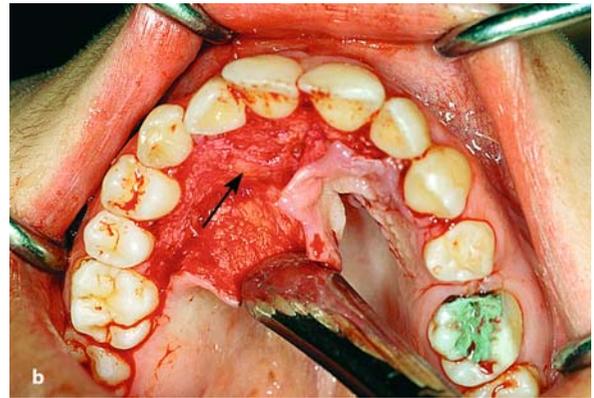
Fig. 7.141 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) after reflection of the flap. *Arrow* points to the protuberance of bone, which indicates the position of the crown of the impacted tooth
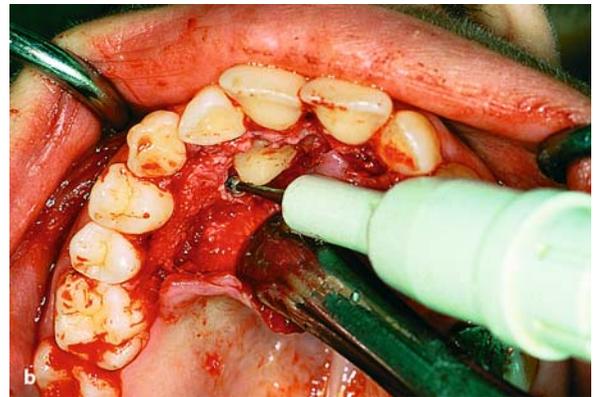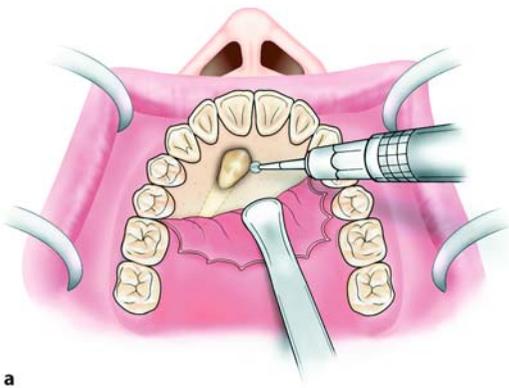
Fig. 7.142 a, b. Removal of bone using a round bur, to expose the crown of an impacted tooth. **a** Diagrammatic illustration. **b** Clinical photograph
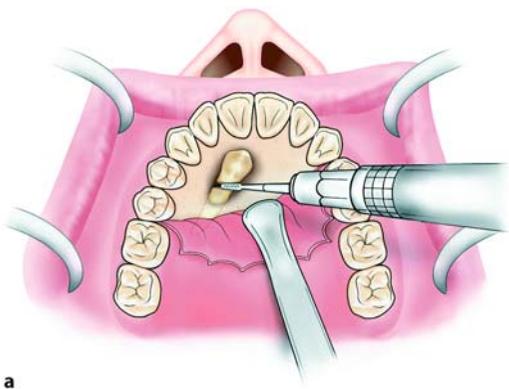
Fig. 7.143 a, b. Sectioning of an impacted tooth at the cervical line and separation of the crown from the root. **a** Diagrammatic illustration. **b** Clinical photograph
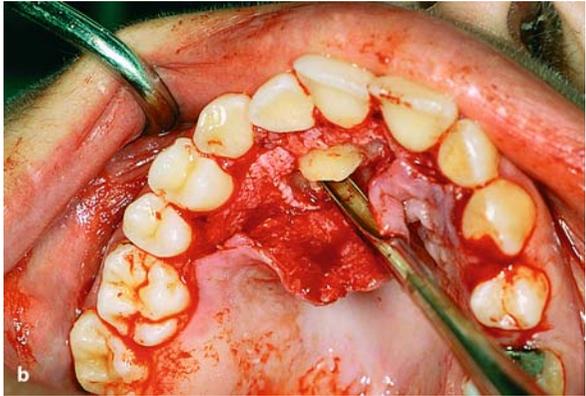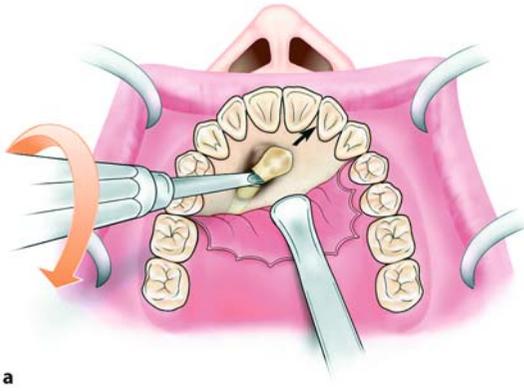
Fig. 7.144 a, b. Placement of the straight elevator in the groove created to separate the crown from the root and removal of the crown. **a** Diagrammatic illustration. **b** Clinical photograph
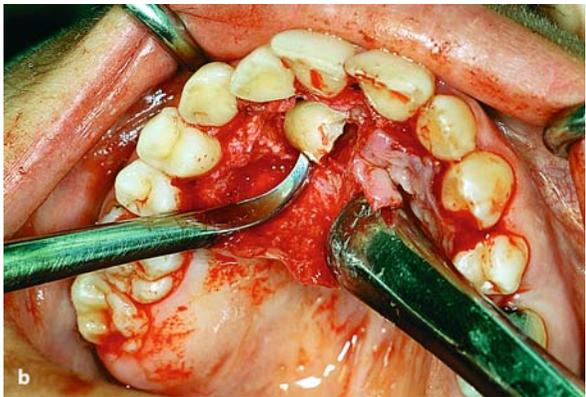
Fig. 7.145 a, b. Removal of root from its position in the bone using an angled elevator. **a** Diagrammatic illustration. **b** Clinical photograph
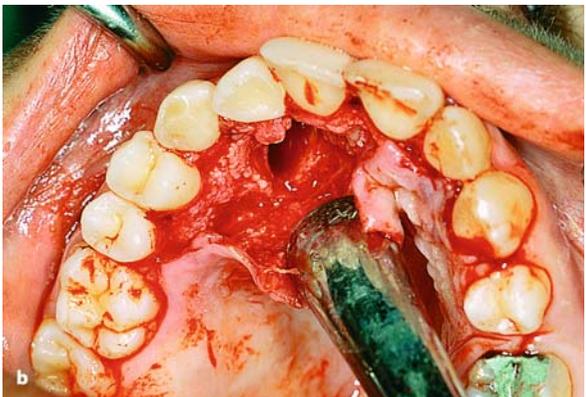
Fig. 7.146 a, b. Surgical field after removal of the impacted tooth. **a** Diagrammatic illustration. **b** Clinical photograph
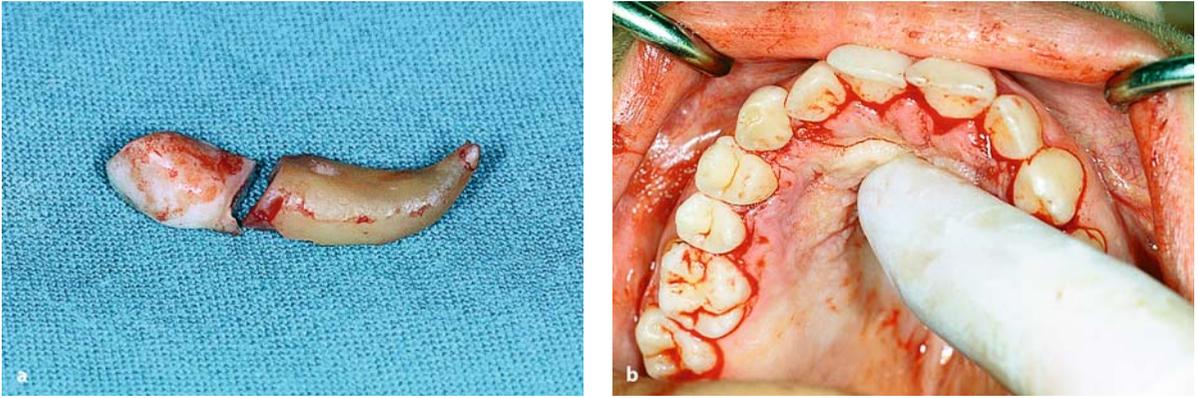
Fig. 7.147 a, b. a The two segments of tooth after removal. **b** The flap is repositioned in its initial position and pressure is applied to the area with the index finger for a few seconds
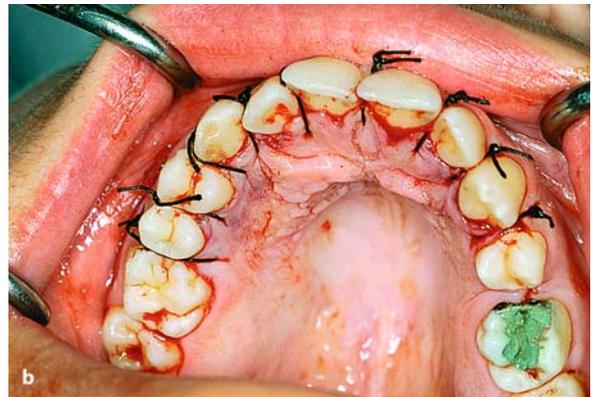
Fig. 7.148 a, b. Surgical field after suturing. **a** Diagrammatic illustration. **b** Clinical photograph

7.8.3
Impacted Premolar with Palatal Position

When an impacted premolar is localized palatally (Fig. 7.149), the surgical approach involves creating a palatal flap. The incision begins at the region of the central incisor and extends along the cervical lines of the teeth, ending at the distal aspect of the first premo-lar (Fig. 7.150). After creation of the flap, the bone covering the impacted tooth is removed using a round bur, until the entire crown is exposed (Figs. 7.151, 7.152). Afterwards, a groove is created around the tooth using a fissure bur, creating room to facilitate its luxation. The blade of the straight elevator is placed in this groove at the mesial and distal aspects of the tooth, luxating it from its socket (Figs. 7.153–7.157).
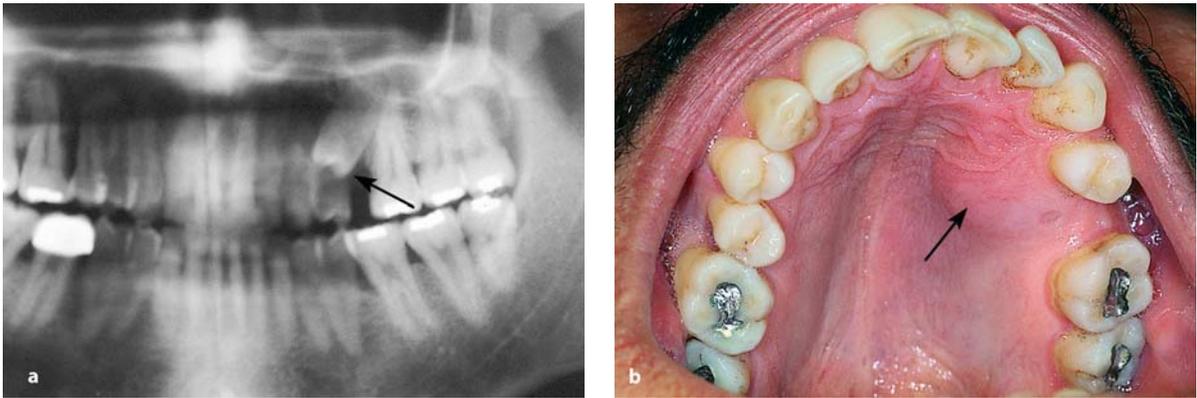
Fig. 7.149 a, b. a Radiograph showing impacted maxillary premolar with a palatal localization. **b** Clinical photograph of the area of impaction
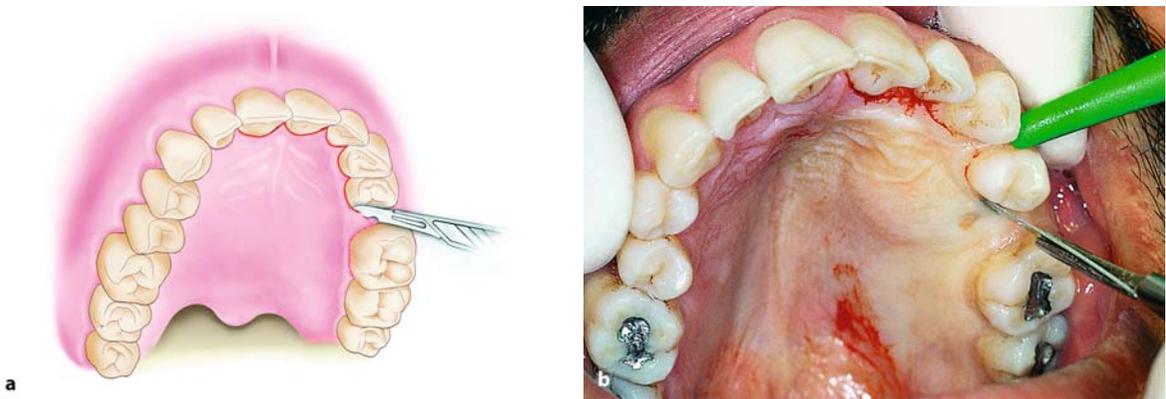

Fig. 7.150 a, b. Palatal incision along the cervical lines of the teeth using a scalpel with no. 15 blade. **a** Diagrammatic illustration. **b** Clinical photograph
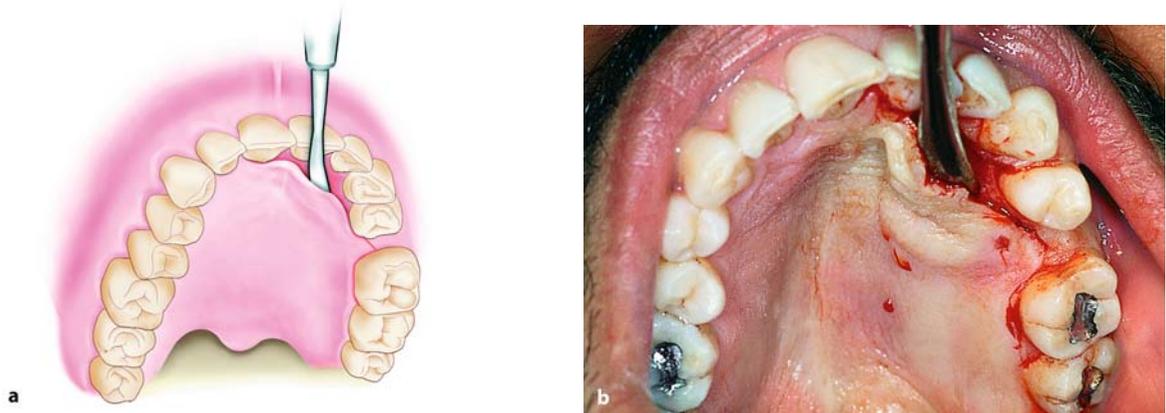
Fig. 7.151 a, b. Reflection of the mucoperiosteal flap. **a** Diagrammatic illustration. **b** Clinical photograph
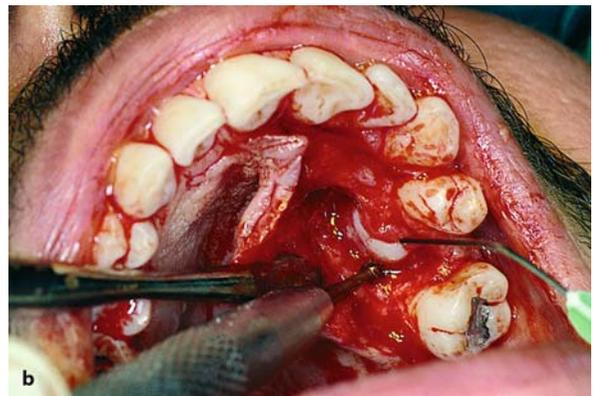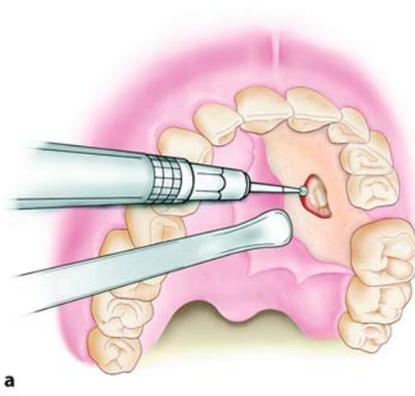
Fig. 7.152. Removal of bone to expose the crown of the impacted tooth. **a** Diagrammatic illustration. **b** Clinical photograph
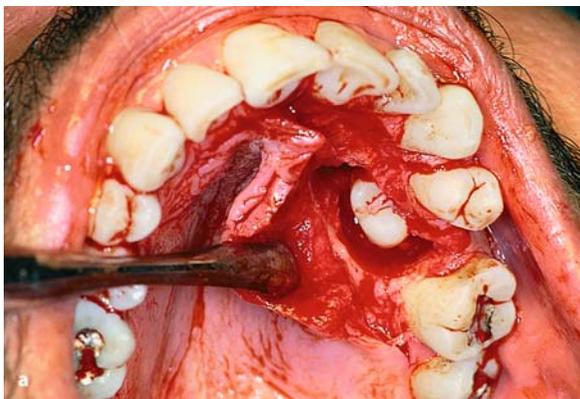
Fig. 7.153 a, b. **a** Groove created around the crown of the tooth to facilitate its luxation. **b** Luxation of the impacted tooth using straight elevator
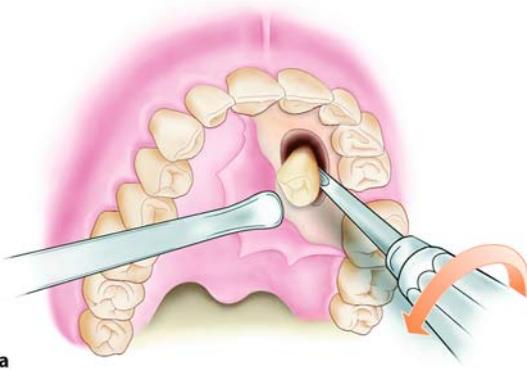
Fig. 7.154 a, b. Final luxation of tooth. **a** Diagrammatic illustration. **b** Clinical photograph
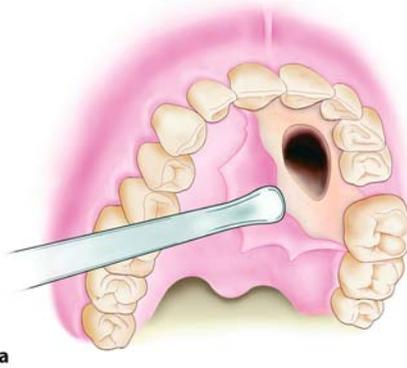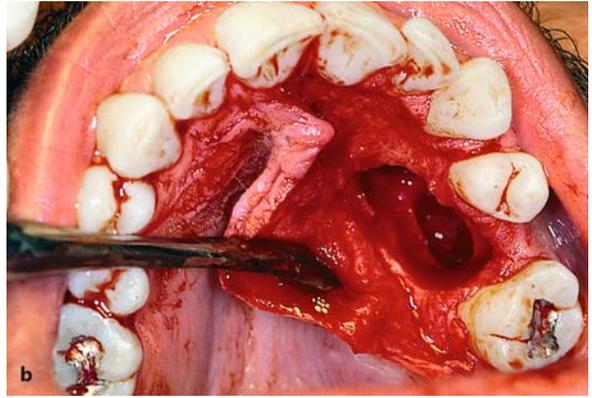
Fig. 7.155 a, b. Surgical field after removal of the impacted tooth. **a** Diagrammatic illustration. **b** Clinical photograph
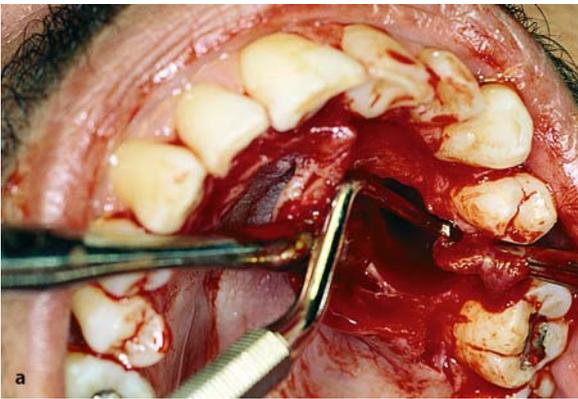
**Fig. 7.156 a, b.** **a** Removal of the follicle using a hemostat and periapical curette. **b** Tooth and follicle after removal
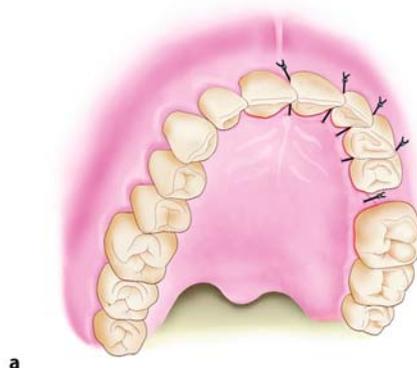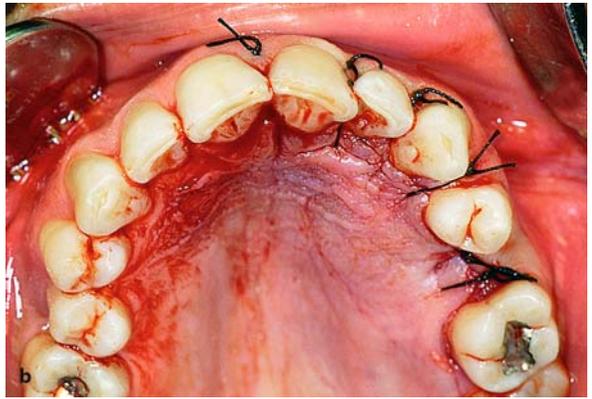
Fig. 7.157 a, b. Surgical field after placement of sutures. **a** Diagrammatic illustration. **b** Clinical photograph

7.8.4
Ectopic Impacted Canine

The presence of ectopic impacted teeth is relatively rare. Ectopic teeth are usually localized in the following places: underneath permanent teeth, near the angle of the mandible, inside the ramus, near the mandibular notch, the coronoid process, the maxillary tuberosity, the wall of the maxillary sinus, the nasal cavity and, rarely, near the orbit.

The case presented involves an impacted canine, localized in the anterior wall of the maxillary sinus (Fig. 7.158). The procedure for removing such impacted teeth is usually as follows. First a horizontal incision is made in the region of the canine fossa, from the lateral incisor as far as the first molar (Fig. 7.159). The mucoperiosteum is then reflected and the bone of the anterior wall of the maxillary sinus is exposed (Fig. 7.160). Holes are drilled through the bone using a small round bur where the impacted tooth is estimated to be, and these holes are then joined together
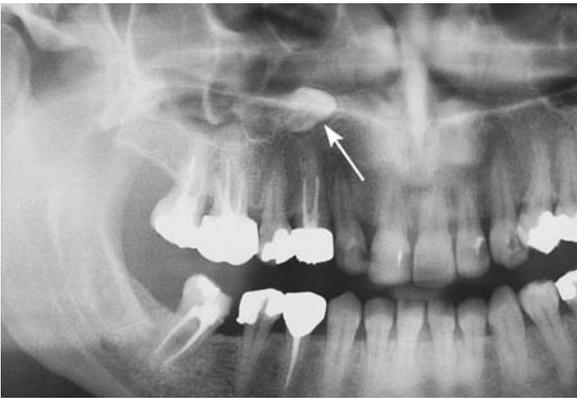
Fig. 7.158. Radiograph showing impacted canine with a labial localization, which is in contact with the anterior wall of the maxillary sinus

Fig. 7.159. Incision in canine fossa region, for sinus trephination using the Caldwell–Luc approach

Fig. 7.160 a, b. Reflection of the mucoperiosteal flap and exposure of the anterior wall of maxillary sinus. **a** Diagrammatic illustration. **b** Clinical photograph

(Figs. 7.161, 7.162). After removal of the bone surface, the impacted tooth is exposed and carefully luxated outwards (Fig. 7.163). After smoothing the bone edges of the wound, the area is irrigated thoroughly with sa- line solution and any foreign matter that has entered the maxillary sinus is aspirated with the suction tip. Finally, the flap is sutured (Fig. 7.164), and nasal decongestants are prescribed.
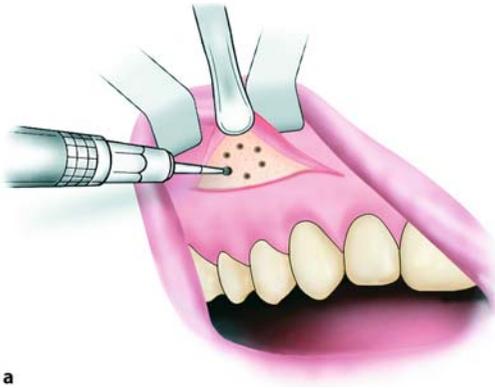
Fig. 7.161 a, b. Holes drilled through the bone surface defining the border of bone to be removed
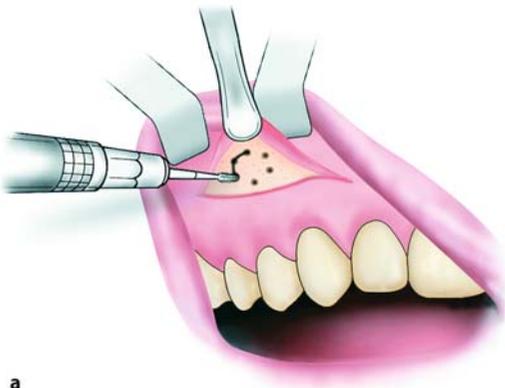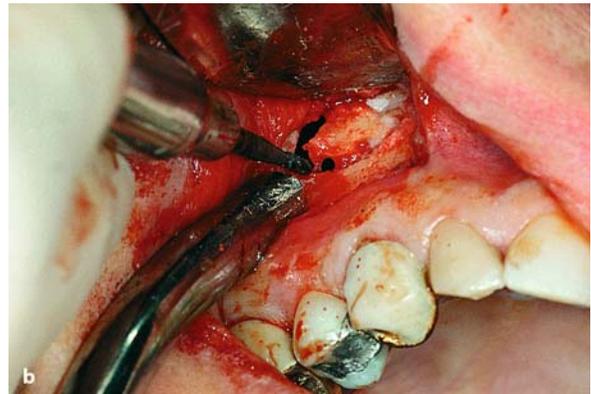
Fig. 7.162 a, b. Connecting holes to remove the bone covering the impacted tooth. **a** Diagrammatic illustration. **b** Clinical photograph
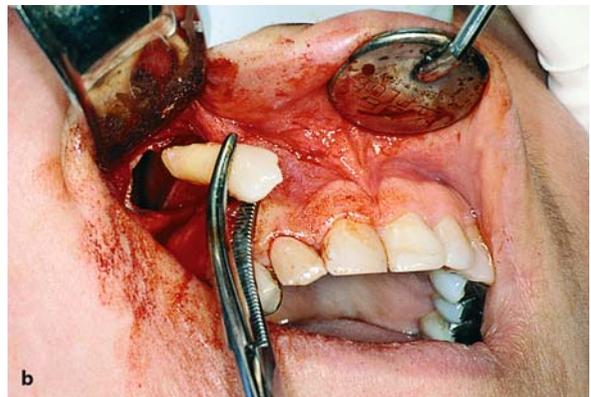
Fig. 7.163 a, b. **a** Exposure and luxation of the impacted tooth using straight elevator. **b** Removal of tooth using a hemo- stat

Fig. 7.164 a, b. Surgical field after suturing. **a** Diagrammatic illustration. **b** Clinical photograph

7.9
Exposure of Impacted Teeth for Orthodontic Treatment

Often, certain permanent teeth remain impacted inside the bone, resulting in a delay of their eruption, causing orthodontic problems. This delay may be the result of endocrine problems (hypothyroidism), supernumerary teeth, odontomas, crowding of teeth, sclerosis of soft tissues covering tooth, etc. In these cases, to facilitate eruption, a combination of surgical and orthodontic techniques is considered necessary. The procedure usually involves exposing the tooth, which is achieved by creating a flap and removing the bone over the tooth. If there are still deciduous teeth, supernumerary teeth, or odontomas, these are removed, and, after exposing a large part of the crown, orthodontic brackets are bonded to the crown, and the tooth is gradually aligned in its correct position. Sometimes the crowns of impacted teeth are covered only by soft tissue. In cases such as these, the soft tissue is removed using a scalpel or electrosurgical blade, thus creating a "window" at the crown of the tooth, which will help it to erupt, either on its own or with orthodontic treatment.

7.9.1
Impacted Canine with Palatal Position

After removal of the deciduous teeth, a palatal flap is created, underneath which part of the bone covering the teeth is exposed. A round bur is then used to remove the bone covering the crowns and orthodontic brackets are placed for traction of the teeth into their normal position in the dental arch. The area is then irrigated with saline solution and the flap is closed with interrupted sutures (Figs. 7.165–7.171).

Fig. 7.165. Radiograph showing impacted maxillary canines with a palatal localization
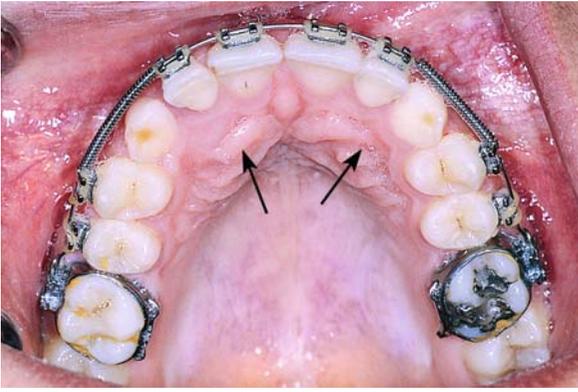
Fig. 7.166. Clinical photograph of the area of impaction
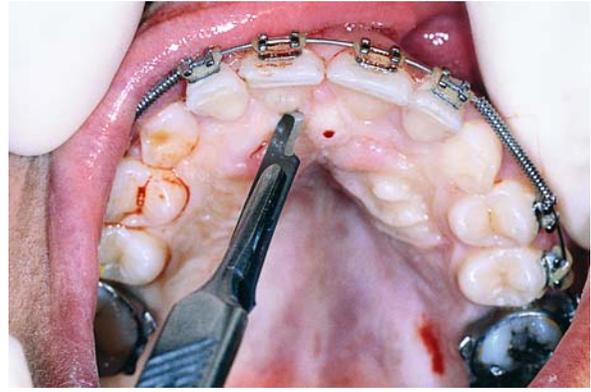
Fig. 7.167. Palatal incision along the cervical lines of teeth using a scalpel with a no. 15 blade
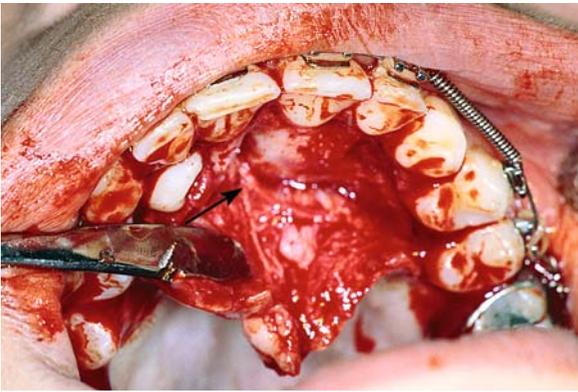
Fig. 7.168. Reflection of the mucoperiosteal flap. *Arrow* points to the nasopalatine nerve
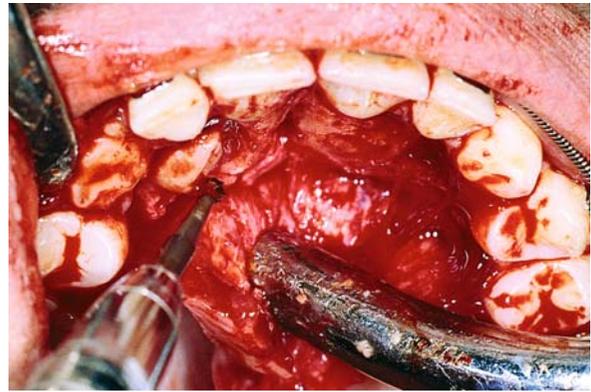
Fig. 7.169. Removal of the bone covering the crowns of impacted teeth

Fig. 7.170. Surgical field immediately after exposure of impacted teeth. Orthodontic brackets have been placed on exposed parts of the crowns of the teeth

Fig. 7.171. Surgical field after suturing

Fig. 7.172. Radiograph showing the impacted mandibular canine, which gives the impression of complete bone impaction

7.9.2
Impacted Mandibular Canine with Labial Position

Exposure of the tooth may be achieved in two ways. The first technique, which has already been mentioned, is used if the area locating the impacted canine presents a slight protuberance and the crown of the tooth is covered by soft tissue only. To expose the tooth, first an incision using an electrosurgical blade is made over the crown, and then the soft tissue is excised using scissors and a periosteal elevator, so that exposure is adequate. Afterwards, a surgical dressing is applied to the wound until the day the orthodontist bonds the bracket for traction of the tooth to its normal position in the dental arch (Figs. 7.172–7.177).

The second technique involves exposure of the crown by creating a flap. More specifically, after creating an L-shaped incision, a small flap is reflected and the crown of the impacted tooth is exposed. The tooth is then dried and after the orthodontist has placed the bracket on the crown of the tooth, the flap is repositioned and the wound is sutured.

Fig. 7.173. Clinical photograph of the area of impaction of the case shown in Fig. 7.172
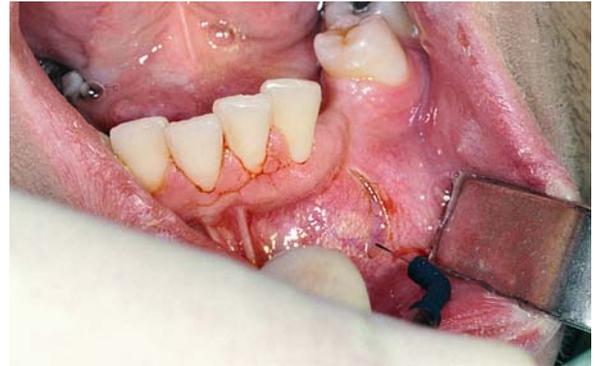
Fig. 7.174. Incision created using an electrosurgical blade to expose the crown of the impacted tooth

Fig. 7.175. Removal of soft tissues covering the crown of the tooth

Fig. 7.176. Surgical field after exposure of the crown

Fig. 7.177. Operation site covered with surgical dressing

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Perioperative and Post-operative Complications

8

F. D. Fragiskos

Undesirable situations are often encountered in dental practice, caused by a dentist's mistake, culpability of the patient, or other unstable factors.

Perioperative complications are the complications that occur during the surgical procedure, while *postoperative complications* occur during the postoperative period.

Perioperative Complications. These mainly include:
- Fracture of the crown of the adjacent tooth or luxation of the adjacent tooth
- Soft tissue injuries
- Fracture of the alveolar process
- Fracture of the maxillary tuberosity
- Fracture of the mandible
- Broken instrument in tissues
- Dislocation of the temporomandibular joint
- Subcutaneous or submucosal emphysema
- Hemorrhage
- Displacement of the root or root tip into soft tissues
- Displacement of an impacted tooth, root or root tip into the maxillary sinus
- Oroantral communication
- Nerve injury

Postoperative Complications. These include:
- Trismus
- Hematoma
- Ecchymosis
- Edema
- Postextraction granuloma
- Painful postextraction socket
- Fibrinolytic alveolitis (dry socket)
- Infection of wound
- Disturbances in postoperative wound healing

8.1
Perioperative Complications

8.1.1
Fracture of Crown or Luxation of Adjacent Tooth

The fracture of the crown of an adjacent tooth that presents extensive caries or a large restoration is a common complication during the extraction procedure. Luxation or dislocation of an adjacent tooth occurs when a great amount of force is exerted during the luxation attempt, particularly when the adjacent tooth is used as a fulcrum. The same complication may arise if care is not taken during the extraction of a deciduous molar. In this case, the forceps may grasp the crown of the succedaneous permanent premolar together with the deciduous tooth and luxate it as well.

When an adjacent tooth is inadvertently luxated or partially avulsed, the tooth is stabilized for approximately 40–60 days. If there is still pain during percussion even after this period, then the tooth must be endodontically treated. If the tooth is dislocated, it must be repositioned and stabilized for 3–4 weeks.

8.1.2
Soft Tissue Injuries

Soft tissue injuries are a common complication and most times are due to the inept or inadvertent manipulation of instruments (e.g., slippage of elevator) during the removal of teeth. The areas most often injured are the cheeks, the floor of the mouth, the palate, and the retromolar area (Figs. 8.1, 8.2). Injury by the elevator may also occur at the corner of the mouth and lips because of prolonged and excessive retraction force and pressure during the extraction of posterior maxillary and mandibular teeth, especially when patients have a reduced aperture (Fig. 8.3).

Fig. 8.1. Injury of posterior area of the palate after elevator slippage during extraction of right mandibular third molar. Wound is sutured

Fig. 8.2. Injury of sublingual area as a result of elevator slippage during extraction

Fig. 8.3. Injury of the corner of the mouth during extraction of an impacted mandibular third molar

Fig. 8.4. Burn of lower lip due to overheating of a surgical handpiece (micromotor)

Fig. 8.5. Abrasion of the lower lip as a result of contact with the rotating shank of a bur during surgical removal of an impacted mandibular third molar

Furthermore, a burn may occur on the lower lip if an overheated surgical handpiece comes into contact with the lip (Fig. 8.4). Abrasions also happen when the shank of a rotating bur comes into contact with the area (Fig. 8.5).

Another soft tissue injury that can occur sometimes is the tearing of the flap during reflection, as well as tearing of the gingiva during extraction. The latter may occur if the soft tissues surrounding the tooth have not been completely severed or loosened, or if part of the alveolar process is removed together with the tooth, thus tearing the soft tissues attached to the bone to a great extent.

Treatment. When injuries are small and localized at the region of the cheek, tongue, or lips, then no particular treatment is considered necessary. In certain cases healing is facilitated if the lesion is covered with

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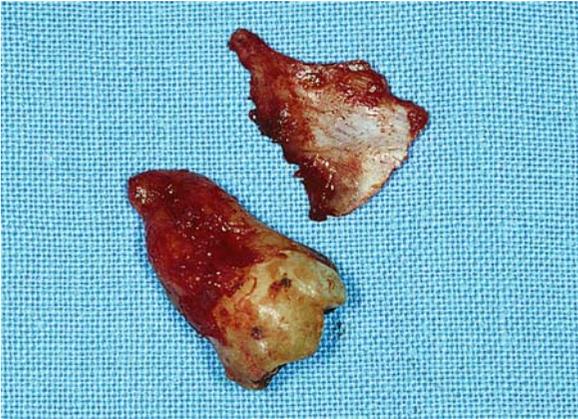
Fig. 8.6. Fracture of lingual plate during extraction of an impacted mandibular third molar

Fig. 8.7. Removal of a small part of the fractured alveolar process, which has been reflected from the periosteum during extraction of a maxillary anterior tooth, using forceps

petrolatum (Vaseline) (e.g., lip injury), or with any other appropriate ointment. This may also lessen the patient's discomfort. When the injury is extensive, though, and there is also hemorrhaging, the surgical procedure must be postponed and the dentist must control the bleeding and proceed with suturing of the wound.

8.1.3
Fracture of Alveolar Process

This complication may occur if extraction movements are abrupt and awkward, or if there is ankylosis of the tooth in the alveolar process, whereupon part of the labial, buccal, palatal or lingual cortical plate may be removed together with the tooth.

Fracture of the alveolar process occurs most often during the extraction of canines, especially if the bone of the region has become weak due to injury or because of a previous extraction of the lateral incisor or the first premolar. Fracture of the lingual cortical plate is especially significant, because the lingual nerve may also be traumatized (Fig. 8.6).

Treatment. When the broken part of the alveolar process is small and has been reflected from the periosteum, then it is removed with forceps and the sharp edges, if any, of the remaining bone are smoothed (Fig. 8.7). Afterwards, the area is irrigated with saline solution and the wound is sutured. If the broken part of the alveolar process is still attached to the overlying soft tissues, then it may remain after stabilization and suturing of the mucoperiosteum.

Fig. 8.8. Fracture of the maxillary tuberosity, during extraction of an ankylosed maxillary molar

8.1.4
Fracture of Maxillary Tuberosity

Fracture of the maxillary tuberosity (Fig. 8.8) is a grave complication, which, depending on its extent, may create problems for the retention of a full denture in the future.

This complication may occur during the extraction of a posterior maxillary tooth and is usually due to the following reasons:
1. Weakening of the bone of the maxillary tuberosity, due to the maxillary sinus pneumatizing into the alveolar process. In this case, risk of fracture is increased if the extraction of a molar is performed with forceful and careless movements.
2. Ankylosis of a maxillary molar that presents great resistance to movements during the extraction attempt. An extensive fracture of the buccal bone or
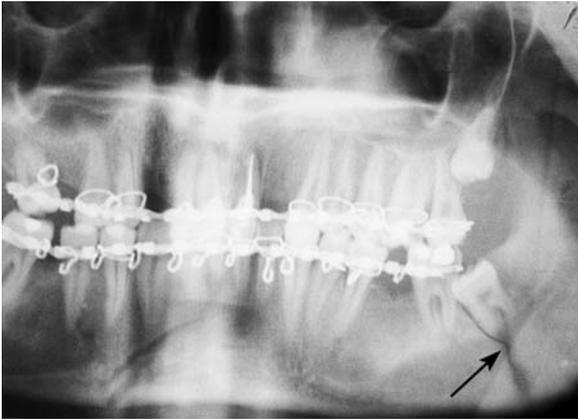
Fig. 8.9. Fracture of the angle of the mandible, as a result of excessive force during the luxation attempt of an impacted third molar. Not enough surrounding bone had been removed from around the crown to create an unimpeded pathway

Fig. 8.10. Photoelastic model of the mandible, showing the development of stress during a luxation attempt of the third molar when insufficient bone has been removed from the tooth peripherally

the distal bone surrounding the ankylosed tooth may occur.

3. Decreased resistance of the bone of the region, due to a semi-impacted or impacted third molar.

Treatment. When the fracture occurs and the fractured segment has not been reflected from the periosteum, it is repositioned and the mucoperiosteum is sutured. In this case, the scheduled extraction of the tooth is postponed, if possible, for approximately 1.5–2 months, whereupon the fracture will have healed and the extraction may be performed with the surgical technique. If, however, the bone segment has been completely reflected from the tissues and oroantral communication occurs, the tooth is first removed and the bone is then smoothed and the wound is tightly sutured. Broad-spectrum antibiotics and nasal decongestants are then prescribed.

8.1.5
Fracture of Mandible

Fracture of the mandible is a very unpleasant, but fortunately rare, complication that is associated almost exclusively with the extraction of impacted mandibular third molars. This may occur during the use of excessive force with the elevator, when an adequate pathway for removal of the impacted tooth has not been created (Figs. 8.9, 8.10). A fracture may also occur during the extraction of a deeply impacted tooth, of a tooth with firm anchorage, or of an ankylosed tooth, even with small amounts of force applied. This may

Fig. 8.11. Panoramic radiograph showing an extensive lesion at the region of the impacted tooth. Due to weakening of mandibular bone, the risk of fracture during the surgical procedure is great

easily occur when the mandible is atrophic or if the bone has become weak, such as when other impacted teeth are also present, or in the case of extensive edentulous regions and the presence of large pathologic lesions in the area of the tooth to be extracted (Fig. 8.11).

Treatment. When a fracture occurs during the extraction, the tooth must be removed before any other procedure is carried out, in order to avoid infection along the line of the fracture. Afterwards, depending on the case, stabilization by way of intermaxillary fixation or rigid internal fixation of the jaw segments is applied for 4–6 weeks and broad-spectrum antibiotics are administered.
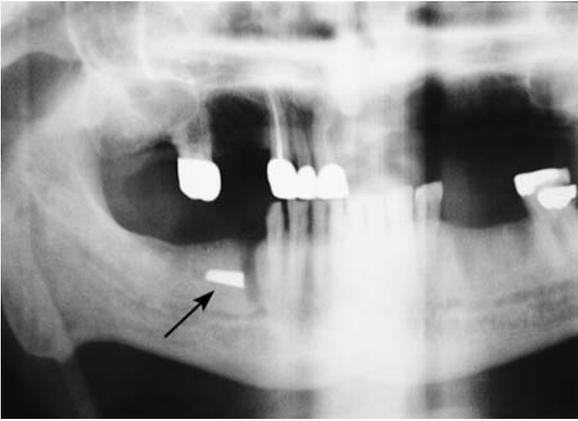
Fig. 8.12. Broken blade of a Chompret elevator, which occurred during luxation of a premolar root
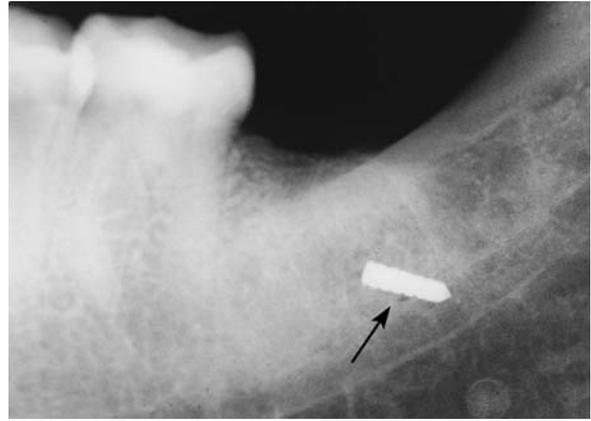
**Fig. 8.13.** Broken fissure bur in tissues, which occurred during the surgical removal of an impacted mandibular third molar
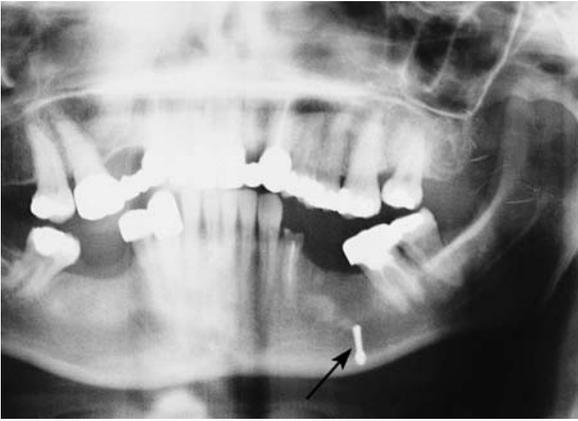
Fig. 8.14. Broken round bur and subperiosteal dislocation of the bur, which occurred during surgical extraction

Fig. 8.15. Unilateral dislocation of the temporomandibular joint, due to excessive opening of the mouth during extraction

8.1.6
Broken Instrument in Tissues

Breakage of an instrument in the tissues is the result of excessive force during luxation of the tooth and usually involves the end of the blade of various elevators (Fig. 8.12). Also, the anesthesia needle or bur may break during the removal of the bone surrounding the impacted tooth or root (Figs. 8.13, 8.14). Breakage may be the result of repeated use of the instrument altering its metallic composition (mainly of the bur). In these cases, after precise radiographic localization, the broken pieces are removed surgically at the same time as extraction of the tooth or root.

8.1.7
Dislocation of Temporomandibular Joint

This complication may occur during a lengthy surgical procedure on patients who present a shallow mandibular fossa of the temporal bone, low anterior articular tubercle, and round head of condylar process. In unilateral dislocation the mandible deviates towards the healthy side (Fig. 8.15), while in bilateral dislocation, the mandible slides forward in a gaping prognathic position. The patient is unable to close their mouth (open bite) and movement is restricted. In order to avoid such a complication, the mandible must be firmly supported during an extraction and patients must avoid opening their mouth excessively, especially those with a history of "habitual temporomandibular joint luxation."

Fig. 8.16. Reduction attempt with downward and posterior movements of the mandible

Fig. 8.17. Restoration of occlusion after reduction

Fig. 8.18. Patient after repositioning of the mandible

Treatment. Immediately after the dislocation, the thumbs are placed on the occlusal surfaces of the teeth, while the rest of the fingers surround the body of the mandible right and left (Fig. 8.16). Pressure is then exerted downward with the thumbs and simultaneously upwards and posteriorly with the rest of the fingers, until the condyle is replaced in its original position (Figs. 8.17, 8.18). After repositioning, the patient must limit any movement of the mandible that may lead to excessive opening of the mouth for a few days. When luxation is habitual, the mandible is often repositioned in its original position spontaneously.

8.1.8
Subcutaneous or Submucosal Emphysema

This complication may occur as a result of air entering the loose connective tissue, when an air-rotor is used in the surgical procedure for the removal of bone or for sectioning the impacted tooth.

Clinically, the region swells, sometimes extending into the neck and facial area, with a characteristic crackling sound during palpation (crepitus). There is no specific treatment. It usually subsides spontaneously after 2–4 days. If it is very large in size, paracentesis may help to remove the air. Some people recommend the administration of antibiotics.

8.1.9
Hemorrhage

Hemorrhage is a common complication in oral surgery, and may occur during a simple tooth extraction or during any other surgical procedure. In all cases, hemorrhage may be due to trauma of the vessels in the region as well as to problems related to blood coagulation. Profuse hemorrhage may occur as a result of injury or severance of the inferior alveolar vessels (Fig. 8.19) or the palatal artery.

Severe hemorrhagic diatheses (e.g., hemophilia, etc.) should be ascertained by taking a thorough medical history, and management must be planned before the surgical procedure.

Postoperative bleeding in healthy patients may be the result of poor hemostasis of the wound due to insufficient compression, or to inadequate removal of inflammatory and hyperplastic tissue from the surgical field.
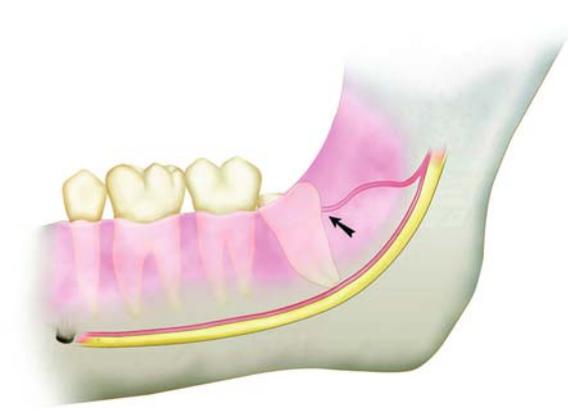
Fig. 8.19. Diagrammatic illustration showing the superficial branch of the inferior alveolar artery close to an impacted third molar. There is a risk of injury during surgical extraction of the impacted tooth
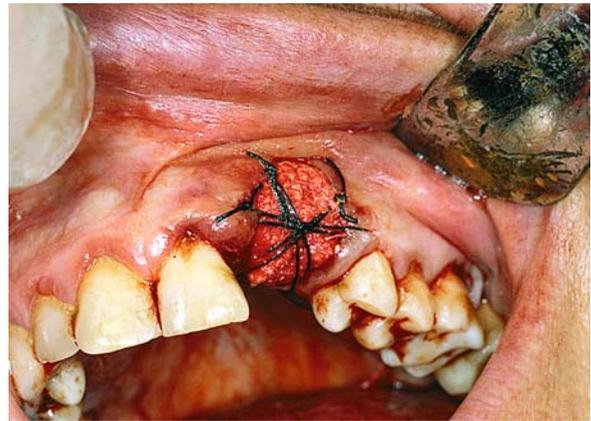

Fig. 8.20. Gauze pack, sutured over a postextraction wound

Treatment. The main means of arresting bleeding are compression, ligation, suturing, electrocoagulation and the use of various hemostatic agents.

Compression aims at causing vasoconstriction and decreasing the permeability of the capillaries, and is achieved by placing gauze over the bleeding site with pressure. Placing pressure by biting on a gauze for 10–30 min over the postextraction wound or other superficial bleeding areas is usually sufficient. If the bleeding does not stop after applying pressure for the aforementioned time, then there is a hemorrhagic problem to a certain degree and blood flow must be arrested, depending on the case. Bone hemorrhage is adequately treated by means of compression of the bone surrounding the vessel, in order to obstruct blood flow. This may be achieved by using a mallet and a small blunt instrument. Sterile bone wax may also be used to arrest bone bleeding, which is placed with pressure inside the bleeding bone cavity. Packing iodoform gauze, which also has antiseptic properties, inside the alveolus may arrest bone bleeding as well. This gauze may remain inside the cavity, depending on the case, for between 10 min and 3–4 days, after which it is removed.

Suturing the wound mechanically obstructs the severed end of the bleeding vessel. This technique is used for arresting soft tissue hemorrhage as well as postextraction bleeding that is treated with tightly suturing the wound margins. If it is impossible to coapt the wound margins, a gauze pack is placed over the wound, which is stabilized with sutures over the postextraction socket for 2–3 days (Fig. 8.20).

Ligation is the most successful way to control soft tissue hemorrhage that involves a large vessel. If, for example, a large vessel is severed during the surgical procedure, a hemostat is used to clamp and ligate the vessel (Figs. 8.21, 8.22). If a small-sized vessel is bleeding, then a narrow hemostat is used to clamp the bleeding area of the soft tissues, arresting hemorrhage within a few minutes, without ligation of the tissues.

Electrocoagulation is based on the coagulation of blood through the application of heat, resulting in the retraction of tissues in a necrotic mass.

Hemostatic materials, such as vasoconstrictors (adrenaline), alginic acid, desiccated alum, etc., have proven to be very effective in the control of bleeding. These materials are used to arrest capillary hemorrhage and are used topically over the bleeding area. Other materials are also used, such as fibrin sponge, gelatin sponge, oxidized cellulose, etc. (see Chap. 4), whose hemostatic properties cause blood coagulation by creating a normal blood clot at the severed ends of the bleeding vessels. These materials are suitable only for local application and are used to arrest generalized capillary bleeding, especially to control bleeding of the postextraction alveolus. The procedure for using the hemostatic agents is usually as follows. In the case of a relatively small hemorrhage, which persists despite biting on a gauze pack over the postextraction wound, an absorbable hemostatic sponge is placed inside the alveolus and pressure is applied over the gauze, or the wound margins are sutured with a figure-eight suture (Fig. 8.23).
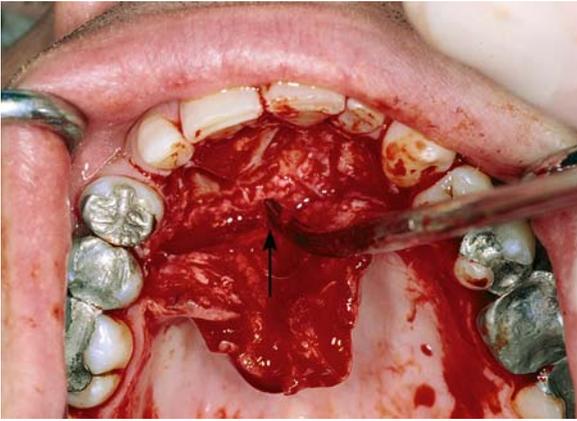
Fig. 8.21. Clamping of a branch of the palatine artery with a hemostat to control the hemorrhaging
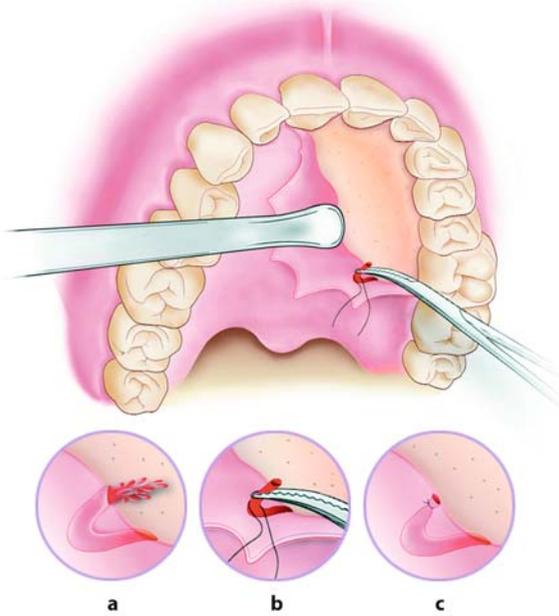
Fig. 8.22 a–c. Diagrammatic illustration showing steps in the ligation of the palatine artery after severance. **a** Severance of the vessel. **b** Vessel clamped by a hemostat. **c** Ligation with a resorbable suture

It is difficult for the dentist alone to control bleeding in patients with a hemorrhagic diathesis. In such cases, after adhering to the specified aforementioned measures, a pressure pack is placed over the wound and the patient is referred to a hospital for more effective treatment (administration of replacement factors, etc.).
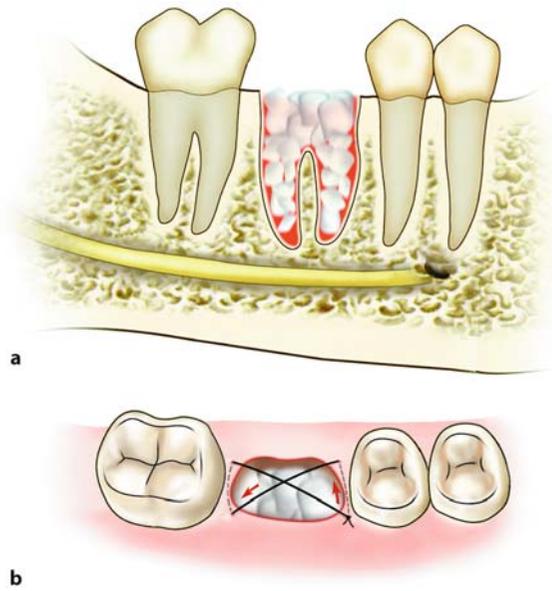
Fig. 8.23 a, b. a Packing of the alveolus with hemostatic materials: gelatin sponge, collagen, etc. **b** Suturing of wound margins with a figure-eight suture

8.1.10
Displacement of Root or Root Tip into Soft Tissues

This complication may occur in the following situations:

- When the buccal or lingual cortical plate, as well as the root tip region of maxillary posterior teeth is eroded. In this case, the root or root tip may easily be displaced during luxation towards the buccal soft tissues or the floor of the mouth, or between the bone and mucosa of the maxillary sinus, respectively.
- In the case of perforation of the bone as a result of continuous attempts to remove the root tip, which may be displaced as described above.

Treatment. Removal of the root tip, especially from buccal soft tissues, is not particularly difficult if its exact position has been localized. This localization is achieved with careful palpation of the area suspected of containing the displaced root tip.

Displacement of the root tip between bone and the mucosa of the maxillary sinus does not usually require any treatment. The root tip usually remains in this position and the patient is given antibiotics. The exact position of the root tip must be verified, though, to make sure that it is not inside the maxillary sinus. If the root tip has been displaced into the floor of the
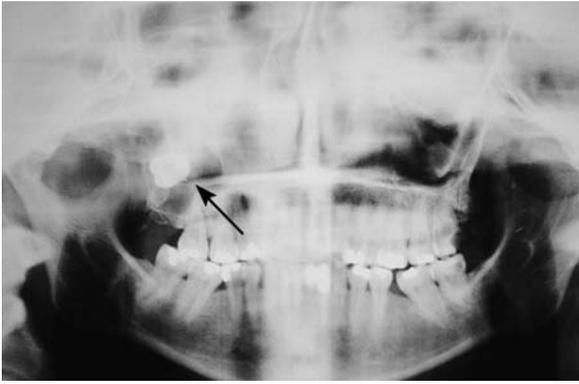
Fig. 8.24. Panoramic radiograph showing displacement of an impacted maxillary third molar into the maxillary sinus, after an unsuccessful extraction attempt
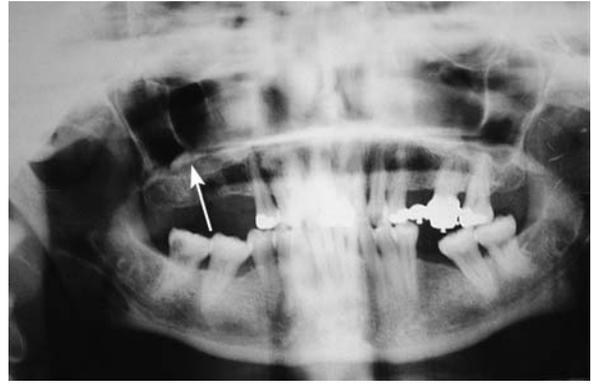
Fig. 8.25. Panoramic radiograph showing the root of a molar in the maxillary sinus
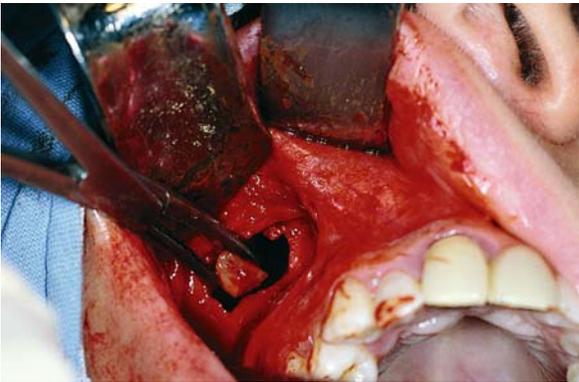
Fig. 8.26. Removal of a root from the maxillary sinus using the Caldwell–Luc surgical technique

Fig. 8.27. Suturing of flap after removal of the root from the maxillary sinus

mouth, its exact position must be verified clinically and radiographically, because the area's anatomy complicates the removal procedure.

8.1.11
Displacement of Impacted Tooth, Root, or Root Tip into Maxillary Sinus

This complication may occur particularly during an attempt to luxate an impacted maxillary third molar, when the impacted tooth is close to the maxillary sinus and the surgical procedure has not been carefully planned (Fig. 8.24). In order to avoid such a complication, exposure of the impacted tooth must be adequate in terms of the extent of the flap and the amount of bone removed, so that the forces exerted during luxation are maximally controlled.

A root or root tip (usually the palatal root of a molar) may also be displaced into the maxillary sinus during the removal attempt (Fig. 8.25).

Treatment. If the tooth or root tip cannot be removed with the surgical technique immediately after the complication arises, any attempt to find the tooth or root tip with various instruments must be avoided and the patient should be informed of the situation. Antibiotic treatment and nasal decongestants are also administered, and surgical removal is scheduled. It must be treated as soon as possible, because there is a risk of infection of the maxillary sinus, which usually worsens due to the existing oroantral communication. The exact position of the tooth or root tip must be confirmed with radiographic examination. Removal of the tooth or root from the maxillary sinus is usually achieved with trephination of the maxillary sinus using a Caldwell–Luc or Lindorf approach (Figs. 8.26, 8.27).

Fig. 8.28. Oroantral communication after extraction of the root of the first molar. The periapical curette enters the alveolus at a greater depth than normal (as far as the angle of the first curvature)


Fig. 8.29. Root tips in direct contact with the floor of the maxillary sinus. The risk of creating oroantral communication after tooth extraction, in the case of inept socket debridement, is obvious

8.1.12
Oroantral Communication

This is a common complication, which may occur during an attempt to extract the maxillary posterior teeth or roots. It is identified easily by the dentist, because the periapical curette enters to a greater depth than normal during debridement of the alveolus, which is explained by its entering the maxillary sinus (Fig. 8.28). Oroantral communication may also be confirmed by observing the passage of air or bubbling of blood from the postextraction alveolus when the patient tries to exhale gently through their nose while their nostrils are pinched (Valsalva test). If the patient exhales through their nose with great pressure, there is a risk of causing oroantral communication, even though communication may not have occurred initially, such as when only the mucosa of the maxillary sinus is present between the alveolus and the antrum.

Oroantral communication may be the result of:
1. Displacement of an impacted tooth or root tip into the maxillary sinus during a removal attempt.
2. Closeness of the root tips to the floor of the maxillary sinus. In this case the bony portion above the root tips is very thin or may even be absent, whereupon oroantral communication is inevitable during extraction of the tooth, especially if the alveolus is debrided unnecessarily (Fig. 8.29).
3. The presence of a periapical lesion that has eroded the bone wall of the maxillary sinus floor (Fig. 8.30).
4. Extensive fracture of the maxillary tuberosity (during the extraction of a posterior tooth), whereupon part of the maxillary sinus may be removed together with the maxillary tuberosity.

Fig. 8.30. Close proximity of periapical lesions to the maxillary sinus floor increases the risk of oroantral communication during debridement of sockets

5. Extensive bone removal for extraction of an impacted tooth or root.

Preventive Measures. In order to avoid oroantral communication as well as displacement of an impacted tooth or root into the maxillary sinus, the following preventive measures are recommended:
- Radiographic examination of the region surrounding the tooth to be extracted
- Careful manipulations with instruments, especially during the luxation of a root tip of a maxillary posterior tooth
- Careful debridement of periapical lesions that are close to the maxillary sinus
- Avoiding luxation of the root tip if visualization of the area is hindered by hemorrhage

Fig. 8.31. Oronasal communication. Complication occurred during extraction of an impacted maxillary canine

Treatment. The management of oroantral communication depends on its size and when treatment is to be scheduled.

For a small-sized oroantral communication, which is perceived immediately after the extraction, treatment consists of suturing the gingiva with a figure-eight suture after filling the alveolus with collagen, unless there are enough soft tissues, in which case placement of tight sutures over the wound is preferred.

When the soft tissues do not suffice, a small portion of the alveolar bone is removed with a bone rongeur so that the buccal and palatal mucosa can be reapproximated more easily, facilitating closure of the oroantral communication. Infection of the maxillary sinus is thus avoided, and the blood clot is held in place, which will aid in the healing process. The same procedure applies to the closure of larger-sized oroantral communications.

The administration of prophylactic antibiotics is not deemed necessary, unless the oroantral communication is the result of an extraction of a tooth with acute periapical inflammation, upon which broad-spectrum antibiotics must be administered. Nasal decongestants must also be prescribed. The patient is informed of the situation, and given appropriate instructions (e.g., avoiding sneezing, blowing nose), and is rescheduled for examination in 15 days.

A large oroantral communication or one that has remained open for 15 days or longer must be treated using other techniques (such as the closure with flap procedure, either immediately or at a later date), which ensure restoration. These techniques are achieved using pedicle mucoperiosteal flaps (buccal, palatal, and bridge flaps) (see Chap. 3, Figs. 3.14, 3.15).

The technique of immediate closure with a flap procedure is indicated when the sinus is free of disease. In this case, the oroantral fistula is covered, without operating on the antrum also. However, when infection of the maxillary sinus is present, the flap procedure technique is performed together with trephination of the antrum.

Oronasal communication may also occur, either labially or palatally (Fig. 8.31). In the first case, the complication may occur especially during the surgical removal of impacted canines with a labial localization, during apicoectomies, etc. In the latter case, the communication occurs during the attempt to remove cysts, palatal exostoses, and deeply impacted canines.

8.1.13
Nerve Injury

Nerve injury, especially the severance of large nerve branches, is one of the most serious complications that may occur during oral surgical procedures.

The most common nerve injuries are of the inferior alveolar, mental, and lingual nerves. Nerve trauma may cause sensory disturbances (anesthesia or hypesthesia[1], paresthesia[2], dysesthesia[3]) in the innervated area, resulting in various undesirable situations, such as a burning sensation, tingling, needles and pins, biting of the tongue and lips, abnormal chewing, burns through consumption of hot foods, etc.

Before describing the complications, basic information involved in the classification of nerve injuries is provided, so that the diagnosis, prognosis, and treatment may be more easily understood.

According to Seddon's classification (Seddon 1943) of nerve injuries, there are three types of nerve damage: neurapraxia, axonotmesis, and neurotmesis.

1. *Neurapraxia*: This type of damage has the most favorable prognosis and may occur even after simple contact with the nerve. Nerve conduction failure is usually temporary and there is complete recovery, without permanent pathologic and anatomic defects. Recovery is quite rapid and occurs gradually within a few days to weeks.

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1) Anesthesia or hypesthesia: loss or decrease, respectively, of sensation in an area.
2) Paresthesia: subjective sensation of burning, tingling, needles and pins, numbness, etc.
3) Dysesthesia: abnormal unpleasant sensation to normal stimulus, e.g., burning sensation to simple touch.

Fig. 8.32. Incorrect incision in the region of the mandibular premolars, resulting in injury of the mental nerve
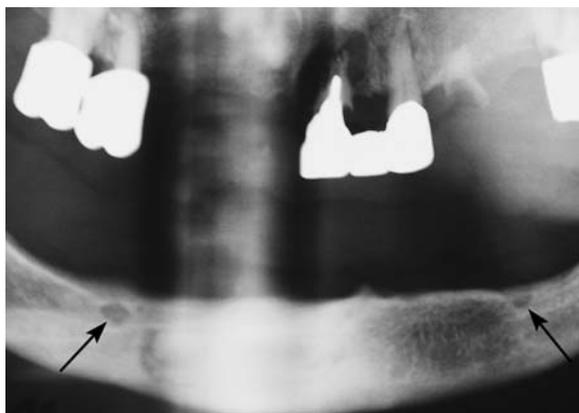
Fig. 8.33. Panoramic radiograph showing mental foramina at the crest of the alveolar ridge, due to bone resorption. An incision in this area could result in injury of the mental nerve

2. *Axonotmesis*: This is a serious injury of the nerve resulting in degeneration of the nerve axons, without anatomic severance of the endoneurium.

   Regeneration and recovery of sensation is slower than in neurapraxia and usually begins as paresthesia 6–8 weeks after injury. Regeneration of the nerve may be exceptionally favorable, but there is a chance of a certain degree of sensory disturbance of the area remaining.

3. *Neurotmesis*: This is the gravest type of nerve injury, resulting in discontinuation of conduction due to severance of the nerve or due to the formation of scar tissue at the area of trauma.

   Neurotmesis may be produced by: trauma of the nerve branch due to traction, ischemia due to prolonged compression, severance or tearing of the nerve, as well as certain chemical substances.

   This type of injury may cause permanent damage to nerve function, including paresthesia or even anesthesia.

   The formation of scar tissue may also prevent axon regeneration.

Etiology. Nerve injury may occur in the following cases:

- During administration of a nerve block (rarely) of the inferior alveolar nerve and mental nerve.
- While creating an incision that extends to the region of the mental foramen (Fig. 8.32) and the lingual vestibular fold.
- While creating an incision at the alveolar ridge of an edentulous patient, whose mental foramen, due to bone resorption, is localized superficially (Fig. 8.33).

Fig. 8.34. Risk of injury of the mental nerve, after exposure, if excessive force is used with the retractors holding the flap

- During excessive flap retraction and compression with retractors during retraction in the region of the mental nerve (Fig. 8.34) or at the lingual region of the third molar.
- When bone near a nerve is excessively heated, if the bur of the surgical handpiece is not irrigated with a steady stream of saline solution.
- In the case of removal of impacted teeth, roots and root tips that are deep in the bone and are close to the mental or inferior alveolar nerves (Figs. 8.35–8.39).
- During perforation of the lingual cortical plate, when roots of a posterior tooth are sectioned or if a crown of an impacted third molar is sectioned (injury to lingual nerve).

Fig. 8.35. Close relationship of impacted mandibular premolars with the mental foramen could lead to injury of the mental nerve during the surgical procedure
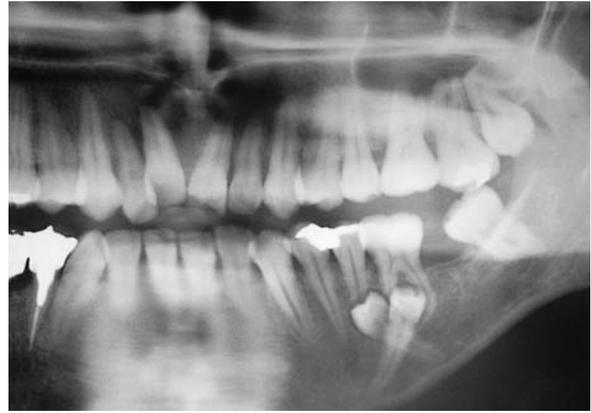
Fig. 8.36. Risk of injury of the mental nerve during surgery for supernumerary impacted teeth, localized very close to the mental foramen

Fig. 8.37. Increased risk of injury of the inferior alveolar nerve during surgical extraction of an impacted ectopic premolar that is in direct contact with the mandibular canal

Fig. 8.38. Close relationship of an impacted third molar with the mandibular canal. Potential risk of injury of the inferior alveolar nerve during the surgical procedure
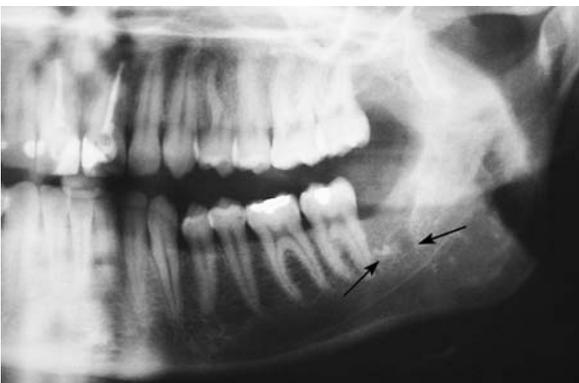
Fig. 8.39. Root tip of the third molar with a periapical lesion, close to the mandibular canal. Removal could lead to injury of the inferior alveolar nerve

- When a bur enters the mandibular canal, during sectioning (separation of the crown from the root) of an impacted mandibular third molar (Fig. 8.40).
- During fracture of the lingual cortical plate.
- In the case of displacement of a root tip inside the mandibular canal (trauma of the inferior alveolar nerve) (Figs. 8.41, 8.42). A very serious injury may result (at a later date) if, during the removal attempt, inadvertent manipulations with instruments injure the nerve.
- During debridement of a periapical lesion of posterior teeth that are in direct contact with the mandibular canal (Fig. 8.43 a, b).
- In the case of compression of the lingual nerve, due to excessive retraction of the tongue with a retractor during the surgical procedure.
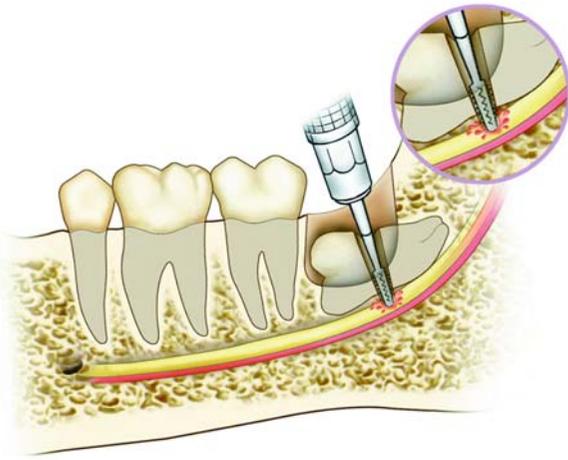
Fig. 8.40. Diagrammatic illustration showing injury of the inferior alveolar nerve when the tooth is close to the mandibular canal and the bur is driven deeply

- In the case of compression and strangulation of a nerve, after inadvertent suturing of the nerve during the suturing of a flap.

Prognosis. The prognosis for recovery of an injured nerve depends on the type of damage, the age of the patient, correct treatment of the case, and the time that elapsed until management of the injury.

Neurapraxia and axonotmesis, which are usually the result of short-term compression, present the most favorable prognosis. In cases such as these, even though there is nerve degeneration, recovery is quite rapid. On the other hand, in neurotmesis, where the nerve has been severely traumatized (compression, ischemia, severance), prognosis is poor because, after destruction of its structure, complete regeneration is extremely difficult and normal sensation never returns completely.
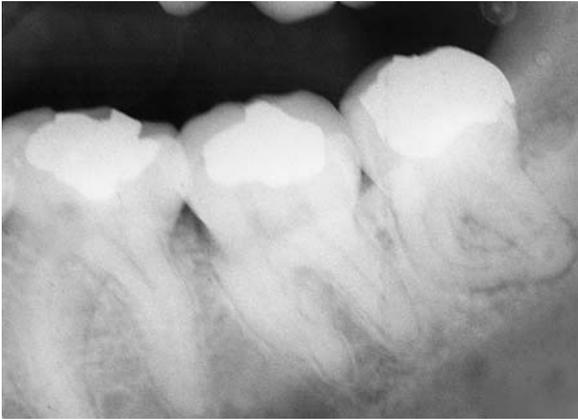
Fig. 8.41. Mandibular third molar, whose roots are in close contact with the mandibular canal

Fig. 8.42. Displacement of the root tip of the third molar (Fig. 8.41) into the mandibular canal during an extraction attempt
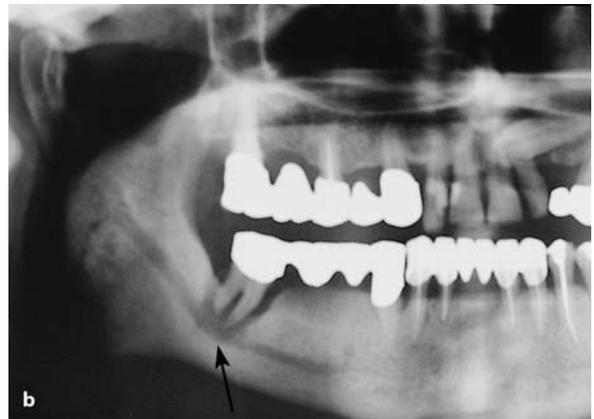

Fig. 8.43 a, b. Communication of the periapical lesion with the mandibular canal. Potential injury of the inferior alveolar nerve during debridement

Treatment. No particular therapy is indicated for neurapraxia or axonotmesis, unless there is a root tip or other foreign body compressing the nerve, in which case it must be removed. Treatment is usually palliative, including the administration of analgesics in painful situations, and multi-vitamin supplements of the vitamin B complex to restore sensation more rapidly. Damage to the nerve as a result of neurotmesis must be treated as soon as possible; often, a graft must replace the injured nerve segments or the severed segments must be sutured.

8.2
Postoperative Complications

8.2.1
Trismus

Trismus usually occurs in cases of extraction of mandibular third molars, and is characterized by a restriction of the mouth opening due to spasm of the masticatory muscles (Fig. 8.44). This spasm may be the result of injury of the medial pterygoid muscle caused by a needle (repeated injections during inferior alveolar nerve block) or by trauma of the surgical field, especially when difficult lengthy surgical procedures are performed. Other causative factors are inflammation of the postextraction wound, hematoma, and postoperative edema.

Treatment. The management of trismus depends on the cause. Most cases do not require any particular therapy. When acute inflammation or hematoma is the cause of trismus, hot mouth rinses are recommended initially, and then broad-spectrum antibiotics are administered. Other supplementary therapeutic measures include:

- Heat therapy, i.e., hot compresses are placed extraorally for approximately 20 min every hour until symptoms subside
- Gentle massage of the temporomandibular joint area
- Administration of analgesics, anti-inflammatory and muscle relaxant medication
- Physiotherapy lasting 3–5 min every 3–4 h, which includes movements of opening and closing the mouth, as well as lateral movements, aimed at increasing the extent of mouth opening (Fig. 8.45)
- Administration of sedatives [bromazepam (Lexotanil): 1.5–3 mg, twice daily], for management of stress, which worsens while trismus persists, leading to an increase of muscle spasm in the area

Fig. 8.44. Reduced aperture of the mouth due to trismus

Fig. 8.45. Attempt to open mouth with physiotherapy, in a case of trismus

8.2.2
Hematoma

This is a quite frequent postoperative complication due to prolonged capillary hemorrhage (Fig. 8.46), when the correct measures for control of bleeding are not taken (ligation of small vessels, etc.). In this case blood accumulates inside the tissues, without any escape from the closed wound or tightly sutured flaps under pressure. Depending on the operation, the hematoma may be submucosal, subperiosteal, intramuscular or fascial. As for patients with hemorrhagic diatheses, hematomas formed in the palatopharyngeal arches are considered most dangerous of all.

Treatment. If a hematoma is formed during the first few hours after the surgical procedure, therapeutic management consists of placing cold packs extraorally during the first 24 h, and then heat therapy to help it to subside more rapidly. Some people recommend the administration of antibiotics to avoid suppuration of the hematoma, and analgesics for pain relief.

Fig. 8.46. Hematoma as a result of surgical extraction

Fig. 8.47. Diffuse ecchymosis after surgical removal of the root of a mandibular premolar. This may be the result of excessive retraction of the flap using retractors

Fig. 8.48. Edema as a result of a difficult surgical procedure to remove an impacted mandibular third molar. The patient did not present with fever, just a mild trismus

Fig. 8.49. Edema of the lower eyelid with a skin hue ranging from very red to cyanotic, as a result of the surgical removal of an ankylosed maxillary canine. Manipulations and pressure exerted by retractors often lead to such clinical images

8.2.3
Ecchymosis

In certain cases, after the surgical procedure, ecchymosis may develop on the patient's skin, which presents as friable capillaries and decreased tissue tone. Other than the generalized trauma of the area, it may be the result of damage during flap retraction with various retractors (Fig. 8.47). In order to avoid such a complication, retractors must be handled gently, especially in the region of the mental foramen, zygomaticoalveolar crest, and canine eminence.

Treatment. No particular treatment is required. The patient should be informed that it is not a serious situation and that ecchymoses gradually subside within a few days, changing color in the process.

8.2.4
Edema

Edema is a complication secondary to soft tissue trauma, up to a point. It is the result of extravasation of fluid by the traumatized tissues because of destruction or obstruction of lymph vessels, resulting in the cessation of drainage of lymph, which accumulates in the tissues. Swelling reaches a maximum within 48–72 h after the surgical procedure and begins to subside on the third or fourth day postoperatively. Clinically, the edema is characterized by smooth, pale, and taut skin (Fig. 8.48). When swelling is due to inflammation, the skin presents with redness, because of the local hyperemia (see Chap. 9). Depending on the amount of tissue injury in the area, the edema ranges from small to moderate and, rarely, severe. Sometimes, when the

Fig. 8.50. Periapical radiograph of the region of the mandibular first molar, showing amalgam remnants inside the alveolar cavity, responsible for the development of a postextraction granuloma

Fig. 8.51. Clinical photograph of a postextraction granuloma shown in Fig. 8.50

surgical procedure is performed in the maxilla, the edema may extend as far as the lower eyelid, either because the tissues in this area are especially loose (Fig. 8.49), or because the patient may have a bleeding disorder (latent purpura, etc.). In such cases, the skin hue is cyanotic.

Treatment. A small-sized edema does not require any therapeutic management. For preventive reasons, cold packs should be applied locally immediately after surgery. They should be placed for 10–15 min every half hour, for the following 4–6 h. When the edema is severe and especially if it does not subside, it must be treated carefully, because an edema present for a prolonged period may lead to fibrosis and development of symphyses. In this case the administration of proteolytic or fibrinolytic medication is indicated, and if the edema is secondary to inflammation, then broad-spectrum antibiotics are also prescribed. If the edema spreads towards the pharyngomaxillary region (danger of asphyxia), then intravenous administration of 250–500 mg hydrocortisone is indicated, which has a rapid action with excellent results.

Fig. 8.52. Postextraction granuloma in the region of the left mandibular first molar

Treatment. This complication is treated with debridement of the alveolus and removal of every causative agent.

8.2.6
Painful Postextraction Socket

This is a common complication, which occurs immediately after the anesthetic wears off. It occurs mainly at the postextraction wound of mandibular posterior teeth, although maxillary posterior teeth may also be involved, due to the anatomy of the bone (dense), where sharp bony spicules are easily created, especially if the extractions are difficult and are performed with awkward manipulations. The uneven bone edges injure the soft tissues of the postextraction socket, resulting in severe pain and inflammation at the extrac-

8.2.5
Postextraction Granuloma

This complication occurs 4–5 days after the extraction of the tooth and is the result of the presence of a foreign body in the alveolus, e.g., amalgam remnants, bone chips, small tooth fragments, calculus, etc. (Fig. 8.50). Foreign bodies irritate the area, so that postextraction healing ceases and there is suppuration of the wound (Figs. 8.51, 8.52).
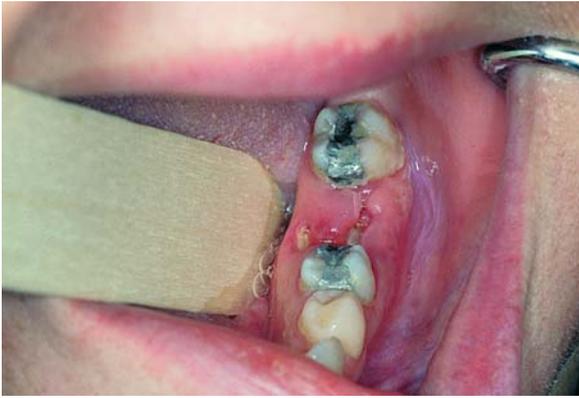
Fig. 8.53. Clinical photograph of a painful postextraction socket with irregular sharp bone edges, which cause injury to soft tissues covering the bone


Fig. 8.54. Periapical radiograph showing sharp spicules of alveolar bone, which remained after the extraction of a tooth
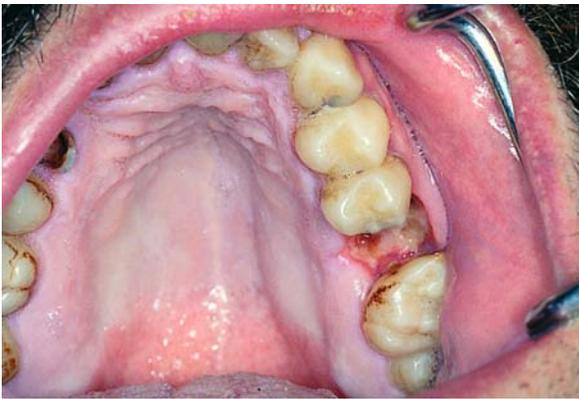
Fig. 8.55. Clinical photograph of case shown in Fig. 8.54, showing sharp bone edges that injure the soft tissues of the postextraction socket

tion site (Figs. 8.53–8.56). In this case, the alveolus is filled with a blood clot that becomes organized for postextraction healing, but not for development of epithelium that will cover the wound.

Treatment. This complication is treated with smoothing of the bone margins of the wound, especially the intraradicular bone (Fig. 8.57). In addition to giving the patient analgesics, gauze impregnated with eugenol should be placed over the wound margins for 36–48 h.
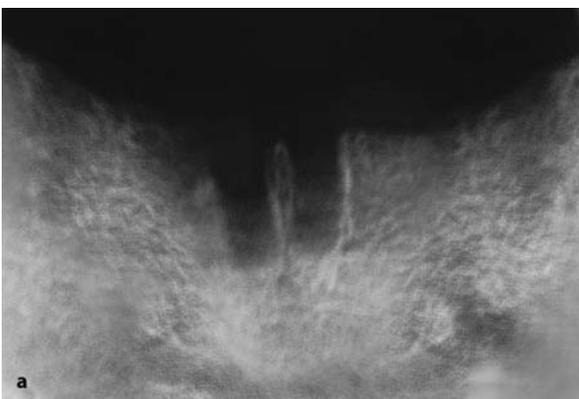
Fig. 8.56 a, b. Painful postextraction socket that is the result of a bone edge projecting from intraradicular bone. **a** Radiograph and **b** clinical photograph
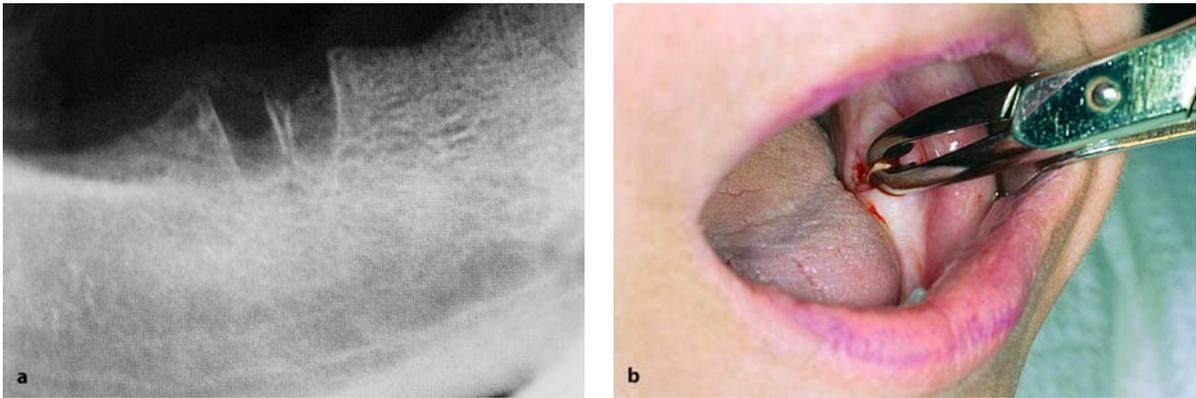
Fig. 8.57 a, b. Treatment of the case shown in Fig. 8.56. Removal of portion of intraradicular bone with bone rongeur

8.2.7
Fibrinolytic Alveolitis (Dry Socket)

This postoperative complication appears 2–3 days after the extraction. During this period, the blood clot disintegrates and is dislodged, resulting in delayed healing and necrosis of the bone surface of the socket (Fig. 8.58). This disturbance is termed fibrinolytic alveolitis and is characterized by an empty socket, fetid breath odor, a bad taste in the mouth, denuded bone walls, and severe pain that radiates to other areas of the head.

As for the etiology and pathogenesis of dry socket, various factors have been cited, some of which include dense and sclerotic bone surrounding the tooth, infection during or after the extraction, injury of the alveolus, and infiltration anesthesia.

Treatment. This type of complication is treated by gently irrigating the socket with warm saline solution, and placing gauze impregnated with eugenol, which is replaced approximately every 24 h, until the pain subsides. Also, gauze soaked in zinc-oxide/eugenol may be used, which remains inside the alveolus for 5 days; alternatively iodoform gauze or enzymes are applied locally. Recent studies have shown Matthews' (1982) and Mitchell's (1986) techniques to be very effective. They used dextranomer granules (Debrisan) and collagen paste (Formula K) without observing a foreign body reaction like that observed with the zinc-oxide/ eugenol mix. With this palliative treatment, the pain gradually subsides, and the patient is given instructions to avoid mastication on the affected side while good oral hygiene is emphasized.

Fig. 8.58. Clinical photograph of fibrinolytic alveolitis (dry socket) in the region of the maxillary second molar

8.2.8
Infection of Wound

Infection of the wound is a complication that may present and spread not only to the superficial surgical wound, but also to the depth and extent of the tissues involved in the surgical manipulations. Infection of the wound may be caused by:

- The use of infected instruments and disposable materials during the surgical procedure.
- A septic substrate over which the surgical procedure is performed.
- Defective bone substrate secondary to diseases of the skeletal system (osteopetrosis), and radiotherapy of the jaw and facial area.
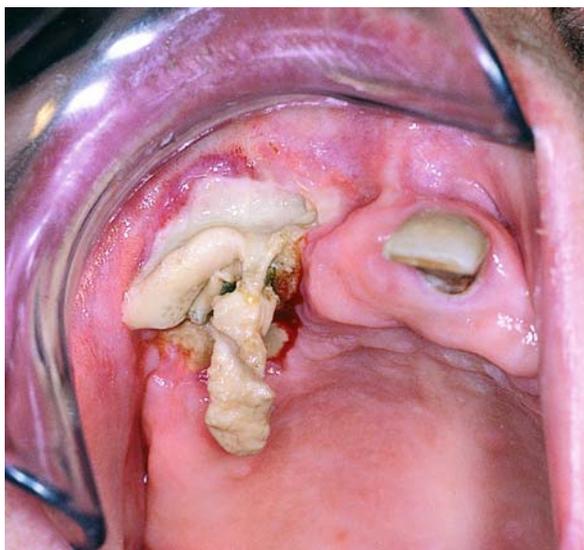
Fig. 8.59. Necrotic sloughing in the region of a lateral incisor, as a result of inadvertent manipulations with various instruments (bur, elevator, etc.) during the surgical extraction

Fig. 8.60. Delayed healing after a surgical extraction. The clinical photograph shows the presence of fibrinolytic alveolitis (dry socket)

● Systemic diseases which lead to increased susceptibility to infection (e.g., leukemia, agranulocytosis), as well as those diseases whose therapy causes immunosuppression. According to past studies, diabetes mellitus is also included in these systemic diseases. Today, though, specialists do not agree with this point of view and consider that patients with controlled diabetes should not be treated in the same way as those patients who suffer from the aforementioned diseases.

When the dentist deems that there is a risk of developing a postoperative infection, prophylactic antibiotics are administered. If the wound has already become infected though, the appropriate antibiotic therapy should be administered, depending on the case.

8.2.9
Disturbances in Postoperative Wound Healing

Wound healing disturbances after a surgical procedure may be caused by general or local factors. General factors include blood diseases (agranulocytosis, leukemia), diabetes mellitus, osteopetrosis, Paget's disease, osteoporosis, etc. Local factors include wound infection, inflammatory hyperplastic granuloma, dry socket, irradiated region, benign and malignant neoplasms, wound damage caused by instruments (burs and elevators) (Figs. 8.59, 8.60), and flap dehiscence due to rupture of sutures (Fig. 8.61).

Fig. 8.61. Wound dehiscence due to rupture of sutures at the vertical releasing incision, resulting in delayed healing

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Odontogenic Infections

9

F. D. Fragiskos

In order to understand how odontogenic infections are treated, the dentist must be familiar with the terminology concerning infection and the pathophysiology of inflammation, which are described below.

Inoculation is characterized by the entry of pathogenic microbes into the body without disease occurring.

An *infection* involves the proliferation of microbes resulting in triggering of the defense mechanism, a process manifesting as inflammation.

Inflammation is the localized reaction of vascular and connective tissue of the body to an irritant, resulting in the development of an exudate rich in proteins and cells. This reaction is protective and aims at limiting or eliminating the irritant with various procedures while the mechanism of tissue repair is triggered. Depending on the duration and severity, inflammation is distinguished as acute, subacute or chronic.

Acute Inflammation. This is characterized by rapid progression and is associated with typical signs and symptoms. If it does not regress completely, it may become subacute or chronic.

Subacute Inflammation. This is considered a transition phase between acute and chronic inflammation.

Chronic Inflammation. This procedure presents a prolonged time frame with slight clinical symptoms and is characterized mainly by the development of connective tissue.

Inflammation may be caused by, among other things, microbes, physical and chemical factors, heat, and irradiation.

Regardless of the type of irritant and the location of the defect, the manifestation of inflammation is typical and is characterized by the following clinical signs and symptoms: rubor (redness), calor (heat), tumor (swelling or edema), dolor (pain), and functio laesa (loss of function).

The natural progression of inflammation is distinguished into various phases. Initially vascular reactions with exudate are observed (serous phase), and then the cellular factors are triggered (exudative or cellular phase). The inflammation finally resolves and the destroyed tissues are repaired. On the other hand, chronic inflammation is characterized by factors of reparation and healing. Therefore, while acute inflammation is exudative, chronic inflammation is productive (exudative and reparative).

Understanding the differences between these types of inflammation is important for therapeutic treatment.

Serous Phase. This is a procedure that lasts approximately 36 h, and is characterized by local inflammatory edema, hyperemia or redness with elevated temperature, and pain. Serous exudate is observed at this stage, which contains proteins and rarely polymorphonuclear leukocytes.

Cellular Phase. This is the progression of the serous phase. It is characterized by massive accumulation of polymorphonuclear leukocytes, especially neutrophil granulocytes, leading to pus formation. If pus forms in a newly developed cavity, it is called an abscess. If it develops in a cavity that already exists, e.g., the maxillary sinus, it is called an empyema.

Reparative Phase. During inflammation, the reparative phenomena begin almost immediately after inoculation. With the reparative mechanism of inflammation, the products of the acute inflammatory reaction are removed and reparation of the destroyed tissues follows. Repair is achieved with development of granulation tissue, which is converted to fibrous connective tissue, whose development ensures the return of the region to normal.

9.1
Infections of the Orofacial Region

The majority (i.e., 90–95%) of infections that manifest in the orofacial region are odontogenic. Of these, approximately 70% present as periapical inflammation,
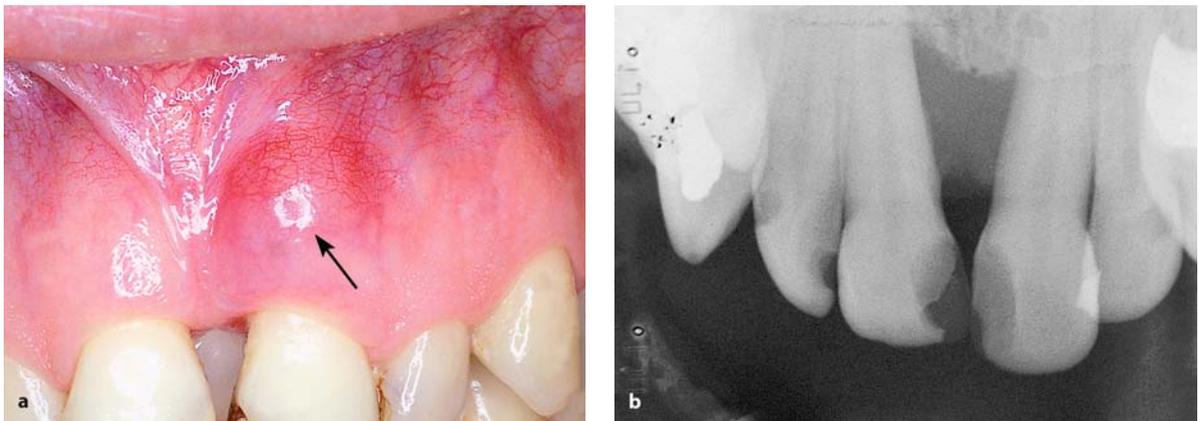
Fig. 9.1 a, b. a Periodontal abscess originating from a maxillary central incisor. **b** Radiograph of same case showing bone resorption, which led to the formation of a periodontal pocket
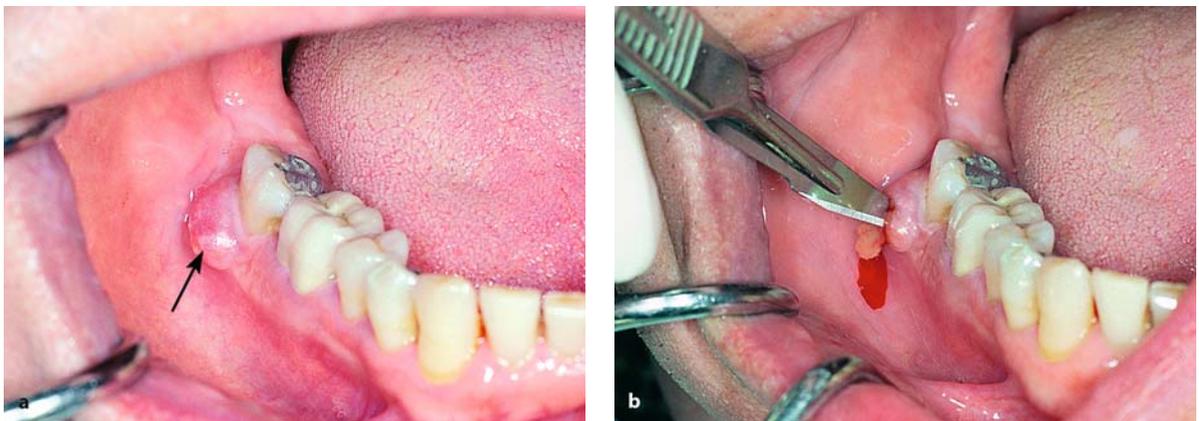
Fig. 9.2 a, b. Periodontal abscess in the region of the mandibular second molar. Incision is performed with no. 11 surgical blade at the top of the swelling

principally the acute dentoalveolar abscess, with the periodontal abscess following, etc.

Etiology. The cardinal causes of orofacial infections are non-vital teeth, pericoronitis (due to a semi-impacted mandibular tooth), tooth extractions, periapical granulomas that cannot be treated, and infected cysts. Rarer causes include postoperative trauma, defects due to fracture, salivary gland or lymph node lesions, and infection as a result of local anesthesia.

located at the middle of the tooth, pain, and redness of the gingiva. These symptoms are not as severe as those observed in the acute dentoalveolar abscess, which is described below.

Treatment of the periodontal abscess is usually simple and entails incision, through the gingival sulcus with a probe or scalpel, of the periodontal pocket that has become obstructed. Incision may also be performed at the gingivae; more specifically, at the most bulging point of the swelling or where fluctuation is greatest (Fig. 9.2 b).

9.1.1
Periodontal Abscess

This is an acute or chronic purulent inflammation, which develops in an existing periodontal pocket (Figs. 9.1, 9.2 a). Clinically, it is characterized by edema

9.1.2
Acute Dentoalveolar Abscess

This is an acute purulent inflammation of the periapical tissues, presenting at nonvital teeth, especially when microbes exit the infected root canals into peri-

apical tissues. Clinically, it is characterized by symptoms that are classified as local and systemic.

9.1.2.1
Local Symptoms

Pain. The severity of the pain depends on the stage of development of the inflammation. In the initial phase the pain is dull and continuous and worsens during percussion of the responsible tooth or when it comes into contact with antagonist teeth. If the pain is very severe and pulsates, it means that the accumulation of pus is still within the bone or underneath the periosteum. Relief of pain begins as soon as the pus perforates the periosteum and exits into the soft tissues.

Edema. Edema appears intraorally or extraorally and it usually has a buccal localization and more rarely palatal or lingual. In the initial phase soft swelling of the soft tissues of the affected side is observed, due to the reflex neuroregulating reaction of the tissues, especially of the periosteum. This swelling presents before suppuration, particularly in areas with loose tissue, such as the sublingual region, lips, or eyelids. Usually the edema is soft with redness of the skin. During the final stages, the swelling fluctuates, especially at the mucosa of the oral cavity. This stage is considered the most suitable for incision and drainage of the abscess.

Other Symptoms. There is a sense of elongation of the responsible tooth and slight mobility; the tooth feels extremely sensitive to touch, while difficulty in swallowing is also observed.

9.1.2.2
Systemic Symptoms

The systemic symptoms usually observed are: fever, which may rise to 39–40 °C, chills, malaise with pain in muscles and joints, anorexia, insomnia, nausea, and vomiting. The laboratory tests show leukocytosis or rarely leukopenia, an increased erythrocyte sedimentation rate, and a raised C-reactive protein (CRP) level.

9.1.2.3
Complications

If the inflammation is not treated promptly, the following complications may occur: trismus, lymphadenitis at the respective lymph nodes, osteomyelitis, bacteremia, and septicemia.

9.1.2.4
Diagnosis

Diagnosis is usually based upon clinical examination and the patient's history. What mainly matters, especially in the initial stages, is the localization of the responsible tooth. In the initial phase of inflammation, there is soft swelling of the soft tissues. The tooth is also sensitive during palpation of the apical area and during percussion with an instrument, while the tooth is hypermobile and there is a sense of elongation. In more advanced stages, the pain is exceptionally severe, even after the slightest contact with the tooth surface. Tooth reaction during a test with an electric vitalometer is negative; however, sometimes it appears positive, which is due to conductivity of the fluid inside the root canal.

Radiographically, in the acute phase, no signs are observed at the bone (which may be observed 8–10 days later), unless there is recurrence of a chronic abscess, whereupon osteolysis is observed. Radiographic verification of a deeply carious tooth or restoration very close to the pulp, as well as thickening of the periodontal ligament, are data that indicate the causative tooth.

Differential diagnosis of the acute dentoalveolar abscess includes the periodontal abscess, and the dentist must be certain of his or her diagnosis, because treatment between the two differs.

9.1.2.5
Spread of Pus Inside Tissues

From the site of the initial lesion, inflammation may spread in three ways:
1. By continuity through tissue spaces and planes.
2. By way of the lymphatic system.
3. By way of blood circulation.

The most common route of spread of inflammation is by continuity through tissue spaces and planes and usually occurs as described below. First of all, pus is formed in the cancellous bone, and spreads in various directions by way of the tissues presenting the least resistance. Whether the pus spreads buccally, palatally or lingually depends mainly on the position of the tooth in the dental arch, the thickness of the bone, and the distance it must travel.

Purulent inflammation that is associated with apices near the buccal or labial alveolar bone usually spreads buccally, while that associated with apices near the palatal or lingual alveolar bone spreads palatally or lingually respectively (Figs. 9.3, 9.4a). For example, the palatal roots of the posterior teeth and the
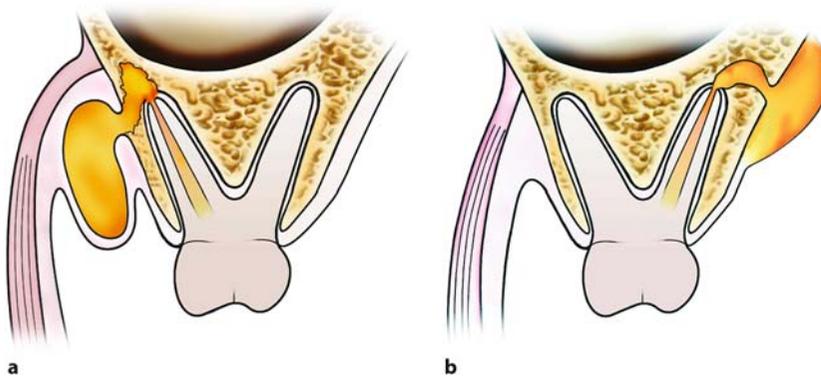
Fig. 9.3 a, b. Diagrammatic illustrations showing spread of infection (propagation of pus) of an acute dentoalveolar abscess, depending on the position of the apex of the responsible tooth. **a** Buccal root: buccal direction. **b** Palatal root: palatal direction
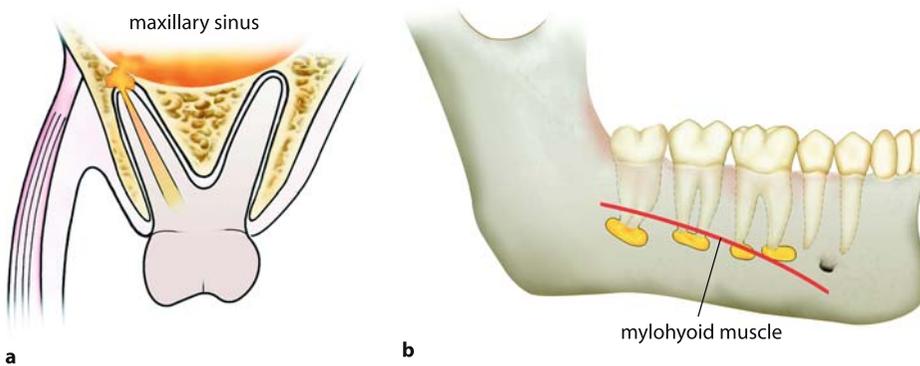
Fig. 9.4 a, b. a Spread of pus towards the maxillary sinus, due to the closeness of the apices to the floor of the antrum. **b** Diagrammatic illustration showing the localization of infection above or below the mylohyoid muscle, depending on the position of the apices of the responsible tooth

maxillary lateral incisor are considered responsible for the palatal spread of pus, while the mandibular third molar and sometimes the mandibular second molar are considered responsible for the lingual spread of infection. Inflammation may even spread into the maxillary sinus when the apices of posterior teeth are found inside or close to the floor of the antrum. The length of the root and the relationship between the apex and the proximal and distal attachments of various muscles also play a significant role in the spread of pus. Depending on these relationships, in the mandible pus originates from the apices found above the mylohyoid muscle, and usually spreads intraorally, mainly towards the floor of the mouth (sublingual space). When the apices are found beneath the mylohyoid muscle (second and third molar), the pus spreads towards the submandibular space (Fig. 9.4b), resulting in extraoral localization.

Infection originating from incisors and canines of the mandible spreads buccally or lingually, due to the thin alveolar bone of the area. It is usually localized buccally if the apices are found above the attachment of the mentalis muscle. Sometimes, though, the pus spreads extraorally, when the apices are found beneath the attachment.

In the maxilla, the attachment of the buccinator muscle is significant. When the apices of the maxillary premolars and molars are found beneath the attachment of the buccinator muscle, the pus spreads intraorally; however, if the apices are found above its attachment, infection spreads upwards and extraorally (Fig. 9.5). Exactly the same phenomenon is observed in the mandible as in the maxilla if the apices are found above or below the attachment of the buccinator muscle.

In the cellular stage, depending on the pathway and inoculation site of the pus, the acute dentoalveolar abscess may have various clinical presentations, such as: (1) intraalveolar, (2) subperiosteal, (3) submucosal, (4) subcutaneous, and (5) fascial or migratory – cervicofacial.

The initial stage of the cellular phase is characterized by accumulation of pus in the alveolar bone and is termed an **intraalveolar abscess** (Fig. 9.6). The pus spreads outwards from this site and, after perforating the bone, spreads to the subperiosteal space, from which the **subperiosteal abscess** originates, where a limited amount of pus accumulates between the bone and periosteum (Fig. 9.7). After perforation of the periosteum, the pus continues to spread through the

Fig. 9.5 a, b. Spread of pus depending on the length of root and attachment of buccinator muscle. **a** Apex above attachment: accumulation of pus in the buccal space. **b** Apex beneath the buccinator muscle: intraoral pathway towards the mucobuccal fold
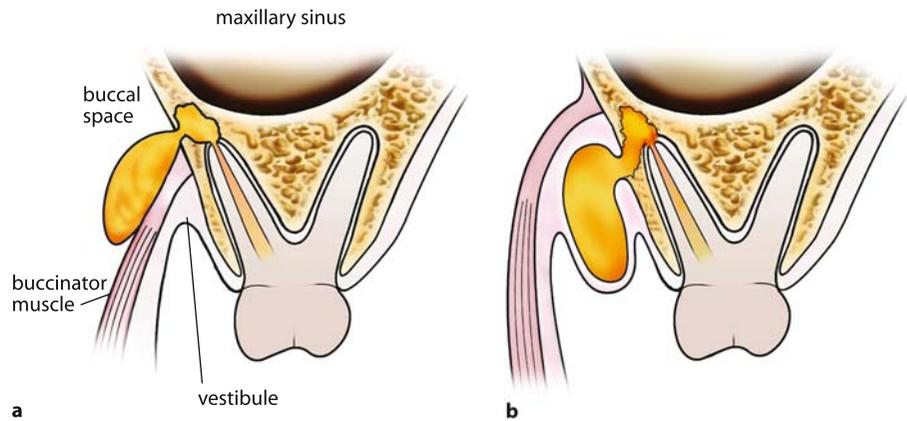
Fig. 9.6 a, b. Intraalveolar abscess of maxilla (**a**) and mandible (**b**). Diagrammatic illustrations show accumulation of pus at a portion of the alveolar bone in relation to the periapical region
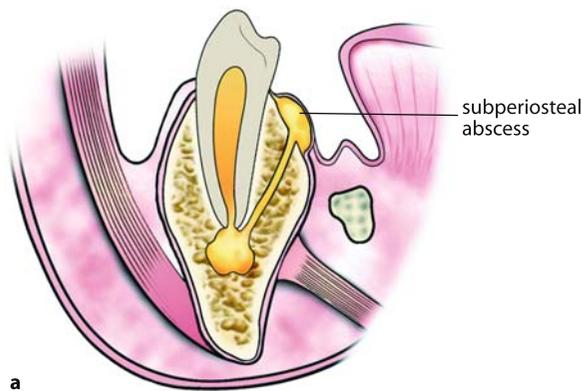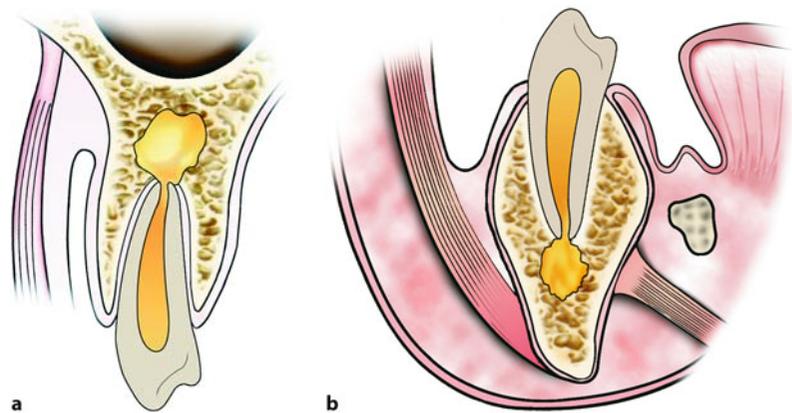
Fig. 9.7 a, b. Subperiosteal abscess with lingual localization. **a** Diagrammatic illustration; **b** clinical photograph

soft tissues in various directions. It usually spreads intraorally, spreading underneath the mucosa forming the **submucosal abscess** (Fig. 9.8). Sometimes, though, it spreads through the loose connective tissue and, after its pathway underneath the skin, forms a **subcutaneous abscess** (Fig. 9.9), while other times it spreads towards the fascial spaces, forming serious abscesses called **fascial space abscesses** (Fig. 9.10).

The fascial spaces are bounded by the fascia, which may stretch or be perforated by the purulent exudate, facilitating the spread of infection. These spaces are potential areas and do not exist in healthy individuals,
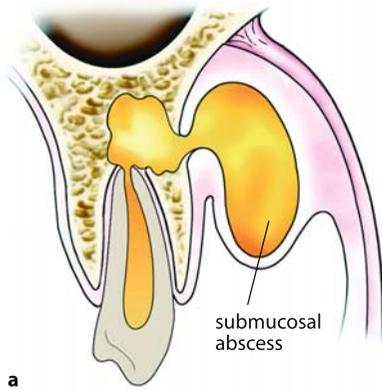
Fig. 9.8 a, b. Submucosal abscess with buccal localization. **a** Diagrammatic illustration; **b** clinical photograph
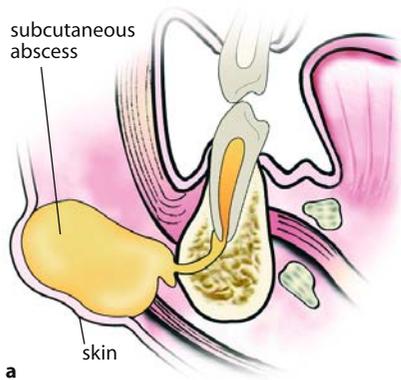
Fig. 9.9 a, b. Subcutaneous abscess originating from a mandibular tooth. **a** Diagrammatic illustration. **b** Clinical photograph. The swelling mainly involves the region of the angle of the mandible
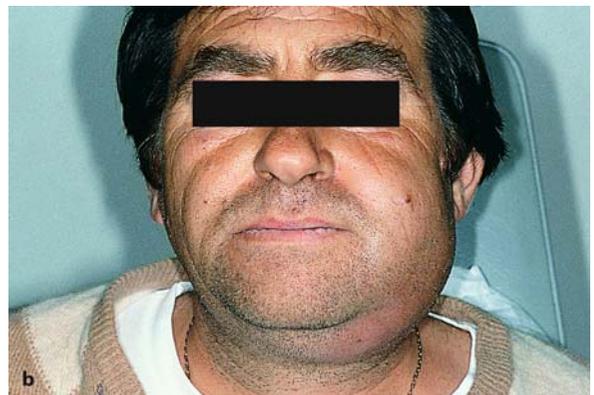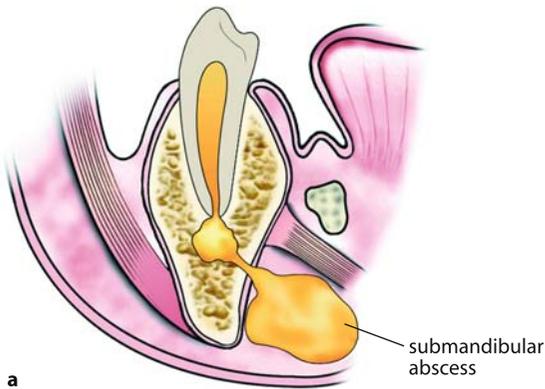
Fig. 9.10 a, b. Fascial abscess (submandibular). **a** Diagrammatic illustration. **b** Clinical photograph

developing only in cases of spread of infection that have not been treated promptly.

Some of these spaces contain loose connective tissue, fatty tissue, and salivary glands, while others contain neurovascular structures. Acute diffuse infection, which spreads into the loose connective tissue to a great extent underneath the skin with or without suppuration, is termed "cellulitis" (phlegmon), and is described below.
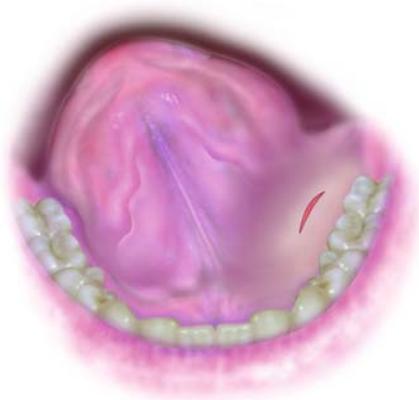
Fig. 9.11. Incision for drainage of a sublingual abscess. The incision is performed parallel to the submandibular duct and the lingual nerve
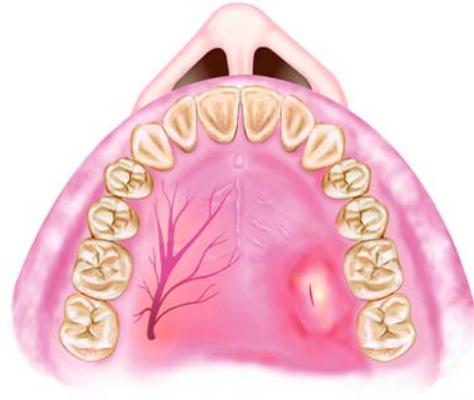
Fig. 9.12. Incision for drainage of a palatal abscess, parallel to the greater palatine vessels

Fig. 9.13 a, b. Incisions for drainage of a submandibular or parotid (**a**), and a sub-masseteric (**b**) abscess. During cutaneous incisions, the course of the facial artery and vein must be taken into consideration (**a**), as well as that of the facial nerve (**b**)
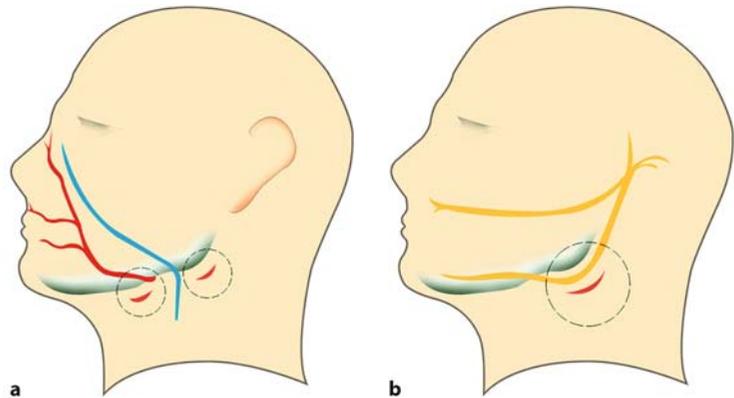
9.1.3
Fundamental Principles of Treatment of Infection

In order to treat an acute dentoalveolar infection as well as a fascial space abscess correctly, the following are considered absolutely necessary:

- Take a detailed medical history from the patient.
- Drainage of pus, when its presence in tissues is established. This is achieved (1) by way of the root canal, (2) with an intraoral incision, (3) with an extraoral incision, and (4) through the alveolus of the extraction. Without evacuation of pus, that is with administration of antibiotics alone, the infection will not resolve.
- Drilling of the responsible tooth during the initial phase of inflammation, to drain exudate through the root canal, together with heat therapy. In this way, spread of inflammation is avoided and the patient is relieved of the pain. Drainage may also be performed with trephination of the buccal bone, when the root canal is inaccessible.

- Antisepsis of the area with an antiseptic solution before the incision.
- Anesthesia of the area where incision and drainage of the abscess are to be performed, with the block technique together with peripheral infiltration anesthesia at some distance from the inflamed area, in order to avoid the risk of existing microbes spreading into deep tissues.
- Planning of the incision so that:
  - Injury of ducts (Wharton, Stensen) and large vessels and nerves is avoided (Figs. 9.11–9.13).
  - Sufficient drainage is allowed. The incision is performed superficially, at the lowest point of the accumulation, to avoid pain and facilitate evacuation of pus under gravity (Fig. 9.14).
  - The incision is not performed in areas that are noticeable, for esthetic reasons; if possible, it is performed intraorally.
- Incision and drainage of the abscess should be performed at the appropriate time. This is when the pus has accumulated in the soft tissues and fluctuates during palpation, that is when pressed between the thumb and middle finger, there is a wave-like

Fig. 9.14 a, b. Superficial incisions on the skin (**a**) and on the mucosa of the oral cavity (**b**)

Fig. 9.15. Spontaneous extraoral (undesirable) drainage of an abscess, after the erroneous placement of hot compresses on the skin

movement of the fluid inside the abscess. If the incision is premature, there is usually a small amount of bleeding, no pain relief for the patient and the edema does not subside.

- The exact localization of pus in the soft tissues (if there is no fluctuation present) and the incision for drainage must be performed after interpretation of certain data; for example, ascertaining the softest point of swelling during palpation, redness of the skin or mucosa, and the most painful point to pressure. This area indicates where the superficial incision with a scalpel is to be made. If there is no indication of accumulation of pus to begin with, hot intraoral rinses with chamomile are recommended to speed up development of the abscess and to ensure that the abscess is mature.

- Avoid the application of hot compresses extraorally, because this entails an increased risk of evacuation of pus towards the skin (spontaneous drainage) (Fig. 9.15).
- Drainage of the abscess is initially performed with a hemostat, which, inserted into the cavity of the abscess with closed beaks, is used to gently explore the cavity with open beaks and is withdrawn again with open beaks (Fig. 9.16). At the same time as the blunt dissection is being performed, the soft tissues of the region are gently massaged, to facilitate evacuation of pus.
- Placement of a rubber drain inside the cavity and stabilization with a suture on one lip of the incision (Fig. 9.17), aiming to keep the incision open for continuous drainage of newly accumulated pus.
- Removal of the responsible tooth as soon as possible, to ensure immediate drainage of the inflammatory material, and elimination of the site of infection. Extraction is avoided if the tooth can be preserved, or if there is an increased risk of serious complications in cases where removal of the tooth is extremely difficult.
- Administration of antibiotics, when swelling is generally diffuse and spreading, and especially if there is fever present, and infection spreads to the fascial spaces, regardless of whether there is an indication of the presence of pus.

Antibiotic therapy is usually empiric, given the fact that it takes time to obtain the results from a culture sample. Because the microorganisms isolated most often in odontogenic infections are streptococci (aerobic and anaerobic), penicillin remains the antibiotic of choice for treatment (see Chap. 16).

Fig. 9.16 a, b. Diagrammatic illustrations showing the incision of an intraoral abscess and the placement of a hemostat to facilitate the drainage of pus
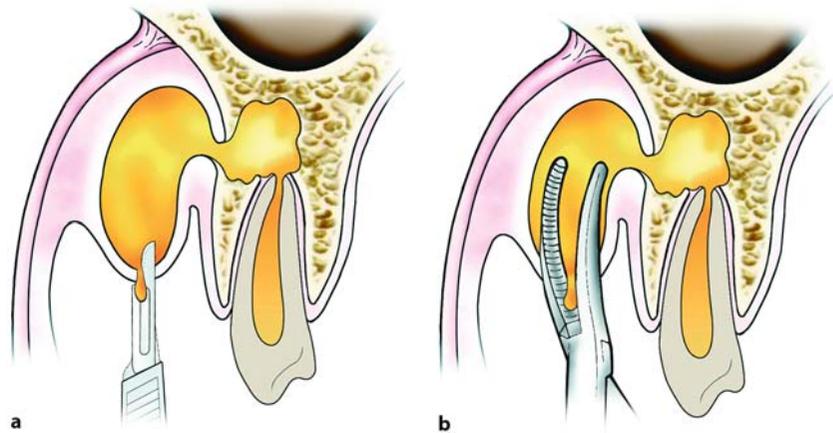
Fig. 9.17 a, b. Diagrammatic illustrations showing the placement of a rubber drain in the cavity and stabilization with a suture on one lip of the incision
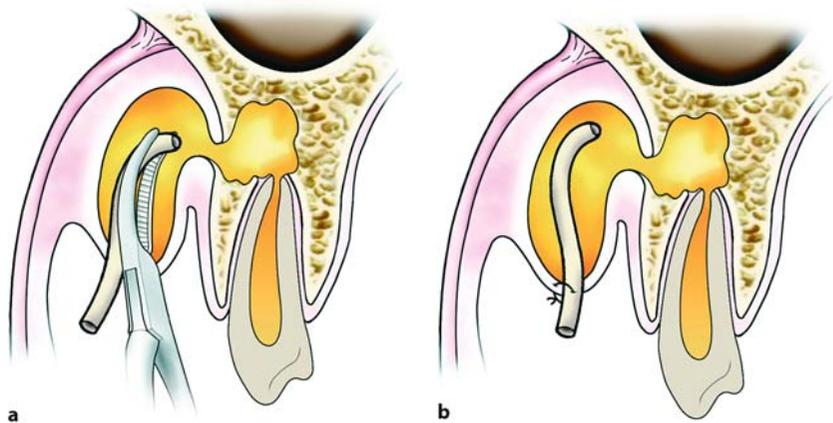
9.1.4
Treatment of Infection in Cellular Stage

In this stage, treatment of the infection depends on the location of existing pus. Localization, as already mentioned, may be intraalveolar, subperiosteal, submucosal or subcutaneous. Each of these cases is discussed below.

9.1.4.1
Intraalveolar Abscess

Anatomic Location. This is an acute purulent infection, which develops at the apical region of the tooth in cancellous bone (Fig. 9.18 a).

Etiology. It is usually caused by bacteria originating from any infected tooth of the maxilla or mandible.

Clinical Presentation. The symptoms that are characteristic of this condition are severe pulsating pain, tooth mobility, and sense of elongation of causative tooth.

Treatment. Treatment aims at relieving the patient of pain initially, and then saving the tooth. First, drainage is attempted through the root canal (Fig. 9.18 b). The tooth is drilled with a high-speed handpiece with manipulations as gentle as possible, because the tooth is exceptionally sensitive even after mere contact. To facilitate the evacuation of pus, the necrotic material must be removed with a barbed broach from the root canal and then slight pressure is applied at the apical region of the tooth.

If drainage through the root canal is not possible, then treatment consists of trephination after the position of the apex is established with a radiograph. During the surgical procedure, a small horizontal incision is made buccally on the mucosa, as close to the apex of the tooth as possible. Afterwards, the periosteum is reflected as far as the tip of the root and the buccal bone is exposed. Using a round blunt bur, with slow rotation and under a steady stream of saline solution, bone is removed, establishing communication with the periapical infection (Fig. 9.19). This procedure results in drainage of exudate and relief of pain. After completion, the wound is sutured, without placement of a rubber drain being necessary.

Fig. 9.18 a, b. Intraalveolar abscess. **a** Diagrammatic illustration showing the accumulation of pus in cancellous bone. **b** Incision and drainage of an intraalveolar abscess through the root canal. *Arrow* points to sanguinopurulent exudate
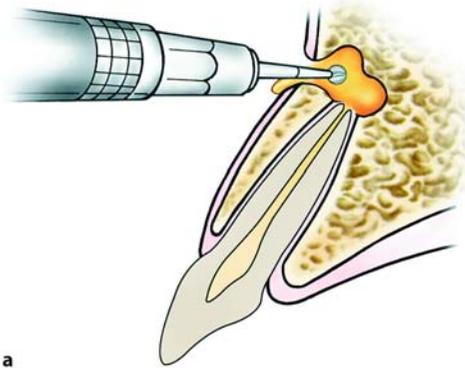
Fig. 9.19 a, b. Trephination of buccal bone for drainage of an abscess. **a** Diagrammatic illustration. **b** Clinical photograph

9.1.4.2
Subperiosteal Abscess

Anatomic Location. The subperiosteal abscess involves limited accumulation of pus that is semi-fluctuant. It is located between bone and the periosteum, at the buccal, palatal, or lingual region, relative to the tooth responsible for the infection (Fig. 9.20).

Etiology. This type of abscess is the result of spread of an intraalveolar abscess, when the pus perforates the bone and becomes established underneath the periosteum.

Clinical Presentation. It is characterized by mild edema, severe pain due to tension of the periosteum, and sensitivity during palpation.

Treatment. This abscess is treated with an intraoral incision and drainage. The incision is performed on the mucosa, taking into consideration the course of the vessels and nerves in the region (mental nerve and palatal vessels and nerves) in order to avoid injury. The scalpel blade reaches bone, to ensure greater drainage of pus (Fig. 9.21).

9.1.4.3
Submucosal Abscess

Anatomic Location. This abscess is located exactly underneath the buccal or labial vestibular mucosa of the maxilla or mandible, as well as the palatal or lingual region, respective to the tooth responsible for the infection (Figs. 9.22, 9.26).
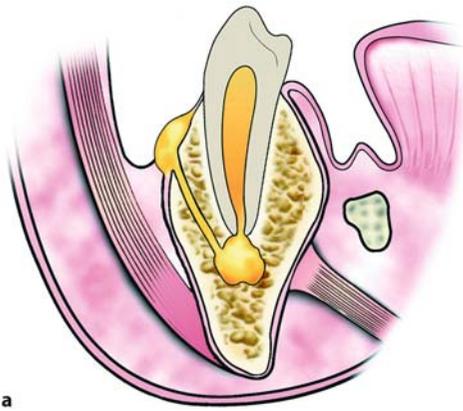
Fig. 9.20 a, b. Subperiosteal abscess with buccal localization. **a** Diagrammatic illustration showing limited accumulation of pus between bone and the periosteum. **b** Clinical photograph of abscess
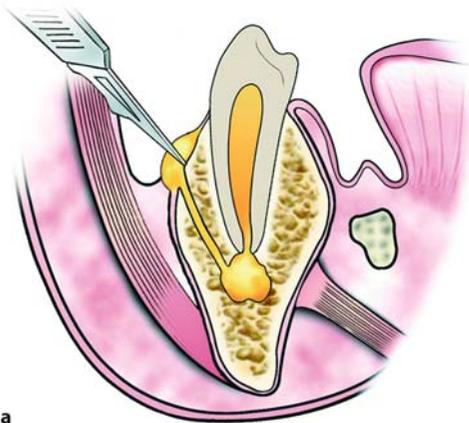
Fig. 9.21 a, b. Incision for a subperiosteal abscess. A no. 11 scalpel blade is used, which is placed against bone to facilitate the drainage of pus

Etiology. The factors responsible for intraalveolar abscesses also cause this type of abscess. The teeth normally considered responsible for the development of a palatal abscess are the molars and lateral incisor of the maxilla.

Clinical Presentation. Swelling of the mucosa with obvious fluctuation is observed, as are sensitivity during palpation, and obliteration of the mucobuccal fold in the area of infection. As far as the palatal abscess is concerned, it manifests as a circumscribed swelling, respective to the responsible tooth (Fig. 9.26). The mucosa appears reddish, while sensitivity is observed during palpation and fluctuation.

Treatment. The incision is made superficially with a scalpel blade. A small hemostat is then inserted inside the cavity in order to create a broader drainage route (Figs. 9.23–9.25) and a rubber drain is inserted so that the drainage route is kept open for at least 48 h. Incision and drainage of palatal abscesses require special attention to ensure avoiding injury to the greater palatine artery, vein, and nerve. Therefore, the incision must not be made perpendicular to the course of the aforementioned vessels and nerve, but near the border of the gingivae or towards the midline and parallel to the dental arch (Fig. 9.27). Drainage of the abscess is achieved with a curved hemostat (Figs. 9.28, 9.29). After drainage, the patient is relieved of pain, and resolution of the abscess, in other words the healing stage, begins.
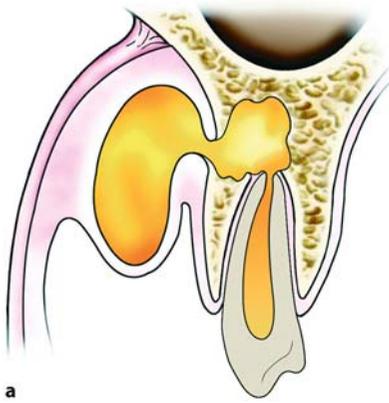
Fig. 9.22 a, b. **a** Diagrammatic illustration of a submucosal abscess of the maxilla with buccal localization. **b** Clinical photograph showing a slightly fluctuant swelling at the depth of the vestibular fold
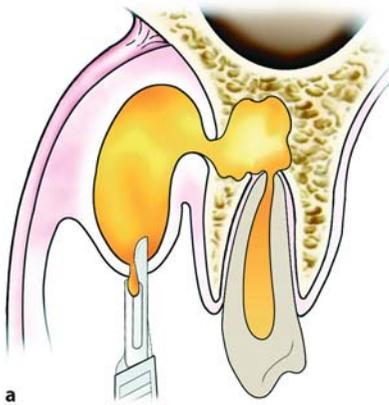
Fig. 9.23 a, b. Incision and drainage of a submucosal abscess. The incision is performed at the lowest point of the swelling, to ensure the complete drainage of accumulated pus
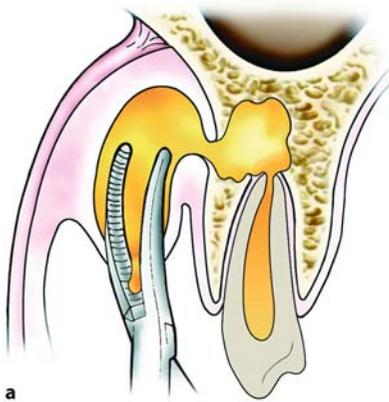
Fig. 9.24 a, b. Placement of a hemostat in the cavity of an abscess to facilitate the drainage of pus. **a** Diagrammatic illustration. **b** Clinical photograph
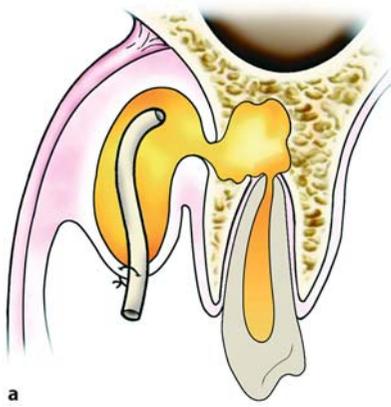
Fig. 9.25 a, b. Rubber drain stabilized with a suture on one lip of the incision
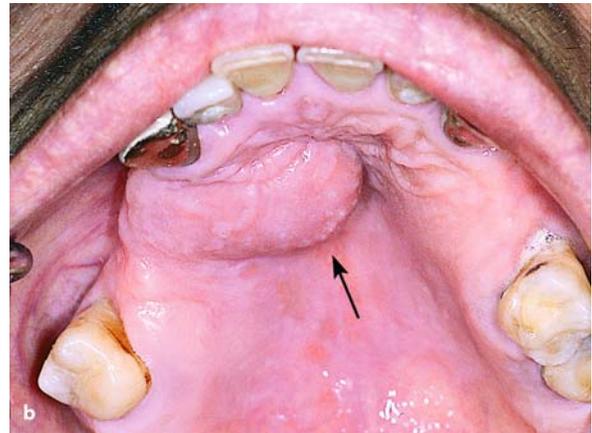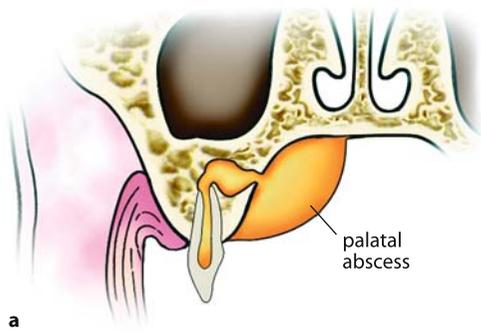
Fig. 9.26 a, b. Submucosal abscess with a palatal localization. **a** Diagrammatic illustration. **b** Clinical photograph showing swelling at the anterior portion of the palate
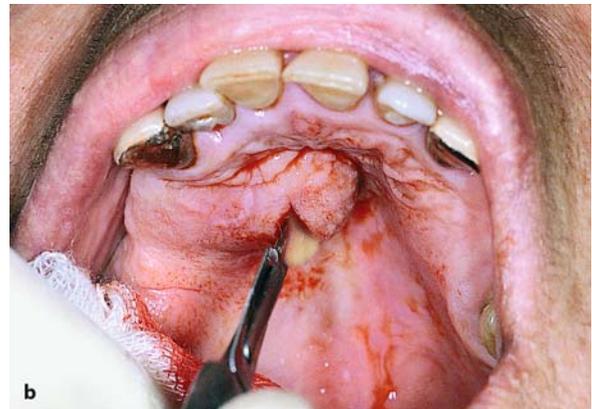
Fig. 9.27 a, b. Incision and drainage of an abscess. **a** Diagrammatic illustration and **b** clinical photograph

Fig. 9.28. Insertion of a hemostat into the cavity of an abscess for drainage of pus

Fig. 9.29. Stabilization of the rubber drain with a suture on one lip of the incision

9.1.4.4
Subcutaneous Abscess

Anatomic Location. This abscess is localized in various areas of the face underneath the skin, with characteristic swelling that usually fluctuates (Fig. 9.30).

Etiology. It is the result of spread of infection from a primary focal site that is not treated soon enough.

Clinical Presentation. Edema is observed, which most times is well-circumscribed; the skin appears reddish and when pressure is applied, a pit is easily formed (Fig. 9.30 b).

Treatment. After administration of local anesthesia, an incision is made (only on the skin) at the lowest point of swelling, very carefully so that nerves or vessels of the area are not injured. Afterwards, a hemostat

is inserted into the purulent accumulation and withdrawn with open beaks, creating a broad drainage site, while the soft tissues of the area are gently massaged until the abscess is emptied. After this procedure, a rubber drain is inserted into the cavity, which is stabilized with a suture for 2–3 days until the wound is drained (Figs. 9.31–9.35).

9.1.5
Fascial Space Infections

These infections involve fascial spaces and are usually of odontogenic origin.

Each of these pathologic conditions is described below, including discussion of their anatomic location, etiology, clinical presentation, and therapeutic treatment.
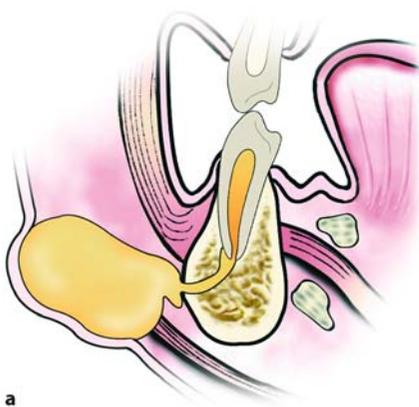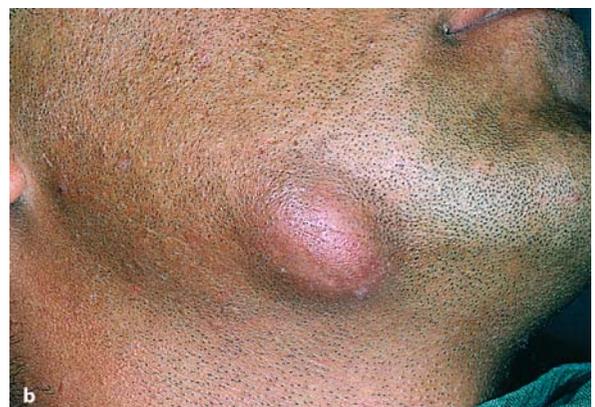
Fig. 9.30 a, b. Subcutaneous abscess. **a** Diagrammatic illustration showing the accumulation of pus beneath the skin. **b** Clinical photograph showing a subcutaneous swelling at the right side of the mandible

Fig. 9.31 a, b. Peripheral infiltration anesthesia of healthy tissues surrounding inflammation, for incision and drainage

Fig. 9.32. Incision with a scalpel at the lowest point of swelling

Fig. 9.33. Insertion of a hemostat into the cavity and slight pressure in the region of the abscess to facilitate evacuation of pus

Fig. 9.34. Placement of a rubber drain into the cavity

Fig. 9.35. Gauze dressing applied to the drainage site
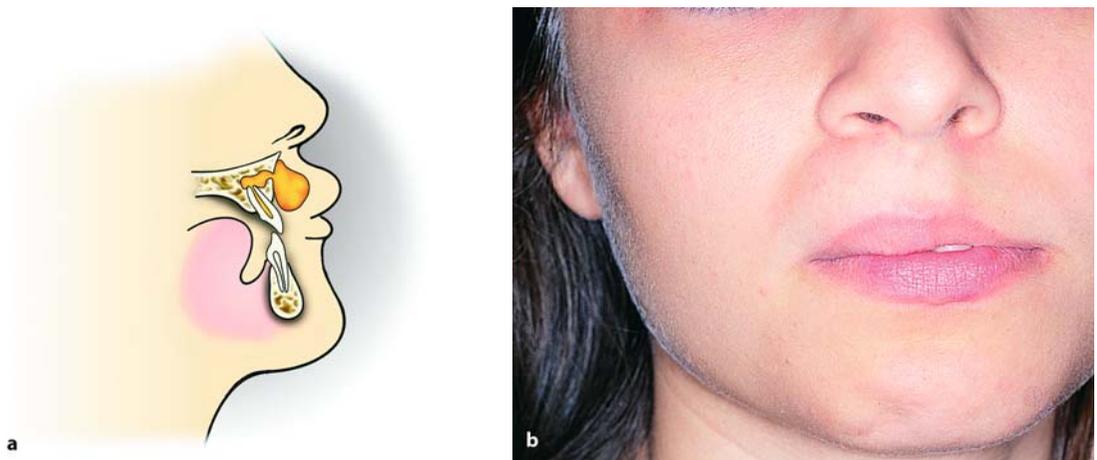
Fig. 9.36 a, b. Abscess of the base of the upper lip. **a** Diagrammatic illustration showing infection of loose connective tissue of the region. **b** Clinical photograph showing edema in half of the upper lip
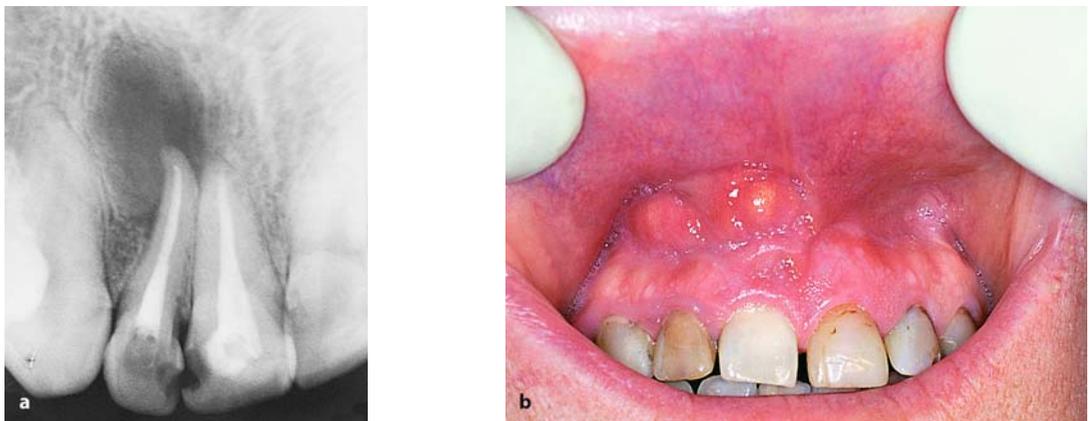
Fig. 9.37 a, b. a Periapical radiograph showing the tooth responsible for the development of infection (maxillary right lateral incisor). **b** The case of Fig. 9.36b shown intraorally

9.1.5.1
Abscess of Base of Upper Lip

Anatomic Location. This abscess develops at the loose connective tissue of the base of the upper lip at the anterior region of the maxilla, beneath the pear-shaped aperture (Fig. 9.36 a).

Etiology. It is usually caused by infected root canals of maxillary anterior teeth.

Clinical Presentation. What characterizes this infection is the swelling and protrusion of the upper lip, which is accompanied by diffuse spreading and obliteration of the depth of the mucolabial fold (Figs. 9.36 b, 9.37a, b).

Treatment. The incision for drainage is made at the mucolabial fold parallel to the alveolar process (Fig. 9.38). A hemostat is then inserted inside the cavity, which reaches bone, aiming for the apex of the responsible tooth, facilitating the evacuation of pus (Fig. 9.39a). After drainage of the abscess, a rubber drain is placed until the clinical symptoms of the infection subside (Fig. 9.39b).

9.1.5.2
Canine Fossa Abscess

Anatomic Location. The canine fossa, which is where this type of abscess develops, is a small space between the levator labii superioris and the levator anguli oris muscles (Fig. 9.40 a).
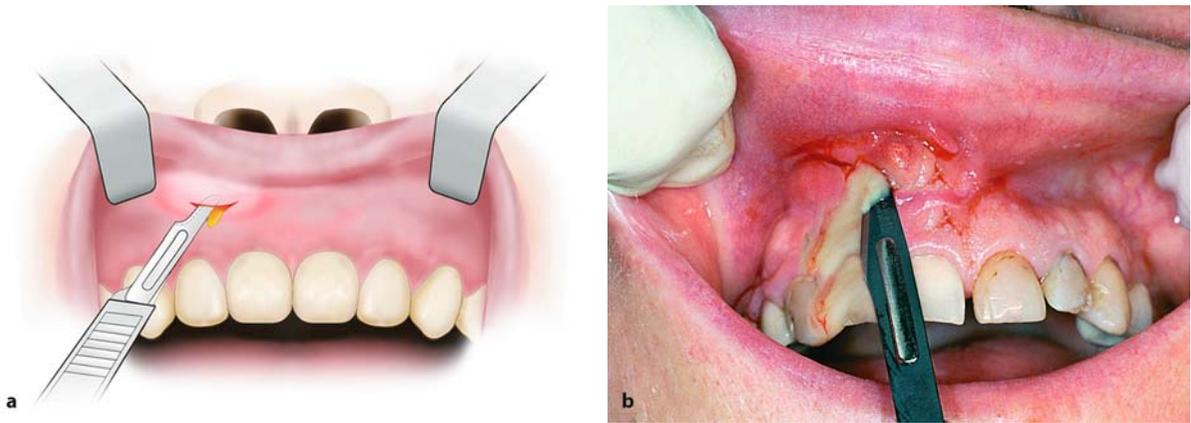
Fig. 9.38 a, b. Incision for the drainage of an abscess. The incision is performed at the vestibular fold, at lowest site of swelling

Fig. 9.39 a, b. a Insertion of a hemostat into the abscess cavity for drainage of pus. **b** Placement and stabilization of a rubber drain at the drainage site
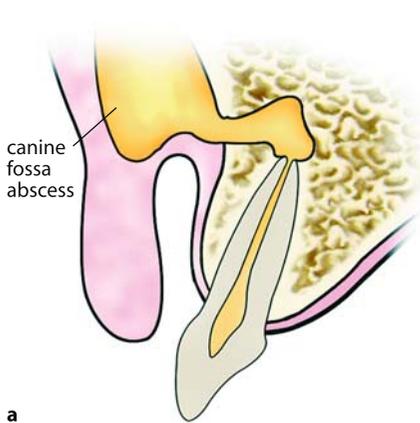
Fig. 9.40 a, b. Canine fossa abscess. **a** Diagrammatic illustration showing the spread of an abscess into the canine fossa. **b** Clinical photograph of the region of the abscess. Extraoral swelling at the infraorbital region and nasolabial fold with red shiny skin

Fig. 9.41 a, b. Incision at the vestibular fold for drainage of an abscess of the canine fossa. **a** Diagrammatic illustration. **b** Clinical photograph
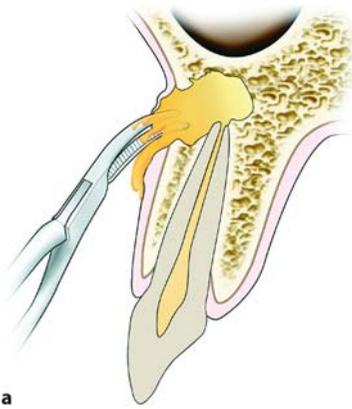
Fig. 9.42 a, b. Insertion of a hemostat and exploration of the abscess cavity as far as the bone surface, to facilitate the drainage of pus

Etiology. Infected root canals of premolars and especially those of canines of the maxilla are considered to be responsible for the development of abscesses of the canine fossa.

Clinical Presentation. This is characterized by edema, localized in the infraorbital region, which spreads towards the medial canthus of the eye, lower eyelid, and side of the nose as far as the corner of the mouth. There is also obliteration of the nasolabial fold, and somewhat of the mucolabial fold.

The edema at the infraorbital region is painful during palpation, and later on the skin becomes taut and shiny due to suppuration, while its color is reddish (Fig. 9.40b).

Treatment. The incision for drainage is performed intraorally at the mucobuccal fold (parallel to the alveolar bone), in the canine region (Fig. 9.41). A hemostat is then inserted, which is placed at the depth of the purulent accumulation until it comes into contact with bone (Fig. 9.42), while the index finger of the nondominant hand palpates the infraorbital margin. Finally, a rubber drain is placed, which is stabilized with a suture on the mucosa (Fig. 9.43).

9.1.5.3
Buccal Space Abscess

Anatomic Location. The space in which this abscess develops is between the buccinator and masseter muscles (Fig. 9.44 a). Superiorly, it communicates with the
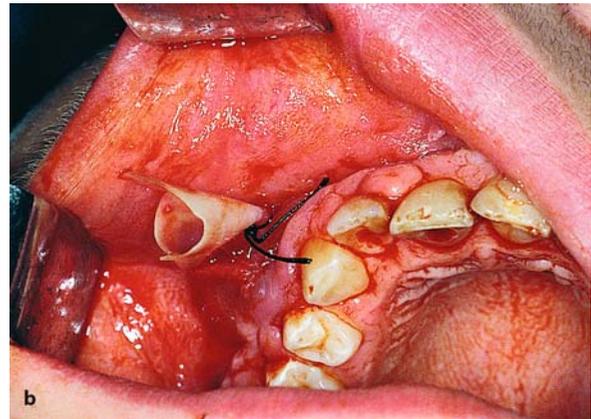
Fig. 9.43 a, b. Rubber drain stabilized in position with a suture. **a** Diagrammatic illustration. **b** Clinical photograph

pterygopalatine space; inferiorly with the pterygo-mandibular space. The spread of pus in the buccal space depends on the position of the apices of the responsible teeth relative to the attachment of the buccinator muscle.

Etiology. The buccal space abscess may originate from infected root canals of posterior teeth of the maxilla and mandible.

Clinical Presentation. It is characterized by swelling of the cheek, which extends from the zygomatic arch as far as the inferior border of the mandible, and from the anterior border of the ramus to the corner of the mouth. The skin appears taut and red, with or without fluctuation of the abscess (Fig. 9.44b), which, if neglected, may result in spontaneous drainage.

Treatment. Access to the buccal space is usually intraoral for three main reasons:
1. Because the abscess fluctuates intraorally in the majority of cases.
2. To avoid injuring the facial nerve.
3. For esthetic reasons.

The intraoral incision is made at the posterior region of the mouth, in an anteroposterior direction and very carefully in order to avoid injury of the parotid duct. A hemostat is then used to explore the space thoroughly.

An extraoral incision is made when intraoral access would not ensure adequate drainage, or when the pus is deep inside the space. The incision is made approximately 2 cm below and parallel to the inferior border of the mandible.
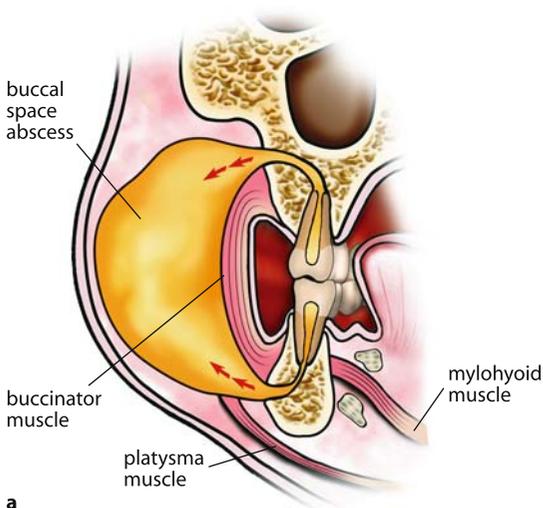
Fig. 9.44 a, b. Buccal space abscess. **a** Diagrammatic illustration showing the spread of an abscess lateral to the buccinator muscle. **b** Clinical photograph showing swelling at the right cheek

Fig. 9.45 a–c. Infratemporal abscess. **a** Diagrammatic illustration showing the spread of the abscess into the infratemporal space. **b** Clinical photograph of an infratemporal abscess. Swelling of the region of the right zygomatic arch and edema of eyelids. **c** Incision at the depth of the vestibular fold for incision and drainage of an infratemporal abscess

9.1.5.4
Infratemporal Abscess

Anatomic Location. The space in which this abscess develops is the superior extension of the pterygomandibular space. Laterally, this space is bounded by the ramus of the mandible and the temporalis muscle, while medially, it is bounded by the medial and lateral pterygoid muscles, and is continuous with the temporal fossa (Fig. 9.45a). Important anatomic structures, such as the mandibular nerve, mylohyoid nerve, lingual nerve, buccal nerve, chorda tympani nerve, and the maxillary artery, are found in this space. Part of the pterygoid venous plexus is also found inside this space.

Etiology. Infections of the infratemporal space may be caused by infected root canals of posterior teeth of the maxilla and mandible, by way of the pterygomandibular space, and may also be the result of a posterior superior alveolar nerve block and an inferior alveolar nerve block.

Clinical Presentation. Trismus and pain during opening of the mouth with lateral deviation towards the affected side, edema at the region anterior to the ear which extends above the zygomatic arch, as well as edema of the eyelids are observed (Fig. 9.45b).

Treatment. The incision for drainage of the abscess is made intraorally, at the depth of the mucobuccal fold, and, more specifically, laterally (buccally) to the maxillary third molar and medially to the coronoid process, in a superoposterior direction (Fig. 9.45c). A hemostat is inserted into the suppurated space, in a superior direction. Drainage of the abscess may be performed extraorally in certain cases. The incision is performed on the skin in a superior direction, and extends approximately 3 cm. The starting point of the incision is the angle created by the junction of the frontal and temporal processes of the zygomatic bone. Drainage of the abscess is achieved with a curved hemostat, which is inserted through the skin into the purulent accumulation.

9.1.5.5
Temporal Abscess

Anatomic Location. The temporal space is the superior continuation of the infratemporal space. This space is divided into superficial and deep temporal spaces. The superficial temporal space is bounded laterally by the temporal fascia and medially by the temporalis muscle, while the deep temporal space is found between the medial surface of the temporalis muscle and the temporal bone.
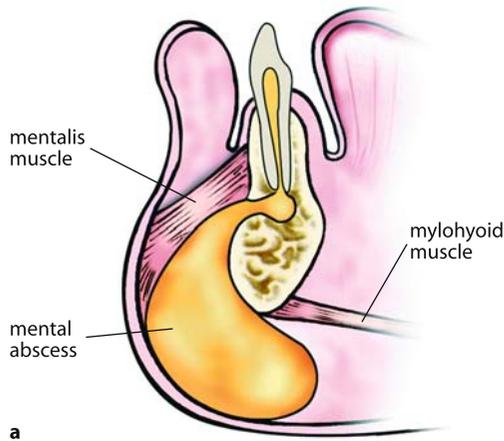
Fig. 9.46 a, b. Mental abscess. **a** Diagrammatic illustration of the spread of the abscess into the anterior region of the mandible corresponding to the symphysis menti. **b** Clinical photograph showing swelling of mental region

Etiology. Infection of the temporal space is caused by the spread of infection from the infratemporal space, with which it communicates.

Clinical Presentation. It is characterized by painful edema of the temporal fascia, trismus (the temporalis and medial pterygoid muscles are involved), and pain during palpation of the edema.

Treatment. The incision for drainage is performed horizontally, at the margin of the scalp hair and approximately 3 cm above the zygomatic arch. It then continues carefully between the two layers of the temporal fascia as far as the temporalis muscle. A curved hemostat is used to drain the abscess.

9.1.5.6
Mental Abscess

Anatomic Location. The accumulation of pus in this space is located at the anterior region of the mandible, near the bone, and, more specifically, underneath the mentalis muscle, with spread of the infection towards the symphysis menti (Fig. 9.46 a).

Etiology. The infection is usually the result of infected mandibular anterior teeth (incisors).

Clinical Presentation. Firm and painful swelling in the area of the chin is observed, while later the skin becomes shiny and red (Fig. 9.46 b).

Treatment. The incision for drainage of the abscess may be performed at the depth of the mucobuccal fold, if the abscess fluctuates intraorally. If the pus has

spread extraorally, though, an incision is made on the skin, parallel to the inferior border of the chin, 1–1.5 cm posteriorly. After drainage is complete, a rubber drain is placed.

9.1.5.7
Submental Abscess

Anatomic Location. The submental space in which this abscess develops (Fig. 9.47 a) is bounded superiorly by the mylohyoid muscle, laterally and on both sides by the anterior belly of the digastric muscle, inferiorly by the superficial layer of the deep cervical fascia that is above the hyoid bone, and finally, by the platysma muscle and overlying skin. This space contains the anterior jugular vein and the submental lymph nodes.

Etiology. Infection of the submental space usually originates in the mandibular anterior teeth or is the result of spread of infection from other anatomic spaces (mental, sublingual, submandibular).

Clinical Presentation. The infection presents as an indurated and painful submental edema, which later may fluctuate (Figs. 9.47 b, 9.48 a) or may even spread as far as the hyoid bone.

Treatment. After local anesthesia is performed around the abscess (Fig. 9.48 b), an incision on the skin is made beneath the chin, in a horizontal direction and parallel to the anterior border of the chin (Fig. 9.49). The pus is then drained in the same way as in the other cases (Figs. 9.50–9.52).
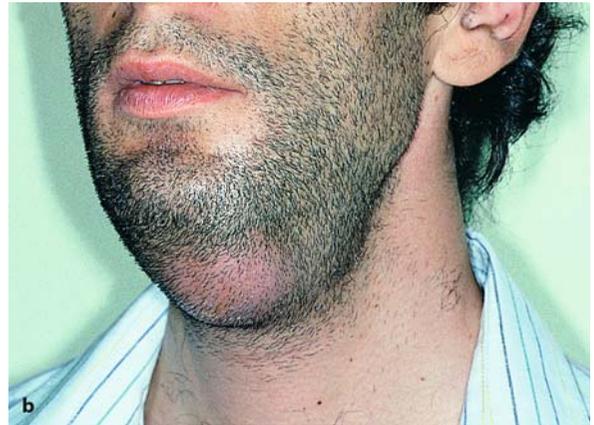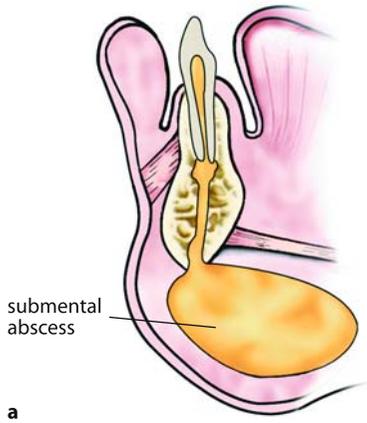
Fig. 9.47 a, b. Submental abscess. **a** Diagrammatic illustration of the spread of the abscess into the submental space. **b** Clinical photograph showing severe extraoral swelling at the submental region

Fig. 9.48 a, b. **a** Mature submental abscess ready for incision and drainage. **b** Peripheral infiltration anesthesia of healthy tissues surrounding inflammation

Fig. 9.49 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) showing the incision for drainage of the abscess. Incision is performed at the skin in the horizontal direction and parallel to the inferior border at the mental region

Fig. 9.50. Insertion of a hemostat and exploration of the abscessed area

Fig. 9.51. Withdrawal of the hemostat from the cavity with open beaks, facilitating the evacuation of pus

Fig. 9.52 a, b. Rubber drain placed at the drainage site of the abscess
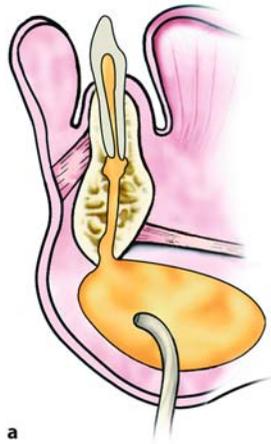
9.1.5.8
Sublingual Abscess

There are two sublingual spaces above the mylohyoid muscle, to the right and left of the midline. These spaces are divided by dense fascia. Abscesses formed in these spaces are known as sublingual abscesses.

Anatomic Location. The sublingual space (Fig. 9.53 a) is bounded superiorly by the mucosa of the floor of the mouth, inferiorly by the mylohyoid muscle, anteriorly and laterally by the inner surface of the body of the mandible, medially by the lingual septum, and posteriorly by the hyoid bone.

   This space contains the submandibular duct (Wharton's duct), the sublingual gland, the sublingual and lingual nerve, terminal branches of the lingual artery, and part of the submandibular gland.

Etiology. The teeth that are most commonly responsible for infection of the sublingual space are the mandibular anterior teeth, premolars and the first molar, whose apices are found above the attachment of the mylohyoid muscle. Also, infection may spread to this space from other contiguous spaces with which it communicates (submandibular, submental, lateral pharyngeal).

Clinical Presentation. The abscess of the sublingual space presents with characteristic swelling of the mucosa of the floor of the mouth, resulting in elevation of the tongue towards the palate and laterally (Fig. 9.53b). The mandibular lingual sulcus is obliterated and the mucosa presents a bluish tinge. The patient speaks with difficulty, because of the edema, and movements of the tongue are painful.
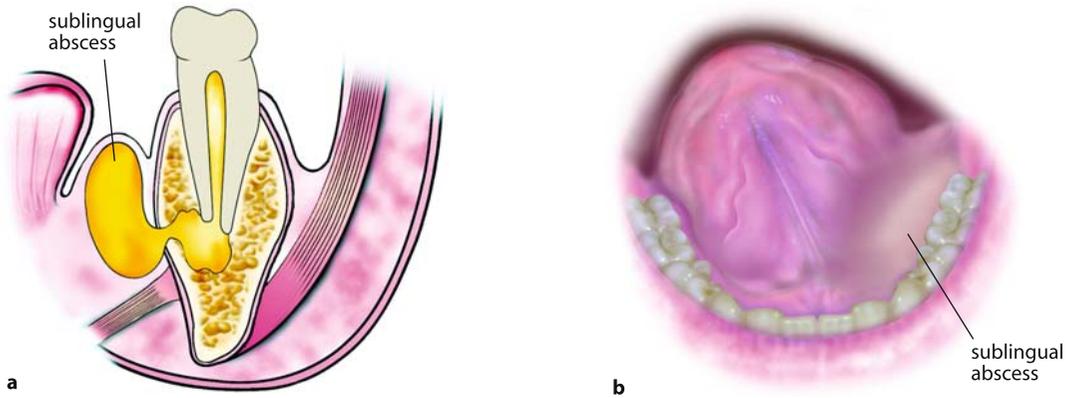
Fig. 9.53 a, b. Sublingual abscess. Diagrammatic illustrations showing: **a** the development of an abscess in the sublingual space; **b** swelling of the mucosa of the mouth floor and characteristic elevation of the tongue towards the opposite side
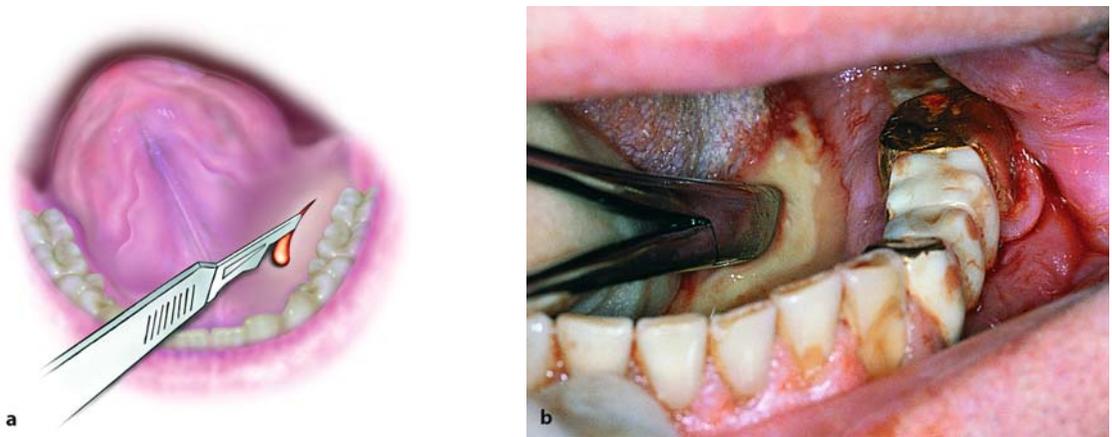
Fig. 9.54 a, b. Incision for the drainage of an abscess. **a** Diagrammatic illustration. **b** Clinical photograph, showing the insertion of a hemostat and exploration of the abscessed space
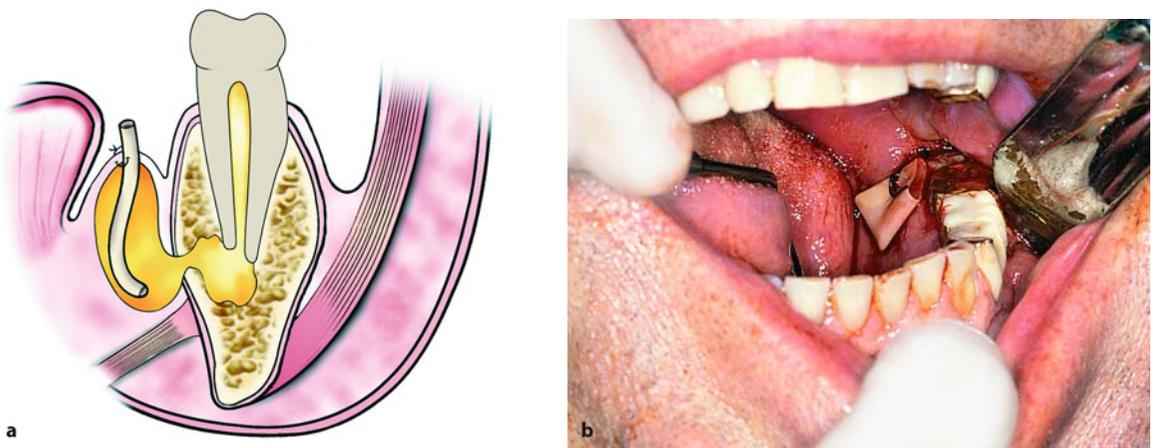
Fig. 9.55 a, b. Stabilization of the rubber drain with a suture at the cavity of the abscess. **a** Diagrammatic illustration. **b** Clinical photograph
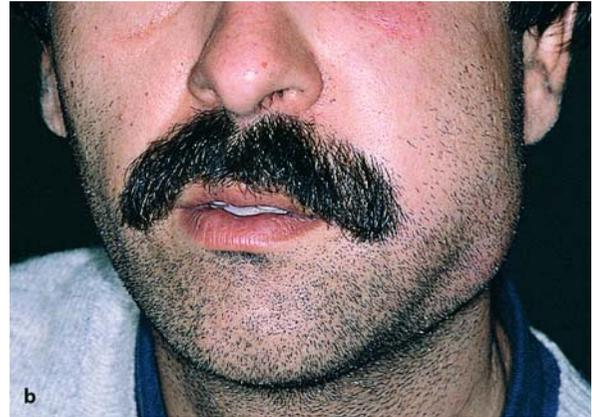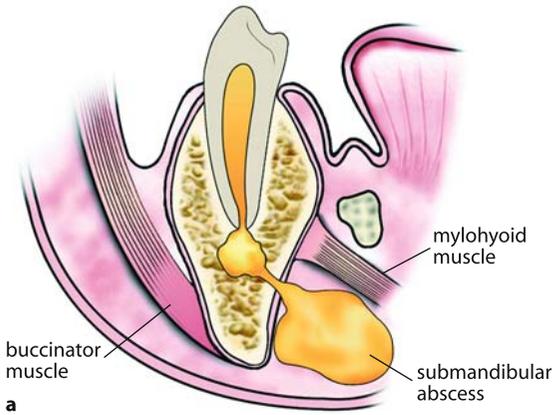
Fig. 9.56 a, b. Submandibular abscess. **a** Diagrammatic illustration showing spread of the abscess into the submandibular space underneath the mylohyoid muscle. **b** Clinical photograph showing severe swelling at the left posterior area of the mandible
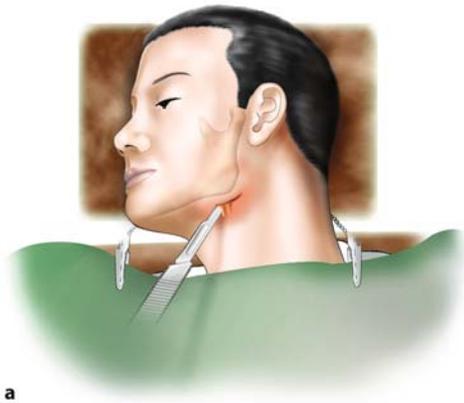
Fig. 9.57 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) showing incision on the skin for drainage of a submandibular abscess

Treatment. The incision for drainage is performed intraorally, laterally, and along Wharton's duct and the lingual nerve (Fig. 9.54 a). In order to locate the pus, a hemostat is used to explore the space inferiorly, in an anteroposterior direction and beneath the gland (Fig. 9.54 b). After drainage is complete, a rubber drain is placed (Fig. 9.55).

9.1.5.9
Submandibular Abscess

Anatomic Location. The submandibular space is bounded laterally by the inferior border of the body of the mandible, medially by the anterior belly of the digastric muscle, posteriorly by the stylohyoid ligament and the posterior belly of the digastric muscle, superiorly by the mylohyoid and hyoglossus muscles, and inferiorly by the superficial layer of the deep cervical fascia (Fig. 9.56 a). This space contains the submandibular salivary gland and the submandibular lymph nodes.

Etiology. Infection of this space may originate from the mandibular second and third molars, if their apices are found beneath the attachment of the mylohyoid muscle. It may also be the result of spread of infection from the sublingual or submental spaces.

Clinical Presentation. The infection presents as moderate swelling at the submandibular area, which spreads, creating greater edema that is indurated and redness of the overlying skin (Fig. 9.56 b). Also, the angle of the mandible is obliterated, while pain during palpation and moderate trismus due to involvement of the medial pterygoid muscle are observed as well.

Treatment. The incision for drainage is performed on the skin, approximately 1 cm beneath and parallel to the inferior border of the mandible (Fig. 9.57). During the incision, the course of the facial artery and vein (the incision should be made posterior to these) and the respective branch of the facial nerve should be
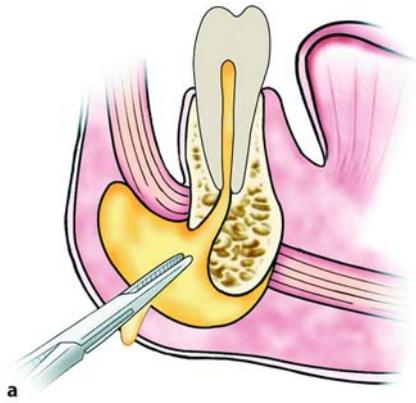
Fig. 9.58 a, b. Insertion of a hemostat and exploration of the cavity of an abscess for drainage of pus

Fig. 9.59. Stabilization of a rubber drain at the site of incision
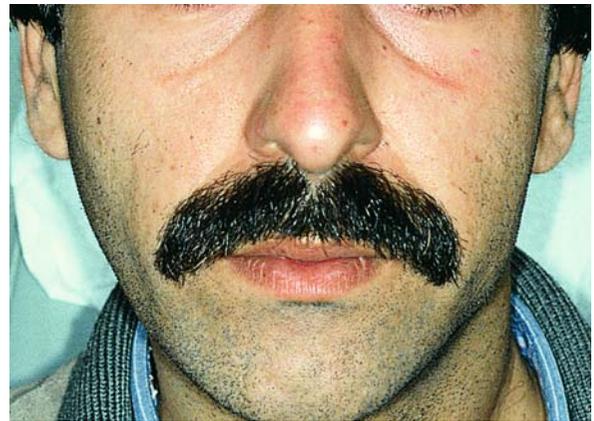
Fig. 9.60. Postoperative clinical photograph 10 days later

taken into consideration. A hemostat is inserted into the cavity of the abscess to explore the space and an attempt is made to communicate with the infected spaces (Fig. 9.58). Blunt dissection must be performed along the medial surface of the mandibular bone also, because pus is often located in this area as well. After drainage, a rubber drain is placed (Figs. 9.59, 9.60).

9.1.5.10
Submasseteric Abscess

Anatomic Location. The space in which this abscess develops is cleft-shaped and is located between the masseter muscle and the lateral surface of the ramus of the mandible (Fig. 9.61a). Posteriorly it is bounded by the parotid gland, and anteriorly it is bounded by the mucosa of the retromolar area.

Etiology. Infection of this space originates in the mandibular third molars (pericoronitis), and in rare cases because of migratory abscesses.

Clinical Presentation. It is characterized by a firm edema that is painful to pressure in the region of the masseter muscle, which extends from the posterior border of the ramus of the mandible as far as the anterior border of the masseter muscle (Fig. 9.61b). Also, severe trismus and an inability to palpate the angle of the mandible are observed. Intraorally, there is edema present at the retromolar area and at the anterior border of the ramus. This abscess rarely fluctuates, while it may present generalized symptoms.

Treatment. Treatment of this abscess is basically intraoral, with an incision that begins at the coronoid process and runs along the anterior border of the ramus towards the mucobuccal fold, approximately as
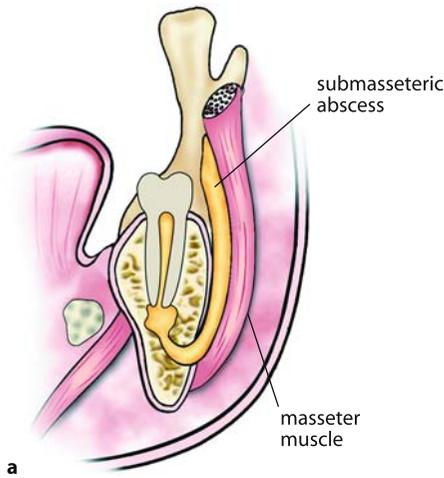
Fig. 9.61 a, b. Submasseteric abscess. **a** Diagrammatic illustration of the spread of the abscess into the submasseteric space. **b** Clinical photograph of extraoral swelling of the left side

far as the second molar. The incision may also be performed extraorally on the skin, beneath the angle of the mandible (Fig. 9.13 b). In both cases, a hemostat is inserted, which proceeds as far as the center of suppuration and until it comes into contact with bone. Because access is distant from the purulent accumulation, often it is difficult to drain the area well, resulting in frequent relapse.

9.1.5.11
Pterygomandibular Abscess

Anatomic Location. This space is bounded laterally by the medial surface of the ramus of the mandible, medially by the medial pterygoid muscle, superiorly by the lateral pterygoid muscle, anteriorly by the pterygomandibular raphe, and posteriorly by the parotid gland (Fig. 9.62). The pterygomandibular space contains the mandibular neurovascular bundle, lingual nerve, and part of the buccal fat pad. It communicates with the pterygopalatal, infratemporal, submandibular, and lateral pharyngeal spaces.

Etiology. An abscess of this space is caused mainly by infection of mandibular third molars or the result of an inferior alveolar nerve block, if the penetration site of the needle is infected (pericoronitis).

Clinical Presentation. Severe trismus and slight extraoral edema beneath the angle of the mandible are observed. Intraorally, edema of the soft palate of the affected side is present, as is displacement of the uvula and lateral pharyngeal wall, while there is difficulty in swallowing.
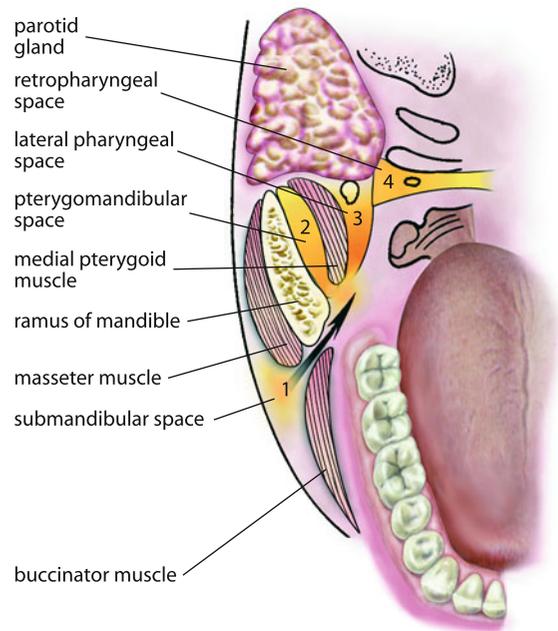
Fig. 9.62. Diagrammatic illustration showing the spread of a dentoalveolar abscess into contiguous fascial spaces. (*1* Submandibular abscess, *2* pterygomandibular abscess, *3* parapharyngeal abscess, *4* retropharyngeal abscess)

Treatment. The incision for drainage is performed on the mucosa of the oral cavity and, more specifically, along the mesial temporal crest (Fig. 9.63). The incision must be 1.5 cm long and 3–4 mm deep. A curved hemostat is then inserted, which proceeds posteriorly and laterally until it comes into contact with the medial surface of the ramus. The abscess is drained, permitting the evacuation of pus along the shaft of the instrument.
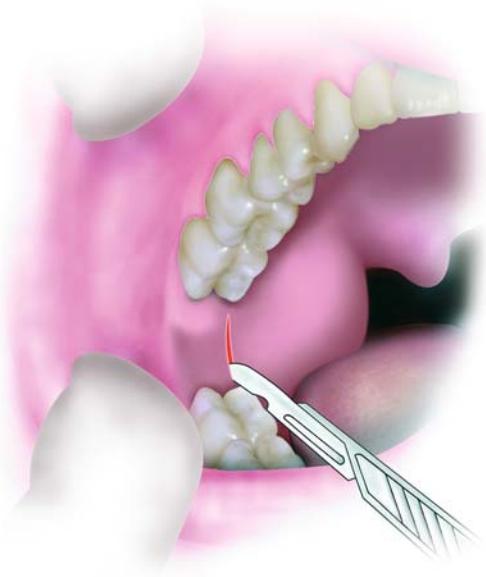
Fig. 9.63. Incision for drainage of a pterygomandibular abscess

9.1.5.12
Lateral Pharyngeal Abscess

Anatomic Location. The lateral pharyngeal space is conical shaped, with the base facing the skull while the apex faces the carotid sheath. It is bounded by the lateral wall of the pharynx, the medial pterygoid muscle, the styloid process and the associated attached muscles and ligaments, and the parotid gland (Fig. 9.62). The lateral pharyngeal space contains the internal carotid artery, the internal jugular vein with the respective lymph nodes, the glossopharyngeal nerve, hypoglossal nerve, vagus nerve, and accessory nerve. It communicates directly with the submandibular space, as well as with the brain by way of foramina of the skull.

Etiology. Infections of this space originate in the region of the third molar and are the result of spread of infection from the submandibular and pterygomandibular spaces.

Clinical Presentation. Extraoral edema at the lateral region of the neck that may spread as far as the tragus of the ear, displacement of the pharyngeal wall, tonsil and uvula towards the midline, pain that radiates to the ear, trismus, difficulty in swallowing, significantly elevated temperature, and generally malaise are noted.

Treatment. Drainage is performed extraorally (similar to that of the submandibular abscess) with an incision 2 cm long, inferior to or posterior to the posterior part of the body of the mandible. Access is achieved using a hemostat, which, after entering the center of the purulent collection, proceeds towards the medial surface of the mandible, to the third molar area, and if possible, behind that area. The rubber drain that is placed remains in position for about 2–3 days. Drainage of the abscess may also be performed intraorally, although it is difficult and risky, because there is a great chance of aspiration of pus, especially if the procedure is carried out under general anesthesia.

9.1.5.13
Retropharyngeal Abscess

Anatomic Location. The retropharyngeal space is located posterior to the soft tissue of the posterior wall of the pharynx and is bounded anteriorly by the superior pharyngeal constrictor muscle and the associated fascia, posteriorly by the prevertebral fascia, superiorly by the base of the skull, and inferiorly by the posterior mediastinum (Fig. 9.62).

Etiology. Infections of this space originate in the lateral pharyngeal space, which is close by.

Clinical Presentation. The same symptoms as those present in the lateral pharyngeal abscess appear clinically, with even greater difficulty in swallowing though, due to edema at the posterior wall of the pharynx. If it is not treated in time, there is a risk of:
- Obstruction of the upper respiratory tract, due to displacement of the posterior wall of the pharynx anteriorly.
- Rupture of the abscess and aspiration of pus into the lungs, with asphyxiation resulting.
- Spread of infection into the mediastinum.

Treatment. Therapy entails drainage through the lateral pharyngeal space, which is where the infection usually begins. Administration of antibiotics is mandatory.

9.1.5.14
Parotid Space Abscess

Anatomic Location. The space in which this abscess develops (Fig. 9.64 a) is located in the area of the ramus of the mandible and, more specifically, between the layers of the fascia investing the parotid gland. It com-
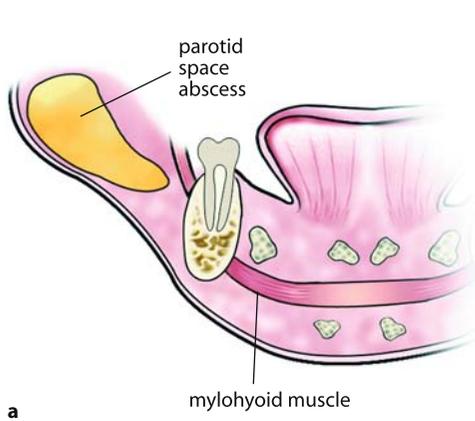
Fig. 9.64 a, b. Parotid space abscess. a Diagrammatic illustration showing spread of the abscess into the parotid space. b Clinical photograph of extraoral swelling of the retromandibular area with red shiny skin

Fig. 9.65 a, b. Incision for sufficient drainage of a parotid space abscess. a Diagrammatic illustration. b Clinical photograph

municates with the lateral pharyngeal and the submandibular spaces. It contains the parotid gland and its duct, the external carotid artery, the superficial temporal and facial artery, the retromandibular vein, the auriculotemporal nerve, and the facial nerve.

Etiology. Infection of this space originates from odontogenic migratory infections of the lateral pharyngeal and submandibular spaces.

Clinical Presentation. It presents with characteristic edema of the retromandibular and parotid region, difficulty in swallowing and pain mainly during chew-

ing, which radiates to the ear and temporal region. In certain cases there is redness of the skin and subcutaneous fluctuation (Fig. 9.64 b). Also, a purulent exudate may be noted from the papilla of the parotid duct after pressure is applied.

Treatment. Depending on the margins of the edema, therapy entails a broad incision posterior to the angle of the mandible (Fig. 9.65), taking particular care not to injure the respective branch of the facial nerve. Drainage of pus is achieved after blunt dissection using a hemostat to explore the purulent collection (Figs. 9.66–9.68).

Fig. 9.66. Insertion of a hemostat and exploration (blunt dissection) of the abscess cavity

Fig. 9.67. Rubber drain placed at the site of incision

Fig. 9.68. Postoperative clinical photograph 10 days after drainage of the abscess

9.1.5.15
Cellulitis (Phlegmon)

Anatomic Location. This condition is an acute, diffuse inflammatory infiltration of the loose connective tissue found underneath the skin (Figs. 9.69 a, 9.71 a). It is believed today that cellulitis and phlegmon are interchangeable terms. The term cellulitis has prevailed and so the term phlegmon has just about been abandoned.

Etiology. It may be the result of any infected tooth and is usually due to a mixed infection. The microorganisms thought to be responsible are aerobic and anaerobic streptococci and staphylococci.

buccinator muscle

accumulation of pus in deep tissues
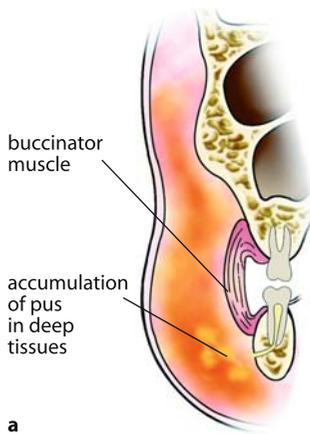
Fig. 9.69 a, b. Cellulitis originating from a mandibular posterior tooth. **a** Diagrammatic illustration showing diffuse inflammatory spread, which extends from the submandibular as far as the infratemporal area, with accumulation of pus in small focal points in deep tissues. **b** Clinical photograph of extensive swelling of the right side, resulting in severe disfigurement of the face
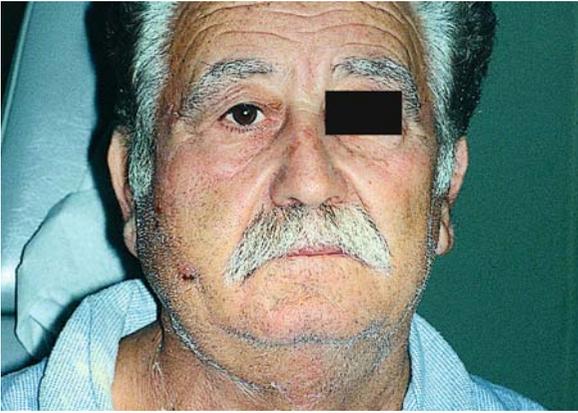
Fig. 9.70. Postoperative clinical photograph 15 days after the incision and drainage of pus

Clinical Presentation. This disease is characterized by edema, headache, and reddish skin. The edema, whose margins are diffuse and not defined, may present in various areas of the face and its localization depends on the infected tooth responsible. For example, if the mandibular posterior teeth are involved, the edema presents as submandibular, and, in more severe cases, spreads towards the cheek or the opposite side, leading to grave disfigurement of the face (Figs. 9.69 b, 9.71b). When the infection originates in the maxillary anterior teeth, the edema involves the upper lip, which presents with a characteristic protrusion (Fig. 9.74).

In the initial stage, cellulitis feels soft or doughy during palpation, without pus present, while in more advanced stages, a board-like induration appears, which may lead to suppuration. At this stage, the pus is localized in small focal sites in the deep tissue.

Treatment. Therapy is pharmaceutical. More specifically, large doses of antibiotics are administered (penicillin or ampicillin parenterally), which may resolve the disease or help it, in conjunction with heat therapy, suppurate to a certain degree. Depending on the spread of inflammation, drainage may be performed in one or more sites to facilitate evacuation of the exudate (Figs. 9.70, 9.72, 9.73). In grave cases admission of the patient to a hospital is recommended.

9.1.5.16
Ludwig's Angina

Anatomic Location. Ludwig's angina is a grave acute cellular infection and is characterized by bilateral involvement of the submandibular and sublingual spaces, as well as the submental space (Fig. 9.75 a). In the past this condition was fatal, although today adequate surgical treatment and antibiotic therapy have almost eliminated fatal episodes.

Etiology. The most frequent cause of the disease is periapical or periodontal infection of mandibular teeth, especially of those whose apices are found beneath the mylohyoid muscle.

Clinical Presentation. The disease presents with severe difficulty in swallowing, speaking and breathing, drooling of saliva, and elevated temperature. The bilateral involvement of the submandibular spaces and submental space results in severe and painful indurated board-like hardness, without apparent fluctuation, because the pus is localized deep in the tissues (Fig. 9.75 b), while the bilateral involvement of the sub-

Fig. 9.71 a, b. Cellulitis with the clinical appearance of Ludwig's angina. **a** Diagrammatic illustration showing diffuse inflammatory spread in loose connective tissue with accumulation of pus in deep tissues, at the anterior and posterior region of both sides of the mandible. **b** Clinical photograph showing extensive swelling at submental and submandibular spaces

Fig. 9.72. Third postoperative day after drainage of the purulent accumulation

Fig. 9.73. Postoperative clinical photograph 20 days later
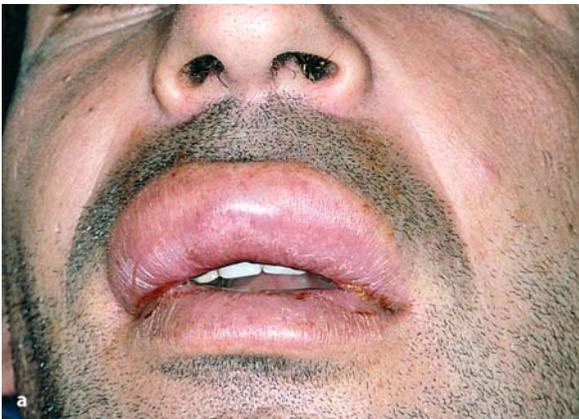
Fig. 9.74 a, b. Clinical photograph showing cellulitis of the upper lip, originating from maxillary anterior teeth. The edema extends all along the upper lip, resulting in a characteristic protrusion

Ludwig's Angina
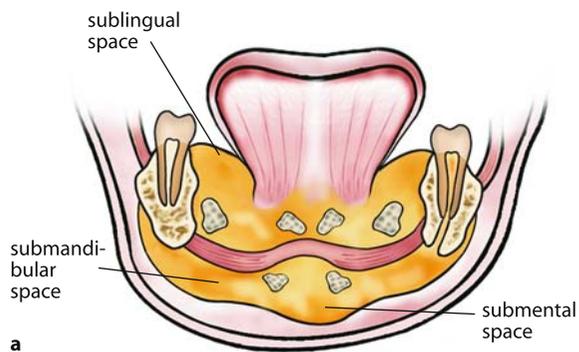
Fig. 9.75 a, b. Ludwig's angina. **a** Diagrammatic illustration showing the spread of purulent infection in five fascial spaces of the mandible. **b** Clinical photograph of extensive extraoral swelling in submental and submandibular spaces

Fig. 9.76. Clinical intraoral photograph showing severe edema of the floor of the mouth and elevation of the tongue, due to suppuration of sublingual spaces (risk of asphyxiation)

Fig. 9.77. Incision for drainage of inflammation

Fig. 9.78. Placement of rubber drains at the sites of incision

Fig. 9.79. Postoperative clinical photograph 1 month after treatment of infection

lingual spaces causes painful indurated edema of the floor of the mouth and the tongue (Fig. 9.76). The middle third of the tongue is elevated towards the palate, while the anterior portion projects out of the mouth. The posterior portion displaces the edematous epiglottis posteriorly, resulting in obstruction of the airway.

Treatment. This is treated surgically with surgical decompression (drainage) of the spaces of infection and concurrent administration of a double regimen of antibiotics. Surgical intervention must be attempted to drain all the abscessed spaces.

The incisions must be bilateral, extraoral, parallel, and medial to the inferior border of the mandible, at the premolar and molar region (Fig. 9.77), and intraoral, parallel to the ducts of the submandibular glands.

Exploration and an attempt to communicate with the spaces of infection, by breaking the septa dividing them and drainage of the contents, are achieved with these incisions. Rubber drains are placed in order to keep the drainage sites open for at least 3 days, until the clinical symptoms of the infection have resolved (Figs. 9.78, 9.79). Many people believe that in the case of continued obstruction, a surgical airway must be established.

9.1.6
Chronic Dentoalveolar Abscess

Many of the acute odontogenic infections, if not treated in time, develop into chronic infections, resulting in spontaneous drainage intraorally or on the skin.

Fig. 9.80. Orifice of the fistula of a dentoalveolar abscess that became chronic (chronic abscess), located at the buccal mucosa of the maxillary alveolar process

Fig. 9.81. Chronic dentoalveolar abscess with drainage, through a fistula, at the buccal mucosa of the mandible

Fig. 9.82. Orifice of a fistula of a chronic dentoalveolar abscess, located at the mucosa of the palate

Fig. 9.83. Cutaneous fistula at the mental region as a result of a chronic dentoalveolar abscess originating from a mandibular central incisor

Fig. 9.84 a, b. Cutaneous fistulas due to chronic dentoalveolar abscesses originating from the mandible

Chronic abscesses that have not been treated result in the development of a fistula, by which seropurulent or sanguinopurulent exudate is periodically discharged from the cavity until it empties. The opening is then obstructed and remains closed until a new collection of pus accumulates. Alternatively, the pus may not drain by way of the fistula, but may be absorbed by the blood vessels or lymph nodes of the body.

The chronic dentoalveolar abscess is usually asymptomatic. Sometimes, though, mild intermittent pain (which is due to the temporary obstruction of the fistula) or mild edema and redness of the tissues of the periapical region may be noted. The tooth is sensitive to percussion and the pulp of the offending tooth usually tests nonvital.

Dentoalveolar fistulas develop intraorally as well as extraorally. Intraoral fistulas are usually observed buccally and more rarely palatally or lingually (Figs. 9.80–9.82), while extraoral fistulas are the result of chronic suppuration of the cheek, mental region, or the superior region of the neck, resulting in a puckered appearance on the skin (Figs. 9.83, 9.84). The exudate discharged from the fistula dries up on the skin, resulting in the formation of a crusted surface.

Radiographically, limited or extensive diffuse radiolucency is observed in cases of chronic dentoalveolar abscesses, which is due to bone destruction.

Treatment consists of eliminating the infection from the responsible tooth with endodontic therapy or in conjunction with surgical treatment (apicoectomy), when endodontic therapy alone does not produce the desired results. Usually in intraoral fistulas, the fistulous tract disappears a few days after endodontic therapy begins, without requiring intervention for excision of the opening. In extraoral fistulas, though, after treating the infected site, the fistulous tract must be excised as far as the bone cavity and, after debridement, must be sutured tightly.

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Preprosthetic Surgery

10

F. D. Fragiskos

Preprosthetic surgery involves operations aiming to eliminate certain lesions or abnormalities of the hard and soft tissues of the jaws, so that the subsequent placement of prosthetic appliances is successful.

10.1
Hard Tissue Lesions or Abnormalities

The abnormalities associated with hard tissues are classified into two categories:

a. Those that may be smoothed with alveoloplasty immediately after extraction of the teeth (sharp spicules, bone edges), or those detected and recontoured in an edentulous alveolar ridge.
b. Congenital abnormalities, such as torus palatinus, torus mandibularis, multiple exostoses.

10.1.1
Alveoloplasty

Alveoloplasty is the surgical procedure performed to smooth or recontour the alveolar bone, aiming to facilitate the healing procedure as well as the successful placement of a future prosthetic restoration.

After tooth extractions, appropriate recontouring of the alveolar process and care of the wound are necessary prerequisites for placement of a prosthetic appliance. Sometimes, the residual crest presents irregularities, undercuts, or bone spicules (Fig. 10.1), which, if not removed before placement of the partial or complete denture, lead to injury and stability or retention problems. If the alveolar ridge is suspected of presenting abnormal morphology after the extraction of one or more teeth, in order to avoid such a possibility, alveoloplasty must be performed at the same surgical session (Fig. 10.2).

Alveoloplasty After Extraction of Single Tooth.
When a tooth is hypererupted due to the absence of an antagonist, bone irregularity is usually observed after its extraction (Fig. 10.3). This may cause problems for

Fig. 10.1. Protrusion of alveolar bone of the premaxilla after multiple extractions of anterior teeth

Fig. 10.2. Supraeruption of maxillary teeth dragging down the alveolar ridge. Indication for alveoloplasty after extraction

the normal healing process and abnormality of the alveolar bone, resulting in obstruction of the placement of a prosthetic restorative appliance. In such cases, immediately after extraction of the tooth, recontouring of the bone in the area must be performed.

The relative procedure is generally as follows. After extraction of the tooth, a flap is created and a rongeur is used to cut the jagged parts of the tooth socket, until
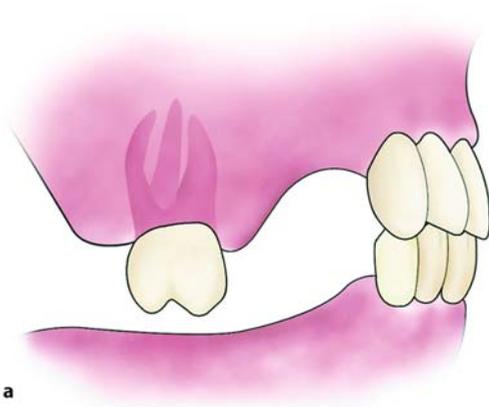
Fig. 10.3 a, b. Supraeruption of a maxillary molar. After extraction of the tooth, surgical recontouring of alveolar bone is required. The procedure aims to create a normal interarch space. **a** Diagrammatic illustration. **b** Clinical photograph
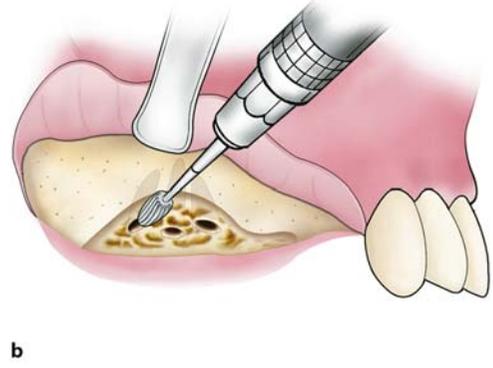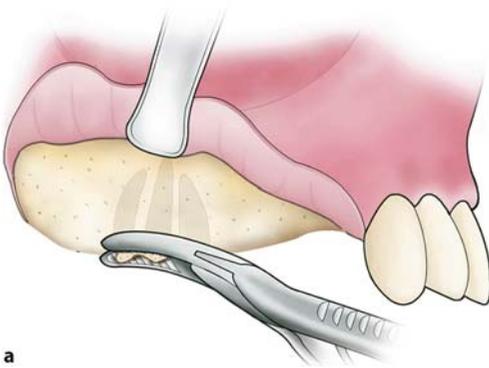
Fig. 10.4 a, b. Smoothing of the alveolar ridge with a bone rongeur (**a**), and with a bone bur (**b**)
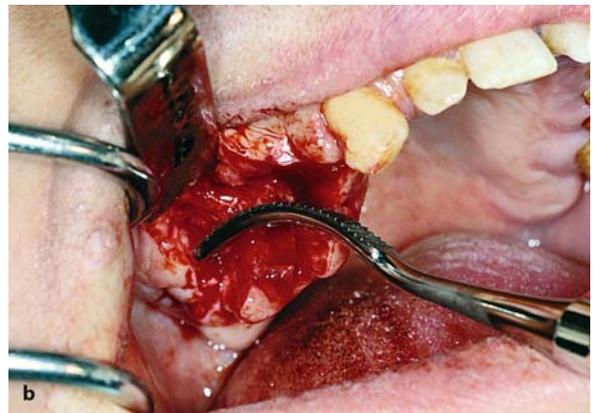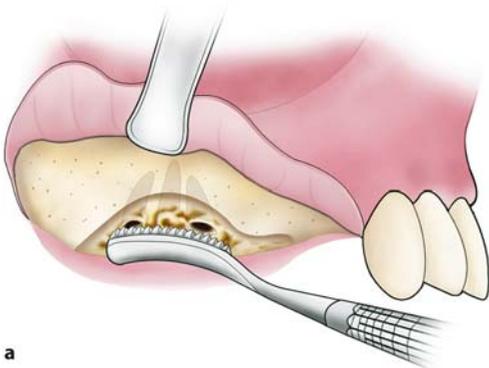
Fig. 10.5 a, b. Smoothing of bone surface with a bone file. **a** Diagrammatic illustration. **b** Clinical photograph

a clinically appropriate interarch space is created (Fig. 10.4 a). Afterwards, the bone surface is smoothed using a bur and bone file (Figs. 10.4 b, 10.5), and excess gingivae are trimmed with soft tissue scissors. The area is irrigated with plenty of saline solution and the wound is sutured with interrupted sutures (Fig. 10.6).
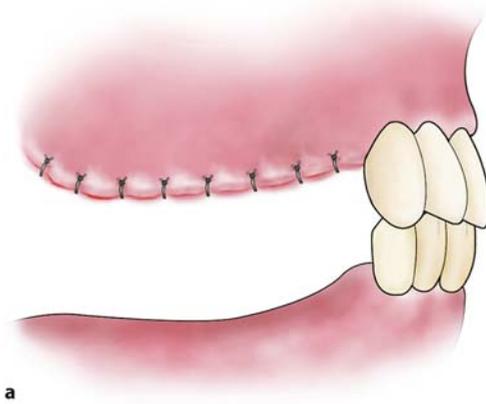
Fig. 10.6 a, b. Operation site after suturing. A satisfactory interarch space is created to allow the placement of prosthetic restoration. **a** Diagrammatic illustration. **b** Clinical photograph

Alveoloplasty After Extraction of Two or Three Teeth. When two or three teeth of the maxilla or mandible are to be extracted (Fig. 10.7), the procedure is almost the same as that mentioned above for extraction of a single tooth. More specifically, after extraction of the teeth, if there are grossly irregular alveolar margins or if the alveolar ridge is high, parts of the mucosa are first removed with wedge-shaped incisions, mesial and distal to the postextraction sockets (Fig. 10.8). Afterwards, the bone is recontoured using a rongeur and an acrylic-type bur, while the wound is then sutured (Figs. 10.9–10.11). When the presence of bone irregularity in postextraction sockets is ascertained by palpation, bone recontouring may be performed with a bone file, alone or in combination with a rongeur (Figs. 10.12–10.16).

Alveoloplasty Using Bone Rongeur and Bone Bur

Fig. 10.7 a, b. **a** Periapical radiograph of the region of the canine and first premolar of the mandible. **b** Clinical photograph. Supraeruption of teeth and a high alveolar ridge are noted
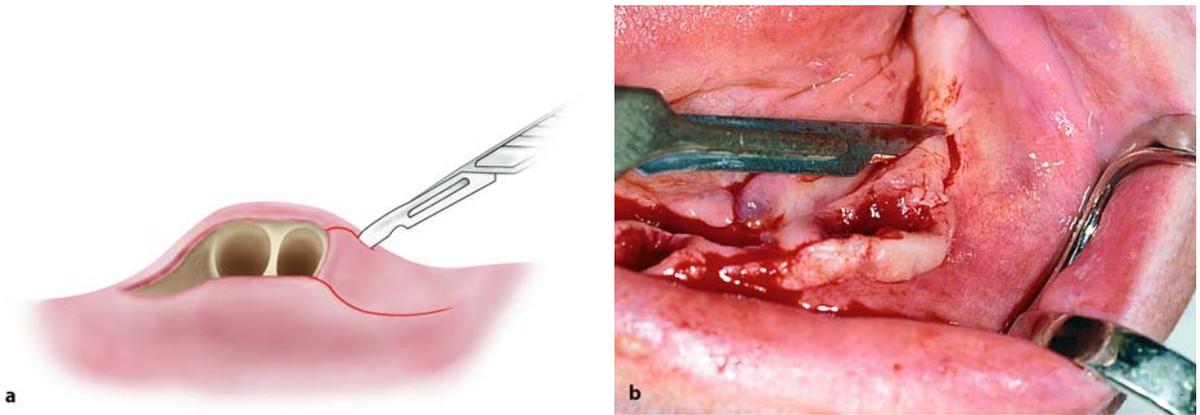
Fig. 10.8 a, b. Removal of wedge-shaped portions of mucosa from the alveolar ridge, from the area mesial and distal to the sockets

Fig. 10.9 a, b. Reflection of the mucoperiosteum and removal of bone margins of the wound with a rongeur
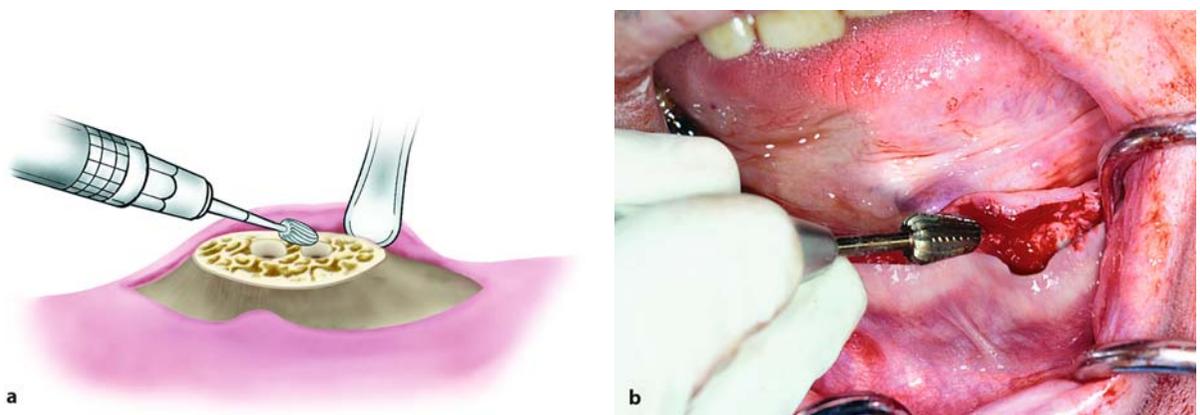
Fig. 10.10 a, b. Smoothing of the bone surface with a bone bur. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 10.11 a, b. a Operation site after placement of sutures. **b** Postoperative clinical photograph 1 month after the surgical procedure

Alveoloplasty Using Bone File and Rongeur
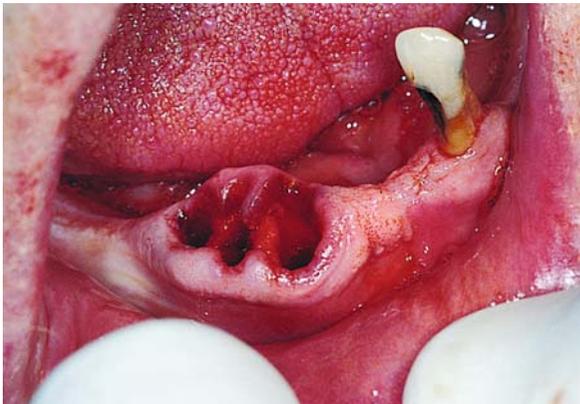
Fig. 10.12. Postextraction sockets of the canine and premolars of the mandible. Gross intraseptal bone irregularities noted

Fig. 10.13. Removal of intraseptal bone with rongeur

Fig. 10.14. Smoothing of the alveolar ridge with a bone file
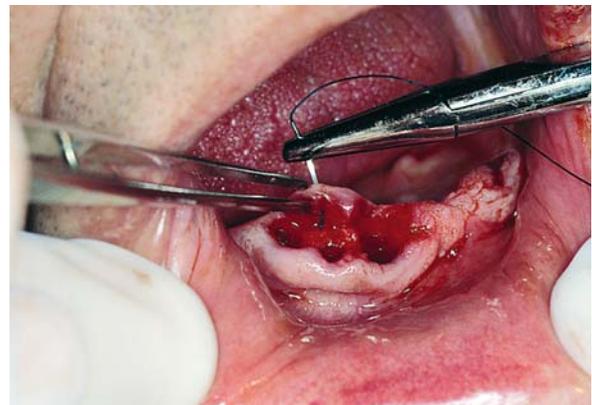
Fig. 10.15. Suturing of wound margins. Passing of the needle from the lingual towards the buccal side (correct procedure) is observed

Fig. 10.16. Operation site after suturing

Alveoloplasty After Multiple Extractions. This procedure includes:

a. Scheduled extractions.
b. Reflection of the gingivae.
c. Smoothing of alveolar bone.
d. Care of wound.
e. Suturing of the mucoperiosteum.

More specifically, the procedure is as follows. After clinical and radiographic examination of the teeth to be extracted (Fig. 10.17), a local anesthetic is administered and all the teeth are removed one at a time very carefully, so that the alveolar walls are left as intact as possible (Fig. 10.18). An incision is then made on the

Fig. 10.17 a, b. a Radiograph of maxillary teeth, after whose removal smoothing of alveolar bone is required. **b** Clinical photograph of teeth to be extracted
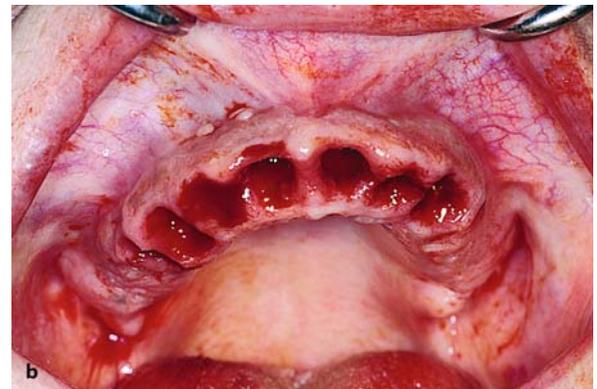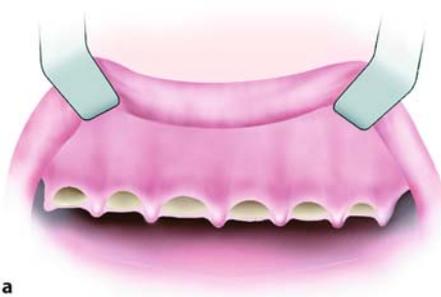
Fig. 10.18 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) of gross intraseptal irregularities after multiple tooth extractions
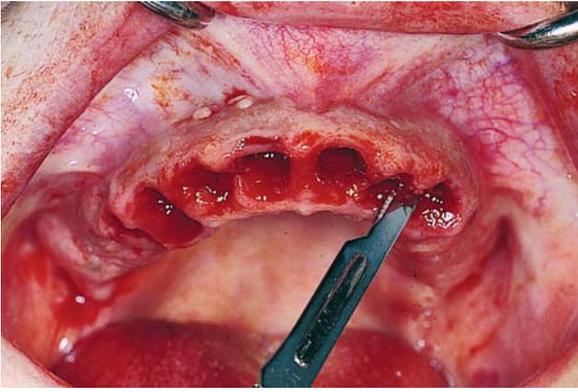
Fig. 10.19. Incision along the alveolar ridge to cut the interdental papillae of the gingivae
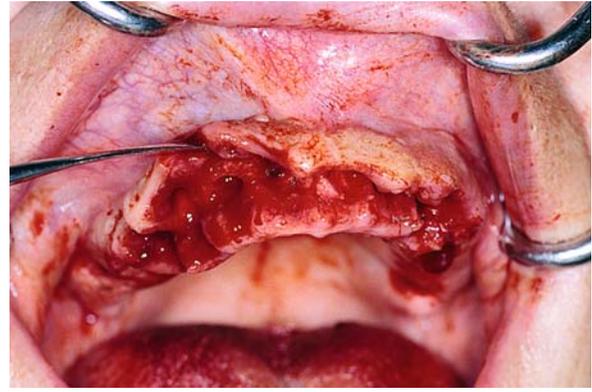
Fig. 10.20. Reflection and elevation of the mucoperiosteal flap to expose the bone area to be recontoured
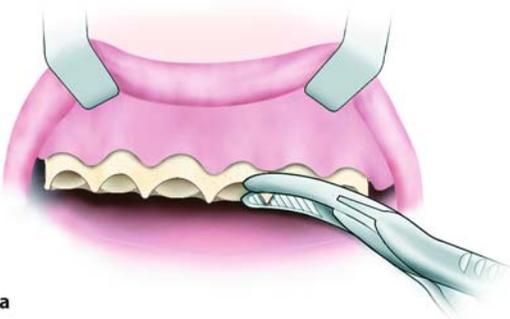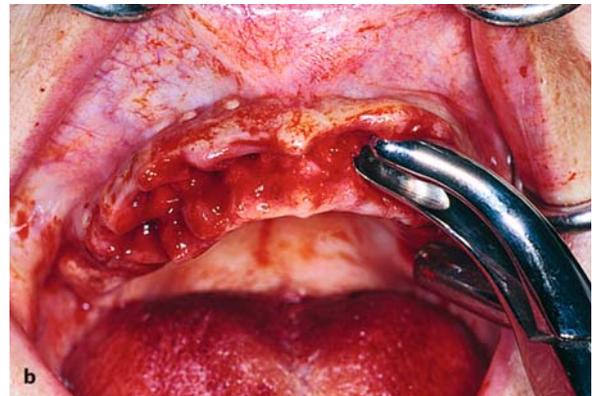
Fig. 10.21 a,b. Removal of sharp bone edges with a rongeur. **a** Diagrammatic illustration. **b** Clinical photograph
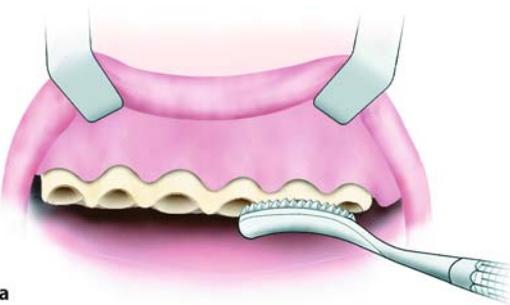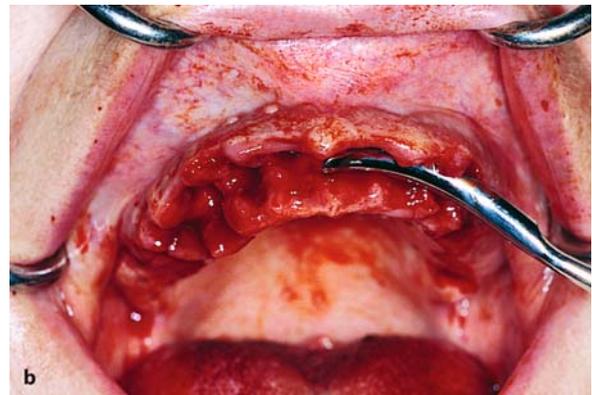
Fig. 10.22 a,b. Smoothing of bone with a bone file. **a** Diagrammatic illustration. **b** Clinical photograph

alveolar ridge to cut the interdental papillae and the gingivae are reflected from the alveolar process (Figs. 10.19, 10.20). Immediately afterwards, the sharp bony edges are removed (irregular intraseptal bone and bony projections) using a rongeur (Fig. 10.21) and after retracting the mucoperiosteum, the bone is smoothed with a bone file, until the bone surface feels smooth to the touch (Fig. 10.22). The flap margins are also trimmed with soft tissue scissors in such a way that there is perfect contact after bone removal
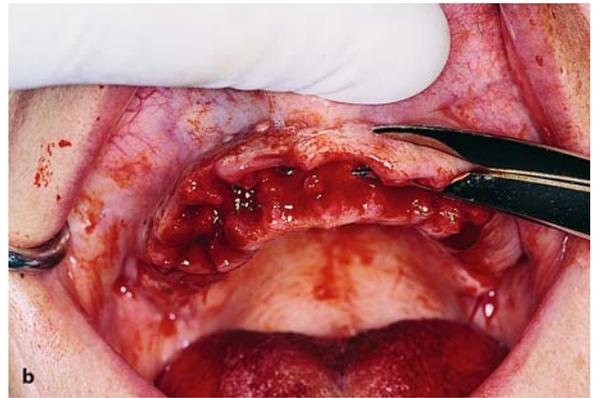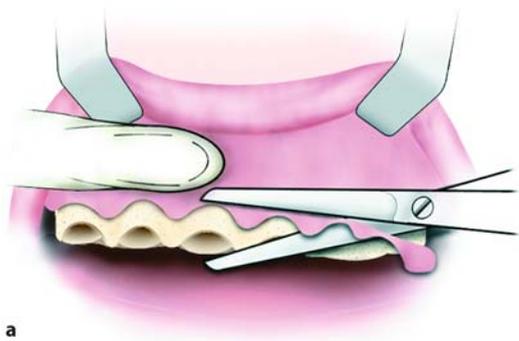
Fig. 10.23 a, b. Removal of excess soft tissues with soft tissue scissors. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 10.24. Operation site after suturing

Fig. 10.25. Postoperative clinical photograph 2 months after surgical procedure

(Fig. 10.23). Afterwards, copious amounts of saline solution are used to irrigate the wound and suturing with a continuous suture follows (Fig. 10.24, 10.25).

Alveoloplasty must be restricted to the recontouring of large irregularities and bone spicules. Otherwise, totally smoothing out the alveolar ridge will lead to negative results as far as stability and retention of the complete denture are concerned.

Recontouring of Edentulous Alveolar Ridge. Sometimes, after tooth extractions and the wound has been healed for a long time, the residual ridge may present irregularities at a certain point or even along the entire alveolar ridge. This is usually the result of not taking the necessary measures of bone recontouring after extracting teeth so as to ensure optimal and speedy healing. In such cases, the bone must be smoothed, to avoid injury and avoid obstructing the proper support of complete dentures. Therefore, if there is a large bony projection at some point along the alveolar ridge, first an incision is made along the length of the crest of the

alveolar ridge, where the projection has been localized, and reflection of the mucoperiosteum follows (Figs. 10.26–10.28). The area is then smoothed using a bone file, and the bone is palpated to ensure smoothness (Figs. 10.29, 10.30). Copious irrigation with saline solution follows, as well as suturing of the wound (Fig. 10.31). During reflection and use of the bone file, the index finger of the nondominant hand must be positioned on the lingual side of the flap, protecting it and ensuring its integrity in case of inadvertent sudden slippage of an instrument, which would otherwise result in tearing of the flap.

When bone irregularities are present along the entire alveolar ridge, the surgical technique includes an extensive incision along the alveolar ridge, reflection of the mucoperiosteum, smoothing of the bone, wound cleansing, and suturing (Figs. 10.32–10.40). This procedure, despite its extent, is not particularly difficult, because large or smaller vessels and nerve branches of the area have a known course and emergence, so that it is easy to avoid injury or trauma.

Recontouring of Edentulous Area of Alveolar Ridge
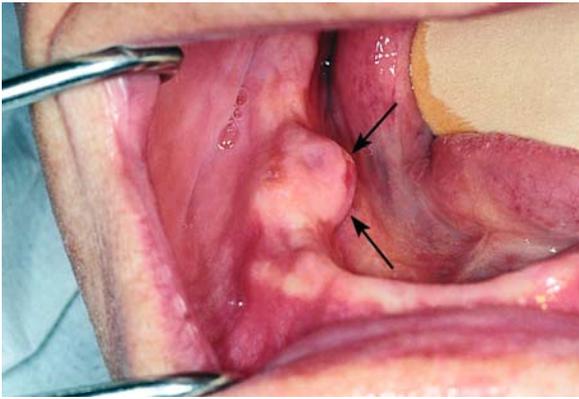
Fig. 10.26. Gross lingual bone irregularity after the extraction of mandibular posterior teeth

Fig. 10.27. Incision along the alveolar ridge where the bone abnormality is located
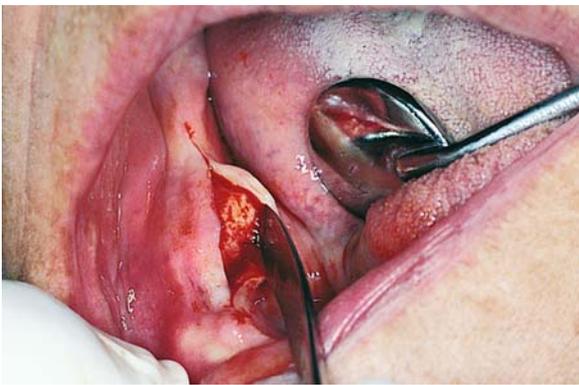
Fig. 10.28. Exposure of exostosis after reflection of the mucoperiosteal flap

Fig. 10.29. Smoothing of bone surface with bone file

Fig. 10.30. Surgical field after the recontouring of bone
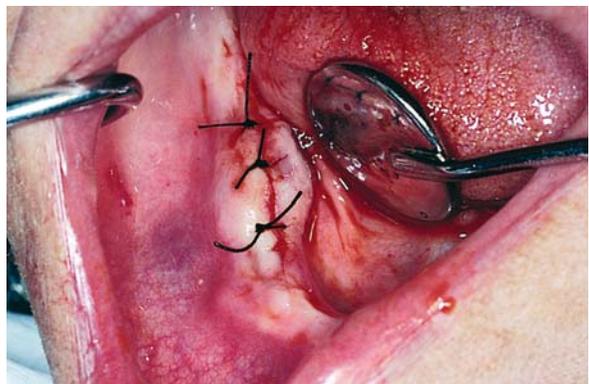
Fig. 10.31. Operation site after placement of sutures

Recontouring of Entire Alveolar Ridge

Fig. 10.32. Bone irregularities of an edentulous alveolar ridge of the mandible after multiple tooth extractions
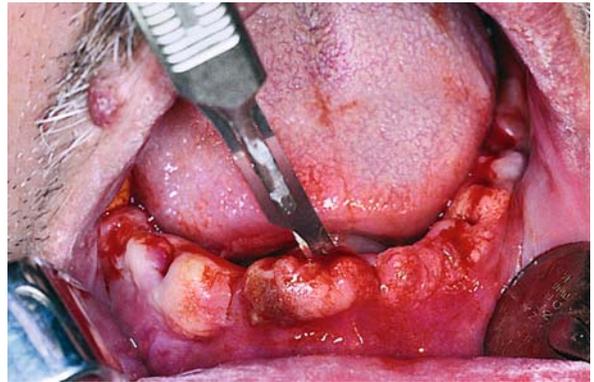
Fig. 10.33. Incision along the alveolar ridge where the bone irregularity is located
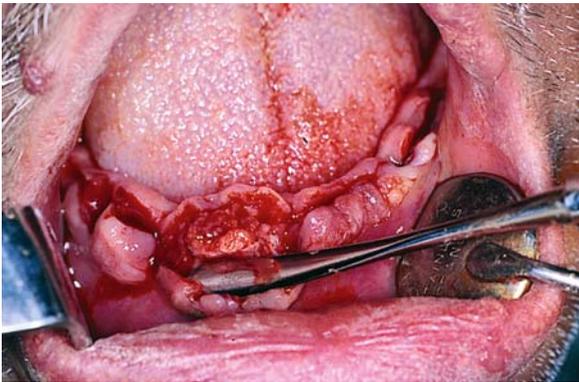
Fig. 10.34. Reflection of the mucoperiosteum to expose the bone irregularity
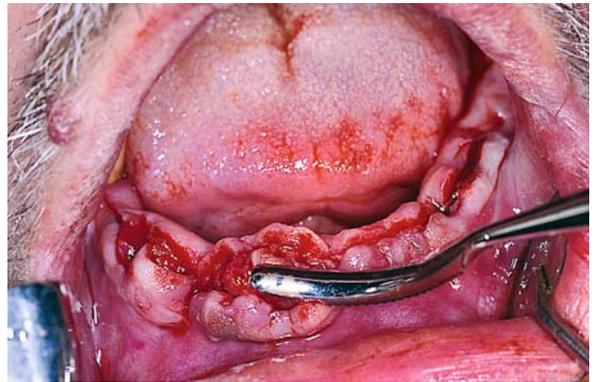
Fig. 10.35. Smoothing of the alveolar ridge with a bone file

Fig. 10.36. Removal of excess soft tissues with soft tissue scissors
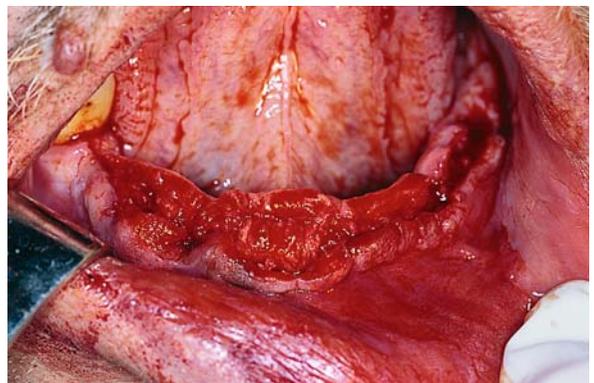
Fig. 10.37. Surgical field after the smoothing of bone and removal of excess soft tissue
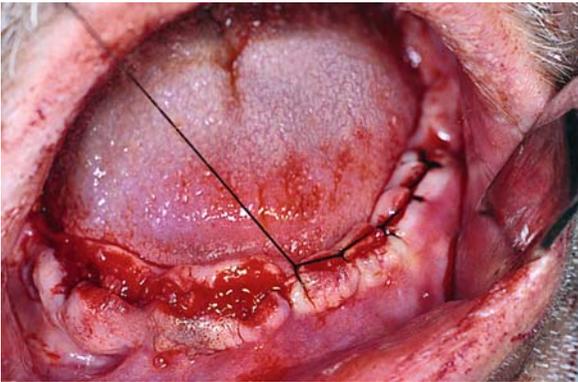
Fig. 10.38. Continuous suture along the alveolar ridge

Fig. 10.39. Operation site after placement of sutures

Fig. 10.40. Clinical photograph of the area 20 days after the surgical procedure. Satisfactory smoothing of the area where prosthetic restoration is to be placed

10.1.2
Exostoses

Exostoses are generally bony protuberances, which develop in various areas of the jaw. They are not considered real neoplasms, but dysplastic exophytic lesions. The etiology of these lesions remains unknown, even though evidence suggests that genetic and environmental factors determine their development. Exostoses are classified into three types: (1) torus palatinus, (2) torus mandibularis, and (3) multiple exostoses.

10.1.2.1
Torus Palatinus

This exostosis is localized at the center of the hard palate and the exact causes remain unknown. Clinically,

they are common asymptomatic bone protuberances, covered by normal mucosa (Fig. 10.41). They vary in size, and the shape ranges from a single discrete exostosis, to multiloculated, to bosselated, to irregular in shape. They usually do not require any special therapy, except for edentulous patients in need of prosthetic rehabilitation, and in cases where the patient is greatly bothered by the exostoses.

Surgical Technique. In order to remove the lesion surgically, an incision is made along the midline of the palate, which is composed of two anterior and posterior oblique incisions (Fig. 10.42). The incision is designed so as to avoid injuring branches of the palatine artery, but also so that there is adequate visualization of, and access to, the surgical field without tension and injurious manipulations during the procedure. After reflection, the flaps are retracted with the aid of sutures or broad periosteal elevators. After complete exposure of the lesion, it is sectioned with a fissure bur and the segments are individually removed using a monobevel chisel (Figs. 10.43, 10.44). More specifically, the chisel is positioned at the base of the exostosis with the bevel in contact with the palatal bone and, thereafter, each segment of the lesion is removed after a slight blow with the mallet (Fig. 10.45). After smoothing the bone surface, excess soft tissue is trimmed and, after copious irrigation with saline solution, the flaps are repositioned and sutured with interrupted sutures (Figs. 10.46–10.48).

If the torus palatinus is small in size, the incision for creation of the flap is again made along the midline, but only with anterior oblique releasing incisions. The procedure is then performed in exactly the same way as that already mentioned.
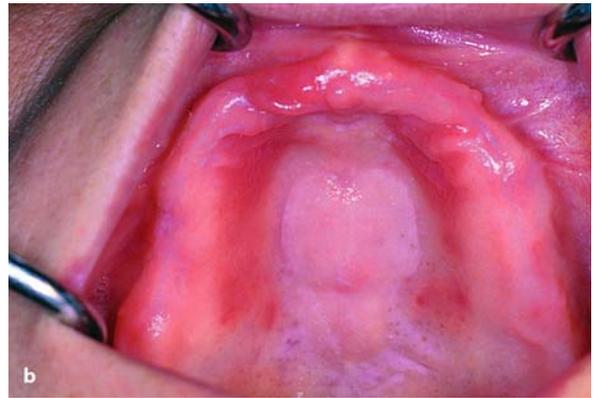
Fig. 10.41 a, b. Torus palatinus. **a** Diagrammatic illustration. **b** Clinical photograph
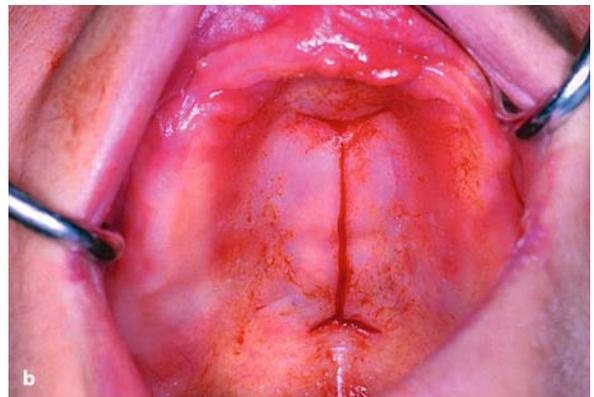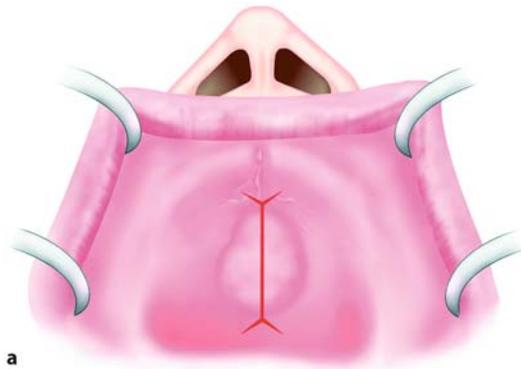
Fig. 10.42 a, b. Surgical procedure for removal of torus palatinus. Incision along the midline of the palate with anterolateral and posterolateral incisions. **a** Diagrammatic illustration. **b** Clinical photograph
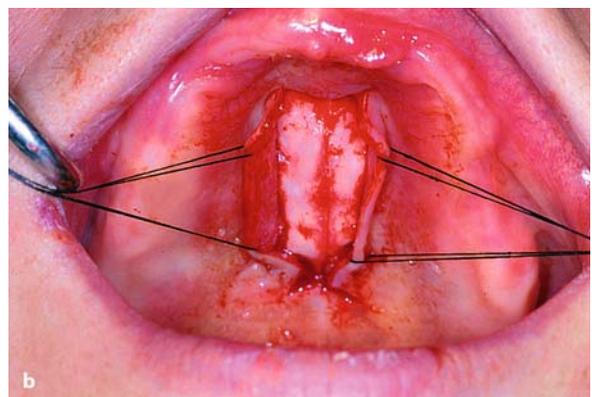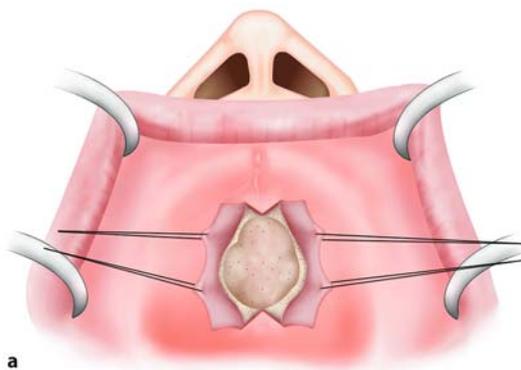
Fig. 10.43 a, b. Mucoperiosteal flaps on either side of the exostosis. Retraction of flaps during the surgical procedure is achieved with the help of traction sutures. **a** Diagrammatic illustration. **b** Clinical photograph
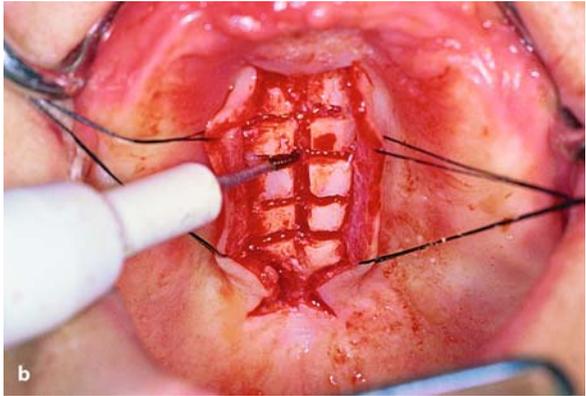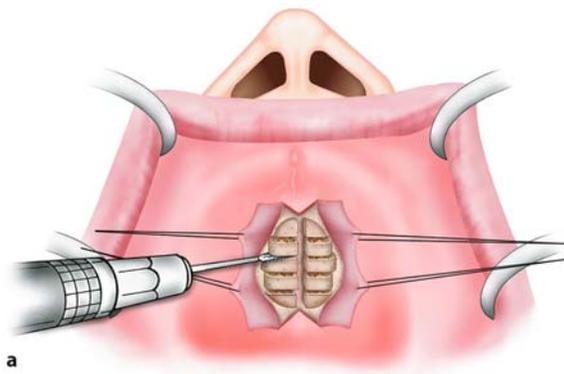
Fig. 10.44 a, b. Sectioning of the lesion into smaller parts using a fissure bur. **a** Diagrammatic illustration. **b** Clinical photograph
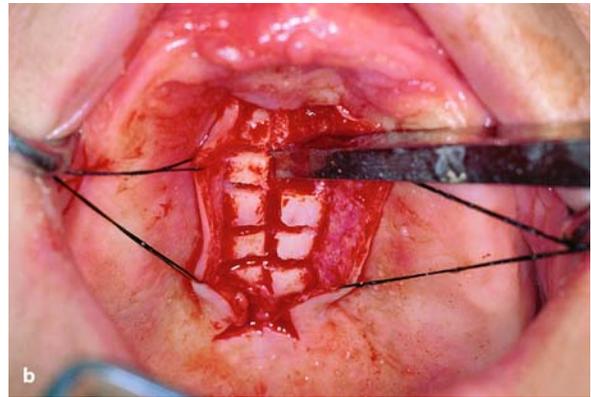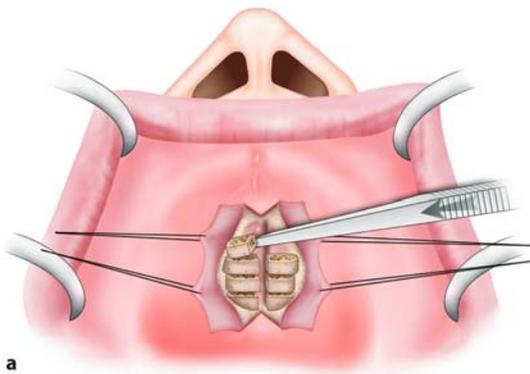
Fig. 10.45 a, b. Removal of the exostosis in fragments with a monobevel chisel. **a** Diagrammatic illustration. **b** Clinical photograph
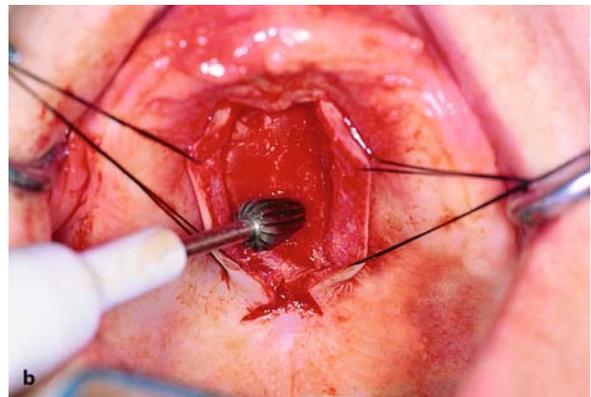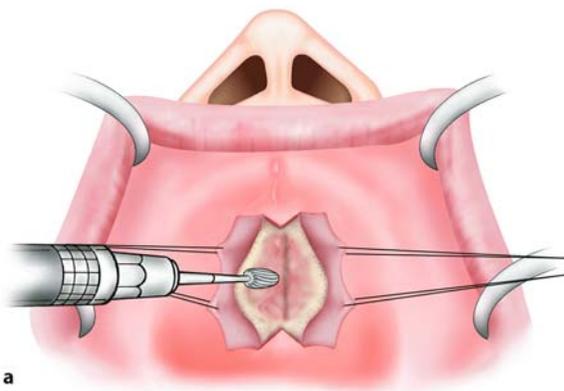
Fig. 10.46 a, b. Smoothing of the bone surface with a bone bur. **a** Diagrammatic illustration. **b** Clinical photograph
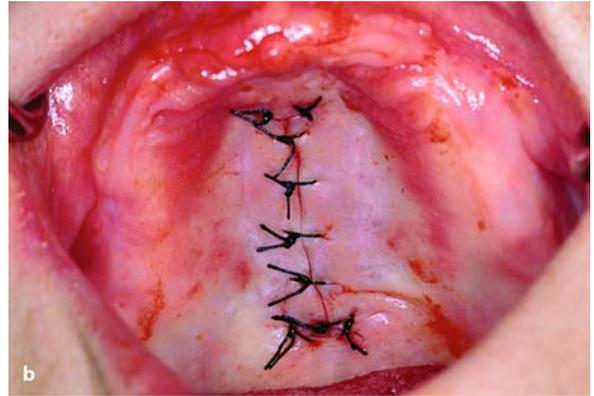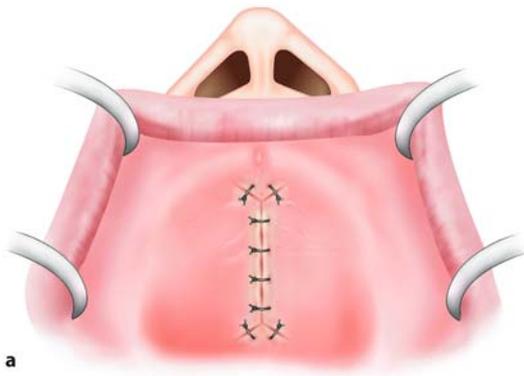
Fig. 10.47 a, b. Operation site after the placement of sutures. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 10.48. Postoperative clinical photograph immediately after removal of sutures

10.1.2.2
Torus Mandibularis

Torus mandibularis is an exostosis of unknown etiology. It is localized in the lingual aspect of the body of the mandible, either on one side or more commonly on both sides, and as a rule in the canine and premolar region (Fig. 10.49). Clinically, it is an asymptomatic bony protuberance covered by normal mucosa. Radiographically, it presents as a circumscribed radiopacity in the area of localization. Torus mandibularis is completely innocent in nature and does not require any therapy whatsoever, except in cases where complete dentures are to be constructed.

Surgical Technique. An incision is made at the crest of the alveolar ridge for the surgical removal of exostoses, and, after extensive reflection of the flap lingually, the lesion is removed using a chisel, bone file, or bur (Figs. 10.50–10.54). The wound is then irrigated with plenty of saline solution and is sutured with interrupted sutures (Fig. 10.55).
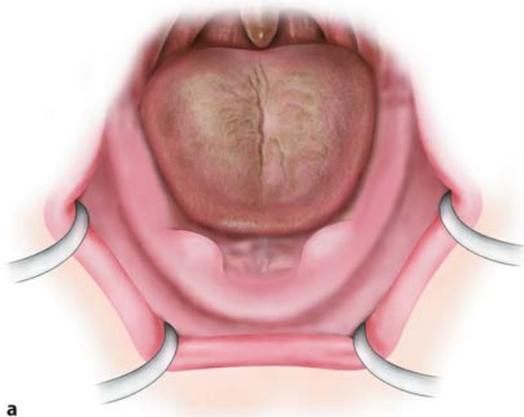
Fig. 10.49 a, b. Tori mandibularis in edentulous (**a**) and dentulous (**b**) patients
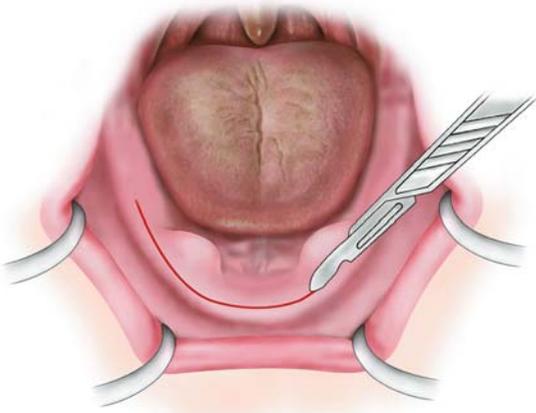
Fig. 10.50. Incision along the alveolar ridge (without vertical releasing incisions)
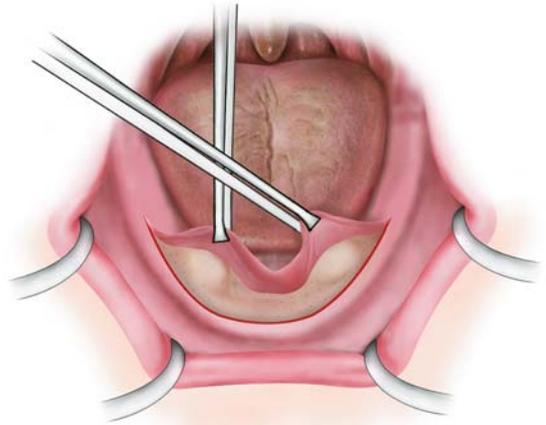
Fig. 10.51. Mucoperiosteal flap reflected to expose the exostoses
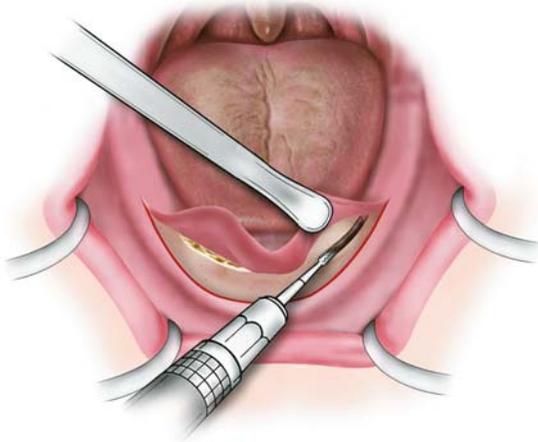
Fig. 10.52. Removal of exostoses with a bone bur
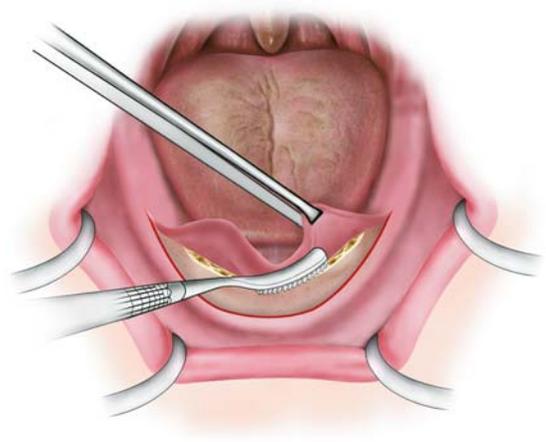
Fig. 10.53. Smoothing of the bone surface with a bone file
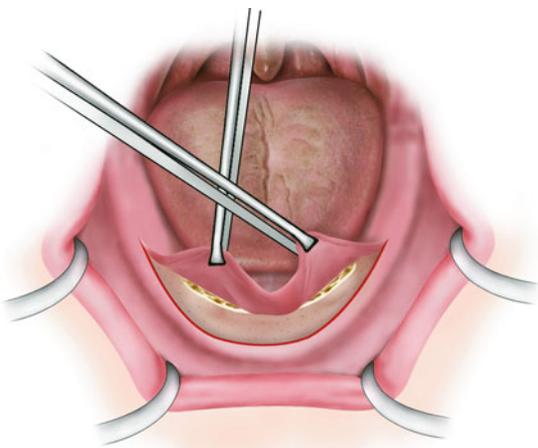
Fig. 10.54. Surgical field after the recontouring of bone
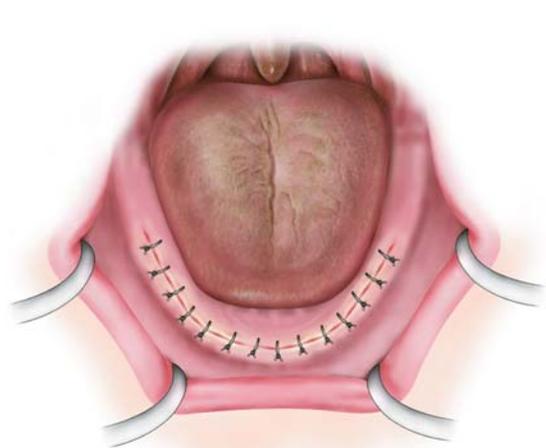
Fig. 10.55. Operation site after suturing

Fig. 10.56. Multiple exostoses at the anterior region of the maxilla

Fig. 10.57. Extremely large multiple exostoses in the maxilla with a multilobular and irregular shape
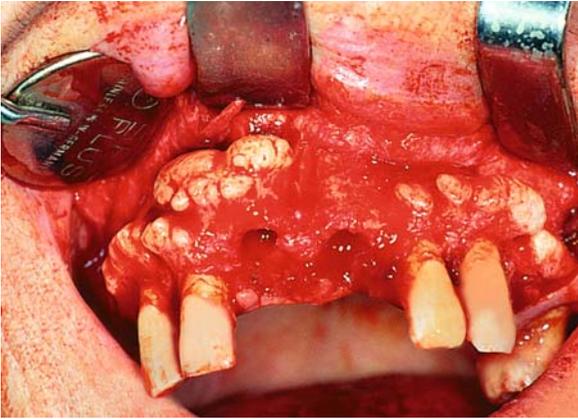
Fig. 10.58. Case of Fig. 10.57 after exposure of exostoses
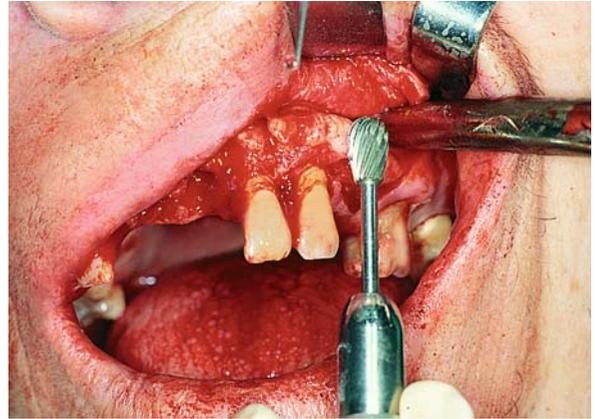
Fig. 10.59. Removal of lesions with a bone bur

Fig. 10.60. Smoothing of the bone surface with a bone file

Fig. 10.61. Operation site after placement of sutures

10.1.2.3
Multiple Exostoses

These are rare asymptomatic bony excrescences, usually localized at the buccal surface of the maxilla and mandible (Figs. 10.56, 10.57). The causes are unknown, although some people suggest that they may be due to bruxism as well as chronic irritation of the periodontal tissues. No therapy is usually required, except for those cases where, due to the large size of the exostoses, severe esthetic and functional problems are created.

Surgical Technique. After administration of a local anesthetic, an incision for the creation of a trapezoidal flap is made. The mucoperiosteum is then reflected carefully, which is quite difficult due to the large size and nodular presentation of the exostoses (Fig. 10.58). During reflection, the index finger of the nondominant hand is positioned above the created flap, in order to facilitate its reflection while protecting its integrity in case of accidental slippage of the periosteal elevator, which would otherwise result in perforation. The exostoses are removed with a rongeur or special bur, under a steady stream of saline solution, in order to avoid overheating of the bone (Fig. 10.59). The bony wound is then smoothed with a bone file and is inspected to ensure the smoothness of the alveolar ridge (Fig. 10.60). After this procedure, the surgical field is

irrigated with saline solution and the excess soft tissues are trimmed, especially the interdental papillae of the gingivae. This aims at more precise reapproximation and immobilization of the flap during suturing with interrupted sutures (Fig. 10.61).

10.1.2.4
Localized Mandibular Buccal Exostosis

This case presents rarely, and, depending on its size, creates esthetic and functional problems in edentulous as well as dentulous patients. Its presence especially in edentulous patients obstructs the placement of complete dentures, in which case its removal is deemed necessary.

Surgical Technique. The surgical technique applied depends on its size and the area of lesion localization. If the premolar area is involved in the exostosis (Figs. 10.62, 10.63), the procedure used is as follows. After local anesthesia, a trapezoidal flap is created, with particular care taken to avoid injuring the mental neurovascular bundle. Therefore, the vertical incisions must be made at a distance from the mental foramen (Fig. 10.64). After being exposed, the lesion is cleaved at its base, in a direction parallel to that of the alveolar ridge (Figs. 10.65–10.67). The bone is then smoothed with a bone bur and the wound is cared for and sutured (Figs. 10.68–10.71).

Fig. 10.62. Radiograph showing exostosis of the mandible, with a buccal localization
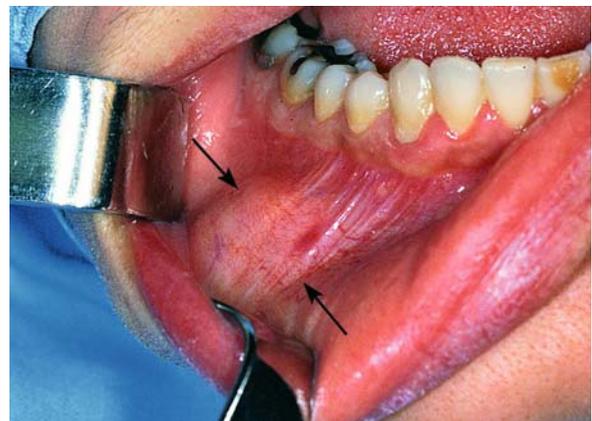
Fig. 10.63. Clinical photograph of the case of Fig. 10.62. Swelling of the mandible is noted buccally at the area beneath the premolars
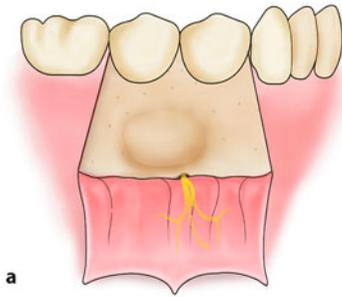
Fig. 10.64 a, b. Exposure of exostosis after reflection of the flap. *Arrow* points to the mental nerve. **a** Diagrammatic illustration. **b** Clinical photograph
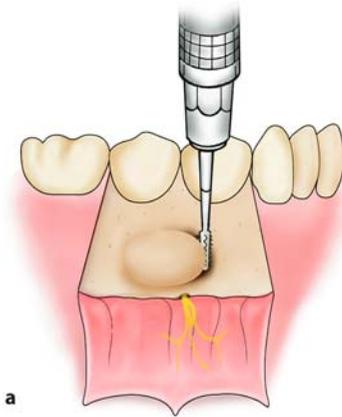
Fig. 10.65 a, b. Small trough created at the base of the exostosis with a fissure bur. **a** Diagrammatic illustration. **b** Clinical photograph


Fig. 10.66. Removal of bone along the line of cleavage completed. Removal is performed using a chisel
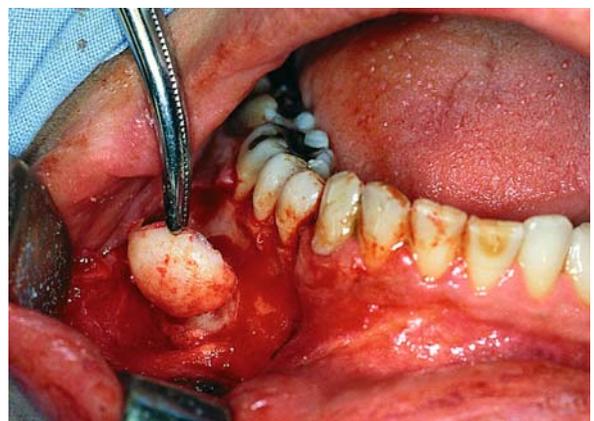
Fig. 10.67. Removal of the excised portion of the exostosis with a hemostat

Fig. 10.68. Smoothing of the bone surface with a bone bur
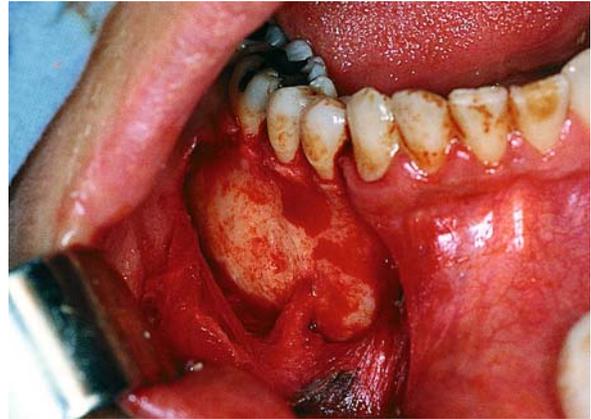
Fig. 10.69. Surgical field after removal of the exostosis and smoothing of the area
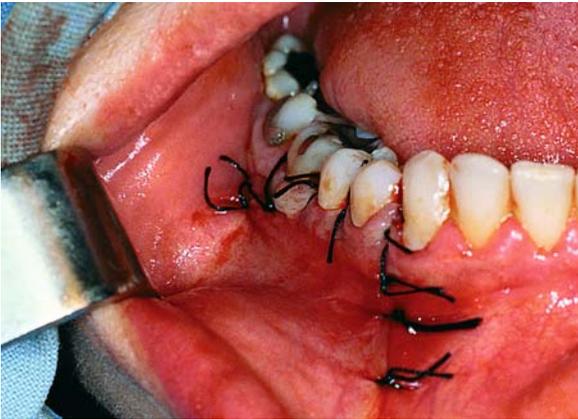
Fig. 10.70. Operation site after suturing

Fig. 10.71. Exostosis after removal

10.2
Soft Tissue Lesions or Abnormalities

Lesions or abnormalities associated with soft tissues and which require alteration are also classified into two categories:
a. Congenital abnormalities, such as a hypertrophic frenum, etc.
b. Abnormalities created after the use of dentures (e.g., fibrous hyperplasia of the mucosa), and other causes.

10.2.1
Frenectomy

In many cases, the placement of a complete denture of the maxilla, or orthodontic procedures in younger persons requires the removal of the labial frenum, especially if it is hypertrophic (Fig. 10.72). Also, in the mandible, the lingual frenum may create problems, causing partial or complete ankyloglossia (Fig. 10.73). This case is due to attachment of the frenum to the floor of the mouth or to the alveolar mucosa. It may even be the result of an extremely short frenum that is connected to the tip of the tongue. Ankyloglossia greatly limits movements of the tongue, resulting in speech difficulties.

Fig. 10.72. Hypertrophic maxillary labial frenum

Fig. 10.73. Ankyloglossia as a result of a short frenum

10.2.1.1
Maxillary Labial Frenectomy

Excision of the labial frenum is easy, within the reach of the general practitioner, and may be performed with various techniques. The method usually employed is that of excision using two hemostats. In this case, the procedure used is as follows. After local anesthesia, the lip is pulled upwards, and the frenum is grasped using two curved hemostats, which are positioned at the superior and inferior margins (Figs. 10.74, 10.75).

The lip is then further retracted and a thin scalpel blade incises the tissue found behind the hemostat, first behind the lower hemostat and then behind the upper hemostat (Figs. 10.76–10.78).

If the frenum is hypertrophic and there is a large space between the central incisors, the tissues found between and behind the central incisors are also removed (Fig. 10.79). Interrupted sutures are placed along the lateral margins of the wound in a linear direction, after the mucosa of the wound margins is undermined using scissors (Figs. 10.80–10.82).

Fig. 10.74 a, b. Characteristic case of a maxillary labial frenum with a low gingival attachment. The orthodontist recommended its removal

Fig. 10.75 a, b. The superior and inferior margins of the frenum are grasped using curved mosquito hemostats. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 10.76 a, b. Initial step in excision of the frenum with a scalpel in contact with the posterior surface of the lower hemostat. **a** Diagrammatic illustration. **b** Clinical photograph
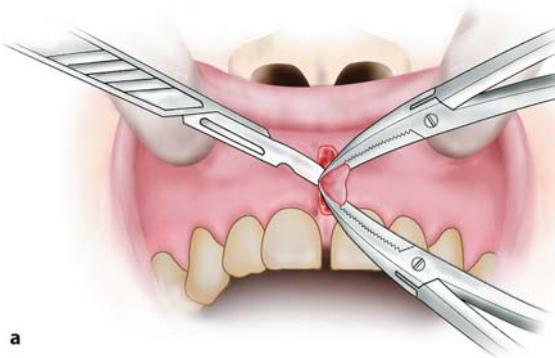
Fig. 10.77 a, b. Final step in excision of the frenum. Incision behind the upper hemostat is performed in a way similar to that shown in Fig. 10.76. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 10.78 a, b. Surgical field after frenectomy. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 10.79 a, b. Removal of hypertrophic tissue found between and behind the central incisors. **a** Diagrammatic illustration. **b** Clinical photograph


Fig. 10.80 a, b. Undermining of mucosa of wound margins from underlying tissues. **a** Diagrammatic illustration. **b** Clinical photograph
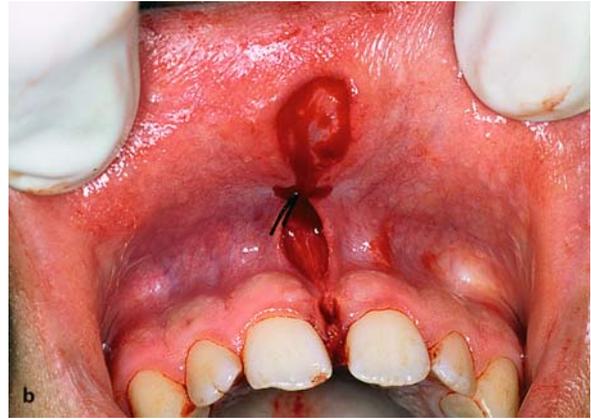
Fig. 10.81 a, b. The first suture is placed at the middle of the wound to facilitate subsequent suturing. **a** Diagrammatic illustration. **b** Clinical photograph
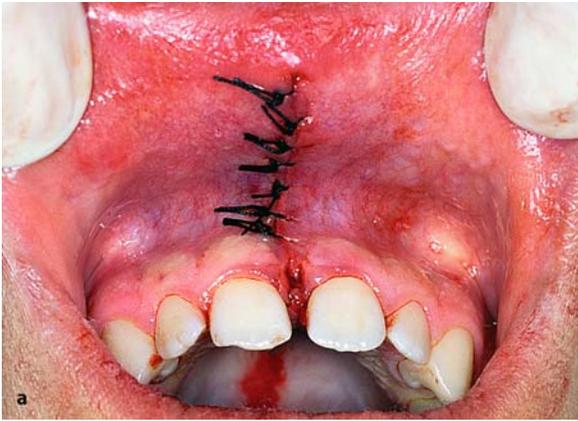
Fig. 10.82 a, b. **a** Operation site after placement of sutures. **b** Postoperative clinical photograph 3 months later

10.2.1.2
Lingual Frenectomy

Removal of the lingual frenum is also a simple procedure, which may be performed with or without the help of a hemostat.

Technique Using Hemostat. After local anesthesia, the tongue is retracted upwards and posteriorly with a traction suture that is passed through the tip of the tongue. The frenum is then grasped approximately at the middle of the vertical length with a straight hemostat, which is parallel to the floor of the mouth (Fig. 10.83). Using a scalpel the clasped portion of tissue is excised, first above the hemostat and then below (Figs. 10.84, 10.85). The wound margins are then undermined with scissors and interrupted sutures are placed (Figs. 10.86–10.88).

Technique Without the Aid of Hemostat. The lingual frenum may be removed with a scalpel without the aid of a hemostat. More specifically, after upward retraction of the tongue, the frenum is incised with converging incisions, first on the area of lingual attachment and then on the other side. After the frenum is loosened and the tongue is released, the tongue is retracted even further superiorly and posteriorly, to facilitate the removal of the rest of the frenum, which is still in place. After removal of the frenum, the wound margins are undermined and suturing follows, as outlined in the previous case (Figs. 10.89–10.93). Because the frenum is attached close to the deep lingual vein and the submandibular duct, careful attention must be given so that injury is avoided during the surgical procedure.

Steps in Frenectomy with Hemostat
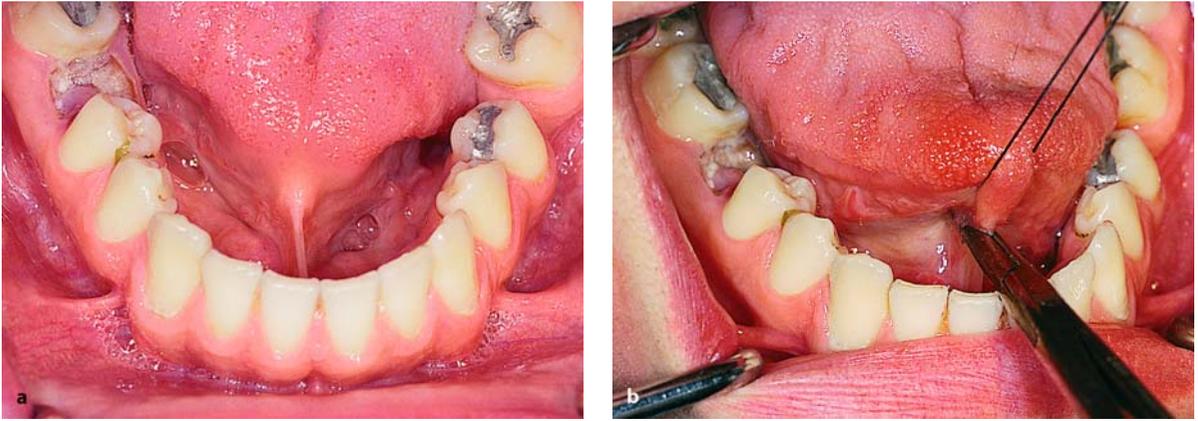
Fig. 10.83 a, b. a Lingual frenum (ankyloglossia) requiring surgical intervention. **b** Elevation of the tongue with the aid of a suture and retraction of the frenum with a straight hemostat, to facilitate removal
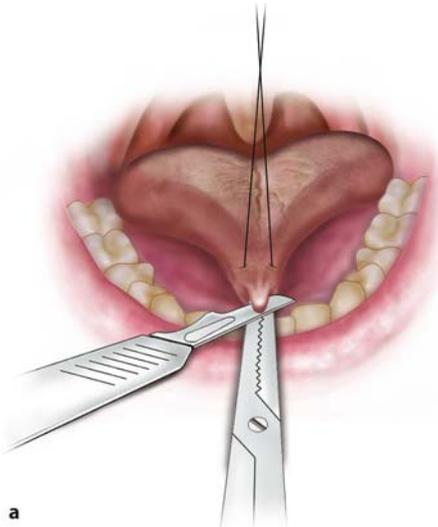
Fig. 10.84 a, b. First step in frenectomy. The scalpel is always in close contact with the upper surface of the hemostat. **a** Diagrammatic illustration. **b** Clinical photograph
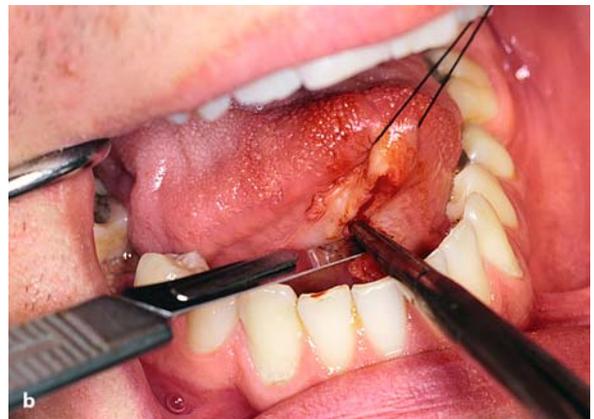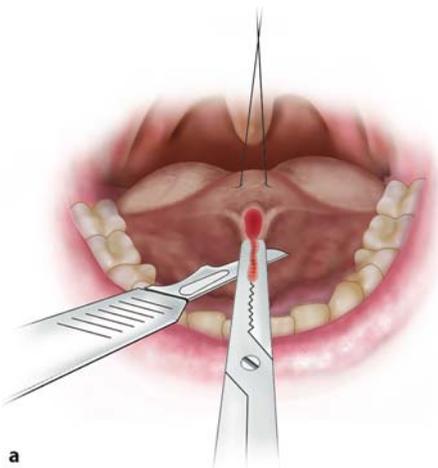
Fig. 10.85 a, b. Second step in frenectomy, involving the portion beneath the hemostat. The procedure is similar to that shown in Fig. 10.84. **a** Diagrammatic illustration. **b** Clinical photograph
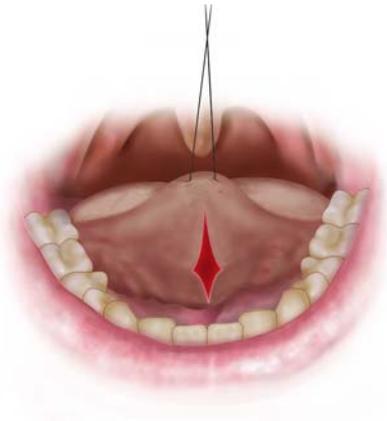
Fig. 10.86 a, b. Surgical field after removal of the frenum. **a** Diagrammatic illustration. **b** Clinical photograph
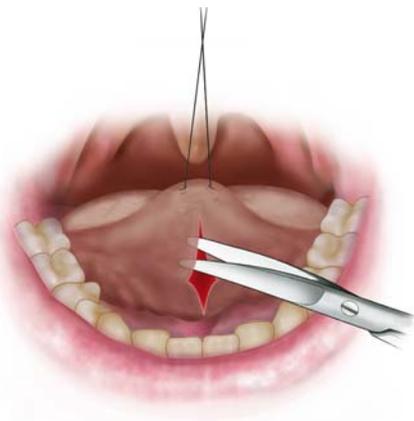
Fig. 10.87 a, b. Undermining the mucosa at wound margins from underlying tissues. **a** Diagrammatic illustration. **b** Clinical photograph
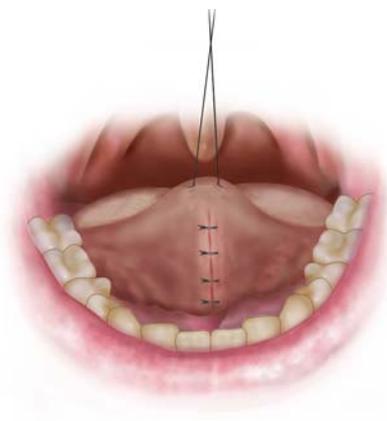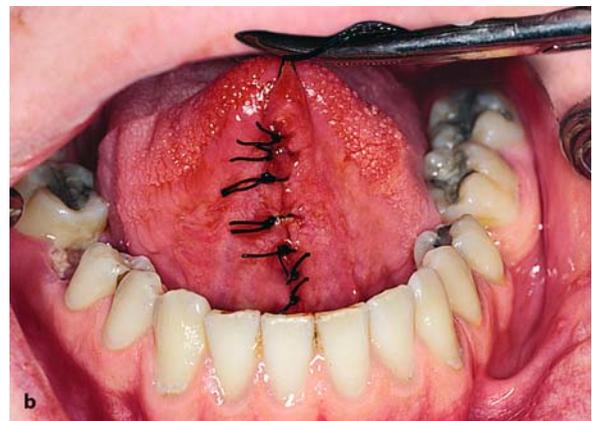
Fig. 10.88 a, b. Operation site after suturing. **a** Diagrammatic illustration. **b** Clinical photograph

Steps in Frenectomy without Hemostat

Fig. 10.89. Excision of the lingual frenum (case of ankyloglossia) using the technique without a hemostat

Fig. 10.90. Elevation of the tongue with a suture placed at the tip of the tongue

Fig. 10.91. Excision of the frenum with converging incisions towards the base of the tongue
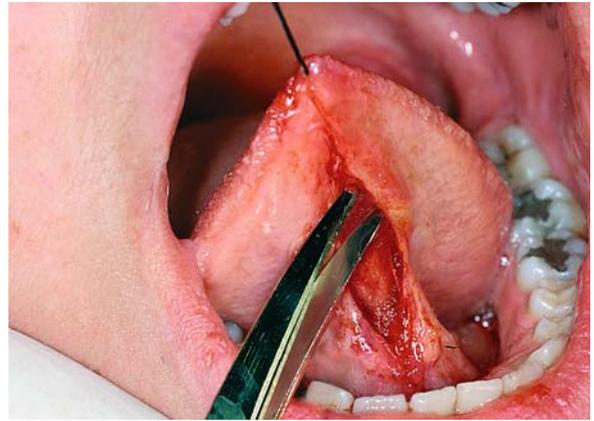
Fig. 10.92. Undermining the wound margins with scissors
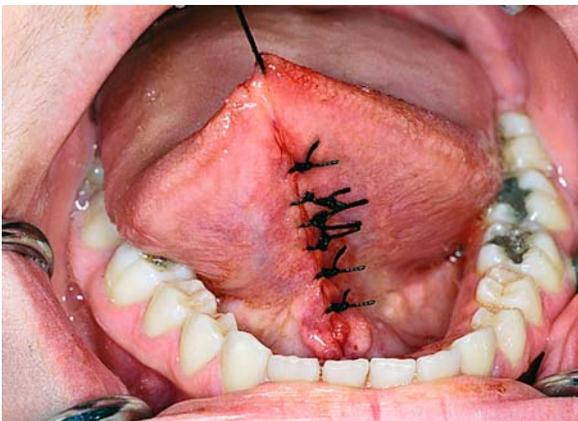
Fig. 10.93. Operation site after the placement of sutures

10.2.2
Denture-Induced Fibrous Hyperplasia

Fibrous hyperplasia of the mucosa (formerly known as epulis fissuratum or inflammatory hyperplasia) is usually due to chronic trauma of the mucosa of the mucolabial or mucobuccal fold, due to ill-fitting complete or partial dentures (Fig. 10.94). More specifically, the denture flanges injure this area, because they are very thin and longer than normal. The lesion may present during initial placement of the dentures, or after a period of time, when, due to resorption of the alveolar process, the anatomy of the region changes and the necessary adjustment of the prosthetic appliance is neglected. Treatment is surgical and consists of excision of the hyperplasia.

Surgical Technique. After local anesthesia, the lesion is grasped with surgical forceps and is gradually excised along the length of the lesion superficial to the underlying periosteum (Figs. 10.95, 10.96). After this procedure is complete, the portion of mucosa that has not been reflected, found at the margin of the lesion and which corresponds to the superior horizontal aspect of the incision, is sutured with the intact periosteum along its entire length, thus creating a void (Fig. 10.97). Reattachment of the wound margins is therefore avoided, which would otherwise result in elimination of the depth of the mucolabial vestibule. After the surgical procedure, and after being lined with a tissue conditioner, the denture is inserted into the mouth and is continuously worn until the day the sutures are removed (Fig. 10.98). Almost the same procedure is performed for smaller lesions that are the result of ill-fitting dentures (Figs. 10.99–10.106).

Steps of Removal of Extensive Denture-Induced Fibrous Hyperplasia

Fig. 10.94 a, b. Extensive fibrous hyperplasia of the mucosa as a result of ill-fitting dentures. **a** Diagrammatic illustration. **b** Clinical photograph
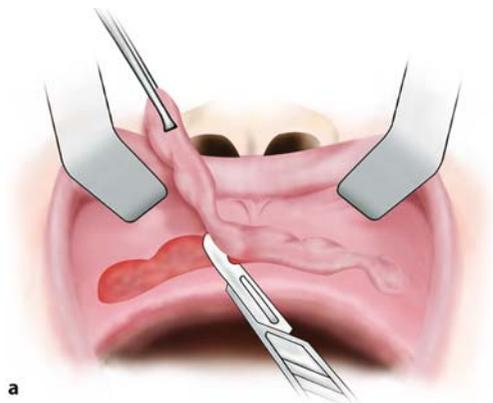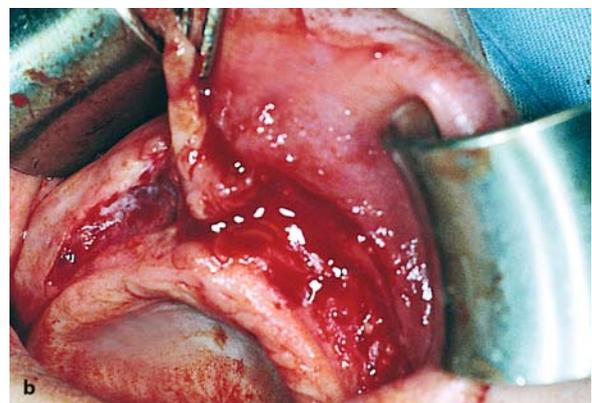
Fig. 10.95 a, b. Removal of the lesion in segments with a scalpel. **a** Diagrammatic illustration. **b** Clinical photograph
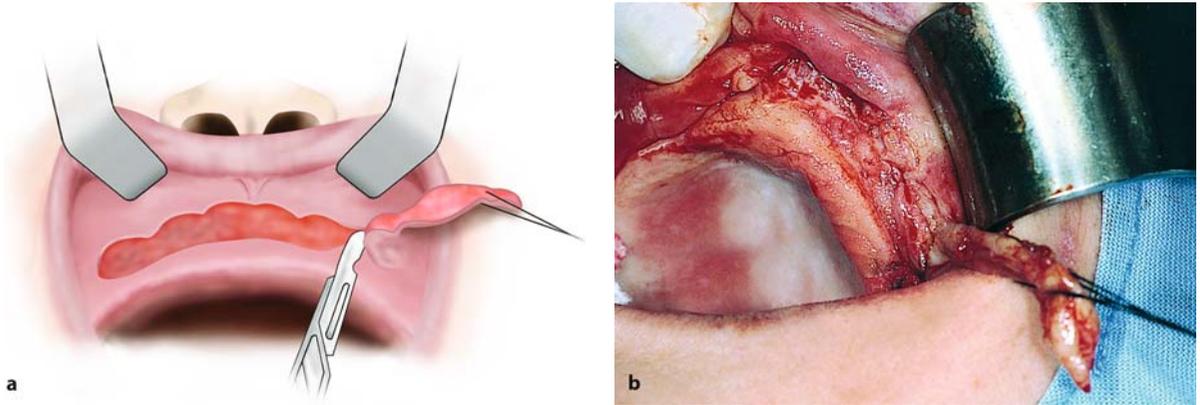
Fig. 10.96 a, b. Final step in the removal of hyperplasia. **a** Diagrammatic illustration. **b** Clinical photograph
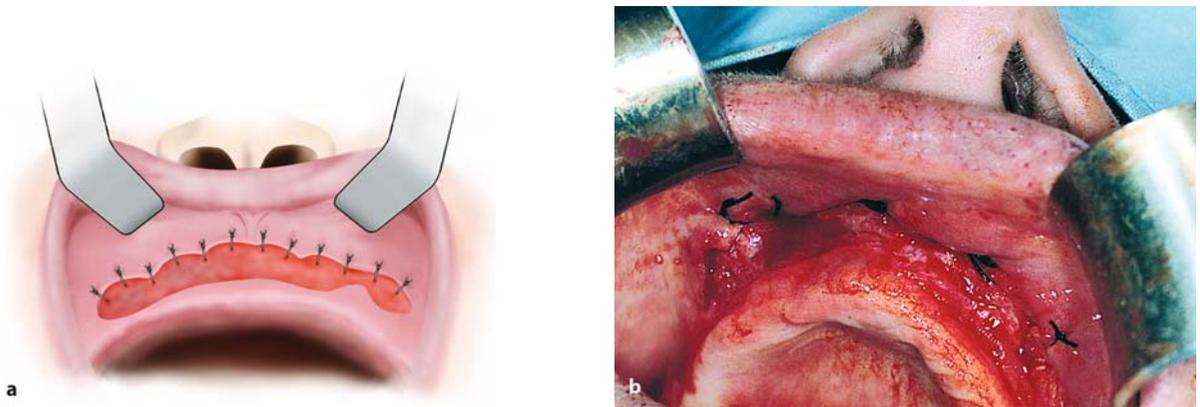
Fig. 10.97 a, b. Suturing of the wound margins with periosteum that has not been reflected, which remains exposed, avoiding a decrease in the depth of the mucobuccal fold. **a** Diagrammatic illustration. **b** Clinical photograph
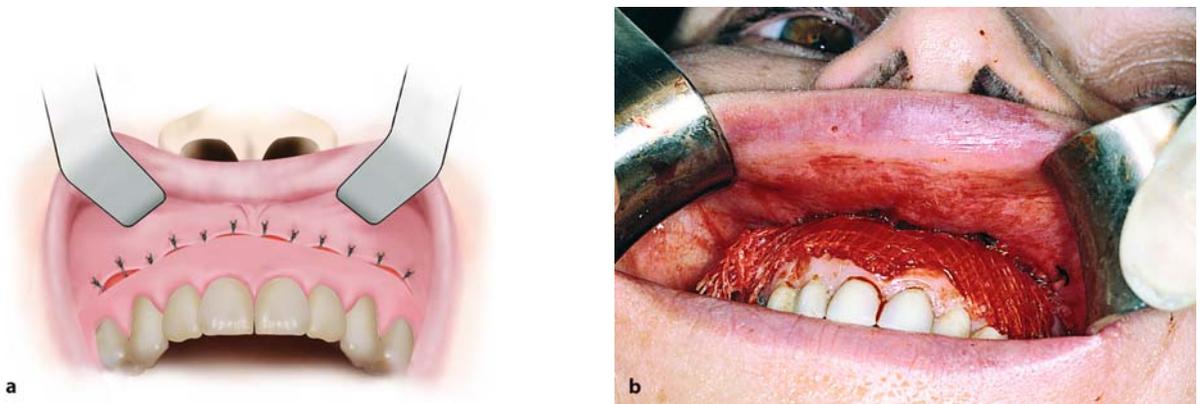
Fig. 10.98 a, b. Replacement of old denture, immediately after the end of the operation, retaining the depth of mucosa of the newly created sulcus. The internal surface of the denture is lined with tissue conditioner. **a** Diagrammatic illustration. **b** Clinical photograph

Removal of Localized Denture-Induced Hyperplasia

Fig. 10.99. Localized fibrous hyperplasia of mucosa as a result of ill-fitting denture
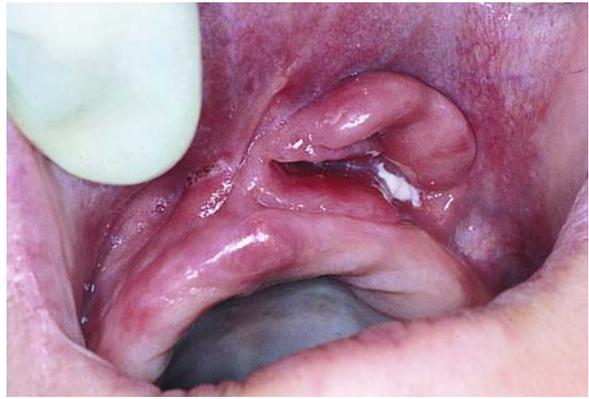
Fig. 10.100. Lesion of Fig. 10.99, after removal of denture

Fig. 10.101. Injection of local anesthetic peripherally around the lesion
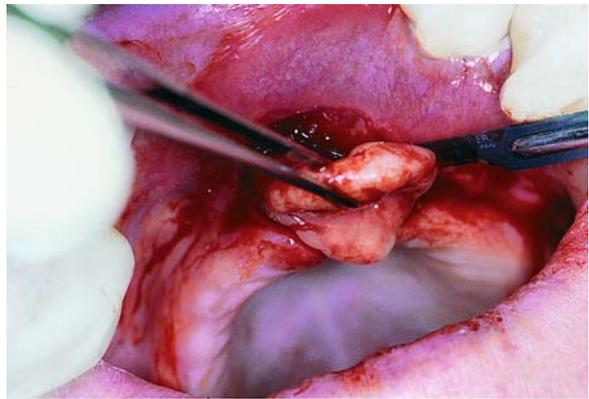
Fig. 10.102. Gradual excision of hyperplasia with scalpel and scissors
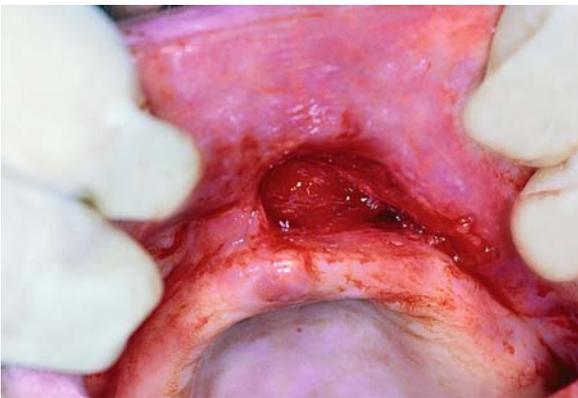
Fig. 10.103. Surgical field after excision of lesion
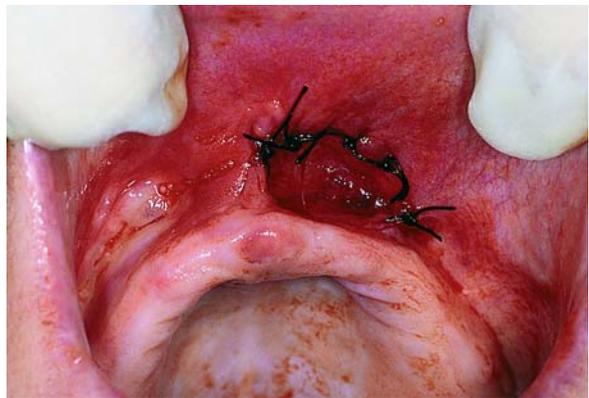
Fig. 10.104. Suturing of superior lip of incision with periosteum that has not been reflected, to avoid a decrease of the depth of the mucolabial fold

Fig. 10.105. Postoperative clinical photograph immediately after removal of sutures

Fig. 10.106. Surgical specimen (hyperplasia) after excision

10.2.3
Fibrous Hyperplastic Retromolar Tuberosity

Fibrous hyperplasia of the soft tissues of the alveolar process is reactive in nature, usually observed in the retromolar edentulous area of the maxilla and is the result of constant irritation during mastication. Clinically, bilateral asymptomatic symmetric lesions with a smooth surface are noted, which are elastic and firm during palpation. Size varies and sometimes the lesion may grow to be so big that it occupies all of the interarch space during occlusion, creating serious problems for construction of a partial or complete denture (Fig. 10.107). Treatment is surgical and aims to decrease the size of the fibrous connective tissue lesion, thus recontouring the alveolar process.

Surgical Technique. After administration of a local anesthetic, the portion of hyperplastic tissue to be excised is demarcated (Fig. 10.108). Two elliptic incisions are then made along the length of the fibrous hyperplasia, one buccally and the other palatally (Figs. 10.109, 10.110). The extent of divergence of the incisions depends on the size of the lesion. That is, the larger the diameter of the hyperplastic lesion, the more the incisions must diverge. The incisions begin at the site of formation of hyperplastic tissue, and are wedge-shaped, with the scalpel proceeding until it touches bone (Figs. 10.111, 10.112). The elongated wedge-shaped portion of the hyperplasia is then removed and the periosteum is reflected buccally and palatally, in order to readapt the wound margins (Fig. 10.113). Thereafter, the buccal and palatal parts are sutured at the midline of the alveolar ridge using a continuous suture (Figs. 10.114–10.116).
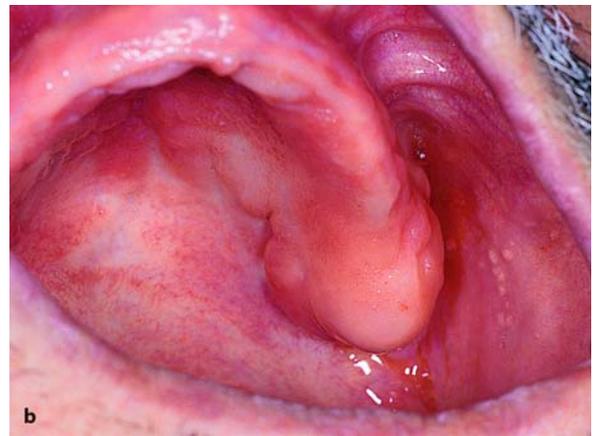
Fig. 10.107 a, b. Fibrous hyperplastic retromolar tuberosity of left maxilla. **a** Diagrammatic illustration. **b** Clinical photograph
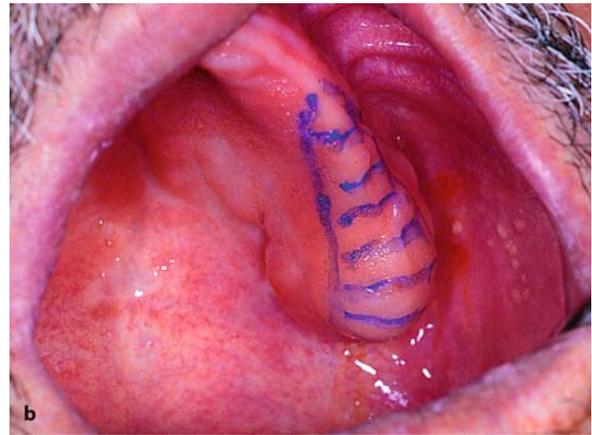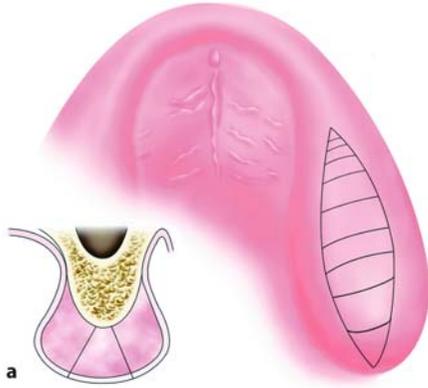
Fig. 10.108 a, b. a Diagrammatic illustration and **b** clinical photograph showing demarcated segment of hyperplastic tissue to be removed
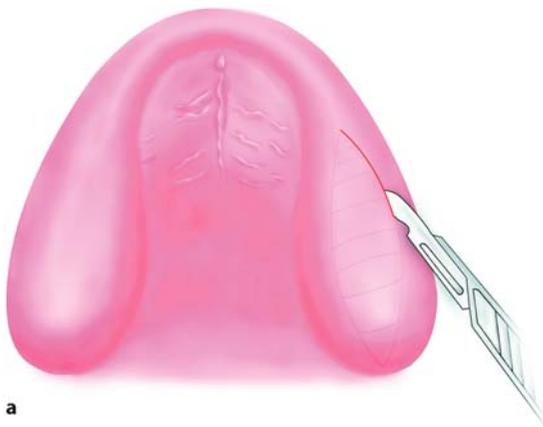

Fig. 10.109 a, b. Removal of lesion. **a** Diagrammatic illustration and **b** clinical photograph showing buccal incision
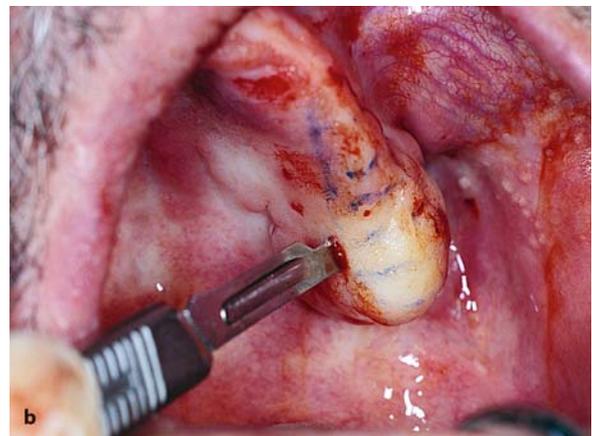

Fig. 10.110 a, b. Continuation of the incision of Fig. 10.109 towards the palatal side
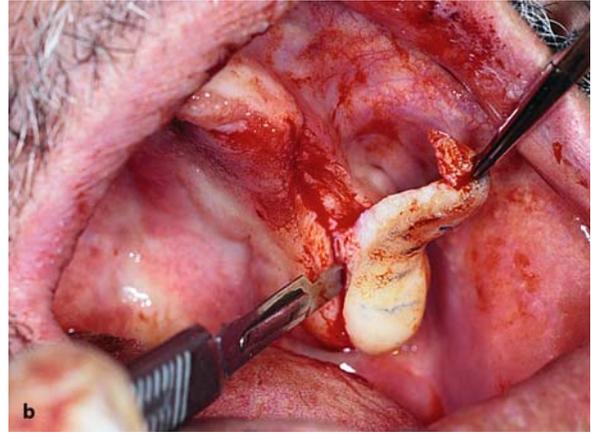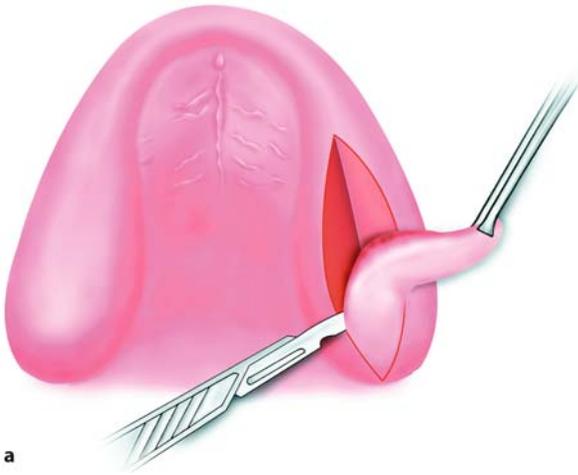
Fig. 10.111 a, b. Gradual excision of the lesion with a wedge-shaped incision reaching as far as the bone. **a** Diagrammatic illustration. **b** Clinical photograph
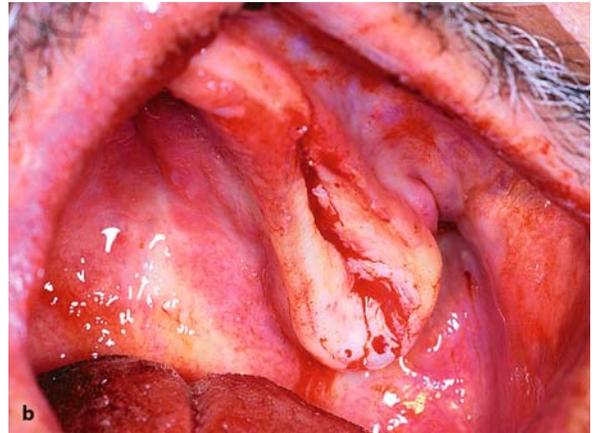
Fig. 10.112 a, b. Surgical field after removal of hyperplastic tissue. **a** Diagrammatic illustration. **b** Clinical photograph
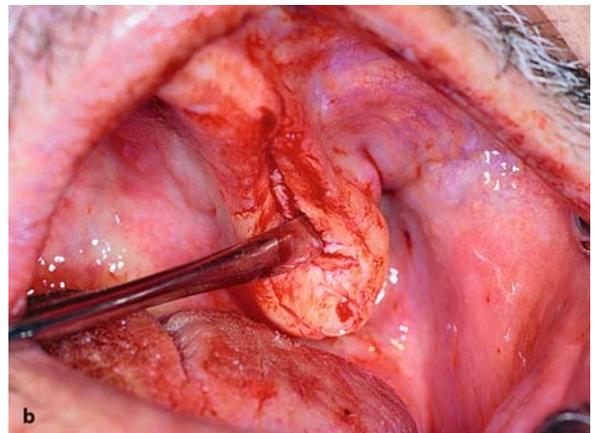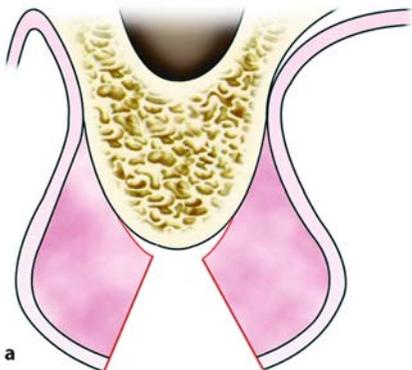
Fig. 10.113 a, b. Reflection of tissues with periosteum, so that wound margins can be reapproximated and sutured
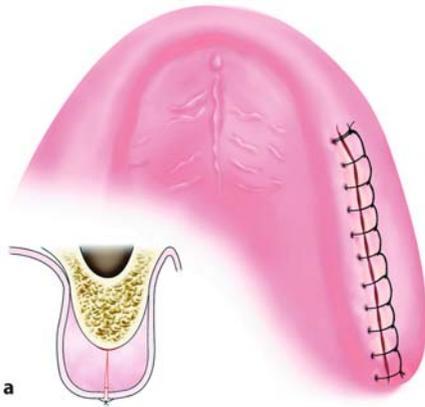
Fig. 10.114 a, b. Operation site after placement of sutures. **a** Diagrammatic illustration. **b** Clinical photograph
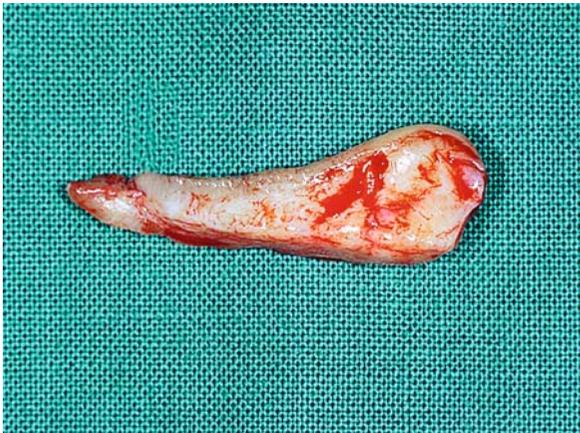
Fig. 10.115. Hyperplastic tissue segment after removal

Fig. 10.116. Postoperative clinical photograph 6 months after the surgical procedure

10.2.4
Papillary Hyperplasia of the Palate

Papillary hyperplasia is a rare pathologic condition localized most often in the palate. It usually occurs in edentulous patients who have been wearing dentures for a long time and is possibly due to inflammatory hyperplasia of the mucosa because of chronic local irritation (Fig. 10.117 a). The lesion may present, to a limited extent, even in patients with dentition (Fig. 10.117 b). In such a case, etiological factors include mechanical and thermal irritation from foods, smoking, etc.

Clinically, these are multifocal hyperplastic nodules of the mucosa of the palate, between which food may accumulate, potentiating the inflammatory reaction.

Treatment is surgical and consists of removal of the lesion with a scalpel or electrosurgical loop.

Surgical Technique. Excision of the papillary hyperplasia is performed with the instrument in constant contact with the superficial mucosa (curettage with large surgical blade as far as the periosteum). An electrosurgical loop may also be used (Fig. 10.118), which is very effective in such cases. The traumatized area is covered with a surgical dressing and healing is achieved by secondary intention (Fig. 10.119).
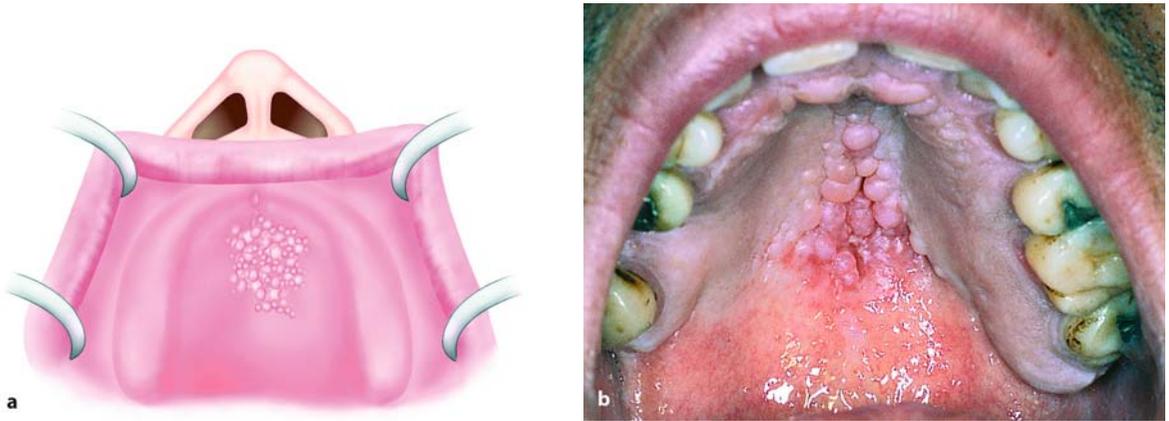
Fig. 10.117 a, b. Papillary hyperplasia of the palate. **a** Diagrammatic illustration of the lesion in an edentulous patient. **b** Clinical photograph in a patient with full dentition
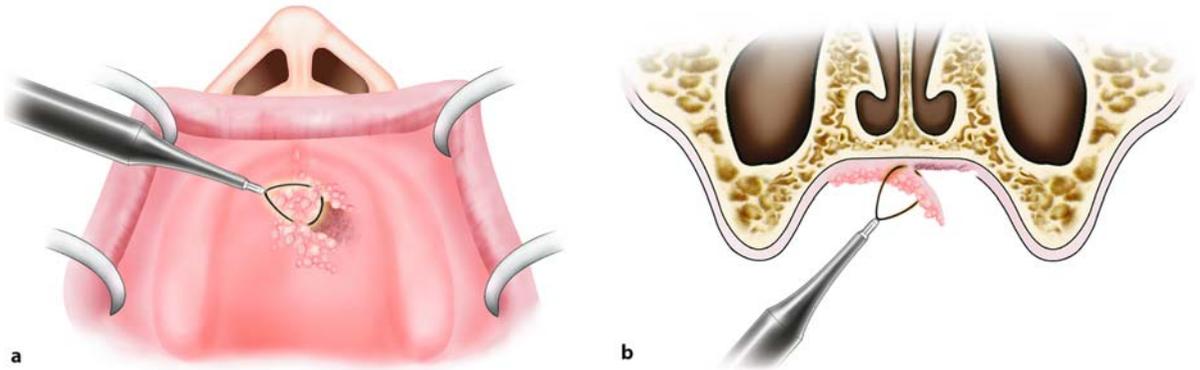

Fig. 10.118 a, b. Diagrammatic illustrations showing removal of the lesion with an electrosurgical loop
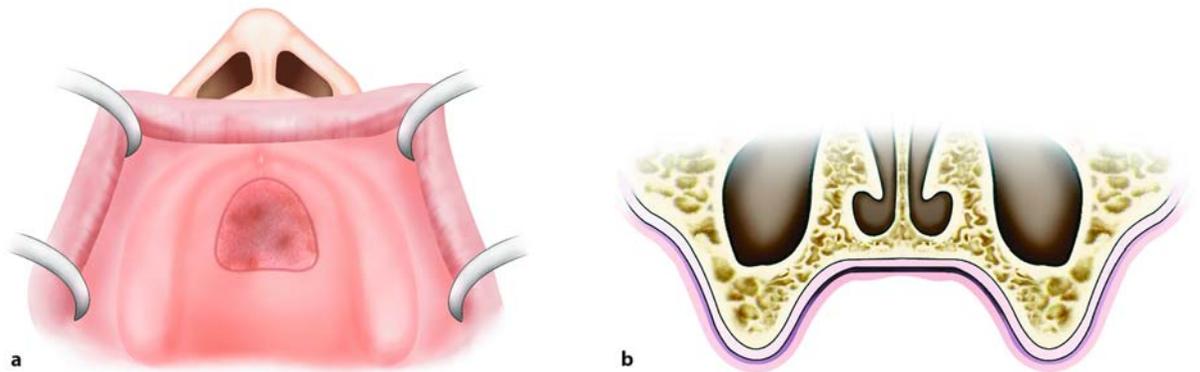
Fig. 10.119 a, b. Diagrammatic illustrations showing the surgical field after removal of the lesion

10.2.5
Gingival Fibromatosis

This is a benign condition, which is characterized by slow progressive swelling of the gingivae proper (attached gingivae) and alveolar mucosa (loose gingivae). The lesion may be generalized or localized and is due to hereditary or acquired causes.

Clinically, gross hyperplasia of the gingivae is observed, which may partially or completely cover the crowns of the teeth, depending on the case. The surface of the gingivae is lobular, reddish, and firm to palpation, while the inflammation and bone resorption vary (Figs. 10.120, 10.121).

Treatment is surgical and consists of segmental excision of the gingivae.

Surgical Technique. After administration of a local anesthetic, the teeth presenting excessive mobility are removed. An incision is then made on the alveolar ridge and the hyperplastic gingivae are reflected buccally and lingually (Fig. 10.122). Excision of the lesion is performed in segments with beveling and is done very carefully, so that the mental and lingual nerves are not injured (Figs. 10.123, 10.124). The alveolar ridge is then smoothed and, after the wound margins are reapproximated, interrupted sutures are placed (Figs. 10.125–10.127).


Fig. 10.120. Radiograph depicting thinning of the roots of mandibular molars and bone resorption in the area

Fig. 10.121. Clinical photograph of case shown in Fig. 10.120, showing gross lobular swelling of the gingivae

Fig. 10.122. Incision along the alveolar ridge and reflection of buccal and lingual gingivae
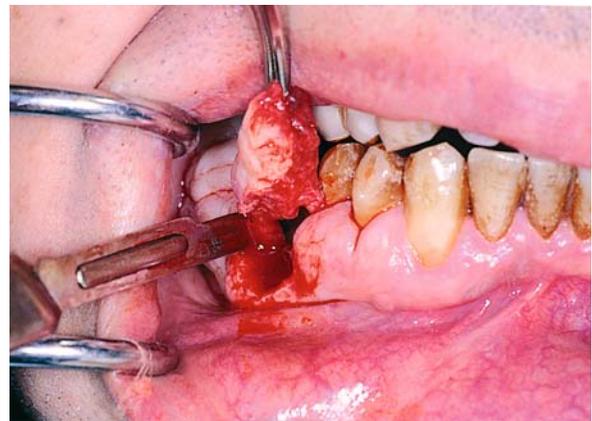
**Fig. 10.123.** Gradual removal of hyperplastic gingivae, beveling in segments
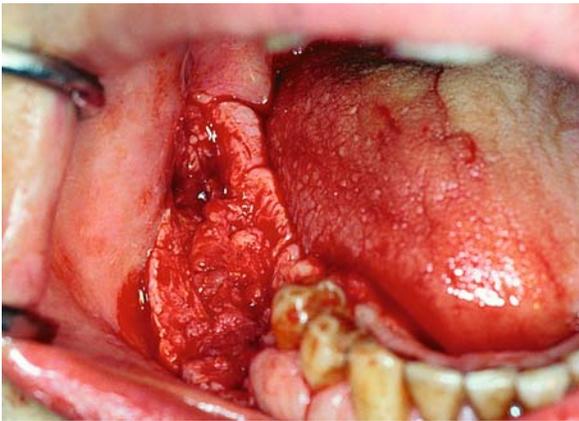
Fig. 10.124. Surgical field after removal of lesion

Fig. 10.125. Suturing of wound with interrupted sutures

Fig. 10.126. Postoperative clinical photograph 2 months after the surgical procedure

Fig. 10.127. Tooth and hyperplastic gingivae after removal

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Biopsy and Histopathological Examination

11

E. Angelopoulou, F. D. Fragiskos

Biopsy is the surgical removal of a tissue specimen from a living organism for microscopic examination and final diagnosis.

A biopsy is a minor surgical procedure and, depending on whether the entire pathologic lesion or part of it is removed, is either an excisional biopsy or incisional biopsy. Furthermore, aspiration or needle biopsy uses a needle to withdraw a sample from the lesion for examination.

11.1
Principles for Successful Outcome of Biopsy

In order for the biopsy procedure to be successful, careful attention must be paid to the following:
- In clinically suspicious lesions, biopsy must be carried out as soon as possible.
- The choice of the biopsy technique to be employed is determined by the indications of each case.
- Direct injection of the local anesthetic solution inside the lesion is to be avoided, because there is a possibility of causing distortion to the tissues.
- The use of the electrosurgical blade is to be avoided, due to the resulting high temperature, which causes coagulation and destruction of tissues.
- The tissue specimen must not be grasped with forceps. When their use is necessary, though, the normal part of the removed tissue should be grasped.
- The tissue specimen taken should be representative.
- Immediately after its removal, the tissue specimen should be placed in a container with fixative. Keeping the tissue specimen outside of the container for a prolonged period dries the specimen, while there is a risk of it falling or being misplaced.
- The fixative solution to be used is 10% formalin, and not water, alcohol, or other liquids that destroy the tissues.
- It is recommended that the container to be sent to the laboratory is plastic to avoid risk of breakage during its transfer and subsequent loss of the specimen.

- The label with the name of the patient and date should be placed on the side of the container, and not on the lid. This way the possibility of mix-up at the laboratory after opening is avoided.

11.2
Instruments and Materials

The instruments necessary for performing surgical biopsy of soft and hard tissues (see Fig. 4.59) are the following: local anesthesia syringe, scalpel handle and blade, surgical–anatomic forceps and hemostat, needle holder, curved scissors, suction tip, periosteal elevator, periapical curette, bone file, and rongeur. The materials considered necessary for biopsy are: local anesthetic cartridge and needle for anesthesia, sutures, surgical dressing, gauze, and vial containing 10% formalin solution for placement of specimen. As for aspiration biopsy, the necessary instruments and materials include the following: trocar needle or a simple low-gauge needle, plastic disposable syringe, glass slides, and fixative material.

11.3
Excisional Biopsy

This technique entails removal of the entire lesion, along with a border of normal tissues surrounding the lesion. The indications for employing incisional biopsy are the following:
- Small lesions, whose size ranges from a few millimeters to one or two centimeters.
- Specific clinical indications that the lesion is benign.
- The surgical procedure may be performed at the dental clinic with the usual armamentarium and if the operation is within the scope of the general practitioner.

Generally, the procedure for performing the biopsy is as follows. After administration of local anesthesia,
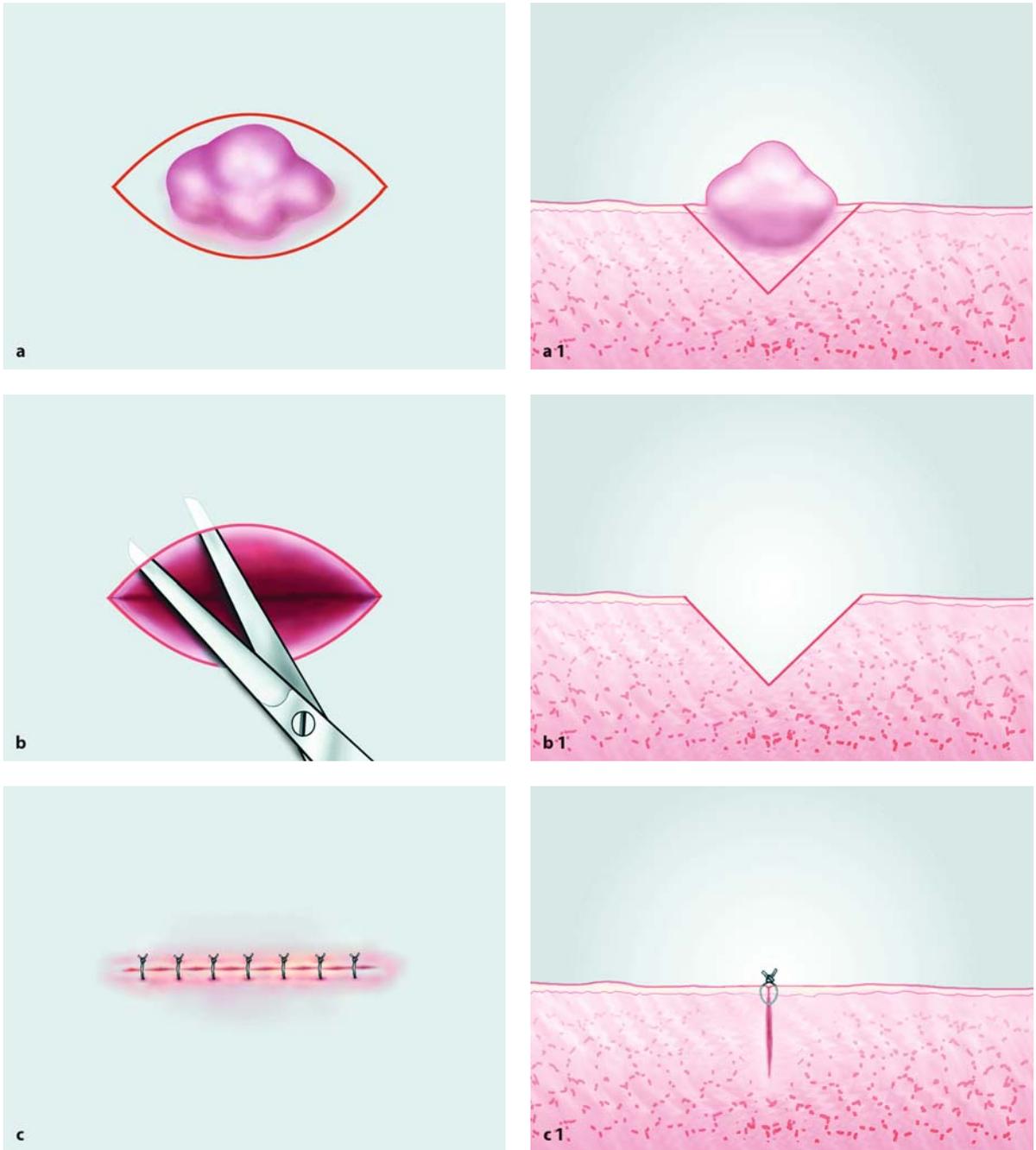
Diag. 11.1 a–c. Diagrammatic representation of excisional biopsy technique. **a** Incision around lesion. **b** Blunt undermining of mucosa of wound margins after removal of lesion.

c Operation site after suturing. **a₁**, **b₁**, **c₁** Steps correspond to **a**, **b**, **c**, in a vertical cross-sectional view

which is performed at the periphery of the lesion and not directly inside the lesion, two elliptical incisions are made on normal tissue surrounding the lesion, which are joined at an acute angle. The lesion is then removed, the mucosa is undermined using blunt scissors, the wound margins are reapproximated, suturing is performed, and healing is achieved by primary intention (Diag. 11.1). If the lesion is located at the gingiva or palate, suturing is not possible. In such a case, a surgical dressing is applied and the wound heals by secondary intention. It is recommended that the lesion be grasped at its base using forceps or a suture. If the

lesion were to be grasped at the center and not at its base, the histological presentation could be altered and could cause problems in diagnosis.

Examples of lesions that may be removed with excisional biopsy are mentioned below.

11.3.1
Traumatic Fibroma

A traumatic fibroma is not a real neoplasm, but a reactive, inflammatory hyperplastic lesion of the connective tissue. It usually occurs at the buccal mucosa, lip, tongue, gingiva, and palate. The lesion is asymptomatic and is due to chronic trauma or irritation, usually involving ill-fitting prosthetic appliances and carious teeth with sharp edges. Clinically, it presents as a well-defined swelling, with normal color, broad base, and smooth surface, feeling like rubber on palpation.

Treatment is surgical and consists of excision of the lesion, while the causative agents must be removed in order to avoid possible recurrence. The cases presented in this chapter involve traumatic fibromas located at the buccal mucosa (Fig. 11.1) and the tongue (Fig. 11.10).

The procedure for removal of the lesion is as follows. After local anesthesia, the lesion is grasped with forceps at its base (on a normal part of tissue) or one or two traction sutures are passed through the lesion. Two elliptical incisions are then made around the lesion, which are joined at an acute angle, and the lesion is carefully reflected with scissors until it is completely separated from the subjacent tissues. After removal of the lesion, the wound margins are bluntly undermined and interrupted sutures are placed (Figs. 11.1–11.17).

Traumatic Fibroma of Buccal Mucosa

Fig. 11.1. Traumatic fibroma of buccal mucosa
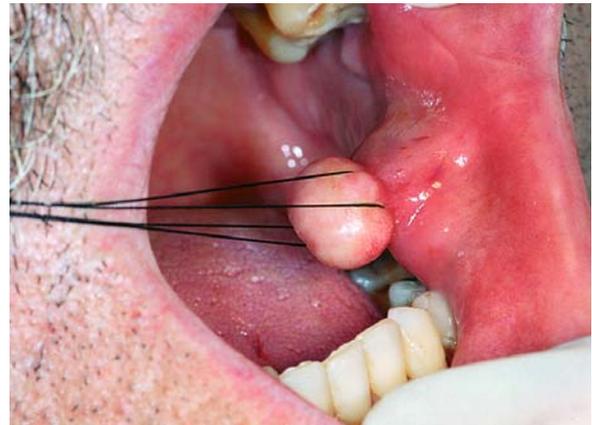
Fig. 11.2. Two traction sutures are passed through the base of the lesion, which help retract the lesion during the surgical procedure
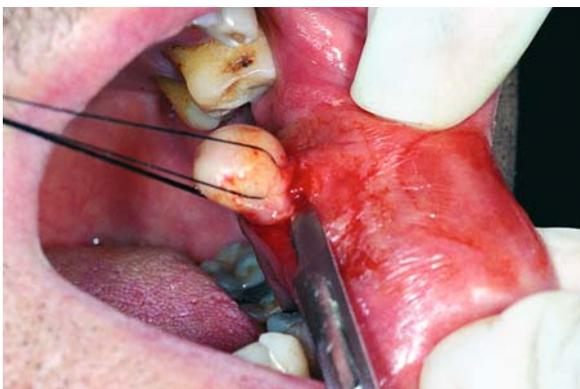
Fig. 11.3. Elliptical incision around lesion with scalpel

Fig. 11.4. Reflection of lesion from underlying tissues with scissors
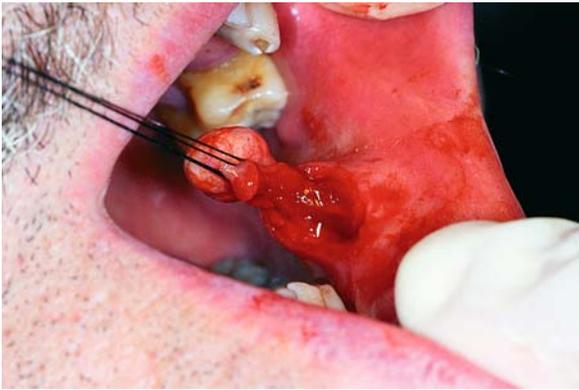
Fig. 11.5. Final step of removal of lesion

Fig. 11.6. Surgical field after removal of lesion

Fig. 11.7. Undermining of mucosa of wound margins from underlying soft tissues with blunt scissors

Fig. 11.8. Operation site after placement of sutures

Fig. 11.9. Lesion after removal

Traumatic Fibroma of Tongue

Fig. 11.10. Traumatic fibroma at lateral border of tongue

Fig. 11.11. Injection of local anesthetic solution in normal tissues surrounding lesion

Fig. 11.12. Elliptical incision at normal tissue border, using a scalpel

Fig. 11.13. Continuation of excision with scissors
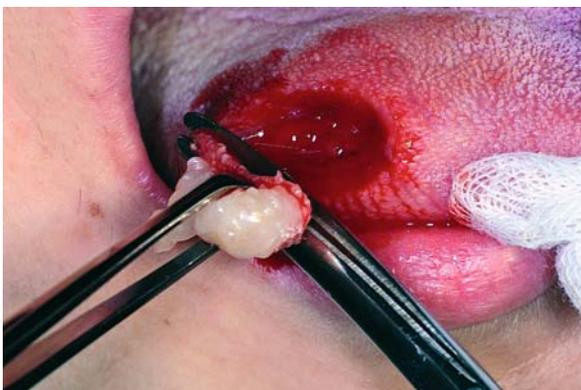
Fig. 11.14. Final step in removal of lesion

Fig. 11.15. Undermining of mucosa from underlying soft tissues

Fig. 11.16. Operation site after placement of sutures

Fig. 11.17 a, b. a Lesion after removal. **b** Postoperative clinical photograph, 2 months later

11.3.2
Peripheral Giant Cell Granuloma

The peripheral giant cell granuloma is also a reactive lesion and is derived from connective tissue of the periosteum or periodontal ligament.

Clinically, it is a well-defined pedunculated or sessile lesion, occurring exclusively at the gingiva. It has a bluish or reddish color, rubber texture, nodular surface, and bleeds easily. Treatment is surgical and entails excision of the lesion.

The region is curetted, ill-fitting prosthetic restorations are replaced, and generally every factor that could be causative should be removed.

The case presented as an example involves a peripheral giant cell granuloma of the maxilla (Fig. 11.18). The technique for removal of the lesion is as follows. An incision is initially made on the normal tissue surrounding the lesion, and, after fully reflecting the lesion, it is removed using a scalpel and periosteal elevator. The bone is then curetted and the wound is irrigated with saline solution and a surgical dressing is applied (Figs. 11.19–11.23).

11.3.3
Hemangioma

A hemangioma is a benign neoplasm that is derived from blood vessels. Histologically, there are two types of hemangiomas, the capillary and the cavernous, depending on the size of the vascular spaces. Clinically, a hemangioma presents as a superficial well-defined or diffuse swelling which is soft on palpation, varying in size, located at the mucosa of the oral cavity (buccal mucosa, lips, tongue, palate) and on the skin of the neck and facial area. Its color is red or bluish-red, and usually blanches with compression.

Treatment depends on the size of the lesion and is usually surgical (excision of the lesion), while cryosurgery, and injection of sclerosing agents in the periphery of the lesion are also employed. The surgical technique is usually performed in cases of small and superficial lesions, while the other techniques are employed in diffuse and extensive hemangiomas. The cases presented involve small superficial hemangiomas of the buccal mucosa and the lower lip. The procedure for removal of the lesions is as follows.

Fig. 11.18. Peripheral giant cell granuloma at the region of the maxillary central incisor

Fig. 11.19. Incision peripheral to the lesion

Fig. 11.20. Reflection of lesion with broad end of periosteal elevator

Fig. 11.21. Surgical field after removal of lesion

Fig. 11.22. Application of surgical dressing at area of removal of lesion

Fig. 11.23. Postoperative clinical photograph 15 days later

Hemangioma of Cheek. After local anesthesia, an elliptical incision is made on the buccal mucosa at the normal tissue borders surrounding the lesion, and its removal is accomplished with a scalpel or scissors (Figs. 11.24–11.26). The wound margins are then undermined from the subjacent tissues using blunt scissors and interrupted sutures are placed (Figs. 11.27, 11.28).

Hemangioma of Lower Lip. When the neoplasm is located at the lower lip, it is excised with a simple wedge-shaped incision at the normal tissue border. During the surgical procedure, the assistant grasps the lip on either side of the incision, compressing the labial artery for hemostasis. The wound is then sutured in layers (mucosa, skin) (Figs. 11.29–11.33).

Hemangioma of Cheek

Fig. 11.24 a, b. Small hemangioma of buccal mucosa. **a** Diagrammatic illustration. **b** Clinical photograph
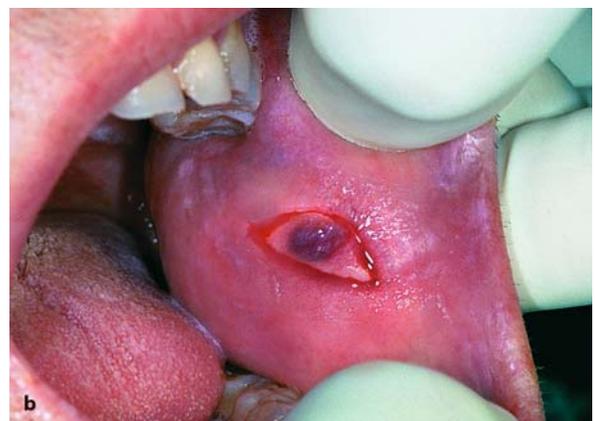
Fig. 11.25 a, b. Elliptical incision at normal tissue border surrounding lesion. **a** Diagrammatic illustration. **b** Clinical photograph
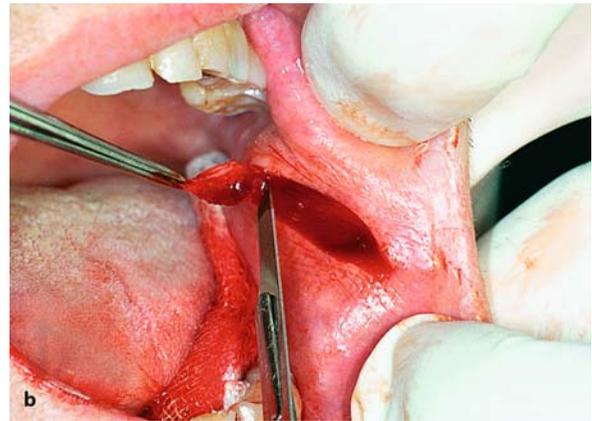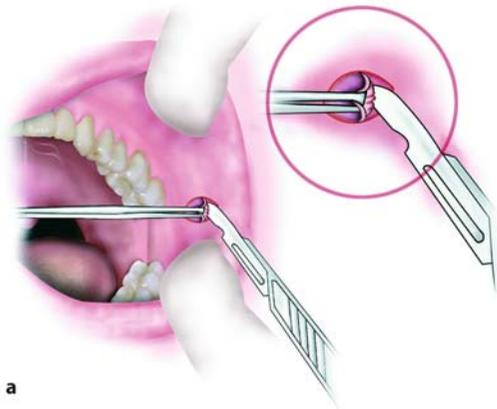
Fig. 11.26 a, b. Excision of lesion with scalpel. **a** Diagrammatic illustration. **b** Clinical photograph
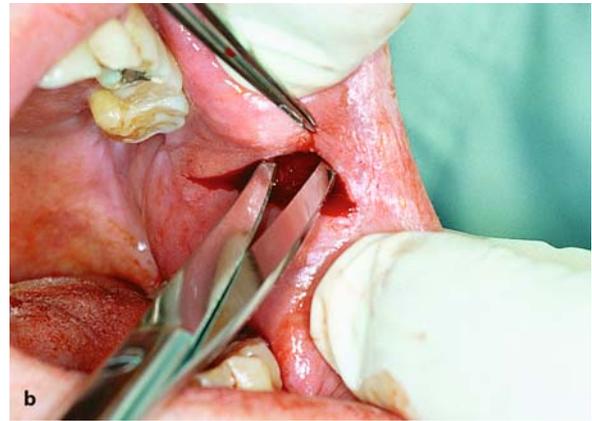
Fig. 11.27 a, b. **a** Surgical field after removal of hemangioma. **b** Undermining of mucosa of wound margins from underlying soft tissues with blunt scissors
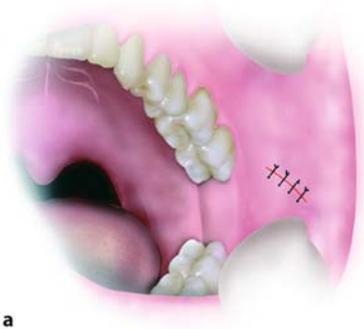
Fig. 11.28 a, b. Suturing of wound with interrupted sutures. **a** Diagrammatic illustration. **b** Clinical photograph

Hemangioma of lower lip

Fig. 11.29 a, b. Hemangioma of lower lip. **a** Diagrammatic illustration. **b** Clinical photograph
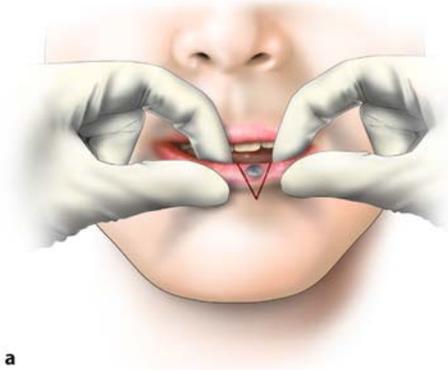
Fig. 11.30 a, b. Surgical technique for excision of hemangioma. Demarcation of wedge-shaped incision which includes the entire lesion. **a** Diagrammatic illustration. **b** Clinical photograph
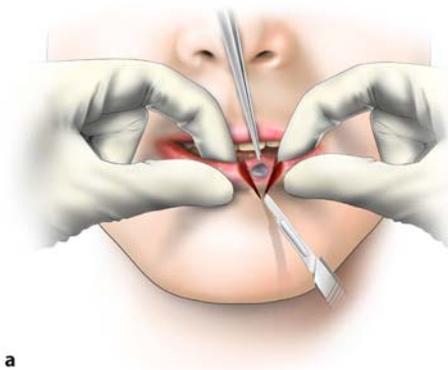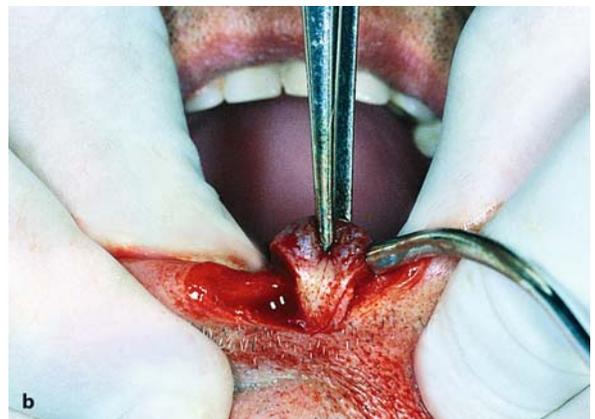
Fig. 11.31 a, b. Simple wedge-shaped excision for removal of entire hemangioma. **a** Diagrammatic illustration. **b** Clinical photograph
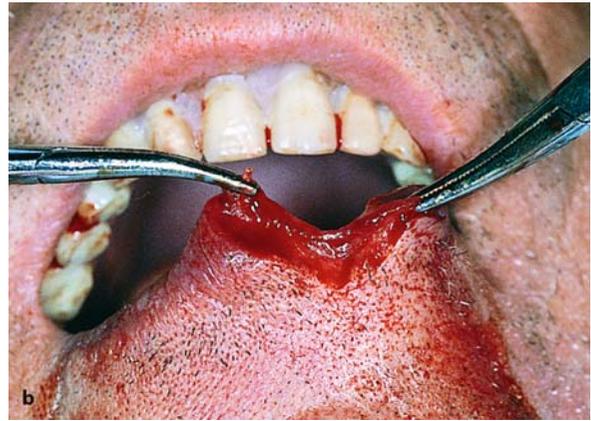
Fig. 11.32 a, b. Suturing of wound with interrupted sutures. **a** Suturing begins at mucosa and ends on skin. **b** Hemostats just inside of wound margins aid in hemostasis of surgical field before suturing

Fig. 11.33 a, b. Operation site after completion of suturing. **a** Diagrammatic illustration. **b** Clinical photograph

11.3.4
Peripheral Fibroma of Gingiva

The peripheral fibroma is a reactive benign tumor located exclusively at the gingiva. Etiologically, just like other reactive tumors, it is associated with the presence of calculus or plaque, ill-fitting prosthetic restorations or fillings, etc. It is usually a sessile tumor with normal color and a smooth surface. A distinct histological characteristic is the presence of calcification or bony islands inside the tumor mass.

The case presented involves a peripheral fibroma located at the gingiva of the maxilla, at the region of the central and lateral incisor (Fig. 11.34).

The technique for removal is similar to that of the peripheral giant cell granuloma (Figs. 11.35–11.40).

Fig. 11.34 a, b. Peripheral fibroma of gingiva located in the region of the lateral and central incisor of the maxilla. **a** Diagrammatic illustration. **b** Clinical photograph


Fig. 11.35 a, b. Incision on normal tissue peripheral to lesion. **a** Diagrammatic illustration. **b** Clinical photograph


Fig. 11.36 a, b. Reflection of lesion with broad end of periosteal elevator. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 11.37 a, b. Surgical field after removal of lesion. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 11.38. Application of surgical dressing at the region of removal of the lesion

Fig. 11.39. Lesion after removal

Fig. 11.40 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) 3 months after the surgical procedure

11.3.5
Leukoplakia

Leukoplakia is a clinical term and refers to every non-specific white plaque on the mucosa of the mouth, which cannot be scraped off and cannot be characterized clinically or histopathologically as any other disease.

Histologically, leukoplakia varies and may be a simple hyperplasia, such as hyperkeratosis or acanthosis, but it may also be dyskeratosis, carcinoma in situ, even invasive squamous cell carcinoma. The etiology is largely unknown, even though various factors, especially smoking, alcohol abuse, chronic local irritants, etc., have been cited as causative agents. Leukoplakia

may occur anywhere on the mucosa, that is, tongue, mucobuccal fold, floor of the mouth, palate, buccal mucosa, etc.

Treatment of leukoplakia consists of conservative surgical removal. Cases of epithelial hyperplasia may regress if the causative agent is removed. The case presented involves leukoplakia of the buccal mucosa, posterior to the commissure of the lip (Fig. 11.41). The procedure for removal of the lesion is as follows. After administration of a local anesthetic, a peripheral incision is made on the normal tissue border surrounding the lesion (Fig. 11.42) and it is gradually removed using scissors (Fig. 11.43). The mucosa of the wound margins is undermined using blunt scissors and interrupted sutures are placed (Fig. 11.44).

Fig. 11.41. Leukoplakia of buccal mucosa posterior to commissure of lip

Fig. 11.42. Demarcation of incision for surgical excision of leukoplakia

**Fig. 11.43.** Gradual removal of lesion with scalpel and scissors

Fig. 11.44. Operation site after suturing

11.4
Incisional Biopsy

Incisional biopsy involves removal of only a portion of a relatively more extensive lesion, so that histopathological examination may be performed and a diagnosis made. It is indicated in cases where the lesion is larger than 1 or 2 cm and when there is suspicion that the lesion is malignant. With incisional biopsy, besides diagnosis, other characteristics of the neoplasm are defined as well, such as differentiation, invasiveness, etc.

The incisional biopsy technique involves the following. After local anesthesia, a wedge-shaped portion of the most representative part of the lesion is removed, usually from the periphery of the lesion, extending into normal tissue as well (Diag. 11.2).
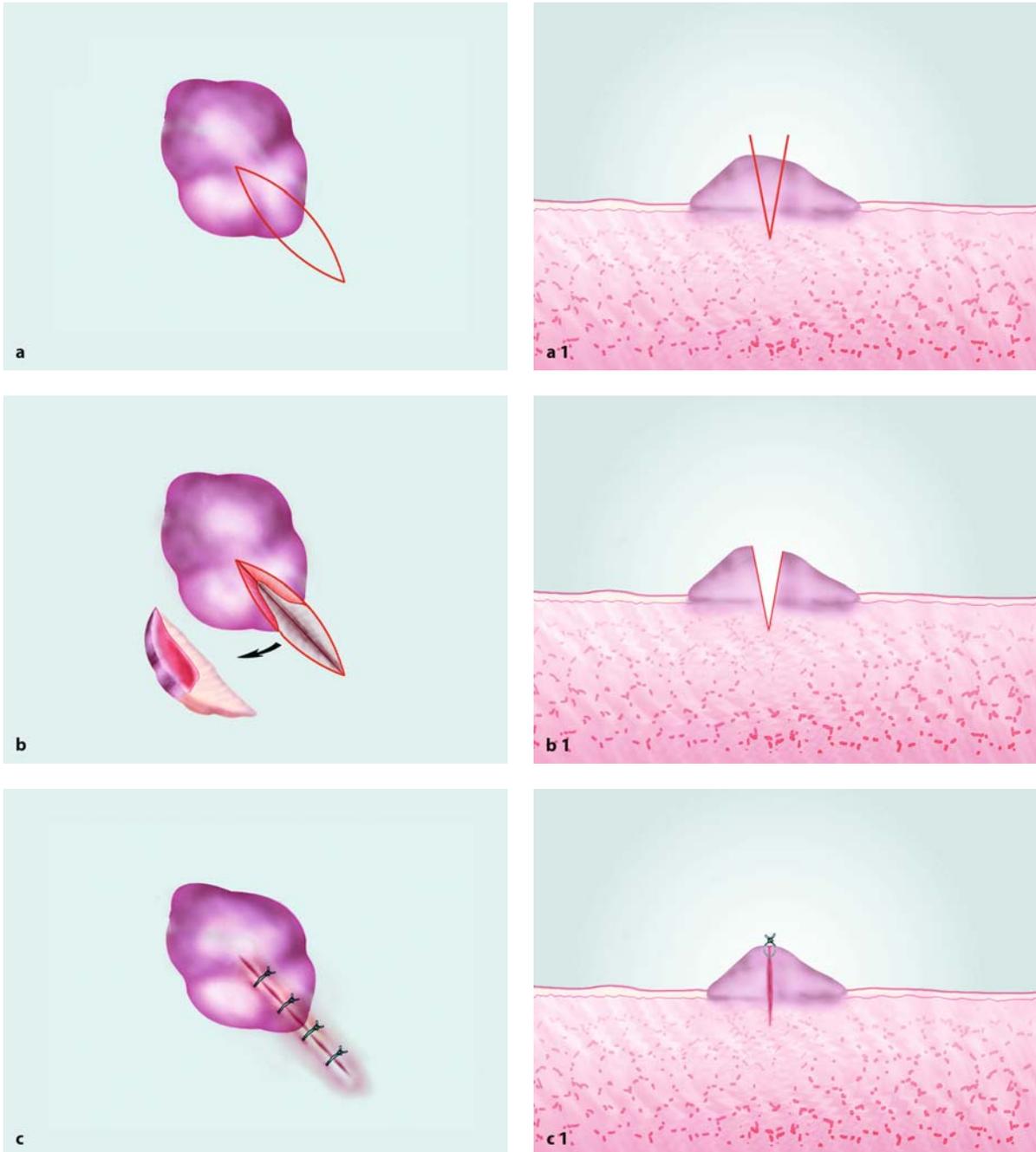
Diag. 11.2 a–c. Diagrammatic representation of incisional biopsy technique. **a** Demarcation of incision. **b** Surgical field after removal of specimen. **c** Operation site after suturing. **a₁**, **b₁**, **c₁** Steps correspond to **a**, **b**, **c**, in vertical cross-sectional view
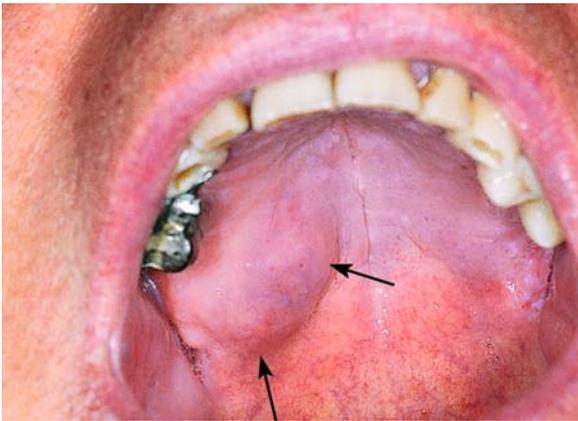
Fig. 11.45. Extensive palatal swelling which is an indication for incisional biopsy

Fig. 11.46. Administration of local anesthesia in normal tissues surrounding lesion

Fig. 11.47. Wedge-shaped incision for removal of part of lesion

**Fig. 11.48.** Surgical field after wedge-shaped excision of tissue
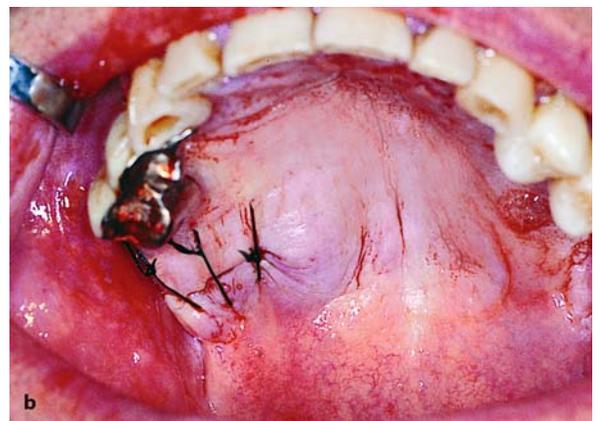
Fig. 11.49 a, b. Operation site after placement of sutures. **a** Diagrammatic illustration. **b** Clinical photograph

When the lesion is located in deeper tissues, surgical access is accomplished after an incision on the mucosa.

The case presented involves an incisional biopsy from a tumor on the palate (Fig. 11.45). Initially, a local anesthetic is administered (Fig. 11.46), and a wedge-shaped incision is made, at adequate depth, of a portion of the lesion together with the overlying mucosa (Figs. 11.47, 11.48). The wound is then sutured (Fig. 11.49).

11.5
Aspiration Biopsy

Aspiration biopsy is indicated in cases where lesions are not accessible for histopathological examination, e.g., tumors of the parotid gland, lymph nodes, cysts, etc.

It is performed using a trocar needle or fine needle (21-gauge to 23-gauge) adapted to a glass syringe or plastic disposable syringe (Fig. 11.50). The aspirated material is smeared on a glass slide (Figs. 11.51–11.53) and immersed in Hoffman solution (95% ethyl alcohol solution and 5% ether solution) in equal parts or it is fixed with hair spray. Cytological examination is then

Fig. 11.50. Aspiration biopsy from a mandibular cyst
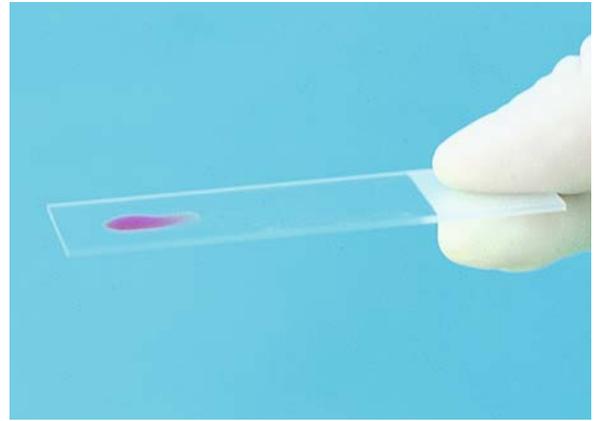
Fig. 11.51. Glass slide with material obtained by aspiration biopsy

**Fig. 11.52.** Smearing of aspirate
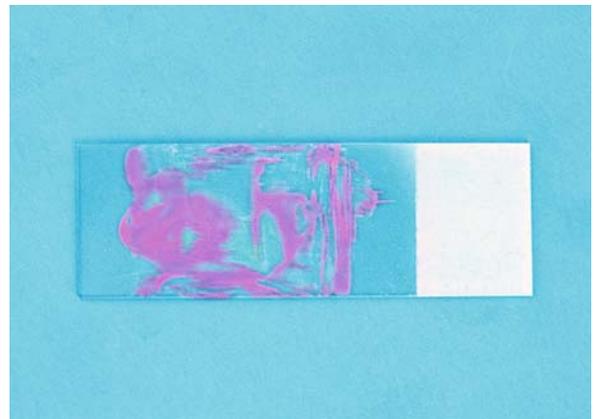
Fig. 11.53. Glass slide after smearing and fixation of aspirate with hair spray

Fig. 11.54. Placement of specimen in vial

performed. A histological examination may be performed if a specimen is sucked into the needle tip, usually with a trocar needle, and expressed onto a glass slide. Figure 11.50 shows aspiration of material from a cyst of the mandible.

11.6
Specimen Care

The tissue specimen removed with biopsy is placed in a vial containing an aqueous solution of 10% formalin (4% formaldehyde) (Fig. 11.54) and sent to the laboratory, along with the biopsy data sheet containing all the necessary clinical information. The pathology laboratory will send the dentist the pathology report that includes a histological description and diagnosis.

11.7
Exfoliative Cytology

This method is to be used as an additional aid to, and not a substitute for, biopsy, mainly providing bacteriological information. The reason for this is that it is considered unreliable due to lack of pathologist expertise in the field of exfoliative cytology. Individual cells are examined, rather than the lesion as a whole, which represents a drawback. The lesion is scraped using a cement spatula or tongue depressor. The superficial cells scraped from the area are smeared evenly on a glass slide. The fixation procedure that follows is the same as that for aspiration biopsy, after which the cells are stained.

11.8
Tolouidine Blue Staining

This method is used most often to indicate the most appropriate biopsy location, even though it does not indicate tumors present under normal epithelium. A 1% tolouidine blue staining solution is applied to the epithelial surface, whereupon rinsing with a 1% acetic acid solution leaves no stain on normal epithelial surfaces or benign erythematous lesions. On the contrary, the stain remains on the surface of premalignant and malignant erythematous lesions. Benign lesions usually have well-defined stain margins, whereas premalignant or malignant lesions have more diffuse margins.

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12

Surgical Treatment of Radicular Cysts

C. Alexandridis

Radicular (periapical) cysts are pathological cavities, lined with epithelium, and contain fluid or semi-fluid material.

They are the most common cystic lesions of the jaws and originate from the epithelial remnants of Malassez rests, which are stimulated after inflammation at the apices of nonvital teeth.

Diagnosis of radicular cysts is based on clinical and radiographic examination, as well as aspiration of the contents of the cystic sac.

12.1
Clinical Presentation

The majority of radicular cysts are asymptomatic, especially those small in size. They are discovered after radiographic examination, unless they are suppurated, whereupon pain as well as other symptoms occur. Large cysts present swelling buccally and more rarely lingually or palatally. This swelling is due to expansion of the buccal cortical plate, which becomes thinned and may demonstrate a crackling sound (crepitus). If the bone is completely destroyed, the cyst is connected to the periosteum and the mucosa in this area looks bluish-red.

12.2
Radiographic Examination

Radiographically, radicular cysts present as osteolytic or radiolucent lesions (round or oval in shape) with well-defined radiopaque borders, unless they have been infected, whereupon the radiopaque periphery does not exist.

12.3
Aspiration of Contents of Cystic Sac

In addition to the clinical and radiographic examination, aspiration of the contents of the cystic sac may be a valuable diagnostic aid. In cysts whose size is larger than 1.5–2 cm, thin or thick fluid may be aspirated, which precludes the presence of other more solid lesions.

12.4
Surgical Technique

Two techniques are employed in clinical practice for the surgical removal of cysts: enucleation and marsupialization.

Enucleation. This technique involves complete removal of the cystic sac and healing of the wound by primary intention. This is the most satisfactory method of treatment of a cyst and is indicated in all cases where cysts are involved, whose wall may be removed without damaging adjacent teeth and other anatomic structures.

The surgical procedure for treatment of a cyst with enucleation includes the following steps:
- Reflection of a mucoperiosteal flap.
- Removal of bone and exposure of part of the cyst.
- Enucleation of the cystic sac.
- Care of the wound and suturing.

After taking a radiograph to determine the exact localization and size of the lesion, a trapezoidal flap is created, whose extent must ensure adequate access and visualization of the surgical field (Figs. 12.1–12.4).

After reflection of the mucoperiosteum, the bone covering the lesion is evaluated, which, as mentioned above, may be normal, thinned, or completely destroyed.

In normal bone, a round bur is used to remove a portion of the buccal cortical plate covering the cyst, and, depending on its extent, a rongeur may be used to enlarge the osseous window created (Figs. 12.5, 12.6). The osseous window must be large enough so that all parts of the cystic cavity may be accessed and removed without particular difficulty.

If the bony wall is thinned or perforated, it is removed peripherally with a rongeur, until it reaches compact bone. A curette is used for enucleation of small cysts, while for larger cysts, the broad end of a periosteal elevator is preferred, which is placed inside the cavity pressing gently between the cystic wall and bone, while the cyst is carefully grasped with forceps (Fig. 12.7).

After removal of the cysts, a curette is used to inspect the cavity for the presence of remnants of the cyst, and copious irrigation with saline solution and suturing of the flap follow (Figs. 12.8–12.10).

The surgical technique for removal of mandibular cysts is exactly the same as that described above (Figs. 12.11–12.18).

Marsupialization. This method is usually employed for the removal of large cysts and entails opening a surgical window at an appropriate site above the lesion.

In order to create the surgical window, initially a circular incision is made, which includes the mucoperiosteum, the underlying perforated (usually) bone, and the respective wall of the cystic sac (Figs. 12.19–12.23). After this procedure, the contents of the cyst are evacuated, and interrupted sutures are placed around the periphery of the cyst, suturing the mucoperiosteum and the cystic wall together (Fig. 12.24). Afterwards, the cystic cavity is irrigated with saline solution and packed with iodoform gauze (Figs. 12.25, 12.26), which is removed a week later together with the sutures. During that period, the wound margins will have healed, establishing permanent communication. Irrigation of the cystic cavity is performed several times daily, keeping it clean of food debris and averting a potential infection.

Healing of the wound is by secondary intention, and the epithelium of the cyst is thus transformed into oral mucosa.

Surgical Removal of Maxillary Cyst

Fig. 12.1. Panoramic radiograph showing an extensive radicular lesion at the region of teeth 22, 23, 24

**Fig. 12.2.** Clinical photograph of case of Fig. 12.1
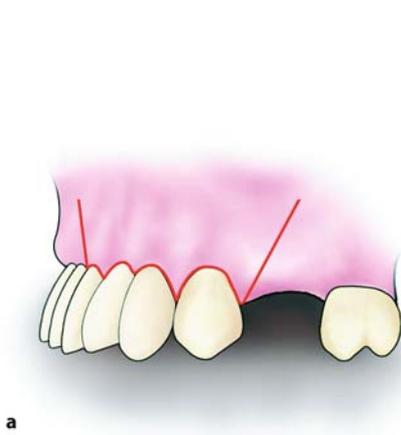
Fig. 12.3 a, b. Removal of maxillary cyst, with labial access. Incision for creating a trapezoidal flap. **a** Diagrammatic illustration. **b** Clinical photograph
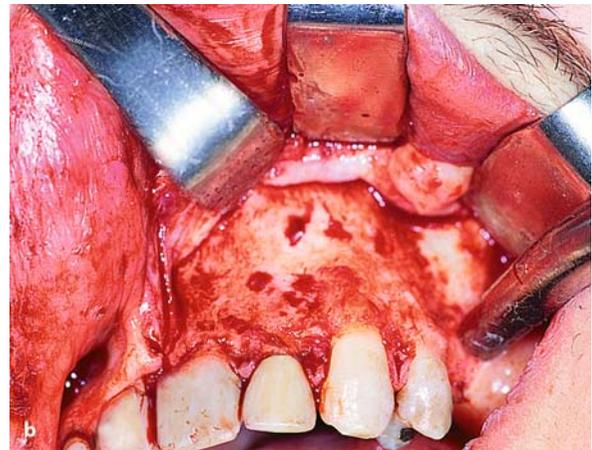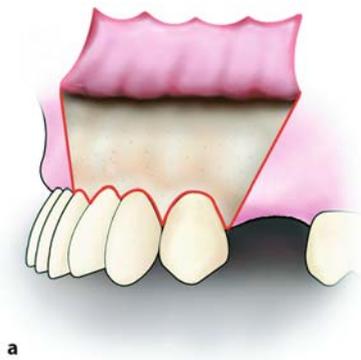

Fig. 12.4 a, b. Reflection of flap and exposure of surgical field. **a** Diagrammatic illustration. **b** Clinical photograph
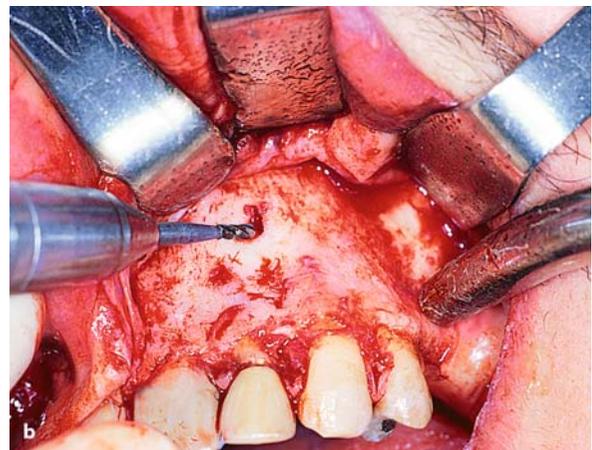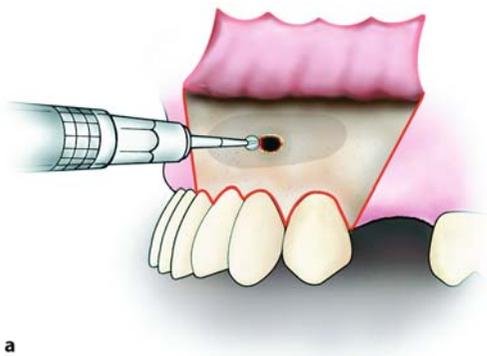

Fig. 12.5 a, b. Removal of bone at the labial aspect respective to the lesion. **a** Diagrammatic illustration. **b** Clinical photograph
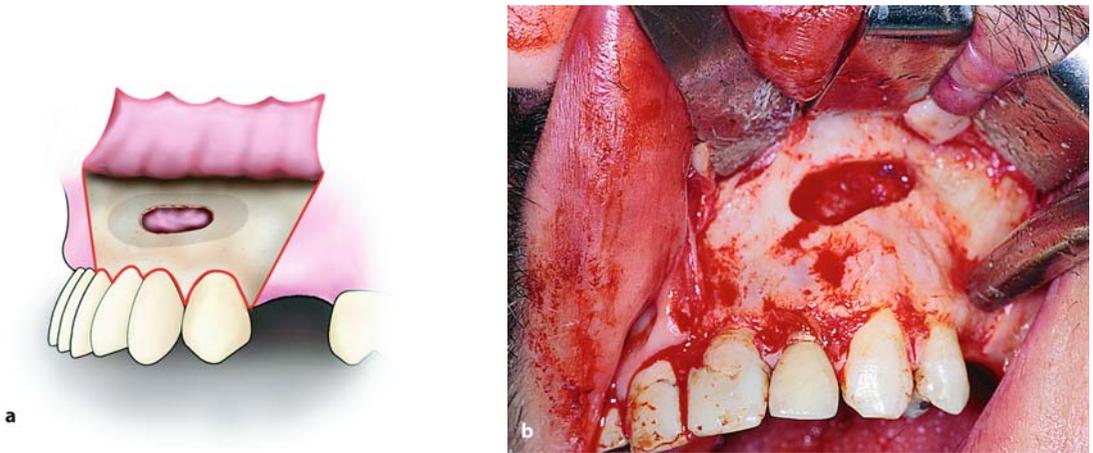
Fig. 12.6 a, b. Osseous window created to expose part of the lesion. **a** Diagrammatic illustration. **b** Clinical photograph
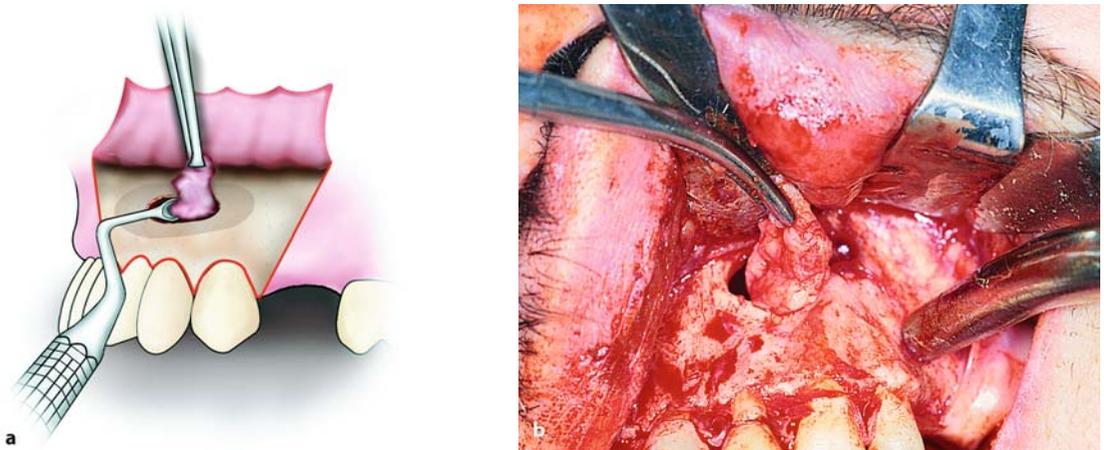
Fig. 12.7 a, b. Removal of cyst from bony cavity, using hemostat and curette. **a** Diagrammatic illustration. **b** Clinical photograph
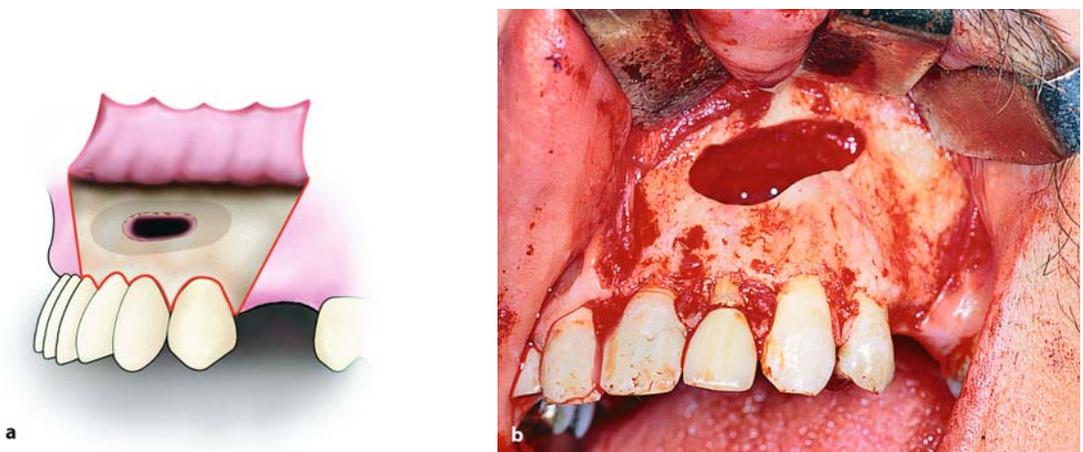
Fig. 12.8 a, b. Surgical field after removal of lesion. **a** Diagrammatic illustration. **b** Clinical photograph
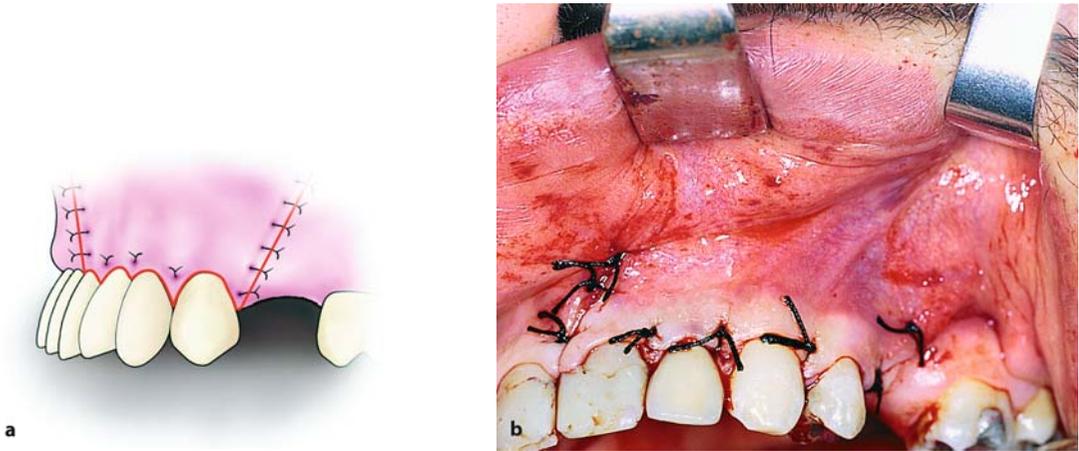
Fig. 12.9 a, b. Operation site after placement of sutures. **a** Diagrammatic illustration. **b** Clinical photograph
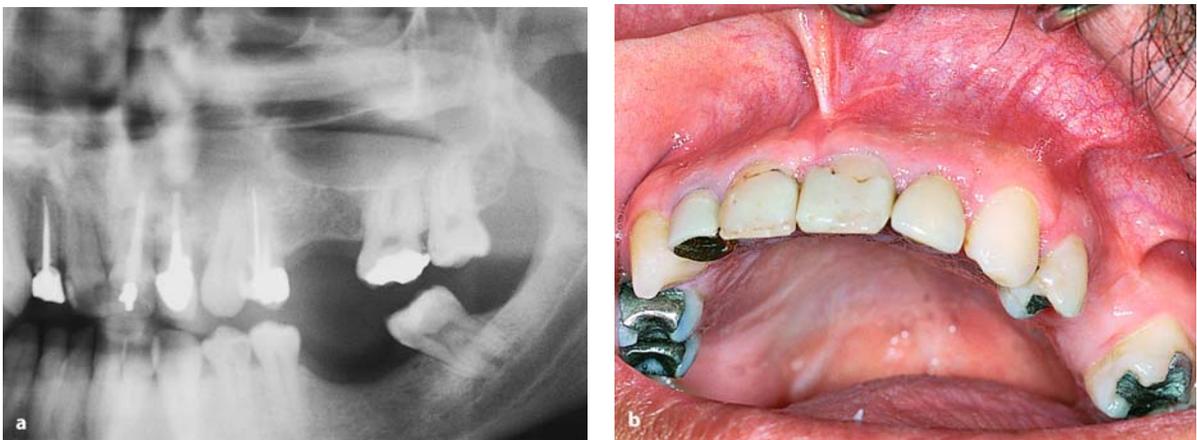
Fig. 12.10 a, b. Panoramic radiograph (**a**) and clinical photograph (**b**) of the area taken 2 months after the surgical procedure

Surgical Removal of Mandibular Cyst
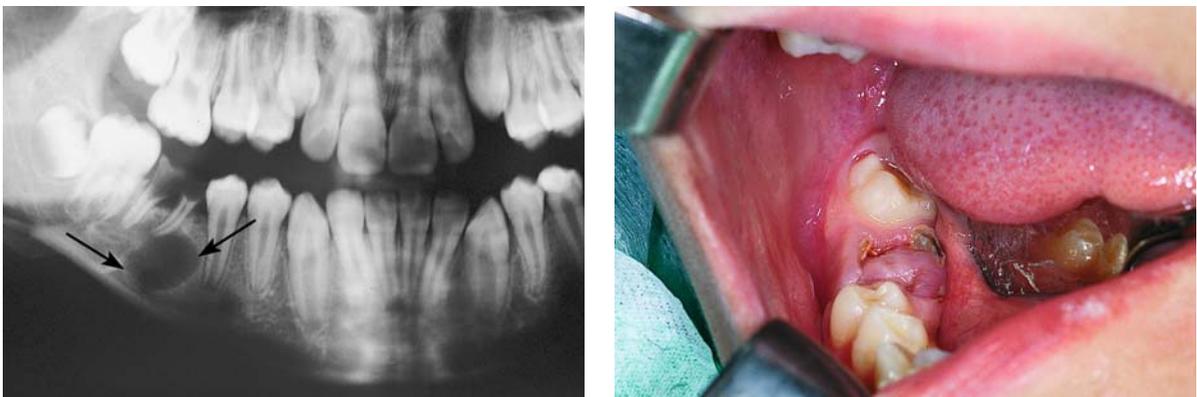
Fig. 12.11. Radiograph showing radicular lesion at area of mandibular first molar

Fig. 12.12. Clinical photograph of case of Fig. 12.11

Fig. 12.13. Incision and reflection of mucoperiosteum
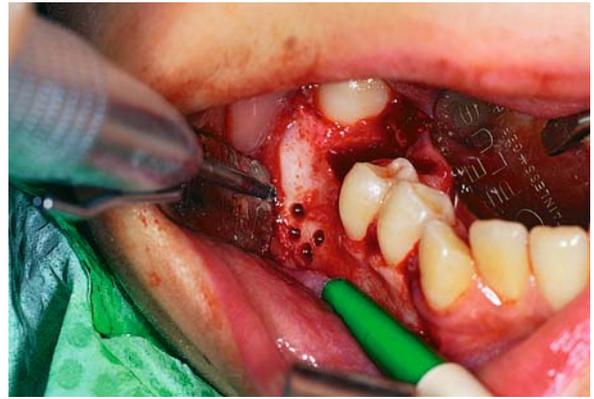
Fig. 12.14. Holes drilled for removal of buccal alveolar plate

Fig. 12.15. Osseous window completed, after joining of holes with fissure bur
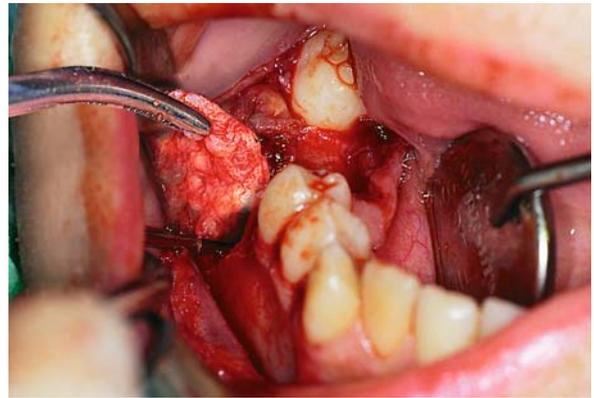
Fig. 12.16. Removal of lesion with help of hemostat and curette

Fig. 12.17. Surgical field after removal of lesion

Fig. 12.18. Suturing of wound with interrupted sutures

Marsupialization of Cyst
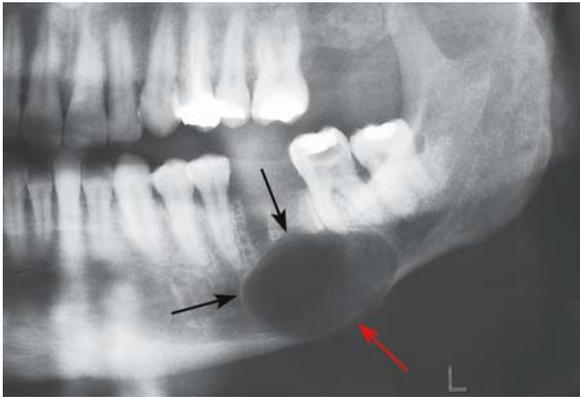
Fig. 12.19. Radiograph showing extensive mandibular cyst. The marsupialization method is indicated for its treatment

Fig. 12.20. Treatment of mandibular cyst with marsupialization method. Circular incision includes mucosa and periosteum

Fig. 12.21. Exposure of buccal cortical plate and removal of portion of bone with round bur

Fig. 12.22. Enlargement of osseous window with rongeur

Fig. 12.23. Exposure of cyst after removal of bone

Fig. 12.24. Suturing of wound margins with cystic wall

Fig. 12.25. Packing of cystic cavity with iodoform gauze

Fig. 12.26. Cystic cavity after insertion of gauze

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Apicoectomy

13

F. D. Fragiskos

Apicoectomy is the surgical resection of the root tip of a tooth and its removal together with the pathological periapical tissues. Accessory root canals and additional apical foramina are also removed in this way, which may occur in the periapical area and which may be considered responsible for failure of an endodontic therapy.

13.1
Indications

The indications for apicoectomy include the following cases:
1. Teeth with active periapical inflammation, despite the presence of a satisfactory endodontic therapy.
2. Teeth with periapical inflammation and unsatisfactory endodontic therapy, which cannot be repeated because of:
   – Completely calcified root canal.
   – Severely curved root canals.
   – Presence of posts or cores in root canal.
   – Breakage of small instrument in root canal or the presence of irretrievable filling material.
3. Teeth with periapical inflammation, where completion of endodontic therapy is impossible due to:
   – Foreign bodies driven into periapical tissues.
   – Perforation of inferior wall of pulp chamber.
   – Perforation of root.
   – Fracture at apical third of tooth.
   – Dental anomalies (dens in dente).

In the above cases, if after the apicoectomy the apex has not been completely sealed, then retrograde filling is required, which is described further down. The purpose of retrograde filling is to obstruct the exit of bacteria and the by-products of nonvital pulp, which remained in the root canal.

13.2
Contraindications

The contraindications for apicoectomy are as follows:
- All conditions that could be considered contraindications for oral surgery concerning the age of the patient and general health problems, such as severe cardiovascular diseases, leukemia, tuberculosis, etc.
- Teeth with severe resorption of periodontal tissues (deep periodontal pockets, great bone destruction).
- Teeth with short root length.
- Teeth whose apices have a close relationship with anatomic structures (such as maxillary sinus, mandibular canal, mental foramen, incisive and greater palatine foramen) and if causing injury to these during the surgical procedure is considered probable.

13.3
Armamentarium

The following instruments are necessary for performing an apicoectomy:
- Microhead handpiece (straight and contra-angle) and microbur (Fig. 13.1).
- Special narrow periapical curette tips for preparation of the periapical cavity (Fig. 13.2).
- Apical retrograde micro-mirror and micro-explorers (Fig. 13.3).
- Local anesthetic syringe and cartridges.
- Scalpel handle.
- Scalpel blade (no. 15).
- Mirror.
- Periosteal elevator.
- Cotton pliers.
- Small hemostat.
- Suction tips (small, large).
- Irrigation receptacle.
- Needle holder.
- Retractors.

Fig. 13.1. Microhead handpiece compared to a conventional handpiece. With this handpiece, preparation of the periapical cavity is greatly facilitated in areas with limited access
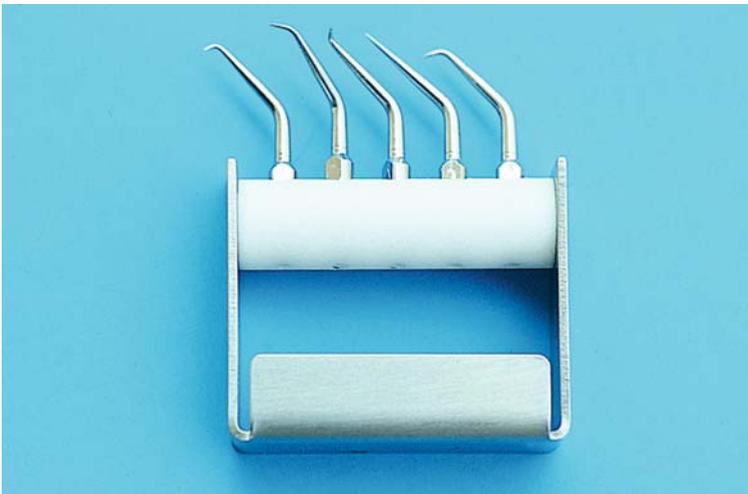

Fig. 13.2. Special narrow periapical curette tips that may be adapted to an ultrasonic device. They are used for preparation of the periapical cavity in areas with limited access


Fig. 13.3. Apical retrograde micro-mirror and micro-explorers for determining the dimensions of the created periapical cavity

- Periodontal curette.
- Periapical curette.
- Appropriate burs (round, fissure, inverted cone).
- Miniaturized amalgam applicator for retrograde fillings (Figs. 13.4, 13.5).
- Narrow amalgam condensers (Fig. 13.6).

Fig. 13.4. Miniaturized amalgam applicator for retrograde fillings, with a knob that controls amalgam increment size

Fig. 13.5. Miniaturized amalgam applicator compared to a standard amalgam carrier

Fig. 13.6. Instruments and materials for retrograde filling. Amalgam capsule (*top left*). Miniaturized amalgam applicator (*top right*). Narrow amalgam condensers, with tips appropriately shaped so that they may enter narrow areas easily (*bottom*)

- Scissors, needles and no. 3–0 and 4–0 sutures.
- Metal endodontic ruler.
- Gauze and cotton rolls/pellets.
- Syringe for irrigating surgical field.
- Saline solution.

13.4
Surgical Technique

The procedure for apicoectomy includes the following steps:
1. Designing of flap.
2. Localization of apex, exposure of the periapical area and removal of pathological tissue.
3. Resection of apex of tooth.
4. Retrograde filling, if deemed necessary.
5. Wound cleansing and suturing.

Designing of Flap. Flap design depends on various factors, which mainly include position of the tooth, presence of a periodontal pocket, presence of a prosthetic restoration, and the extent of the periapical lesion.

There are three types of flaps principally used for apicoectomy: the semilunar, triangular, and trapezoidal. The semilunar flap is indicated for surgical procedures of limited extent and is usually created at the anterior region of the maxilla, which is where most apicoectomies are performed. In order to ensure optimal wound healing, the incision must be made at a distance from the presumed borders of the bony defect, so that the flap is repositioned over healthy bone. If there is an extensive bony defect, especially towards the alveolar crest, then the triangular or trapezoidal flap is preferred. It must be noted that the pathological lesion, which has perforated the bone and has become attached to the periosteum, must be separated from the flap with a scalpel. In case of a fistula, the fistulous tract must also be excised near the bone, because, if it is excised at the mucosa, then there is risk of even greater perforation, resulting in disturbances of the healing process.

When the apicoectomy is performed at the anterior region (e.g., maxillary lateral incisor) and there is an extensive bony defect near the alveolar crest (Figs. 13.7, 13.8), the surgical procedure is performed using a trapezoidal flap. The incision for creating the flap begins at the mesial aspect of the central incisor and, after continuing around the cervical lines of the teeth, ends at the distal aspect of the canine. With a periosteal elevator, the mucoperiosteum is then carefully reflected upwards (Figs. 13.9, 13.10).

Localization and Exposure of Apex. The next step after creating a flap is localization and exposure of the apex. When the periapical lesion has perforated the buccal bone, localization and exposure of the root tip is easy, after removing the pathological tissues with a curette. If the buccal bone covering the lesion has not been completely destroyed, but is very thin, then its surface is detected with an explorer or dental curette, whereupon, due to decreased bone density, the underlying bone is easily removed and the apex localized. When the buccal bone remains completely intact, then the root tip may be located with a radiograph. More specifically, after taking a radiograph, the length of the root is determined with a sterilized endodontic file or metal endodontic ruler. The length measured is then transferred to the surgical field, determining the exact position of the root tip. Afterwards, with a round bur and a steady stream of saline solution, the bone covering the root tip is removed peripherally, creating an osseous window until the apex of the tooth is exposed (Fig. 13.11). If the overlying bone is thin and the pathological lesion is large, the osseous window is enlarged with a blunt bur or a rongeur. Enough bone is removed until easy access to the entire lesion is permitted. A curette is then used to remove pathological tissue and every foreign body or filling material, while resection of the root tip follows (Fig. 13.12).

Resection of Apex of Tooth. The apex is resected (2–3 mm of the total root length) with a narrow fissure bur and beveled at a 45° angle to the long axis of the tooth (Fig. 13.13). For the best possible visualization of the root tip (Fig. 13.14), the beveled surface must be facing the dental surgeon. After this procedure, the cavity is inspected and all pathological tissue is meticulously removed by curettage, especially in the area behind the apex of the tooth. If the entire root canal is not completely filled with filling material or if the seal is inadequate, then retrograde filling is deemed necessary.

Retrograde Filling. After beveling of the apex and curettage of periapical tissues, gauze impregnated with adrenaline to minimize bleeding is placed in the bony defect. A microhead handpiece with a narrow round microbur is then used to prepare a cavity approximately 2 mm long, with a diameter slightly larger than that of the root canal (Fig. 13.15). The cavity may be enlarged at its base using an inverted cone-shaped bur to undercut the preparation for better retention of the filling material (Fig. 13.16). During preparation of the cavity, the dentist must pay careful attention to the width of the cavity, which must be as narrow as possible, because there is a risk of weakening the root tip and causing a fracture (which may not even be perceived) during condensing. After drying the bone cavity with gauze or a cotton pellet, sterile gauze is packed inside the bone deficit and around the apex of the

## Apicoectomy with Trapezoidal Flap
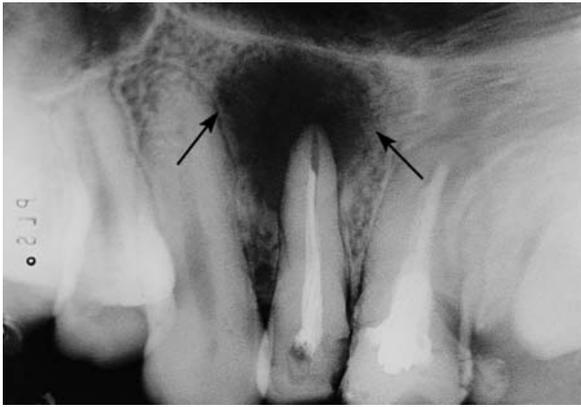
Fig. 13.7. Extensive periapical lesion at maxillary right lateral incisor. Indication for apicoectomy

Fig. 13.8. Clinical photograph of case shown in Fig. 13.7. *Arrow* points to possible location of lesion

Fig. 13.9 a, b. Surgical procedure for removal of periapical lesion, together with apicoectomy at lateral incisor of maxilla. Incision for creation of trapezoidal flap. **a** Diagrammatic illustration. **b** Clinical photograph
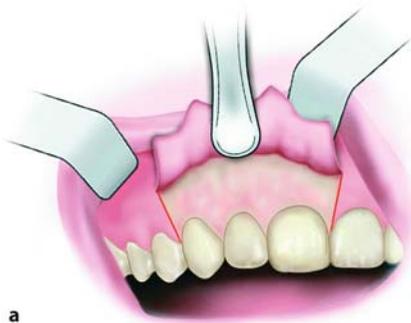
Fig. 13.10 a, b. Reflection of mucoperiosteum and exposure of labial alveolar plate after elevation of flap. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 13.11 a, b. Removal of labial bone covering apical third of root. **a** Diagrammatic illustration. **b** Clinical photograph
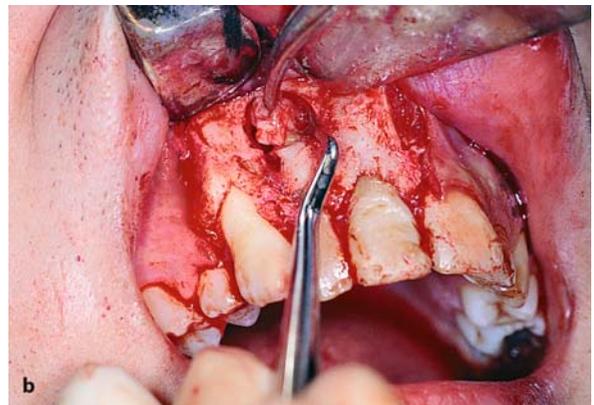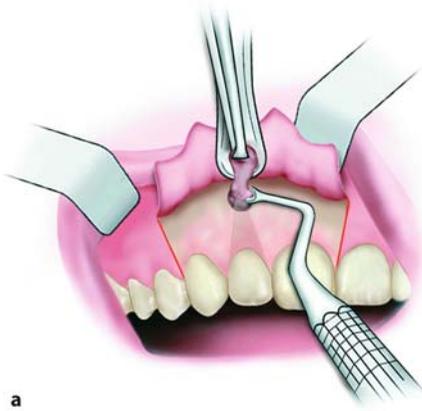
Fig. 13.12 a, b. Removal of periapical lesion with hemostat and curette. **a** Diagrammatic illustration. **b** Clinical photograph
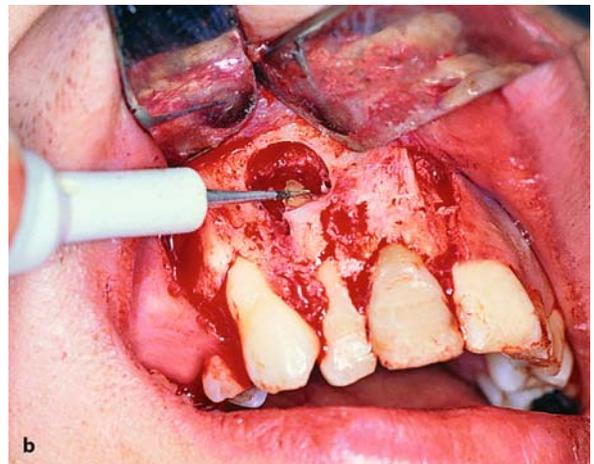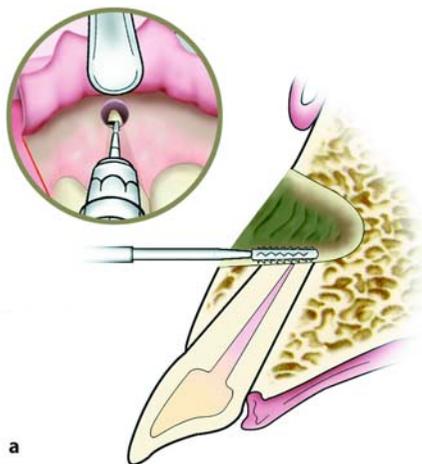
Fig. 13.13 a, b. Resection of apex with fissure bur and beveling at a 45° angle. The resection faces the surgeon and is at a distance of 2–3 mm from the root tip
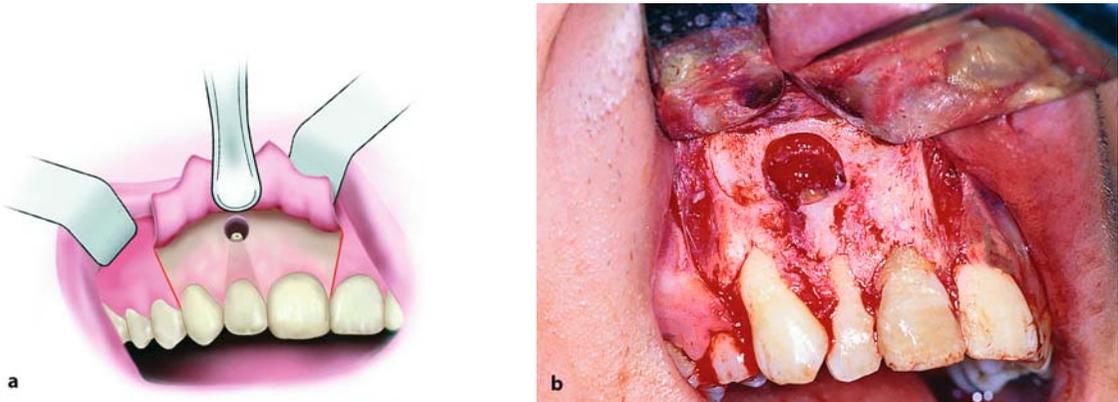
Fig. 13.14 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) showing beveled root of lateral incisor
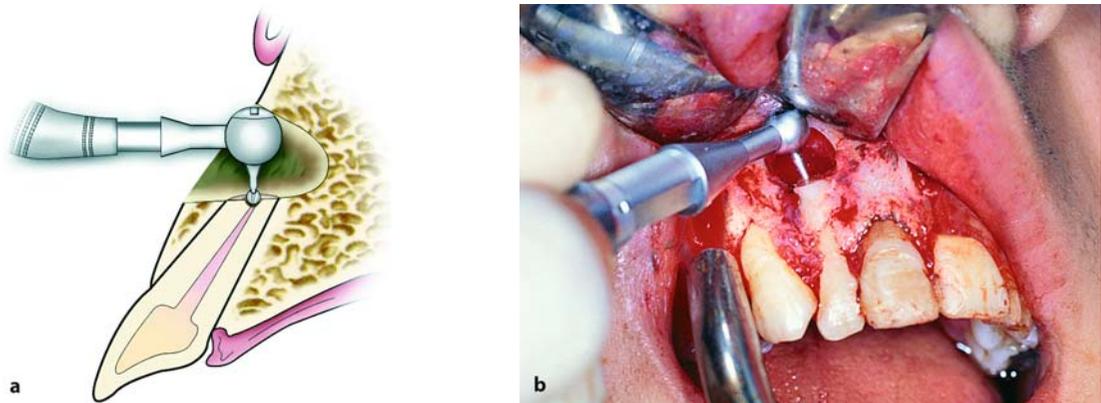
Fig. 13.15 a, b. Preparation of cavity at root tip of tooth using microhead handpiece. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 13.16 a, b. Cavity created (inverted cone-shaped) where filling material is to be placed. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 13.17 a, b. Placement of filling material in cavity of apex using miniaturized amalgam applicator. **a** Diagrammatic illustration. **b** Clinical photograph
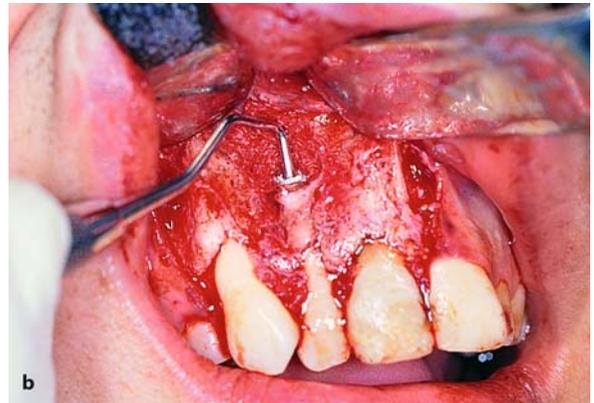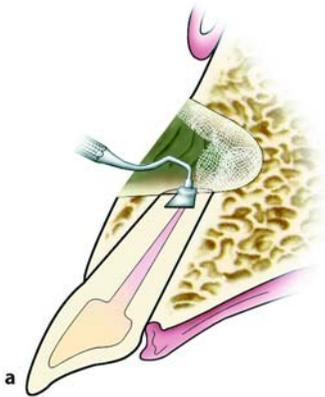
Fig. 13.18 a, b. Condensing of amalgam with narrow amalgam condenser. **a** Diagrammatic illustration. **b** Clinical photograph
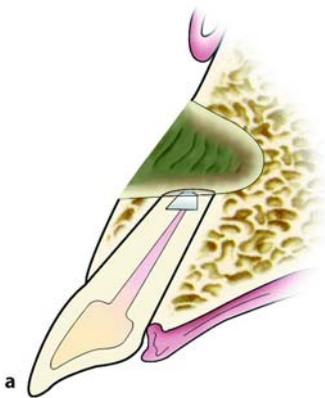
Fig. 13.19 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) showing the apex of the tooth with retrograde filling complete
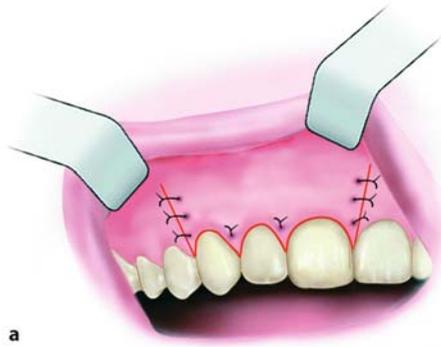
Fig. 13.20 a, b. Operation site and placement of sutures. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 13.21. Radiograph taken before suturing of flap, which shows retrograde amalgam filling

tooth, in such a way that only the prepared cavity of the root end is exposed. Splattering of amalgam[1] is thus avoided at the periapical region. The amalgam is placed inside the cavity with the miniaturized amalgam applicator and is condensed with the narrow amalgam condenser (Figs. 13.17, 13.18). The excess amalgam is carefully removed and the filling is smoothed with the usual instruments (Fig. 13.19).

Wound Cleansing and Suturing of Flap. After placement of the amalgam, the gauze is carefully removed from the bony defect and, after copious irrigation with saline solution, a radiographic examination is performed to determine if there is amalgam splattering in the surrounding tissues. The flap is repositioned and interrupted sutures are placed (Figs. 13.20, 13.21). Healing of the periapical area is checked every 6–12 months radiographically, until ossification of the cavity is ascertained. In order to evaluate the result, a preoperative radiograph is necessary, which will be compared to the postoperative radiographs later.

When apicoectomy is performed in the anterior region (e.g., maxillary central incisor) and the size of the lesion is small, and when there are esthetic crowns on the anterior teeth, the semilunar flap is preferred.

The procedure in such a case is similar to that of the previously mentioned surgical procedure employing the trapezoidal flap (Figs. 13.22–13.35).

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1) Amalgam is the most commonly used retrograde filling material. Recently, though, IRM and Super-EBA cement have been considered choice materials, with preparation of the cavity being performed in exactly the same way as that for amalgam.

Apicoectomy with Semilunar Flap

Fig. 13.22. Radiograph of maxillary central incisor, showing periapical lesion and unsatisfactory filling of the root canal


Fig. 13.23. Clinical photograph of the case shown in Fig. 13.22

Fig. 13.24 a, b. Surgical procedure for apicoectomy at maxillary left central incisor. Semilunar incision made for flap. **a** Diagrammatic illustration. **b** Clinical photograph
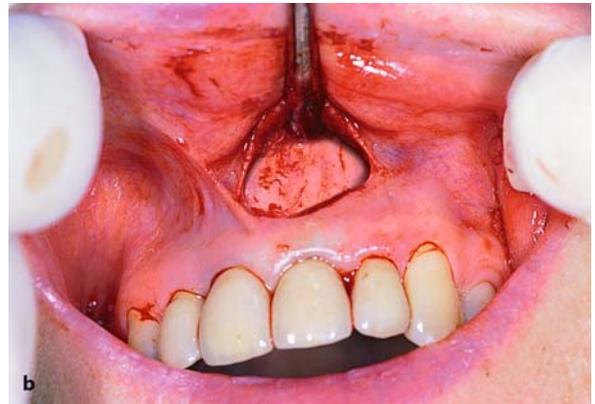

Fig. 13.25 a, b. Reflection of flap and retraction with broad end of periosteal elevator. **a** Diagrammatic illustration. **b** Clinical photograph
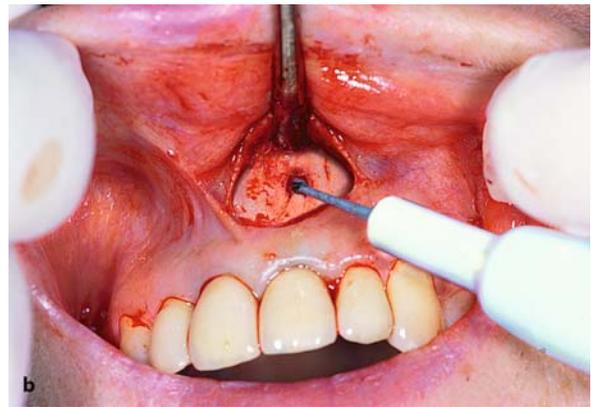
Fig. 13.26 a, b. Removal of bone covering apex of tooth. **a** Diagrammatic illustration. **b** Clinical photograph
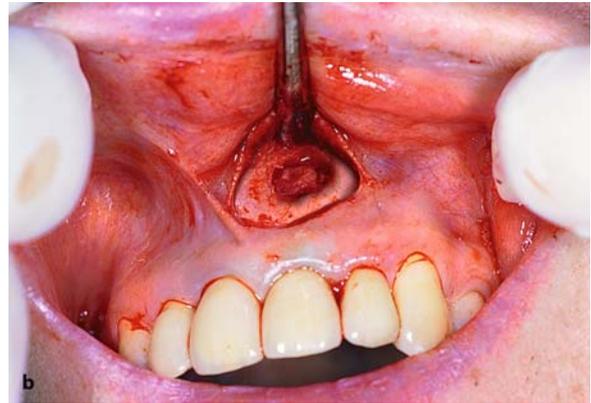
Fig. 13.27 a, b. Exposing periapical lesion and apex of tooth together after removal of respective buccal bone. **a** Diagrammatic illustration. **b** Clinical photograph
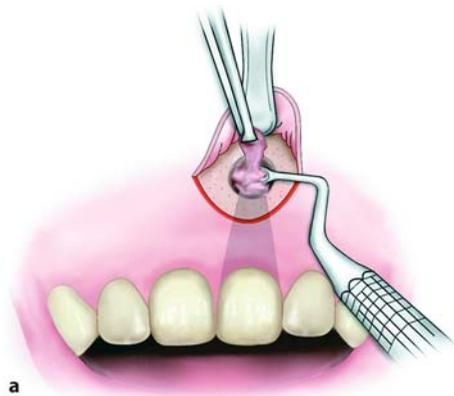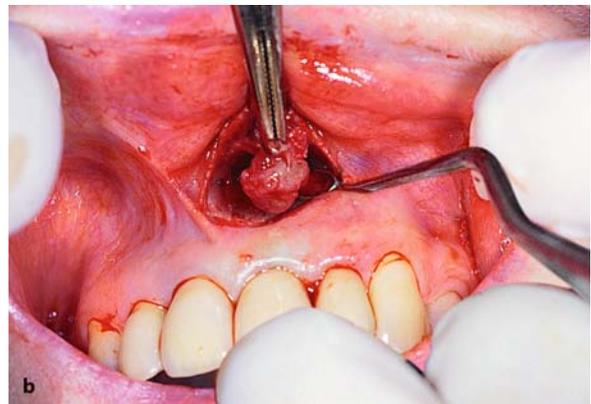
Fig. 13.28 a, b. Removal of periapical lesion with hemostat and periapical curette. **a** Diagrammatic illustration. **b** Clinical photograph
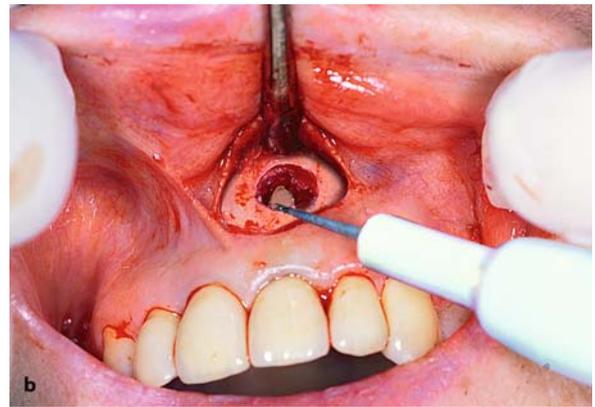
Fig. 13.29 a, b. Resection of apex of tooth at a 45° angle. **a** Diagrammatic illustration. **b** Clinical photograph


Fig. 13.30 a, b. Preparation of cavity at apex with microhead handpiece. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 13.31 a, b. Diagrammatic illustration (**a**) and clinical photograph (**b**) showing prepared cavity ready for placement of filling
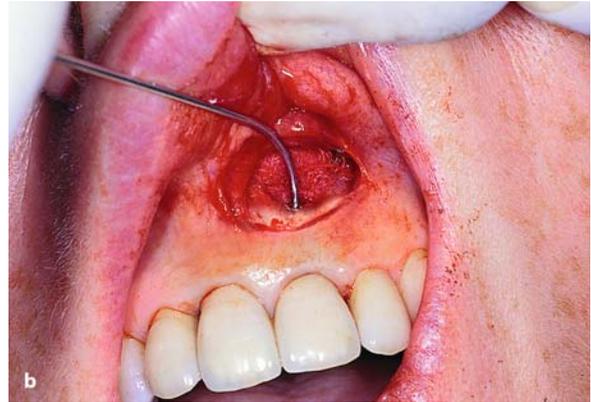
Fig. 13.32 a, b. Placement of filling at root tip with miniaturized amalgam applicator. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 13.33 a, b. Condensing amalgam at periapical cavity with narrow amalgam condenser. **a** Diagrammatic illustration. **b** Clinical photograph


Fig. 13.34 a, b. Operation site after placement of sutures. **a** Diagrammatic illustration. **b** Clinical photograph
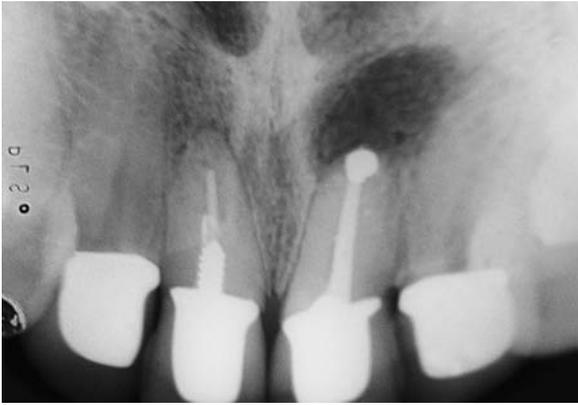
Fig. 13.35. Periapical radiograph taken after suturing of flap, showing retrograde amalgam filling

Fig. 13.36. Amalgam splatter at operation site, as a result of improper manipulations for removal of excess material

13.5
Complications

The most common perioperative and postoperative complications that may occur during and after the surgical procedure, respectively, are:

- Damage to the anatomic structures in case of penetration of the nasal cavity, maxillary sinus and mandibular canal with the bur.
- Bleeding from the greater palatine artery during apicoectomy of palatal root.
- Splattering of amalgam at the operation site, due to inadequate apical isolation and improper manipulations for removal of excess filling material (Fig. 13.36).
- Staining of mucosa due to amalgam that remained at the surgical field (amalgam tattoo) (Figs. 13.37, 13.38).
- Healing disturbances, if the semilunar incision is made over the bony deficit (Fig. 13.39) or if the flap, after reapproximation, is not positioned on healthy bone.
- Dislodged filling material due to superficial placement, as a result of insufficient preparation of apical cavity (Fig. 13.40).
- Incomplete root resection, due to insufficient access or visualization and misjudged length of root (Fig. 13.41). As a result, the apical portion of the root remains in position and the retrograde filling is placed improperly, with all the resulting consequences.

Fig. 13.37. Staining of mucosa due to amalgam that remained at surgical field after apicoectomy (amalgam tattoo)

Fig. 13.38. Periapical radiograph of the case shown in Fig. 13.37

Fig. 13.39. Wound dehiscence, as a result of improper design of semilunar incision

Fig. 13.40. Malpositioned retrograde obturation material, due to insufficient preparation of apical cavity
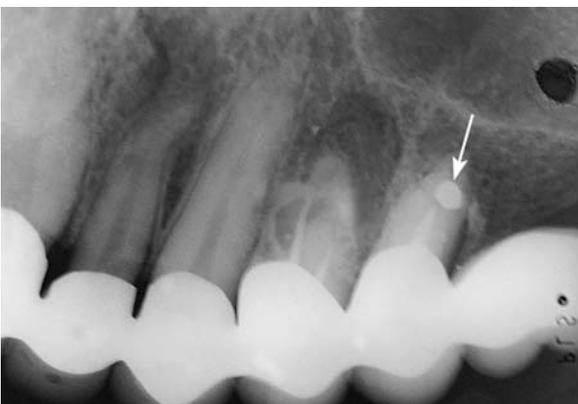
Fig. 13.41. Periapical radiograph showing unsatisfactory apicoectomy at maxillary second premolar, due to failure to define root before resection

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Surgical Treatment of Salivary Gland Lesions

14

F. D. Fragiskos

The most common surgical procedures for lesions associated with salivary glands and which may be performed with local anesthesia at the dental office are the removal of sialoliths from the ducts of glands and the removal of retention cysts.

14.1
Removal of Sialolith from Duct of Submandibular Gland

Sialolithiasis may occur in the ducts of large salivary glands or in the parenchyma of the glands themselves. Of these glands, the submandibular is the most common site of occurrence (70–80%) compared to the parotid and sublingual glands. Fifty per cent of sialoliths (stones) of the submandibular gland are located at the anterior portion and the middle of the gland, another 35% at its posterior portion, and the remaining 15% inside the gland itself. Sialolithiasis is the most common cause of inflammation of the gland, resulting in sialadenitis. If this condition is not treated, it becomes chronic with frequent recurrences, and may lead to destruction of the gland.

The main symptoms characterizing obstruction of the duct are pain and transient swelling of the respective salivary gland during meals. These symptoms are the result of increased saliva production during mastication, which – understandably enough, due to obstruction of the duct – is not secreted into the oral cavity.

The first clinical symptom is acute pain that occurs at the region of the gland and which is usually milder in the case of partial obstruction and more severe when obstruction is complete. Many times, the pain reflects to the floor of the mouth, tongue, pharynx, and cervical area. Swelling of the gland follows, which, depending on the amount of obstruction, gradually subsides after mealtimes.

Diagnosis is made based on clinical and radiographic data. In between meals, redness and slight swelling at the mucosa are observed, along the duct. The presence of a sialolith is also confirmed by bimanual palpation. More specifically, the index finger of one

hand is placed at the floor of the mouth, while the fingers of the other hand are placed at the submandibular area, simultaneously palpating the duct of the submandibular salivary gland in a posteroanterior direction. With this manipulation, a hard, semi-round moveable swelling presenting tenderness is ascertained. A fundamental diagnostic aid is the occlusal radiograph. In difficult and doubtful situations, a sialogram and ultrasonic examination are considered necessary.

Treatment is surgical and consists of excision of the sialolith from the duct.

Surgical Technique. The case presented involves a sialolith located inside the duct of the submandibular salivary gland (Figs. 14.1–14.3 a). The procedure for its removal is as follows. After local anesthesia, an incision is made on the mucosa of the floor of the mouth


Fig. 14.1. Occlusal radiograph showing sialolith in duct of submandibular salivary gland
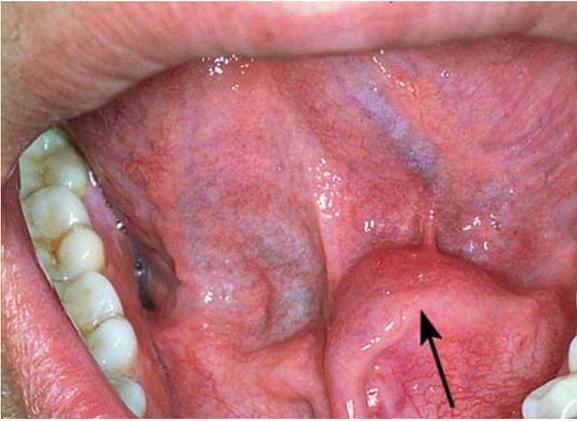
Fig. 14.2. Clinical photograph of case shown in Fig. 14.1. *Arrow* points to swelling as a result of the sialolith

along the length of the duct, while the floor of the mouth is extraorally simultaneously pushed upwards. The incision is 1–1.5 cm long and is made exactly over the position of the sialolith (Fig. 14.3 b). After localization and preparation of the duct, a traction suture is placed underneath the duct and posterior to the sialolith, to facilitate the incision procedure, but also to avoid distant displacement of the sialolith (Figs. 14.4, 14.5) (ligation may be also performed at the beginning, before the incision, as is shown in Fig. 14.3 b). Afterwards, the suture is retracted upwards and an incision is made at the duct along its long axis, resulting in spontaneous exposure of the sialolith, which is removed with a curette or a hemostat (Figs. 14.6, 14.7). The wound is then sutured with interrupted sutures at the mucosa only, without including the duct (Figs. 14.8, 14.9).
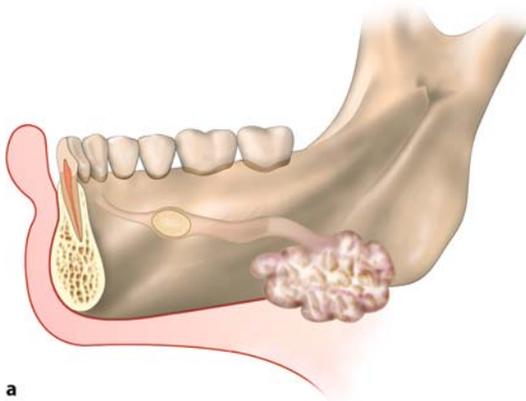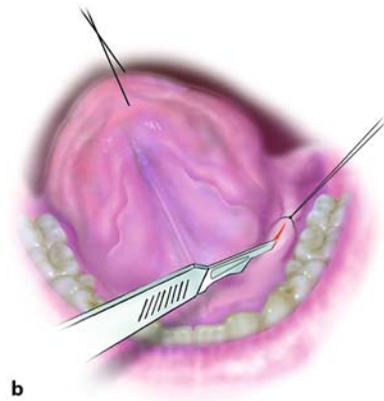
Fig. 14.3 a,b. Diagrammatic illustrations, showing: **a** the position of the sialolith in the duct, and **b** the incision on the mucosa, underneath which the sialolith is localized
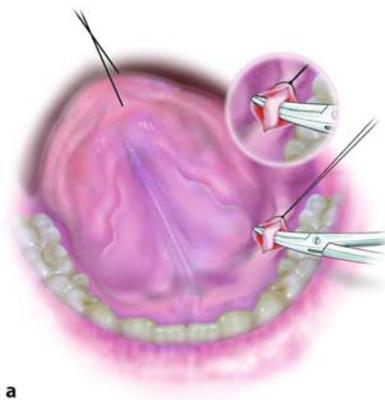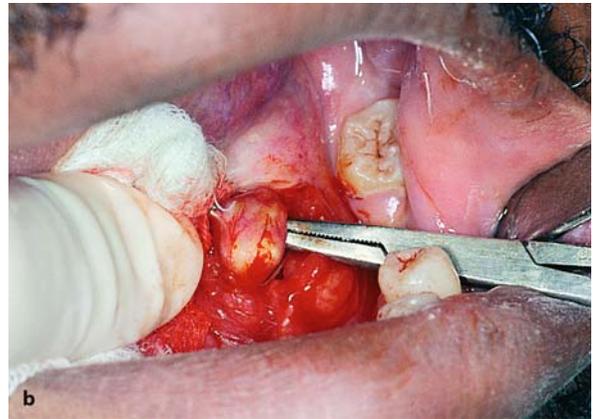

Fig. 14.4 a,b. Exposure and preparation of the duct of the salivary gland after incision on mucosa. **a** Diagrammatic illustration. **b** Clinical photograph
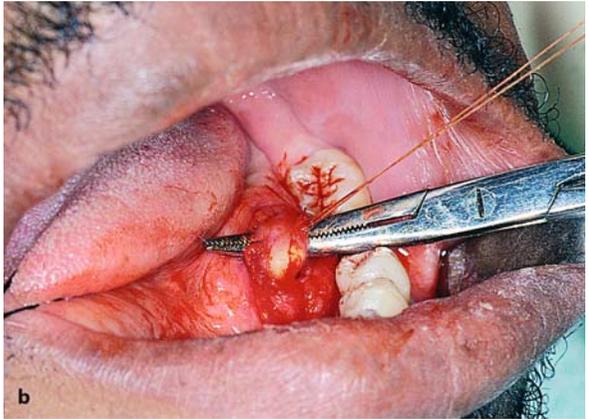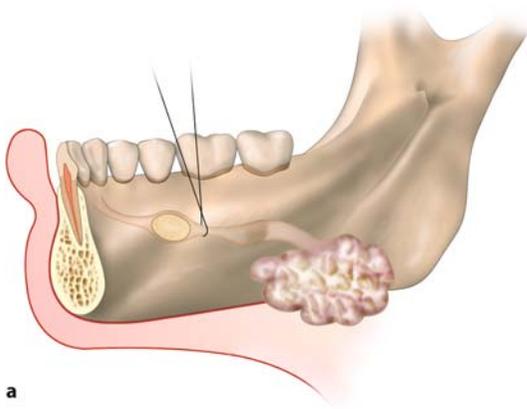
Fig. 14.5 a, b. Ligation of the duct posterior to the sialolith, in order to avoid distal displacement of the sialolith during surgical procedure. **a** Diagrammatic illustration. **b** Clinical photograph
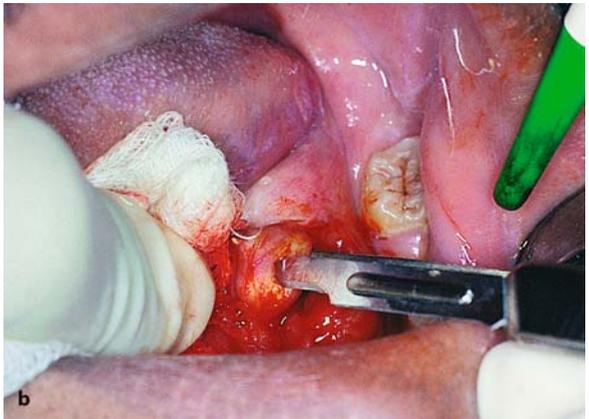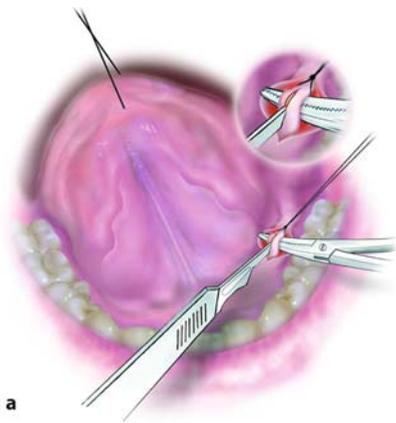

Fig. 14.6 a, b. Incision along the length of the duct where the sialolith is located. **a** Diagrammatic illustration. **b** Clinical photograph
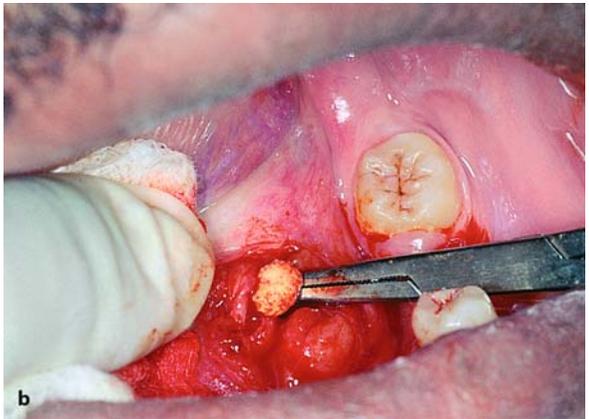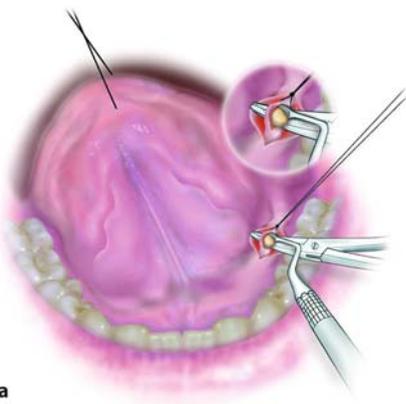

**Fig. 14.7 a, b.** Exposure and removal of the sialolith using hemostat and curette. **a** Diagrammatic illustration. **b** Clinical photograph
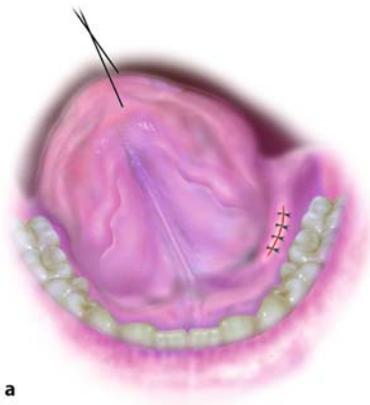
Fig. 14.8 a, b. Operation site after suturing. **a** Diagrammatic illustration. **b** Clinical photograph. The orifice of the duct is not sutured


Fig. 14.9. Sialolith after removal

During the surgical procedure, the dentist must pay particular attention to the proper preparation of the duct, in order to avoid risk of severance, which would result in chronic sialadenitis. Also, care must be taken when the sialolith is located in a posterior area, where the duct is in close proximity to the lingual nerve. Careful manipulations must also be performed in such a case with the aforementioned technique, because injury or severance of the nerve would result in permanent hypesthesia or anesthesia of the respective half of the tongue.

14.2
Removal of Mucus Cysts

The most common surgical procedures for removal of mucus cysts and which may be performed with local anesthesia at the dental office involve mucoceles and ranulas. These are both retention phenomena, essentially differing in localization only.

14.2.1
Mucocele

"Mucocele" is the clinical term used to describe the mucus extravasation phenomenon, as well as the mucus retention cyst. The mucus extravasation phenomenon is due to trauma of the minor salivary gland excretory duct, resulting in retention of saliva in the surrounding tissues, and is essentially classified as a false cyst, since it lacks an epithelial lining. This lesion mainly occurs at the mucosa of the lower lip, due to frequent biting, and may be superficial or deep in the tissues. The mucus retention cyst differs from the mucus extravasation phenomenon in that it is the result of obstruction of salivary flow, as well as being surrounded by granulation tissue.

Clinically, the lesion is painless and presents as a smooth round or oval swelling that fluctuates. Its color is normal or slightly bluish, and its size ranges from a few millimeters up to 2 cm (Fig. 14.10).

Treatment is surgical and entails excision of the lesion.

Surgical Technique. After local anesthesia, an elliptical incision is made on the mucosa around the cyst, in order to facilitate dissection of the lesion (Figs. 14.11–14.13). The superior wall of the cyst is grasped with a hemostat together with the overlying mucosa and is separated from the surrounding tissues (Figs. 14.14, 14.15) using scissors. During dissection care must be taken, because the cyst may easily rupture and shrivel, which will make removal difficult. In such a case, preparation may be facilitated if gauze is placed inside the erupted cystic cavity, so that the cavity is again expanded and restored to its previous condition. After removal of the lesion, the mucosa of the wound mar-
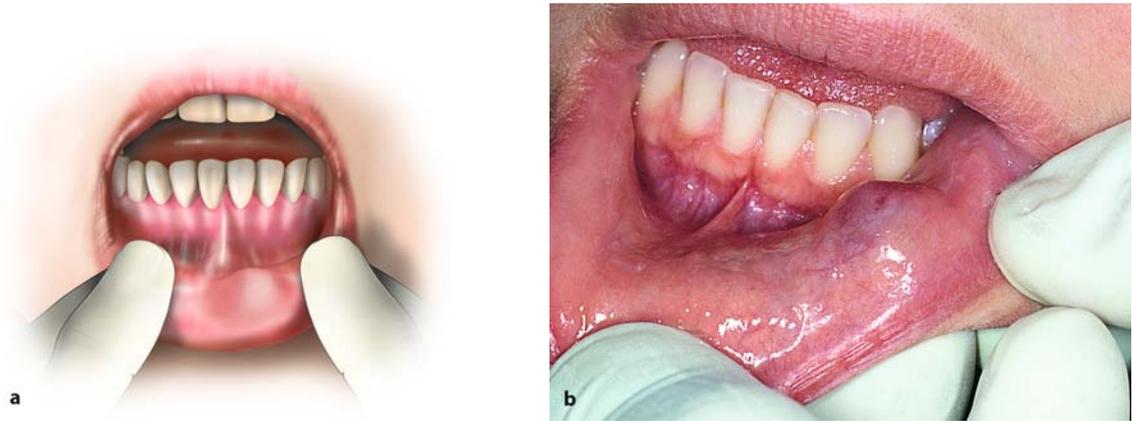
Fig. 14.10 a,b. Mucus extravasation phenomenon of the lower lip (mucocele). **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 14.11 a,b. Peripheral infiltration in normal tissues surrounding lesion
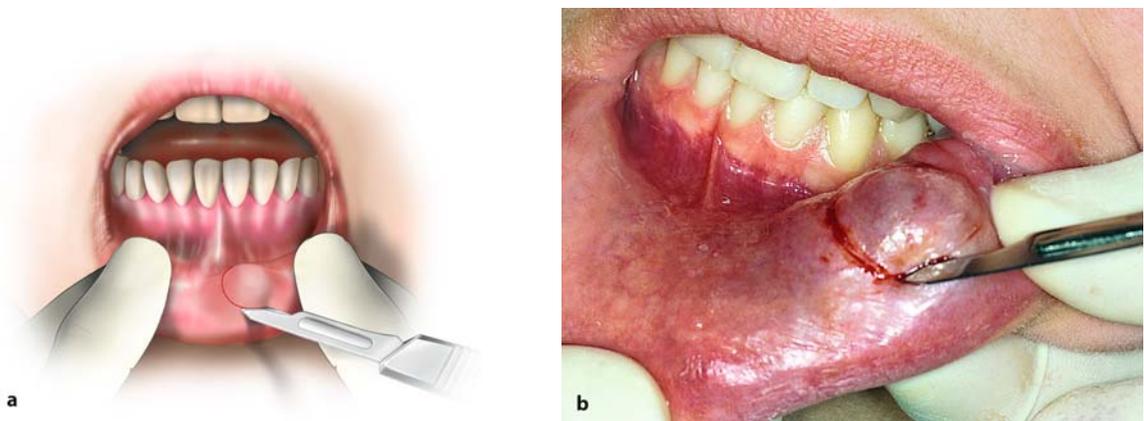

Fig. 14.12 a,b. Elliptical incision around cyst with scalpel. **a** Diagrammatic illustration. **b** Clinical photograph

gins are undermined and superficially sutured (only at the mucosa), avoiding injury to the underlying salivary glands (Figs. 14.16–14.18).
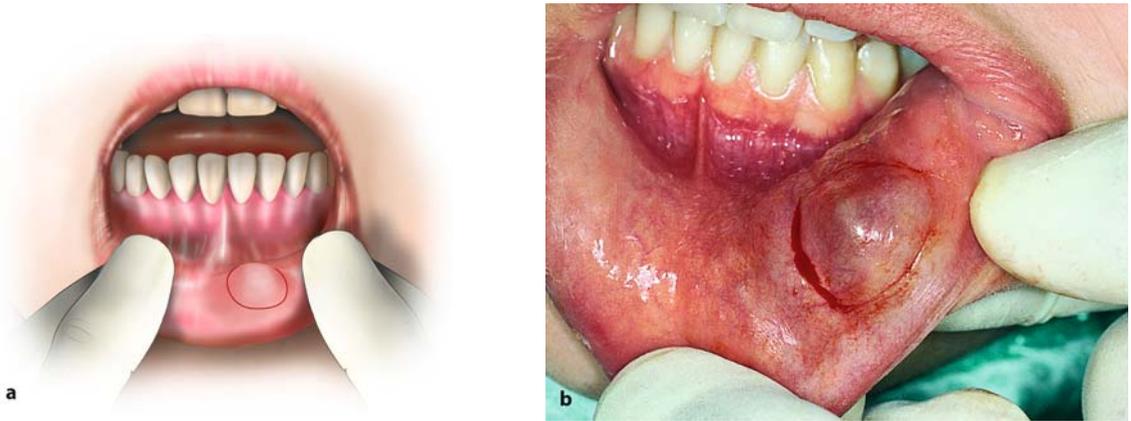
**Fig. 14.13 a, b.** Diagrammatic illustration (**a**) and clinical photograph (**b**) of completed incision
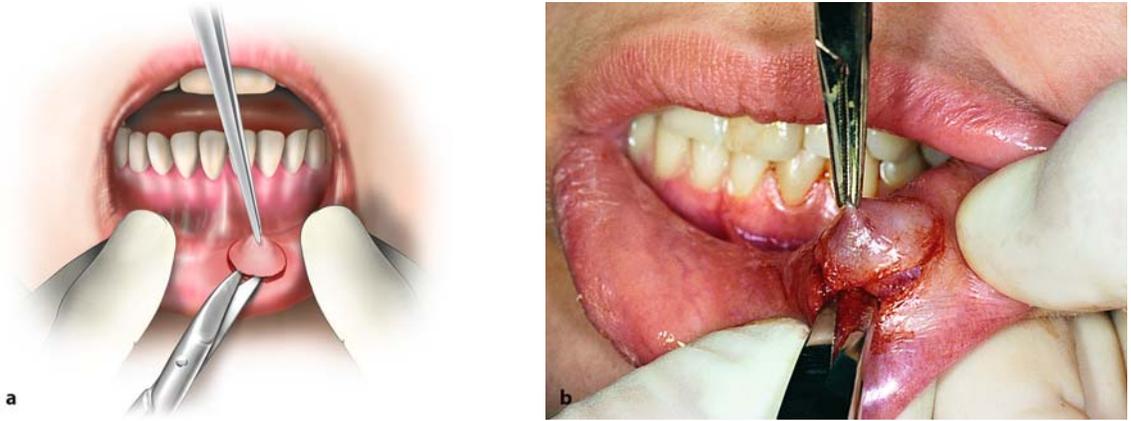
Fig. 14.14 a, b. Lesion is grasped with hemostat and is dissected using scissors. **a** Diagrammatic illustration. **b** Clinical photograph
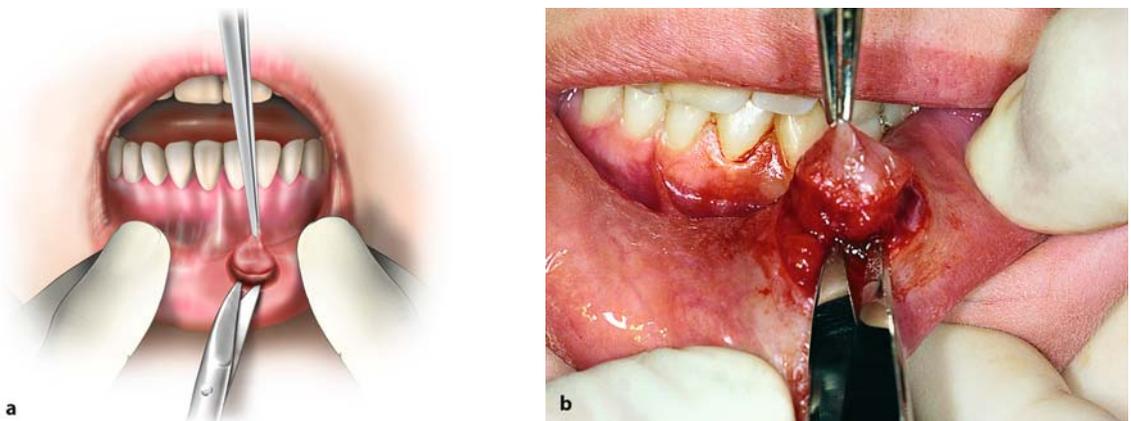

Fig. 14.15 a, b. Final step in removal of cyst from underlying soft tissues. **a** Diagrammatic illustration. **b** Clinical photograph
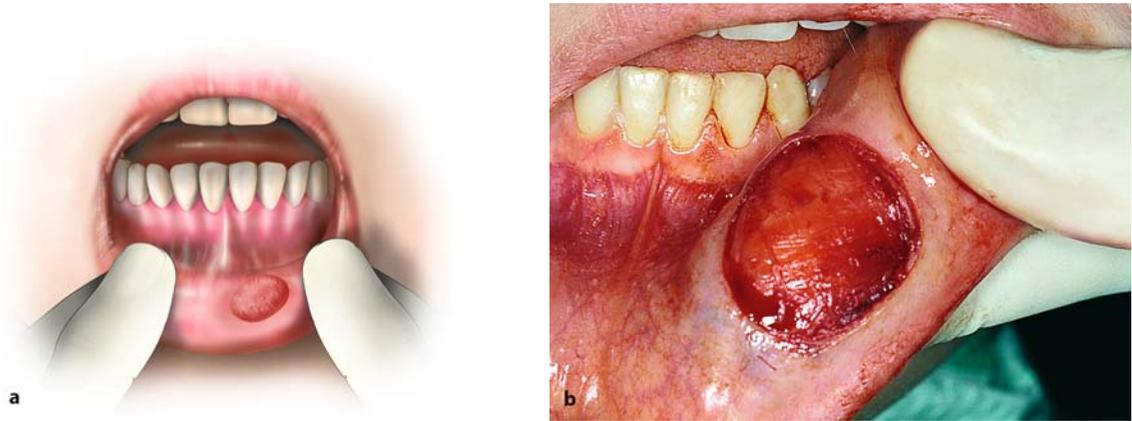
Fig. 14.16 a, b. Surgical field after removal of lesion. **a** Diagrammatic illustration. **b** Clinical photograph
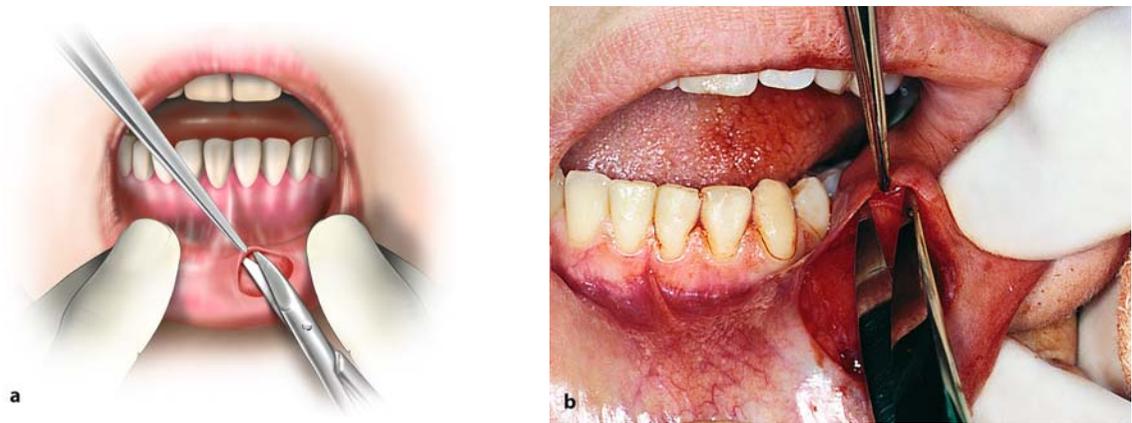

Fig. 14.17 a, b. Undermining of mucosa of wound margins with blunt scissors. **a** Diagrammatic illustration. **b** Clinical photograph
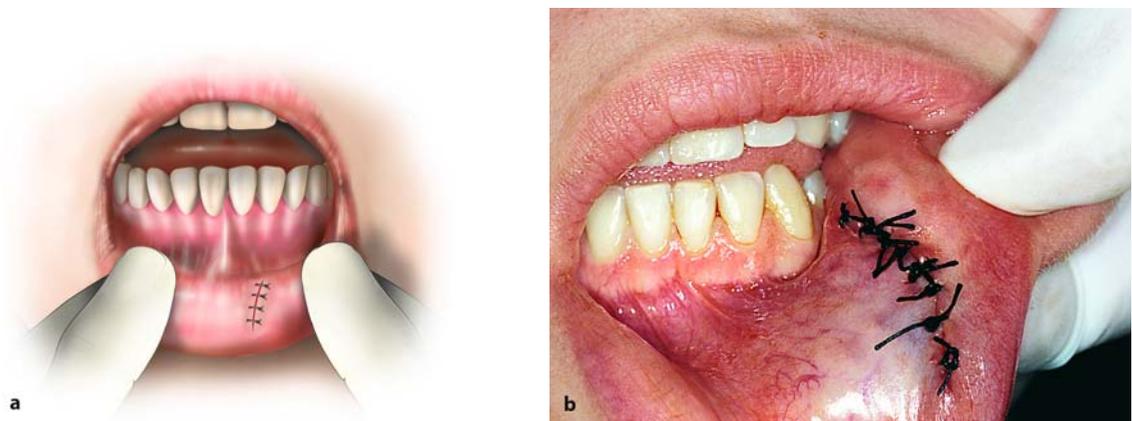

Fig. 14.18 a, b. Operation site after placement of sutures. **a** Diagrammatic illustration. **b** Clinical photograph

14.2.2
Ranula

This is essentially a retention cyst that is due to obstruction or trauma of the duct of the sublingual or submandibular salivary gland, resulting in extravasation and retention of mucus, thus presenting as a mucus retention cyst and the mucus extravasation phenomenon, respectively. The ranula is located in the floor of the mouth and is usually unilateral, with a diameter ranging 1–3 cm.

Clinically, it presents as a soft fluctuant swelling with a normal or bluish hue, and resembles a frog's belly (Fig. 14.19). It develops gradually and, depending on its size, may cause medial and superior deviation of the tongue, creating problems during speech, mastication, and deglutition. If it is large in size, it may progress in the deep tissues and cross the midline while projecting submandibularly and posteriorly. The wall of the cyst is very thin, and, when ruptured, extravasation of inspissated mucin occurs, resulting in shriveling of the cavity after evacuation of its contents.

The ranula is treated surgically, principally with the method of marsupialization.

Surgical Technique. After local anesthesia, the superior wall of the cyst is grasped with a hemostat and a circular incision is made, which includes the oral mucosa covering the lesion together with its superior wall (Fig. 14.20). After aspiration of the contents, the margins of the mucosa are sutured with the margins of the
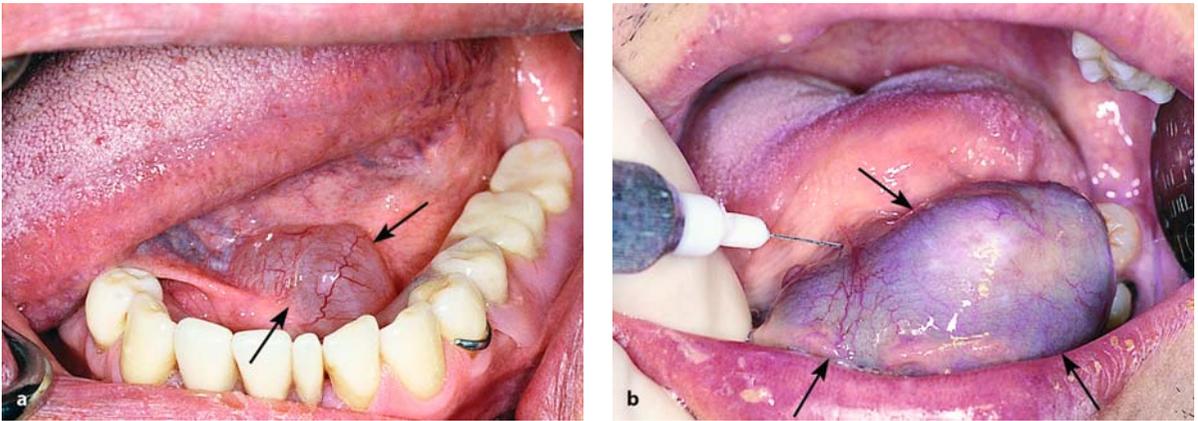

Fig. 14.19 a, b. Two cases of ranula, located at the left side of the floor of the mouth. **a** Small-sized lesion. **b** Large lesion
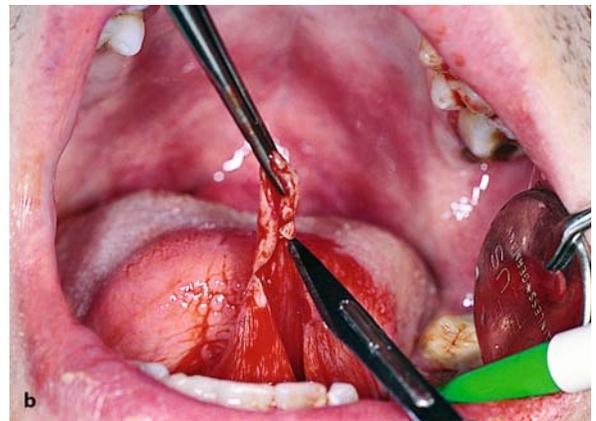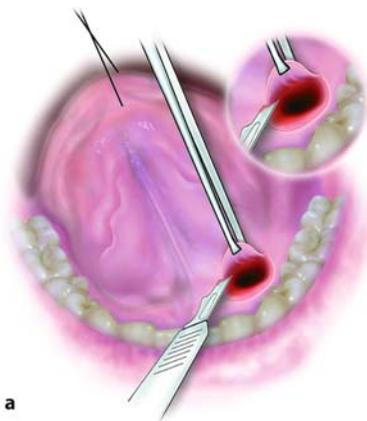

Fig. 14.20 a, b. Excision of portion of lesion includes the overlying oral mucosa and superficial wall of cyst. **a** Diagrammatic illustration. **b** Clinical photograph
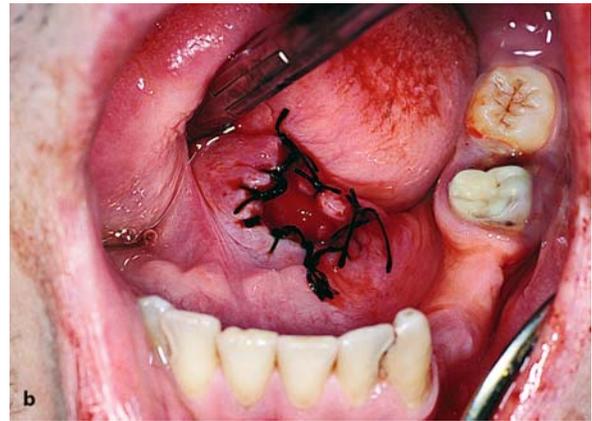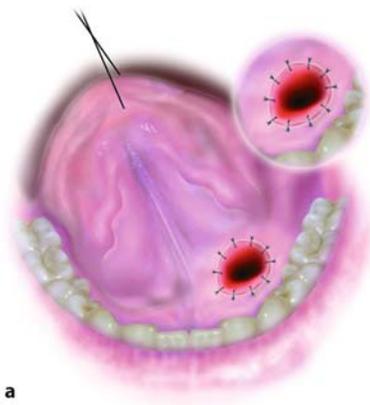
Fig. 14.21 a,b. Suturing of oral mucosa and margins of cystic wall with interrupted sutures. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 14.22. Clinical photograph taken 20 days after marsupialization of cyst

cyst peripherally, and the sutures remain in place for a week (Fig. 14.21). The wound remains open or is covered by iodoform gauze that is stabilized with sutures, while healing is achieved by secondary intention (Fig. 14.22).

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Osseointegrated Implants 15

F. D. Fragiskos, C. Alexandridis

Fixed prosthetic restoration in edentulous patients has concerned researchers for many years. Various types of implants were manufactured for this purpose, without yielding the expected results, while being criticized by many, mainly because of the infections they caused. For a long time, the placement of most implants was a failure. This failure was attributed to inadequate research data, but also to the fact that the whole implant procedure was not based on biological principles, which are mandatory for the long-term success of implants in the oral cavity.

Nowadays osseointegrated implants are used, which have been proven to be totally biocompatible.

Osseointegration refers to the immediate structural, biological, and functional connection between metal implants and healthy bone, without soft, noncalcified connective tissue intervening, so that the bone may remodel and adjust to the load-bearing implants.

15.1
Indications

The indications for placement of osseointegrated implants include:

- Patients who cannot be treated using other techniques (compromised retention of denture, defects of the jaw).
- Patients who benefit from dental implants compared to the conventional therapy (edentulous, shortened arch, single crowns, orthodontic retention).
- Patients who have comparable functional outcome using dental implants or a conventional therapy. In these cases subjective personal or esthetic reasons may justify the implant therapy.

15.2
Contraindications

The contraindications for placement of implants are the same as for all other dental surgical procedures.

15.3
Instruments

The instruments used for the placement of screw-type implants are the following:
1. Surgical micromotor with handpieces (Fig. 15.1)
2. Titanium and stainless steel instruments, which are separated and placed in a special tray during the surgical procedure (Fig. 15.2)

15.4
Surgical Procedure

The placement of osseointegrated implants includes two stages: the first is the principal surgical procedure of implanting, while the second entails exposure of the implants and installation of the abutments on the implant body, which will then support the prosthetic restoration.

The first stage includes the following:

Creation of Flap. In the edentulous mandible, and after administration of an inferior alveolar nerve block, an incision is made using a no. 15 scalpel blade at the depth of the mucolabial fold, which inclines towards the alveolar crest in the region of the mental foramina. The mucoperiosteum is reflected until the alveolar crest is exposed between the canines, while part of the alveolar crest is also exposed lingually.

In an edentulous maxilla, after administration of bilateral nerve blocks of the anterior superior alveolar nerve, nasopalatine nerve, as well as infiltration anes-

**Fig. 15.1.** Surgical micromotor appropriate for placement of implants
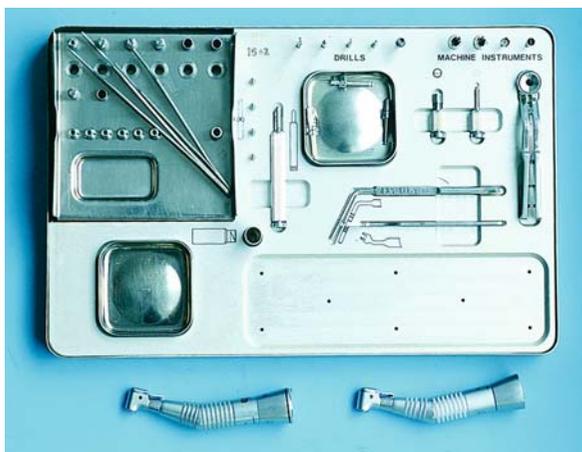
Fig. 15.2. Set of instruments for placement of osseointegrated implants

thesia labially or buccally and palatally, a straight incision is made labially or buccally, at two-thirds the height of the alveolar crest or on top of the crest itself. The incision then extends from the region of the right

first molar until the respective area of the opposite side (Fig. 15.3). The flap is adequately reflected towards the labial or buccal and palatal bone surface, so that there is adequate visualization and access to the surgical field (Fig. 15.4).

Preparation of Implant Recipient Site by Drilling at High Speed. The first bur used to prepare the bone is the round guide bur. This bur is used to initially drill (at high speed, approximately 2000 rpm) all of the implant recipient sites very carefully, after taking into consideration the anatomy and topography of the jaw area (Fig. 15.5). Drilling of the bone is performed with constant irrigation of saline solution, while the bur must move in an up-down direction, so that the saline solution may reach the depth of the implant recipient site. The bone chips are thus removed, while bone-damaging heat buildup is also prevented.

A spiral bur with a diameter of 2 mm is then used to prepare the implant recipient sites. There are markings on the surface of the bur indicating suitable preparation depths for the various implant recipient sites. The dentist must pay particular attention at this stage so that the bur is positioned in the right direction in order to avoid perforation of the bone buccally or palatally. A paralleling pin is then placed in the recipient site, serving as a guide for the gradual preparation of the rest of the recipient sites, so that they are parallel to each other (Fig. 15.6).

In some cases a pilot bur with a diameter of 2–3 mm can be used to widen the implant recipient sites, and the paralleling pins are successively removed (Fig. 15.7 a).

The next stage of widening the implant recipient sites is achieved using a longer twist bur, also with a diameter of 3 mm. The entire length of the recipient sites is widened with this bur and the paralleling pins are consecutively placed once again (Fig. 15.7 b, c).

A marginal countersink with a conical shape can often be used to prepare the shelf for installation of the implant (Fig. 15.8) if the implant site is in an esthetically relevant position.

Preparation of Threads in Implant Recipient Site by Drilling at Low Speed (Required by Only a Few Systems). This stage involves the preparation of threads inside the recipient site by drilling at low speed (15–20 rpm). The entire procedure is performed using the screw tap bur, which, after being inserted in the contra-angle handpiece, prepares the threads at the implant recipient site in bone, at a depth that corresponds to the length of the implant to be placed (Fig. 15.9).
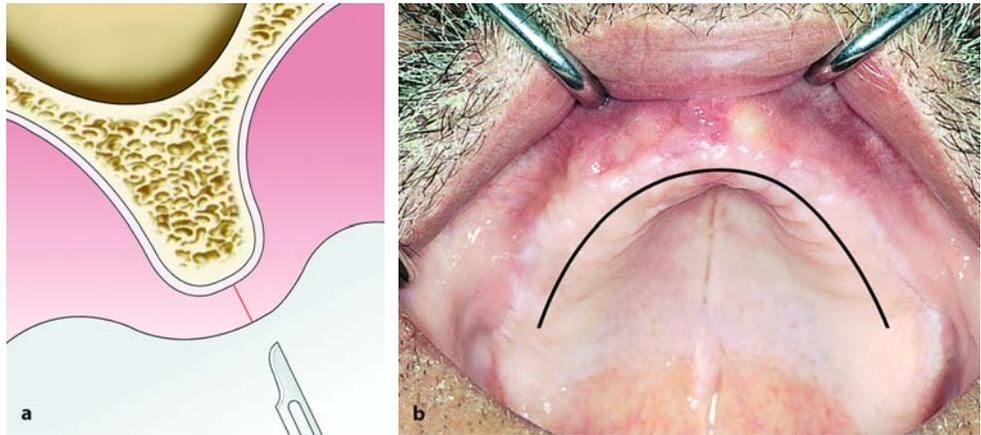
Fig. 15.3 a, b. Surgical procedure for placement of Branemark implants in maxilla. Diagrammatic illustration (**a**) and clinical photograph (**b**) showing planning of incision for creation of appropriate flap
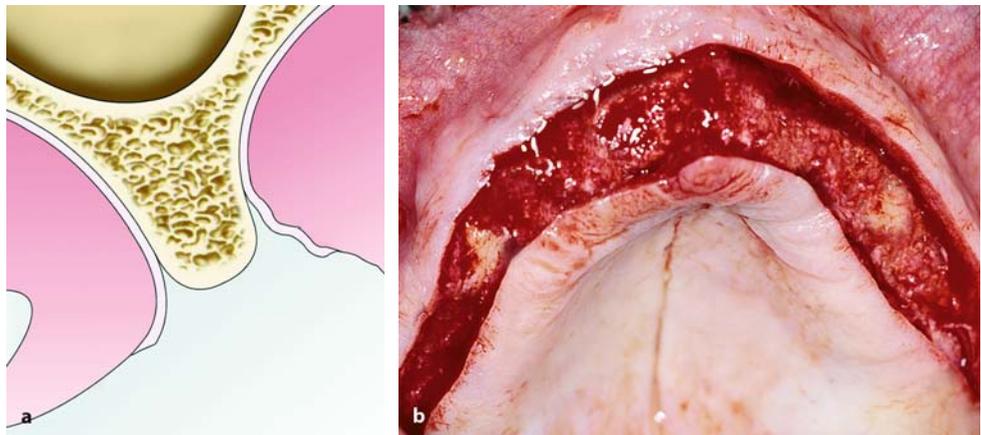

Fig. 15.4 a, b. Reflection of flap and exposure of bone where implants are to be placed. **a** Diagrammatic illustration. **b** Clinical photograph
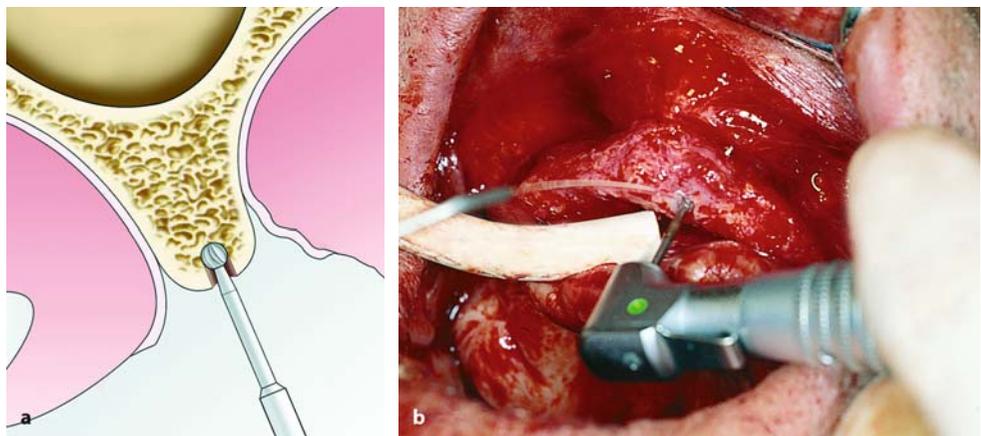

Fig. 15.5 a, b. Guide drill preparation at cortical bone using round bur. **a** Diagrammatic illustration. **b** Clinical photograph
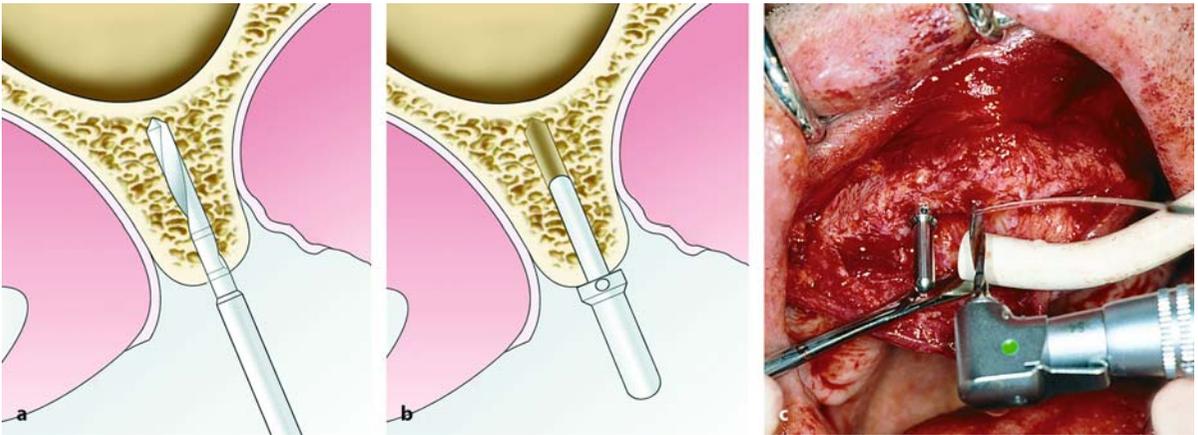
Fig. 15.6 a–c. Preparation of initial recipient site with a 2-mm-diameter bur and placement of paralleling pin. **a, b** Diagrammatic illustrations. **c** Clinical photograph
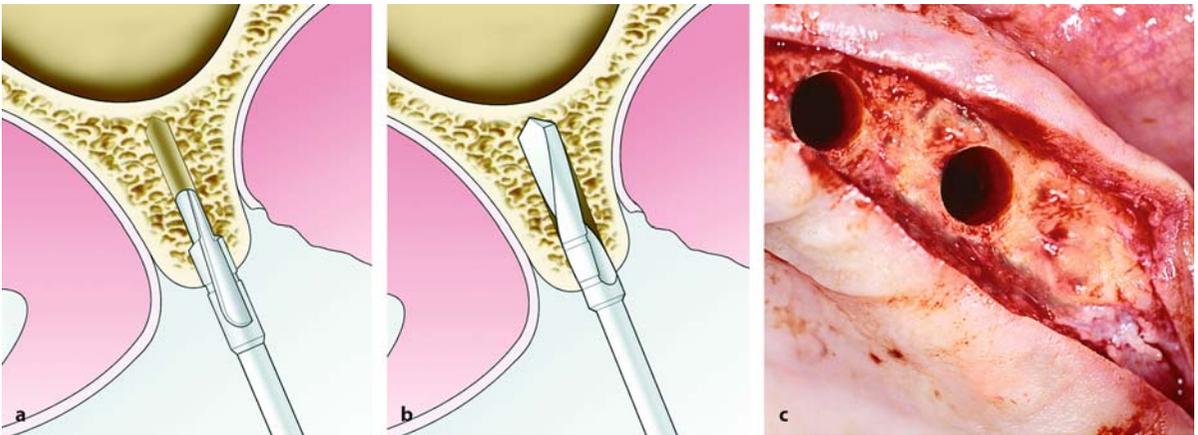
Fig. 15.7 a–c. a Initial widening of bone recipient site with a 3-mm pilot bur. **b, c** Completion of preparation of recipient site with 3-mm-diameter standard twist bur
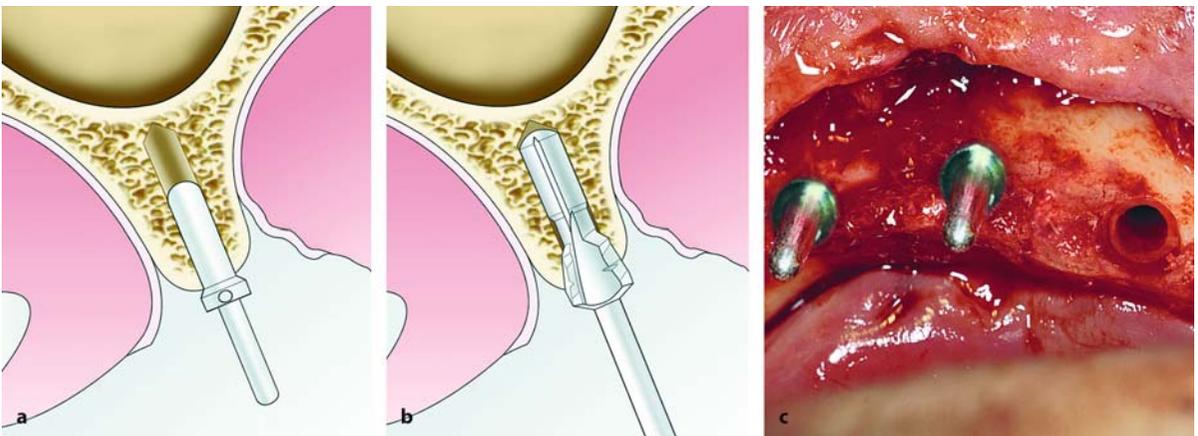
Fig. 15.8 a–c. Placement of respective paralleling pin at recipient site in bone, and creation of bevel or countersink margin with conical bur. This bur is used to prepare the shelf for the cervical portion of the implant within the marginal compact layer of bone. **a, b** Diagrammatic illustrations. **c** Clinical photograph
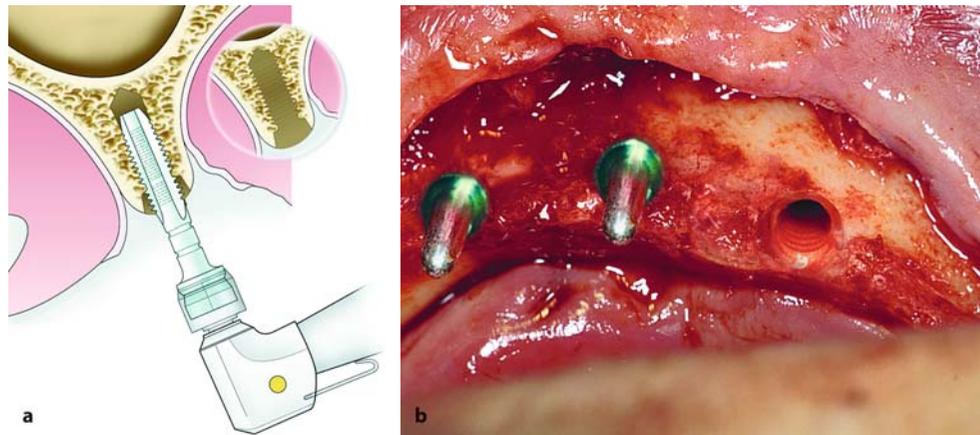
Fig. 15.9 a, b. Threaded implant recipient site prepared with screw tap bur. **a** Diagrammatic illustration. **b** Clinical photograph
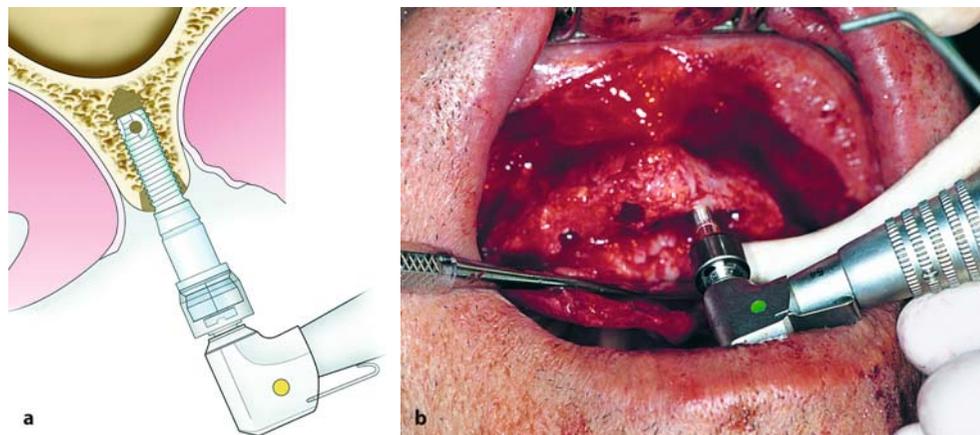

Fig. 15.10 a, b. Installation of implant by way of screwing into prepared recipient site at bone. **a** Diagrammatic illustration. **b** Clinical photograph

Installation of Implant and Placement of Cover Screw. In this step, the implant is adapted to the receiver of the implant mount, which has been placed in the low-speed contra-angle handpiece and is transferred to the implant recipient site. The first implant is placed in the left distal site. Irrigation with saline solution is not permitted until the lower border of the implant is installed well within the implant recipient site in the bone, so that the saline solution will not be compressed into the medullary bone by the implant. The implant is screwed into the bone without pressure, until the engine of the handpiece stops on its own (Fig. 15.10). Afterwards, a cylinder wrench is used to screw the implant manually as far as the deepest part of the recipient site (Fig. 15.11). The implant mount is removed either by hand using a screwdriver, or mechanically with a screwdriver attached to the low-speed contra-angle handpiece. A paralleling pin is screwed in the canal of the first implant installed, and the rest of the implants are then placed.

In the final step, a cover screw is placed, which covers the horizontal surface of each implant, thus preventing intervention or proliferation of the mucosal tissues inside the implant (Fig. 15.12). Final tightening must be done by hand, being careful that it is not so tight that removal is rendered difficult in the second stage of surgery. The same procedure is followed for the rest of the implants.

Copious irrigation with saline solution is then performed, and the flap is repositioned and sutured with interrupted sutures (Fig. 15.13). As for the surgical procedure, antibiotics are administered prophylactically (preoperatively), as well as analgesics for management of postoperative pain. The sutures are removed 7 days
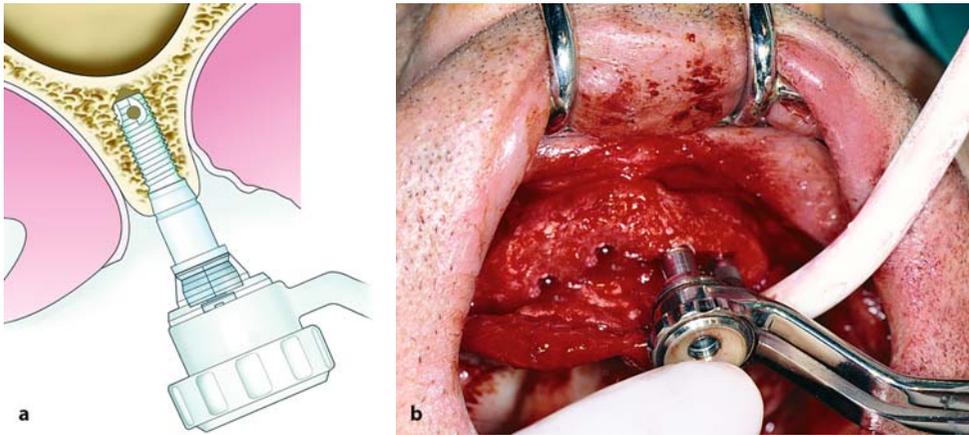
Fig. 15.11 a, b. Continuation of insertion manually with cylinder wrench, until implant reaches deepest part of recipient site. **a** Diagrammatic illustration. **b** Clinical photograph
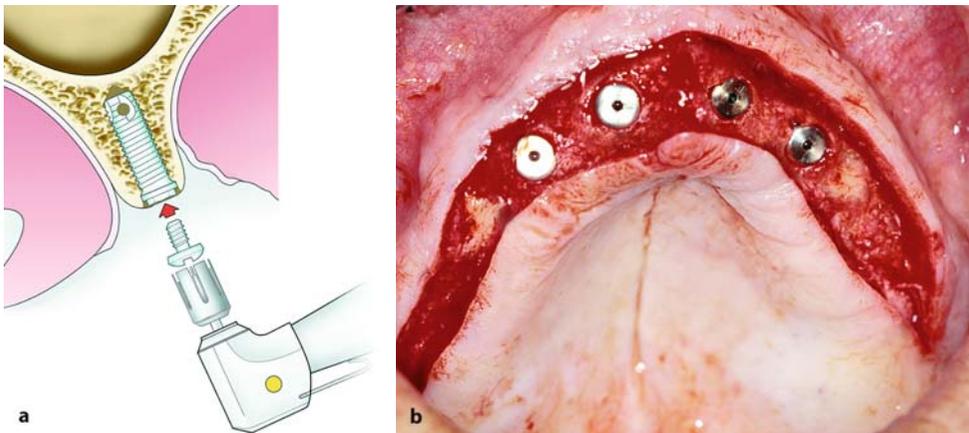
Fig. 15.12 a, b. Placement of cover screw over implant, to preventing intervention or proliferation of mucosal tissues inside implant. **a** Diagrammatic illustration. **b** Clinical photograph
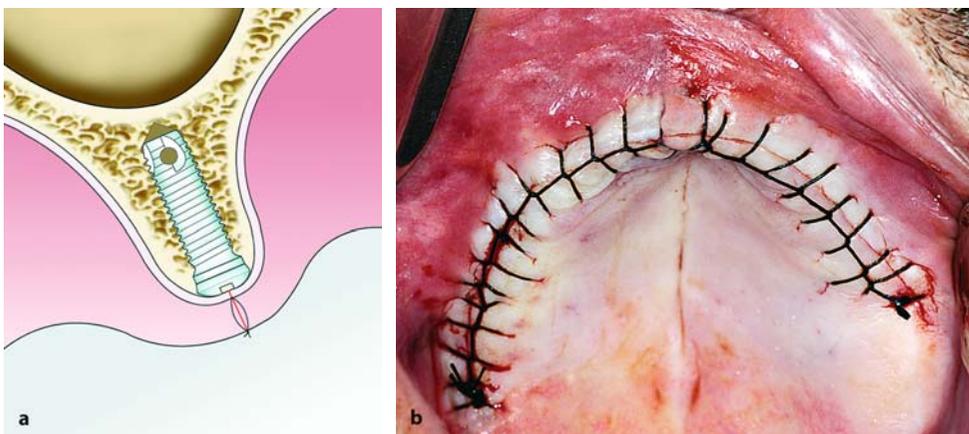

Fig. 15.13 a, b. Operation site after repositioning and suturing of flap. **a** Diagrammatic illustration. **b** Clinical photograph

after the operation. The healing phase varies depending on the primary stability of the implants and the prosthetic reconstruction. Immediate loading of implants often is possible in splinted restorations and in the hard bone of the mandible. Usually a healing time of 8 weeks is recommended by the manufacturers.

Abutment Connection. After the first-stage surgical procedure, the second phase of the surgical procedure follows, which involves the exposure of the implants and the placement of abutments on the implants.

After administration of local anesthesia, the position of the implants is identified with palpation and the cover screw is localized using an explorer. Exposure is achieved with a continuous incision on the alveolar mucosa, corresponding to the pre-calculated positions of the implants (Fig. 15.14). There are various methods used for uncovering of the implant, including the following. The soft tissues over the cover screw may be removed with a tissue punch (Fig. 15.15). This is easiest when the implant itself may be palpated, or if there is sufficient keratinized tissue. Its advantages include minimal trauma and very little discomfort for the patient. Other methods that may be employed are the full-thickness flap technique and the crestal incision. These methods also require sufficient attached tissue. They have the advantage of direct visualization of the bone area and not having to rely on tactile sense alone. If there is insufficient keratinized tissue, then the partial-thickness flap gingivectomy technique is used. This method is more painful and
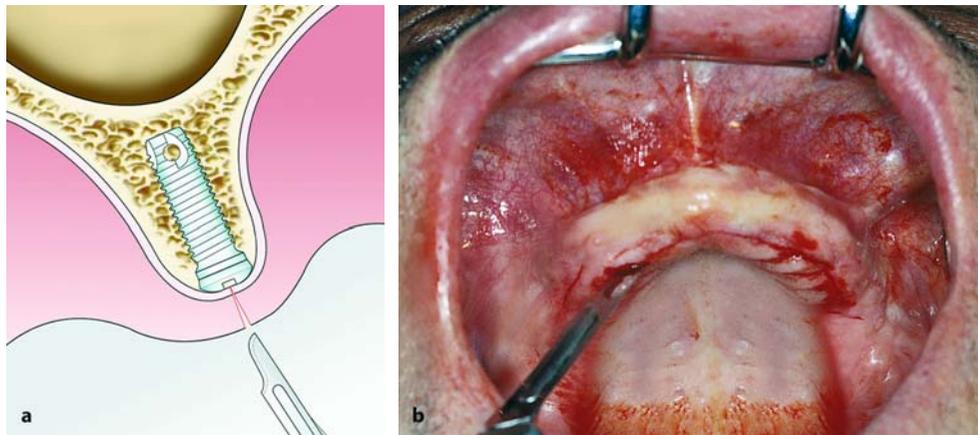

Fig. 15.14 a, b. Identification of position and exposure of implants. Incision along length of alveolar crest, respective to pre-calculated positions of implants. **a** Diagrammatic illustration. **b** Clinical photograph
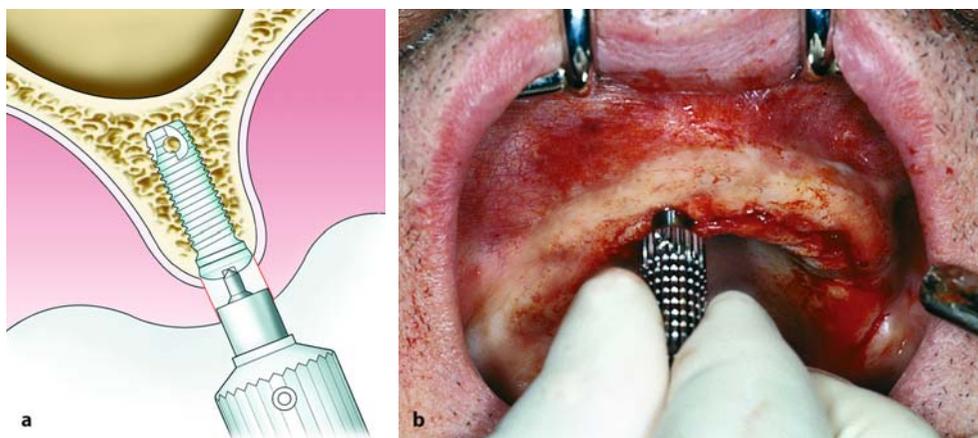

Fig. 15.15 a, b. Removal of soft tissue over cover screw with tissue punch. **a** Diagrammatic illustration. **b** Clinical photograph
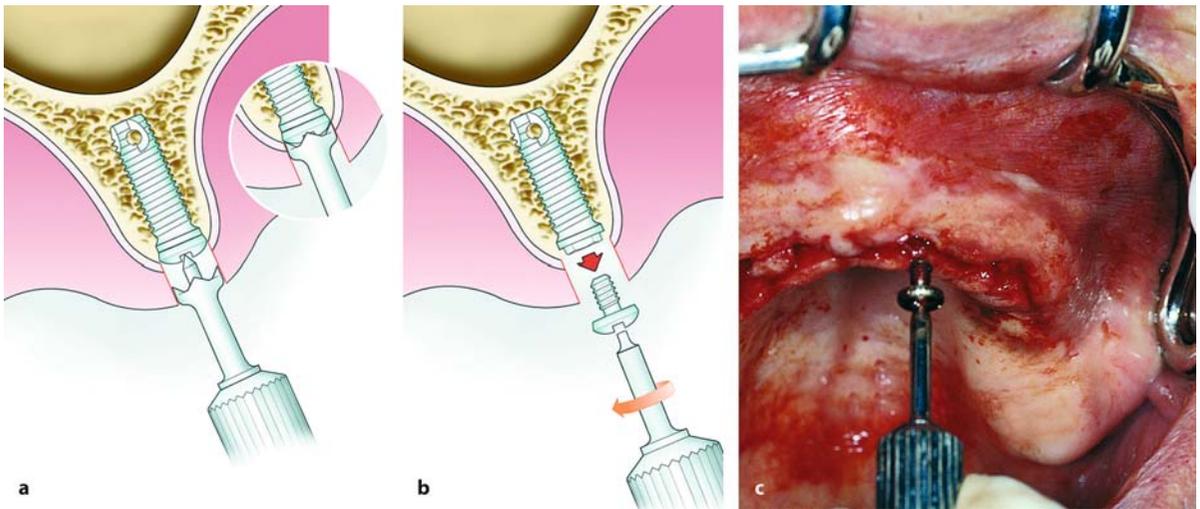
Fig. 15.16 a–c. a Removal of osseous overgrowth over cover screw with cover-screw mill. **b**, **c** Removal of cover screw manually with screwdriver
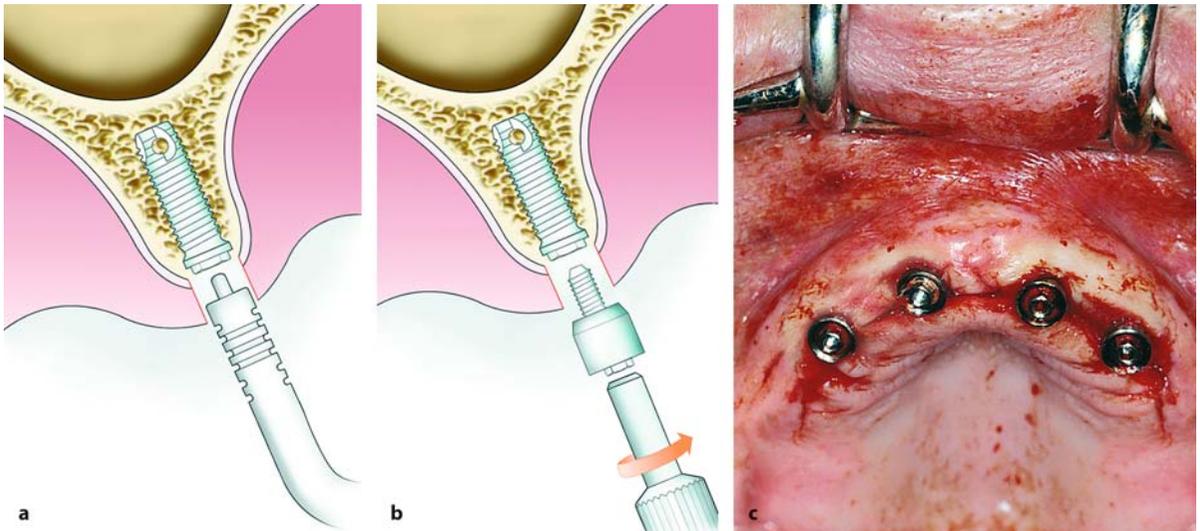
Fig. 15.17 a–c. a Selection of appropriate length of abutment is achieved with graded abutment probe; **b, c** abutment installed in canal of implant

requires longer healing time. Supraperiosteal flaps to gain fixed gingiva around the implant are thought to be advantageous. If osseous overgrowth is found over the screw, it is easily removed using a cover-screw mill (Fig. 15.16 a) and the screws are then removed manually with a screwdriver (Fig. 15.16 b, c). Any hard or soft tissues, which may intervene between the implant and the cover screw, must be removed in cases of external connections for the abutment (e.g., Branemark type), otherwise the precise and complete adaptation and seating of the abutment on the implant will be prevented (Fig. 15.17 a, b, c). Systems with internal connections (e.g., Strauman, Replace, Calmog) are not

critical for this problem. A healing abutment is used for 7–14 days before the impression can be taken (Fig. 15.18).

A radiograph to ascertain the precise connection between the abutments and implants is only necessary for external implant abutment connections (Branemark type).

Then 15–20 days after placement of the abutments, the patient is ready to begin the procedure for a fixed or mobile prosthetic restoration (Fig. 15.19). A bar may be fabricated joined to the implants with screws, and an overdenture may be adapted to the bar with the aid of clips (Figs. 15.20–15.22).
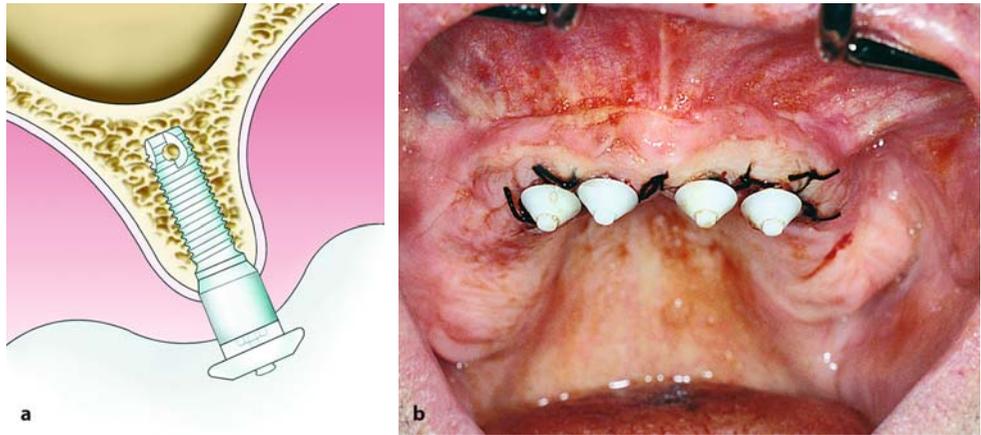
Fig. 15.18 a, b. Healing caps placed on abutments of implants. **a** Diagrammatic illustration. **b** Clinical photograph

Fig. 15.19. Clinical photograph showing abutments immediately after removal of sutures

Fig. 15.20. Implants joined by overdenture bar over which prosthetic restoration is to be placed

Fig. 15.21. Clips in denture which snap onto bar for retention and support of denture

Fig. 15.22. Clinical photograph showing prosthetic restoration adapted to implants

15.5
Complications

The main complications that may arise during placement of the implants as well as postoperatively are:

- Damage to adjacent anatomic structures, in the case of perforation of the maxillary sinus, nasal cavity, and mandibular canal by the implant
- Mucosal perforation, which may be caused by mishandling during flap retraction or by damage of the soft tissues due to a temporary prosthetic restoration
- Failure of osseointegration, which may be due to premature loading of implants during the healing period, to bone damage because of the surgical procedure, to improper design of the prosthetic restoration or ill-fitting prosthetic work, and to poor judgment of the quality of bone at the implant recipient site
- Gingivitis, gingival hyperplasia, or the appearance of a fistula
- Exposure of implant threads
- Fracture of implant, which usually involves the abutment screw or the implant itself

15.6
Bone Augmentation Procedures

Bone augmentation procedures are considered necessary sometimes, particularly when placement of implants would otherwise be considered problematic. These include such cases as those with decreased alveolar ridge height or width. This is accomplished with bone grafting. As already mentioned in Chap. 4, there are various types of grafts, depending on the composition of the graft.

Autografts are considered the most successful, even though one major disadvantage of this technique is that a second concurrent surgical procedure for obtaining the bone is required. Also, there is increased morbidity and resorption following the surgical procedure. Bone onlays tend to be resorbed quickly, unless loading is provided by means of dental implants. Bone from the iliac crest, rib, sternum, chin or even cartilage may be placed on the surface of the alveolar ridge, particularly in the mandible. Osseointegrated implants may be placed either at the time of the surgical procedure or after stabilization of the graft 6 months later, minimizing bone resorption by stabilizing the prosthesis.

Pedicle or interpositional bone grafting involves osteotomization to allow placement of a block of bone, with decreased bone resorption postoperatively compared to the above techniques. However, disadvantages include general anesthesia, the need for hospitalization, delayed healing and hence postponement of postoperative wearing of dentures and potential neurosensory disturbance due to nerve trauma.

Bone augmentation with bone substitutes or alloplastic materials such as hydroxylapatite eliminate the need for a second surgical procedure. One major drawback, however, is the possibility of migration of the material into other areas if it cannot be immobilized at the implantation site. This technique has gained popularity because of decreased morbidity and ease of placement.

A sinus lift procedure may be employed to increase bone depth in the posterior maxilla before placement of implants. In this technique bone grafts are used to lift the sinus lining itself, offering more support in the alveolar ridge area.

Guided bone regeneration inhibits connective tissue regeneration within osseous defects by way of a barrier, such as a membrane or foil. Long-term success is aided by implant insertion, minimizing bone resorption due to loading of the area.

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Prophylactic and Therapeutic Use of Antibiotics in Dentistry

16

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16.1
Treatment of Odontogenic Infections

Since ancient times, odontogenic infections – which are the most frequent of the oral cavity – have been the most common infections of the human body. These infections, due to complications which are rare but life-threatening (e.g., intracranial, retropharyngeal or pleuropneumonic spread, hematogenous spread to heart valves and prosthetic materials), demand careful evaluation and opportune treatment aiming at appropriate drainage as well as administration of suitable antibiotic therapy. Various regimens have been suggested and used in clinical practice for the treatment of odontogenic infections, many fundamental principles of which are still in effect today. In the last two decades, though, as a result of the widespread use of antibiotics for treatment of infections, significant changes have taken place concerning prescriptions. These changes were deemed necessary for two main reasons. First was the emergence of more and more resistant microorganisms responsible for odontogenic infections (a phenomenon mainly due to injudicious use of antibiotics), and second was the greater life expectancy of the general population and of patients with grave diseases or immunocompromised patients, who develop more serious odontogenic infections. Furthermore, there has been a sharp increase in the number of antibiotics and specifications of each one of these based on indications, contraindications, recommended routes of administration, bacterial sensitivity, pharmacological characteristics, drug interactions, adverse reactions or side-effects, cost, and patient cooperation. In general practice these factors and the therapeutic potential available today may make the choice of the most effective therapeutic regimen difficult. Certain fundamental principles and data concerning the choice of antibiotics for treatment of odontogenic infections are described below.

16.1.1
Oral Flora of Odontogenic Infections

The oral cavity cannot be considered a simple, uniform environment. Even though representative types of microorganisms may be found in most regions of the mouth, certain areas such as the tongue, tooth surfaces, gingival sulcus, and saliva tend to favor colonization of specific microorganisms (Table 16.1). Quantitative studies show that obligate anaerobic bacteria make up a large and important part of the oral flora. All in all, the species *Streptococcus*, *Peptostreptococcus*, *Veillonella*, *Lactobacillus*, *Corynebacterium*, and *Actinomyces* compose over 80% of the entire oral flora. Facultative aerobic Gram-negative rods are not common in healthy adults, although they may prevail in seriously ill, hospitalized, and elderly patients. Other than anatomic factors, numerous aspects such as age, nutrition, eruption of deciduous teeth, oral hygiene, smoking, caries or periodontal disease, hospitalization, antibiotic therapy, pregnancy, as well as genetic and racial factors may influence the composition of oral flora.

Most odontogenic infections are the result of bacteria, which normally colonize the bacterial plaque, tongue, saliva, and gingival sulcus. When caries is present, *Streptococcus mutans* is the predominant microorganism. When gingivitis is present, Gram-negative anaerobic rods prevail, with *Prevotella intermedia* (formerly known as *Bacteroides intermedius*) being the most common pathogen. When periodontitis is present, anaerobic Gram-negative microorganisms prevail, with *Porphyromonas gingivalis* (formerly known as *Bacteroides gingivalis*) as the most common pathogen. In suppurative odontogenic infections (e.g., periapical abscesses) or in infections of the deep fascial spaces, there is usually polymicrobial flora, with melaninogen *Bacteroides*, *Fusobacterium nucleatum*, as well as the species *Peptostreptococcus*, *Actinomyces*, and *Streptococcus* as the most common microbes. Finally, except for certain patients with serious underlying diseases, the facultative aerobic Gram-negative bacilli and

Table 16.1. Predominant bacteria cultured from various sites of the oral cavity

Type	Predominant species	Mean total number of viable bacteria (%)			
		Gingival sulcus	Dental plaque	Tongue	Saliva
Obligate aerobic					
Gram-positive cocci	*Streptococcus spp.*	28.8	28.2	44.8	46.2
	S. mutans	0–30	0–50	0–1	0–1
	S. sanguis	10–20	40–60	10–20	10–30
	S. mitior	10–30	20–40	10–30	30–50
	S. salivarius	0–1	0–1	40–60	40–60
Gram-positive rods	*Lactobacillus spp.* *Corynebacterium spp.* }	15.3	23.8	13.0	11.8
Gram-negative cocci	*Moraxella spp.*	0.4	0.4	3.4	1.2
Gram-negative rods	Enterobacteriaceae	1.2	–	3.2	2.3
Anaerobic					
Gram-positive cocci	*Peptostreptococcus spp.*	7.4	12.6	4.2	13.0
Gram-positive rods	*Actinomyces spp.* *Eubacterium spp.* *Lactobacillus spp.* }	20.2	18.4	8.2	4.8
	Leptotrichia spp.	10.7	6.4	16.0	15.9
Gram-negative cocci	*Veillonella spp.*	16.1	10.4	8.2	4.8
Gram-negative rods	*Fusobacterium spp.*	1.9	4.1	0.7	0.3
	Prevotella, Porphyromonas	4.7	–	0.2	–
	Bacteroides spp.	5.6	4.8	5.1	2.4
	Campylobacter spp.	3.8	1.3	2.2	2.1
	Leptotrichia spp.	10.7	6.4	16.0	15.9
Spirochetes	*Treponema spp.*	1.0	–	–	–

Staphylococcus aureus are uncommon pathogens. The aforementioned microbial specialization for the various odontogenic infections possibly depicts the development of the unique microbial flora during the formation of supragingival dental plaque and the subsequent subgingival dental plaque. Plaque accumulating in the gingival sulcus is primarily composed of Gram-positive, facultative, and microaerophilic cocci and rods, while plaque beneath the gumline is mainly composed of Gram-negative anaerobic bacteria and mobile forms including spirochetes.

Most odontogenic infections are usually mixed, with at least two bacteria prevailing. Identification of the microbial pathogens associated with odontogenic infections may be achieved in most clinical microbiological laboratories by using classical and newer techniques. The indications for culturing of a sample are described in Table 16.2.

Table 16.2. Indications for culture of specimens from odontogenic infections

Immediate culture is recommended if:

Initial therapy with antibiotics failed to control infection

Palpation of spread of infection with the hand is indicative of spread in the head and neck area, and along certain layers of the face

Patient presents signs and symptoms of septicemia

Patient is immunocompromised (HIV infection, administration of immunosuppressives, etc.)

It is recommended to postpone culture if:

Infection is small or limited locally to soft tissue

Any specimen may be infected with microbial flora of the mouth (e.g., from dental plaque or from the crown of the tooth with gingivitis)

Infection has spontaneous drainage and there is no indication of obvious spread of infection

16.1.2
Principles of Treatment of Odontogenic Infections

The first step in evaluating the patient is to determine the severity of infection. This is accomplished by ascertaining the time of presentation and development of the infection as well as by examining the patient. The signs and symptoms indicating immediate need for administration of an antibiotic include trismus, fever or chills, and local lymphadenitis. Other significant signs and symptoms are weakness, dizziness, tachypnea and cellulitis, which is not localized and is spreading.

The second step is the evaluation of the patient's defenses. The dentist must be aware of any disease the patient has or medication he or she may be taking that may adversely affect the patient's condition. Special circumstances that require the use of antibiotics include bacteremia, immunosuppression, organ transplant, and inadequately controlled diabetes mellitus. The administration of antibiotics is not deemed necessary in simple post-traumatic edema, pain due to pulpitis or trauma, small localized abscess, fistula of a nonvital tooth, inflammation of the periodontium surrounding the tooth, dry socket, and gingivitis around the crown of an erupting tooth that does not present complications.

The third step is surgical treatment, which includes drainage and removal of necrotic tissue. The need for endodontic therapy or extraction of the tooth presenting inflammation and which is the primary focal site of the infection is a priority. Effective surgical treatment demands detailed knowledge of the potential pathways of spread of the infection, while an equally important factor is the timing of incision and drainage (see Chap. 9).

The fourth step involves the empiric administration of antibiotics, which is based on knowledge of the most likely pathogens.

Finally, the fifth step is reexamination of the patient, in order to evaluate the patient's response to the therapy and to investigate any adverse reactions or side-effects. Positive response to the therapy is expected within 48 h and the therapy must be continued for 3 days after the symptoms have resolved. Carefully adhering to these principles ensures maximum effectiveness with minimal risk for the patient.

Choosing the most appropriate antibiotic for the individual patient requires knowledge of antimicrobial effectiveness, side-effects, adverse reactions, contraindications, and the cost of the most common antibiotics used for treatment of odontogenic infections.

16.1.2.1
Penicillins

Penicillin inhibits synthesis of the cell wall. It is extremely effective against aerobic Gram-positive rods and anaerobic Gram-positive and -negative cocci. It is not at all effective against aerobic Gram-negative rods, while, on the other hand, it is effective against a broad spectrum of the corresponding anaerobes. As such, it is considered an antibiotic of choice for the treatment of odontogenic infections.

During recent years, though, through production of β-lactamases, bacterial resistance to penicillin is increasing, such as the species *Bacteroides* and *Prevotella*, resulting in the failure of treatment with penicillin. Even so, recent data show that initial treatment with penicillin (as phenoxymethylpenicillin or penicillin V for oral administration and as penicillin G for intravenous administration) remains the most appropriate choice. The recommended dose for penicillin V is 1,500,000 IU every 6 h on an empty stomach or at least 2 h after eating.

The semisynthetic derivatives of penicillin, ampicillin and amoxicillin, have the same mechanism of action as penicillin as well as a similar antimicrobial spectrum. They are advantageous compared to penicillin, though, in that they are relatively effective against aerobic Gram-negative rods. Amoxicillin is preferred to ampicillin for oral administration (per os, p.o.), due to its better absorption (twofold), which is not affected by food intake. The semisynthetic derivatives do not present significant advantages compared to penicillin as an empiric treatment of first choice. The recommended dose for p.o. administration is 500–1000 mg every 6–8 h for ampicillin, and 500 mg every 8 h for amoxicillin.

Recently, in an attempt to overcome the resistance problem, which is due to production of enzymes (β-lactamases) that render β-lactam antibiotics inactive, combinations of semisynthetic penicillins with various β-lactamase inhibitors have become available, such as ampicillin with sulbactam and amoxicillin with clavulanic acid, resulting in a broadening of the antimicrobial aerobic and anaerobic spectrum of these antibiotics. They may be administered orally, and the recommended doses are 375–750 mg every 12 h for ampicillin/sulbactam, and 625 mg every 8 h for amoxicillin/clavulanic acid.

The most common and most serious adverse reactions to penicillins are hypersensitivity reactions (3–5% of the population). These mainly entail mild skin reactions, such as itching, maculopapular or urticarial rash, and urticaria, while life-threatening reac-

tions, such as anaphylactic shock, are rare (4/10,000–100,000), especially after oral administration.

It is worth noting that penicillins are not contraindicated during pregnancy, and are classed as relatively safe drugs (category B according to the FDA categorization[1)], while the oral daily dose needs adjustment only in cases of advanced renal failure. Combinations with inhibitors of β-lactamases have a much greater cost, which must also be taken into consideration.

16.1.2.2
Cephalosporins

The mechanism of action of cephalosporins, regardless of generation, is the same as that of penicillin. As far as antimicrobial effectiveness is concerned, orally administered first-generation cephalosporins (cefalexin and cefadroxil) are not advantageous compared to penicillin or ampicillin, while orally administered second-generation cephalosporins (cefaclor, cefatrizine, loracarbef, cefprozil and cefuroxime) are characterized by resistance to β-lactamases, which neutralize ampicillin, and may be used as alternative drugs if there is no response to penicillin. Newer orally administered third-generation cephalosporins (cefixime, cefetamet, ceftibuten and cefpodoxime), being

resistant to β-lactamases, have potentiated effectiveness against Enterobacteriaceae, but not against anaerobes. Therefore, they should not be prescribed for odontogenic infections of the oral cavity that do not present complications, with one possible exception of immunocompromised patients, where a combination with a nitroimidazole is required (e.g., metronidazole) in order to be effective against anaerobes. In short, all orally administered cephalosporins are either not effective at all or are only slightly effective against anaerobes, and the cost of newer antibiotics, especially of those belonging to third-generation cephalosporins, is very high. Furthermore, the last category includes antibiotics with restricted use (in some countries), being prescribed only in cases where microorganisms resistant to all other antibiotics are isolated in culture.

The most serious side-effects of cephalosporins, as of penicillins, are hypersensitivity reactions (1–5% of patients). Because 5–10% of the patients with hypersensitivity to penicillin present hypersensitivity to cephalosporins also, they must not be administered to patients with a history of immediate hypersensitivity reaction to penicillin (anaphylactic reaction), while they may be prescribed with relative safety when there is a history of delayed hypersensitivity (e.g., allergic rash or itching occurring a few days after administration of penicillin). Cephalosporins are considered relatively safe drugs during pregnancy (category B according to FDA categorization) and their dose needs to be decreased only in case of advanced renal failure.

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1) Food and Drug Administration categorization concerning pregnancy:
  A. Controlled studies in pregnant women failed to prove risk for the embryo, regardless of its age. Therefore, the risk of fetal harm is considered negligible.
  B. Animal studies have not proven risk for the embryo. Studies in pregnant women or animal reproductive studies did not prove complications in the first trimester of pregnancy, without being confirmed in controlled studies. As far as the second or third trimester is concerned, there were no indications of risk for the embryo.
  C. Animal studies have shown adverse reactions (congenital malformations, death of embryo, etc.), but there are no controlled studies in pregnant women. Drugs belonging to this category must be prescribed only in cases where the expected benefit is greater than the potential risk their administration entails.
  D. Risk for the human embryo due to administration of these drugs has been verified. Therefore, administration is only permitted in cases where the relative need is greater than the risk.
  X. Studies in animals and patients have shown fetal anomalies after administration of these drugs. Therefore, the risk of adverse reactions to the drug outweighs any possible benefits, forbidding administration.

16.1.2.3
Macrolides

Erythromycin and newer macrolides (roxithromycin, clarithromycin, azithromycin and dirithromycin) inhibit protein synthesis by microbial cells on a ribosomal level. Their antimicrobial spectrum includes Gram-positive aerobic and anaerobic cocci of the mouth, while Gram-negative aerobes and anaerobes are resistant. As such, they are a good alternative solution for treatment of odontogenic infections without complications of mild and intermediate severity in patients allergic to β-lactams. The high cost of newer macrolides compared to erythromycin must be noted, without a substantial difference in effectiveness against oral pathogens. Gastrointestinal disturbances (nausea, vomiting, abdominal cramping, diarrhea) are the most common side-effects of erythromycin. Newer macrolides are advantageous compared to erythromycin in that they are better tolerated and may be administered, due to their longer half-life, every 12 or 24 h instead of every 6 h.

Erythromycin and azithromycin are considered relatively safe drugs for pregnant patients (category B according to FDA categorization), while clarithromycin may be administered only if there is no other choice (category C according to FDA categorization). The daily dose needs to be adjusted only in cases of advanced renal failure.

16.1.2.4
Clindamycin

This drug has a similar mechanism of action to macrolides and is exceptionally effective in treating serious or resistant odontogenic infections, due to its remarkable in vitro effectiveness against the most frequent pathogens in odontogenic infections, such as Gram-positive aerobic and anaerobic cocci and Gram-negative anaerobic rods. Clindamycin is not effective against Gram-negative aerobic rods. The recommended dose for oral administration is 300 mg every 8 h, which does not need to be adjusted even in end-stage renal failure.

The most serious and common side-effect of clindamycin is antibiotic-associated diarrhea (0.3–21%) and an even more severe diarrheal state, pseudomembranous colitis (1.9–10%). Today, it has been proven that concurrent administration of *Saccharomyces boulardii* –17 (Ultra-Levure®) at a dose of 500 mg every 8 h dramatically decreases the incidence of diarrhea. Clindamycin belongs to category B according to the FDA categorization for pregnancy and has been extensively used during pregnancy. Even so, there are no controlled studies concerning its safety in humans.

16.1.2.5
Tetracyclines

Tetracyclines (tetracycline hydrochloride, oxytetracycline, doxycycline, and minocycline) are bacteriostatic drugs that, by inhibiting the biosynthesis of proteins of microbial cells at a ribosomal level, are very effective against aerobes and anaerobes of the mouth. Doxycycline and minocycline are advantageous compared to other tetracyclines in that they are more effective against anaerobes, are fully absorbed when administered orally, and may be administered twice daily (100 mg every 12 h) due to their longer half-life.

Gastrointestinal disturbances (nausea, vomiting, abdominal cramping) are the most frequent untoward side-effect of tetracyclines, while minocycline also causes disturbances of the vestibulocochlear nerve (dizziness, vertigo).

Tetracyclines are contraindicated in pregnancy (category D according to FDA categorization), in children under 8 years of age due to permanent discoloration of teeth, as well as in cases of liver disease. Finally, the dose needs to be decreased even in cases of moderate renal insufficiency.

16.1.2.6
Nitroimidazoles

Mainly metronidazole and ornidazole belong to the group of nitroimidazole drugs, whose mechanism of action has not been fully clarified even today. They are drugs with rapid bactericidal action principally against Gram-negative anaerobes, a slightly more restricted bactericidal action against Gram-positive anaerobes (microaerophilic and aerobic streptococci must be considered resistant), and essentially without any effectiveness against aerobic pathogens. As such, they must not be administered as sole treatment for odontogenic infections, except in cases of acute necrotizing ulcerative gingivitis and advanced periodontitis. The usual dose for oral administration is 500 mg every 8 h for metronidazole, and 500 mg every 12 h for ornidazole.

Gastrointestinal disturbances (metallic taste, nausea, vomiting, abdominal cramping) are also the most frequent untoward side-effect, while the concurrent consumption of alcohol is prohibited. Pregnancy is not a contraindication for administration (category B of FDA categorization), but nitroimidazoles must be avoided during the first trimester, while the dose must be decreased to half the normal dose only in cases of severe renal failure.

Table 16.3 briefly describes the most common antibiotics used for treatment of odontogenic infections and their recommended dose.

In short, antibiotic treatment is considered important in inhibiting local spread of infection and for prophylaxis of hematogenous spread. Seriously immunocompromised patients are considered high-risk for uncontrollable and spreading odontogenic infections, and, as such, empiric treatment with broad-spectrum antibiotics is indicated. In patients with life-threatening infections of deep fascial spaces and in patients who do not respond or who have a delayed response to the initial therapy, usually with penicillin, a regimen effective against anaerobic as well as facultative aerobic Gram-negative rods must be administered (see Table 16.4A). Outpatients with less serious odontogenic infections may be treated with one of the aforementioned antibiotics orally, which will be chosen

Table 16.3. Antibiotics usually administered for treatment of odontogenic infections. (bid Twice a day, i.m. intramuscularly, i.v. intravenously, qid four times a day, qxh every x h, tid three times a day)

Antibiotic	Recommended dosage	
	Oral	Parenteral
Penicillins		
Penicillin V	1,500,000 IU qid	–
Ampicillin	500 mg qid or 1 g tid	1 g q6 h or q8 h i.m. or i.v.
Amoxicillin	500–1000 mg tid	1 g q6 h or q8 h i.m. or i.v.
Ampicillin/sulbactam	375–750 mg bid	1.5 g q6 h or q8 h i.m. or i.v.
Amoxicillin/clavulanic acid	625 mg q6 h or q8 h	1.2 g tid i.v.
Cephalosporins		
First-generation:		
Cefalexin	500–1000 mg qid	–
Cefadroxil	1 g bid	–
Cefazolin	–	1–2 g tid i.m. or i.v.
Second-generation:		
Cefaclor	500 mg q6 h or q8 h	–
Cefatrizine	500–1000 mg bid	–
Cefuroxime	250–500 mg bid	750–1500 mg tid i.m. or i.v.
Loracarbef	200–400 mg bid	–
Cefprozil	250–500 mg bid	–
Ceforanide	–	1 g bid i.m. or i.v.
Cefoxitin	–	1 g tid i.m. or i.v.
Macrolides		
Erythromycin	500 mg qid	–
Roxithromycin	150–300 mg bid	–
Clarithromycin	250–500 mg bid	–
Dirithromycin	250 mg bid	–
Azithromycin	500 mg qid	–
Clindamycin	300 mg q6 h or q8 h	300–600 mg tid i.m. or i.v.
Tetracyclines		
Doxycycline	100 mg bid	–
Tetracycline hydrochloride	500 mg tid	–
Oxytetracycline	500 mg tid	–
Minocycline	100 mg tid	–
Nitroimidazoles		
Metronidazole	500 mg tid	500 mg tid i.v.
Ornidazole	500 mg bid	500 mg bid i.v. or 1 g i.v. once

based on its specific characteristics. Finally, immuno-compromised patients, e.g., patients with hematologic malignancies and severe neutropenia or neutropenia secondary to chemotherapy for a solid tumor, must be hospitalized and administered antimicrobial therapy for anaerobic and aerobic pathogens, especially aerobic Gram-negative rods (including *Pseudomonas aeruginosa*), as shown in Table 16.4B.

Table 16.4. Empiric antibiotic regimens for treatment of odontogenic infections of soft tissues

A. Immunocompetent host
  Penicillin G, 1–4,000,000 IU, i.v. q4–6 h
  Clindamycin, 600 mg, i.v. q6–8 h
  Cefoxitin, 1–2 g, i.v. q6 h
  Amoxicillin/clavulanic acid, 1.2 g, i.v. q6–8 h
  Ampicillin/sulbactam, 3 g, i.v. q8 h

B. Immunocompromised host
  Piperacillin, 4 g, i.v. q6h
  Ticarcillin/clavulanic acid, 3.2–5.2 g, i.v. q6–8 h
  Piperacillin/tazobactam, 4.5 g i.v. q6–8 h
  Imipenem, 0.5 g i.v. q6 h
  Meropenem, 1 g i.v. q6–8 h

The above may have to be used in conjunction with an aminoglycoside

Table 16.5. Frequency of bacteremia associated with oral manipulations and dental procedures

Type of manipulation or procedure	Frequency % (range)
Tooth extraction	60 (18–85)
Periodontal surgery	88 (60–90)
Tooth brushing or use of irrigation devices	40 (7–50)

16.2
Prophylactic Use of Antibiotics

16.2.1
Prophylaxis of Bacterial Endocarditis

Most dental procedures or oral manipulations usually cause transient (lasting less than 15 min) and low-grade [<10 cfu/ml (microbial colonies per milliliter of blood)] bacteremia, as a result of trauma of mucosal surfaces with rich microbial flora (Table 16.5).

As such, patients suffering from certain anatomic defects of the heart or of large vessels are at greater risk for bacterial endocarditis or endarteritis. Bacterial endocarditis, even though not very common, is a serious infection with a high mortality rate (10–30%), and most of the cases are due to bacteria (streptococci), which under normal circumstances are found in the oral cavity. Prophylactic administration of antibiotics is thus recommended for patients who run the risk of endocarditis and on whom dental procedures or oral manipulations likely to cause bacteremia are performed. Generally, prophylaxis is effective when administered a short while before the procedure (1–2 h earlier) and in doses capable of achieving sufficient concentration in the serum, both during and for some time after the procedure. Administered antibiotics prevent endocarditis mainly by inhibiting adhesion of bacteria to valves and, under certain circumstances, by way of intravascular killing of bacteria. Due to the fact that there are no controlled clinical studies in

humans for prophylaxis of endocarditis, because of ethical reasons and because the disease is so rare, the recommendations of international associations (American Heart Association, British Society for Antimicrobial Chemotherapy) are based on animal studies and clinical experience. Furthermore, because endocarditis may occur in spite of appropriate antibiotic prophylaxis, dentists must have a high awareness level concerning any clinical signs and symptoms, and especially inexplicable fever, following dental manipulations in patients at risk for endocarditis. In such a case, fever must not be masked with antibiotics, because it would only delay diagnosis of existing endocarditis.

Bad oral hygiene and periodontal and periapical abscesses may cause bacteremia even without dental procedures being performed. Therefore high-risk patients must be informed and encouraged to have as good oral hygiene as possible. Ulceration as a result of prosthetic appliances may even cause bacteremia. Even though it has not been proven in clinical studies, it appears that the use of antibacterial mouth rinses (e.g., chlorhexidine, povidone iodine) in patients belonging to the above category before a tooth extraction may lessen bacteremia following the extraction by 2–4 times.

As a guide to prophylactic antibiotic administration, Tables 16.6 describes the dental procedures and oral manipulations that have the potential to cause significant bacteremia, and Table 16.7 describes the cardiac conditions that predispose patients to endocarditis. Antimicrobial prophylaxis may be administered safely up to 2 h after a procedure that unexpectedly produced soft tissue trauma, for which the patient had not been administered antibiotic prophylaxis.

The main changes in the recent revision of guidelines recommended by the American Heart Association (*Journal of the American Medical Association* 1997) concerning prophylaxis of bacterial endocarditis, compared to the recommendations that were in effect up to then (*New England Journal of Medicine* 1995), include:

Table 16.6. Dental procedures and oral manipulations

A. Antibiotic prophylaxis recommended for[a]

Dental extractions

Periodontal procedures including surgery, scaling and root planing, probing, and recall maintenance

Placement of dental implants and reimplantation of avulsed teeth

Endodontic therapy or surgical procedures performed beyond the apex

Subgingival placement of antibiotic fibers or strips

Initial band and archwire placement, but not brackets, for orthodontic treatment

Intraligamentary local anesthetic injections

Prophylactic cleaning of teeth or implants where bleeding is anticipated

B. Antibiotic prophylaxis is not recommended for

Restorative dentistry[b] (dental surgery and prosthetic restorations) with or without gingival retraction cord[c]

Administration of local anesthesia (except for periodontal ligament injection)

Intracanal endodontic treatment, post placement and buildup

Placement of rubber dam

Postoperative removal of sutures

Placement of prosthetic denture or orthodontic appliance

Taking of impression

Fluoride treatment

Intraoral radiographs

Adjustment of orthodontic bands and appliances

Exfoliation of deciduous teeth (shedding of primary tooth)

[a] Involves patients with heart diseases with high and intermediate degree of risk (see Table 16.7)
[b] Restoration of carious teeth (fillings) is included as well as replacement of missing teeth
[c] The administration of antibiotics may also be indicated in certain situations, which may cause significant hemorrhage, as deemed necessary by the dentist

a. A decrease of the initial dose of amoxicillin from 3 g to 2 g and eliminating the second dose that was administered 6 h after the initial dose.
b. No longer recommending erythromycin, due to gastrointestinal disturbances and the complex pharmacokinetics of its various compounds, to persons allergic to penicillin.

Table 16.7. Underlying heart diseases and conditions

A. Antibiotic prophylaxis is recommended for

Prosthetic cardiac valves, including bioprosthetic and homograft valves[a]

Patients with a history of previous endocarditis, even if heart disease is not present[a]

Complex cyanotic congenital heart disease[a]

Most other congenital heart malformations[a]

Surgically corrected shunts of systemic-pulmonary circulation[a]

Rheumatic or other acquired valve defects, even after surgical correction

Hypertrophic cardiomyopathy

Mitral valve prolapse with valve regurgitation and/or thickening of cusps

B. Antibiotic prophylaxis is not recommended for
Isolated secundum atrial septal defect

Surgical repair, without residuary defect, of atrial septal or ventricular septal defect or patent ductus arteriosus after 6 months or more have elapsed

Previous coronary by-pass graft surgery

Mitral valve prolapse without valvar regurgitation

Physiologic, functional or innocent heart murmurs

Patients with a history of Kawasaki disease without valve defect

Patients with a history of rheumatic fever without valve defect

Cardiac pacemakers and implanted defibrillators

[a] Patients belonging to these groups are considered high risk for endocarditis, while for the patients of the rest of the groups in A, the risk is considered intermediate

c. Recommending various other antibiotics such as cefalexin, cefadroxil, cefazolin, and the newer macrolides azithromycin and clarithromycin as alternative regimens of prophylaxis.

As far as patients with underlying cardiac defects are concerned, and who are administered supplementary prophylaxis against rheumatic fever with monthly administration of benzathine penicillin (Penadur®), this regimen does not suffice for prophylaxis of bacterial endocarditis. Therefore, when these patients are to be administered prophylaxis for a dental procedure or oral manipulation, the antibiotic used must not be amoxicillin but one of the other alternative

Table 16.8. Recommendations of the American Heart Association for prophylaxis of bacterial endocarditis in patients undergoing dental procedures or oral manipulations

Antibiotic	Regimen
Standard general prophylaxis	
Amoxicillin	2 g orally (p.o.) 1 h before surgery
Patients allergic to penicillin/amoxicillin	
Clindamycin	600 mg p.o. 1 h before surgery
or	
Cefalexin or cefadroxil[a]	2 g p.o. 1 h before surgery
or	
Azithromycin or clarithromycin	500 mg p.o. 1 h before surgery
Patients unable to use oral medication	
Ampicillin or amoxicillin	2 g intramuscularly (i.m.) or intravenously (i.v.) 30 min before surgery
or	
Cefazolin[a]	1 g i.m. or i.v. 30 min before surgery
Patients unable to use oral medication, allergic to penicillin/ampicillin	
Clindamycin	600 mg i.v. 30 min before surgery
or	
Cefazolin[a]	1 g i.m. or i.v. 30 min before surgery
Children	
Amoxicillin or ampicillin	50 mg/kg p.o. or i.m. or i.v.
Clindamycin	20 mg/kg p.o. or i.v.
Cefalexin or cefadroxil	50 mg/kg p.o.
Cefazolin	25 mg/kg i.m. or i.v.
Azithromycin or clarithromycin	15 mg/kg p.o.

[a] Cephalosporins should not be used in patients with a history of immediate type hypersensitivity reaction (urticaria, angioneurotic edema or anaphylaxis) to penicillins

regimens, because, due to the long-term administration of penicillin, the mucosal surfaces of the mouths of these patients, as a rule, present streptococci relatively resistant to penicillin and amoxicillin. The same applies to patients who have been administered even one dose of penicillin, amoxicillin, or another antibiotic within the last 14 days for other reasons. If such is the case, if possible, the procedure should be performed 10–14 days after cessation of the antibiotic, whereupon the same antibiotic may be administered again.

As such, it is obvious that for patients requiring prophylaxis of bacterial endocarditis, any dental procedure involving blood must be performed in one session, if possible. If that is not feasible, the sessions must either be scheduled at least 10–14 days apart, or the prophylactic antibiotics given at each session should belong to different categories. For example, if amoxicillin was administered in the first session and the second session has been scheduled 5 days later than the first, the antibiotic administered before the second session must be a macrolide or clindamycin.

The antibiotics used and their regimens, as recommended by the American Heart Association, are described in Table 16.8.

The need for antibiotic prophylaxis before dental procedures for patients with prosthetic joints is still subject to debate today. Even though animal studies show that inoculation of the prosthetic joint from remote sites of infection is possible, there are few proven cases of infection of prosthetic joints due to transient bacteremia of dental origin. Even so, for patients with orthopedic prostheses, orthopedists usually recommend, and dentists usually administer, antibiotic prophylaxis similar to that used for endocarditis. In a recent analysis of data by the Mayo Clinic, it was demonstrated that the overall incidence (due to infection because of *Streptococcus viridans*) in large joint prostheses was 0.06/1000 joints per year, a percentage similar to that of endocarditis in the general population and much lower than that of the group of patients for whom the American Heart Association recommends prophylaxis for endocarditis. Therefore, routine antibiotic prophylaxis is not recommended for patients

Table 16.9. Classification of surgical procedures according to risk of causing postoperative infections

Classification	Type of procedure	Description	Expected incidence of postoperative infection (%)
I	Clean	Surgical procedure without entering respiratory, gastrointestinal, or genito-urinary system	2
II	Clean – contaminated	Surgical procedure on respiratory, gastrointestinal or genito-urinary system without significant bacterial infection	10–15
III	Contaminated	Recent trauma (<8 h)	20–30
		Entering genito-urinary system with infection present	
		Operation on biliary ducts	
		Operation on gastrointestinal system with significant bacterial infection	
IV	Dirty	Surgical procedure in an area with ascertained infection	50
		Old trauma (>8 h)	

Table 16.10. Classification of immunocompromised patients

Description	Representative diseases
1. Inadequately controlled metabolic disease	Diabetes mellitus, liver cirrhosis, malnutrition, end-stage chronic renal failure
2. Hematologic disorders	Lymphoma, leukemia, hypogammaglobulinemia, etc.
3. Administration of immunosuppressive agents, e.g., cytotoxic drugs, cortisone, ciclosporin	Patients with transplants, cancer patients, patients with collagen diseases, etc.

with prosthetic joints and the decision for certain patients [e.g., patients with advanced periodontal disease, rheumatoid arthritis, recent (<2 years) arthroplasty, obvious infection or abscess at the site of the dental procedure, prolonged dental procedure, uncontrolled diabetes, corticosteroid treatment] with total hip arthroplasty must be determined by the dentist in consultation with the patient's orthopedic surgeon and physician.

16.2.2
Prophylaxis of Wound Infections (Perioperative Chemoprophylaxis)

The principles of antimicrobial prophylaxis against postoperative infections were described approximately 30 years ago, based on experimental and clinical studies conducted by Burke, Polk and Stone. These principles, which apply to every aspect of surgery, are:

First principle:

In order to administer antibiotics prophylactically, the risk of postoperative infection must be significant. The incidence of postoperative infection depends on the type of surgery (Table 16.9) and on the state of host defenses of immunocompromised patients (Table 16.10). It must be emphasized that clean surgical techniques and the prophylactic use of antibiotics in certain patients may significantly reduce the incidence of postoperative infections.

Second principle:

The antibiotics to be used for prophylaxis against postoperative infections must: (a) be effective against pathogenic microorganisms that have the potential to cause these infections, (b) achieve a high level of drug in the plasma, and (c) not have significant untoward side-effects. The most common microorganisms considered responsible for infection after procedures in the oral cavity are streptococci, anaerobic Gram-positive cocci, and

anaerobic Gram-negative rods. Because postoperative infections due to anaerobes are unusual, prophylaxis must mainly focus on aerobic streptococci. Based on these data, penicillin and amoxicillin are the most appropriate antibiotics for prophylaxis. When there is a history of allergic reactions (usually urticarial rash) to penicillin, a first-generation cephalosporin may be administered, provided that the patient has not previously had a severe anaphylactic shock reaction; if this is the case clindamycin is preferred. If the surgical procedure is to be performed through the skin, the most common microorganisms implicated in postoperative infections are staphylococci, which are usually found on the skin. Cefazolin (first-generation cephalosporin) is preferred in surgical procedures with cutaneous access.

Third principle:

The antibiotic level in tissues during the surgical procedure must be high. This means administering higher doses than usual a few minutes before the operation, preferably at the onset of general anesthesia, or if oral surgery is involved that entails local anesthesia, 1 h before the procedure. Administration of antibiotics must not start the day before the procedure or hours before the operation, because we aim for peak drug levels at the site of intervention when the procedure is underway, whereupon the possibility of wound infection due to manipulations is greatest.

Fourth principle:

The antibiotics used for perioperative chemoprophylaxis must be administered for a limited period of time. Usually one dose of the antibiotic half an hour to an hour before the operation begins is enough. In the case of prolonged surgery, a second dose of antibiotic 4 h after the initial dose (for amoxicillin and cefazolin) is recommended. The administration of antibiotics for a greater period of time is not recommended, because it has been proven that, on the one hand, better prophylaxis is not achieved, while on the other hand, the cost is increased, as is the possibility of untoward side-effects or resistance to antibiotics.

Another fundamental principle concerning the prophylactic administration of antibiotics is that the benefit from their use must be significantly greater than the possibility of adverse reactions or side-effects. Keeping these principles in mind, the indications for prophylactic administration of antibiotics in oral and maxillofacial surgery are mentioned below.

The incidence of postoperative infections after a simple tooth extraction or surgical extraction, as well as after surgical procedures involving benign tumors of the oral cavity, e.g., fibromas, lipomas, soft tissue tumors, etc., is very low. As such, in otherwise healthy persons prophylactic administration of antibiotics is not deemed necessary before most dental procedures. The same applies to patients with metabolic diseases that are controlled. A typical example involves diabetic patients, who do not require prophylactic administration of antibiotics when the diabetes is under good medical control[2]. On the other hand, patients undergoing antineoplastic chemotherapy must be administered antibiotic prophylaxis, if the surgical procedure cannot be postponed until after cessation of the therapy. The same applies to patients with pharmaceutical immunosuppression secondary to transplantation of a solid organ (e.g., kidney).

Orthognathic procedures and certain procedures involved in preprosthetic surgery mainly of the hard tissues, as well as operations with combined intraoral and extraoral access for treatment of tumors, have an expected incidence of postoperative infections of 10–15% (category II operations). Prophylaxis is recommended for these surgical procedures with one to two doses of antibiotics, even though as far as orthognathic procedures are concerned, that recommendation has not been fully justified, as a result of lack of prospective clinical studies. As for mandibular fractures, because of the high incidence of postoperative infections (50%), the short-term perioperative administration of antibiotics is deemed necessary.

Of all the surgical procedures of the mouth and jaws, the operation that has created the most controversy as whether to administer antibiotic prophylaxis is the extraction of the impacted third molar. Despite the fact that most dentists and oral and maxillofacial surgeons administer antibiotics prophylactically to their patients, existing studies do not justify this widely used practice. The possibility of postoperative infection after such a procedure ranges from 1% to 6%, while the majority is limited to infections of minor significance. With this information in mind and knowing that most available studies (which have compared the incidence of postoperative infections after the administration of, or without administration of,

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2) According to recent guidelines of the American Diabetic Association (1999), a patient with controlled diabetes is one that has fasting blood glucose levels **<140 mg/dl**, or glycosylated hemoglobin (HbA, C) value **<7%**.

antibiotic prophylaxis) did not show a decreased incidence in the group that was administered an antibiotic, we cannot recommend their administration. Some studies showed that the prophylactic administration of antibiotics resulted in fewer, noninfectious complications, such as trismus, pain, edema, and fibrinolytic alveolitis (dry socket). Even so, some of these studies presented methodological planning problems. Two recent reviews do not recommend routine prophylactic administration of antibiotics for surgical extraction of the impacted third molar, concluding that their administration is justified only in very difficult cases, for example when impaction is deep and a large amount of bone has to be removed. Also, according to the recommendations of the British Society for Antimicrobial Chemotherapy (1992) administration of prophylaxis is not recommended for this surgical procedure.

To conclude, it must be emphasized that the administration of antibiotics for a period greater than 24–48 h after the operation is not considered prophylaxis but therapy. Indications for therapy are limited and include: (a) the presence of edema with pain or sensitivity that suggests cellulitis or an abscess that must absolutely be drained, (b) presence of trismus, unless it is secondary to postoperative edema, hematoma, trauma, (c) presence of purulent exudate, unless the cause was removed and the focal site of infection is far from the airway passages, (d) no improvement of symptoms 48 h later or worsening 36 h or more after surgical procedure, and (e) tachycardia (>100 beats per min) and fever (>38 °C). Fever is not necessarily a symptom of infection, especially in elderly people in whom severe infection may occur without fever.

In conclusion and according to recent data, prophylaxis with antibiotics is recommended for few dental procedures. In these limited cases the antibiotic must be administered shortly before the operation. A second dose is recommended only in the case of extensive and prolonged surgery.

16.3
Osteomyelitis

Osteomyelitis is a rare complication of odontogenic infections. In most cases it is the result of spread of infection from a dentoalveolar or periodontal abscess, or from the paranasal sinuses, by way of continuity through tissue spaces and planes. It occasionally occurs as a complication of jaw fractures, or as a result of abusive manipulations during surgical procedures. It is classified as acute or chronic osteomyelitis.

In the acute form, which, though rarely, may also be of hematogenous origin, the infection begins in the medullary cavity of the bone. The resulting increase of intrabony pressure leads to a decreased blood supply and spread of the infection, by way of the Haversian canals, to the cortical bone and periosteum. This aggravates the ischemia, resulting in necrosis of the bone. Predisposing factors include compromised host defenses due to compromised local blood supply (Paget's disease, radiotherapy, bone malignancy, etc.), or systemic disease (e.g., alcoholism, diabetes mellitus, leukemia, AIDS, etc.), and infection from microorganisms with great virulence. In such cases even a periapical abscess may be implicated in osteomyelitis. The mandible, due to decreased vascularity, is involved 6 times more often than the maxilla. The main pathogens are streptococci, *Klebsiella* spp., *Bacteroides* spp., and other anaerobic bacteria. Piercing, deep, and constant pain predominates in the clinical presentation in adults, while low or moderate fever, cellulitis, lymphadenitis, or even trismus may also be noted. In the mandible, paresthesia or dysesthesia of the lower lip may accompany the disease. When the disease spreads to the periosteum and the surrounding soft tissues, a firm painful edema of the region is observed, while the tooth becomes loose and there is discharge of pus from the periodontium. Radiographic examination reveals osteolytic or radiolucent regions (Figs. 16.1, 16.2), which sometimes surround a portion of dense bone (sequestrum). Therapy entails combined surgical (incision, drainage, extraction of the tooth, and removal of sequestrum) and pharmaceutical treatment with antibiotics. Antibiotics must be administered intravenously, in large doses, for at least 3–4 days after the fever ceases. Treatment may then continue orally for another 2–4 weeks, depending on the extent of the disease, the causative pathogen, and the clinical response. The antibiotic of choice is penicillin (3×10^6 units every 4 hours, i.v.), and in the case of allergy to penicillin, clindamycin is administered (600 mg every 6 h, i.v.). If staphylococcus or another "difficult" to treat microorganism develops, consultation with an infectious diseases specialist is recommended. In the case of fracture of the mandible, which has occurred over 48 h previously, the possibility of osteomyelitis is great. The patient should be administered antibiotic therapy intravenously as soon as possible, particularly in cases of compound fractures of the mandible.

Chronic osteomyelitis is characterized by a clinical course lasting over a month. It may occur after the acute phase, or it may be a complication of odontogenic infection without a preceding acute phase. The clinical
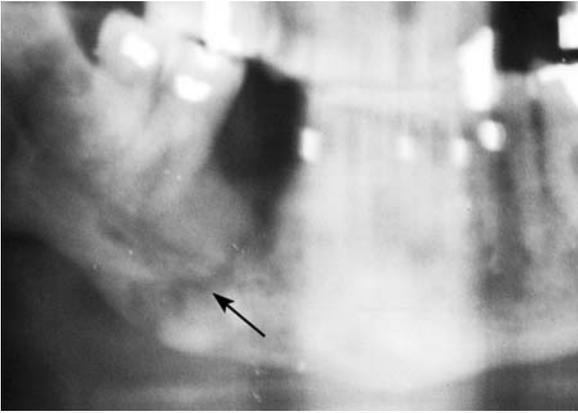
Fig. 16.1. Pathologic (spontaneous) fracture at premolar region of the right side of the mandible as a result of previous osteomyelitis
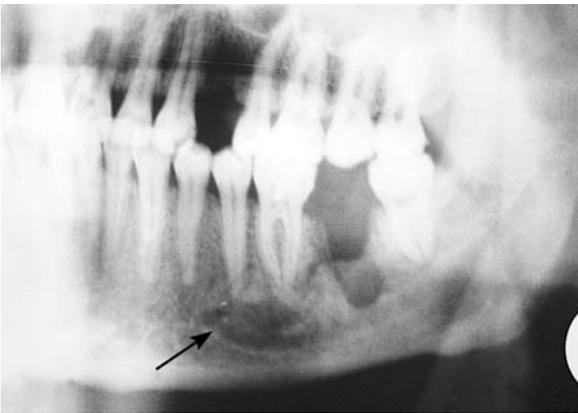
Fig. 16.2. Chronic osteomyelitis at the molar region and region of first premolar of the left side of the mandible

Fig. 16.3. Cutaneous sinus secondary to osteomyelitis of the mandible

presentation is milder, with painful exacerbations and discharge of pus, or sinus tracts (Fig. 16.3). Diagnosis is often difficult to make, while scintigraphy with ^{99m}Tc helps to reveal latent sites. Generally treatment is the same as that for the acute form, but it lasts a much longer period of time. Hyperbaric oxygen has been used to successfully treat difficult cases. Squamous cell carcinoma is a remote complication of chronic osteomyelitis (incidence ranging from 0.2% to 1.5%).

16.3.1
Sclerosing Osteomyelitis

Other rarer types of osteomyelitis are the chronic focal and chronic diffuse sclerosing osteomyelitis.

The focal type represents an unusual bone reaction, with normal defense mechanisms, to an infection caused by microorganisms of low virulence. It occurs in persons under 20 years old with significant carious lesions, especially the first molar (Fig. 16.4). Either endodontic therapy or extraction of the tooth is required.

The diffuse form mainly occurs in elderly people, and is exhibited in edentulous areas of the mandible. The symptoms are mild, and include episodes of recurrent pain, edema, and/or trismus. Upon radiographic examination, depending on the phase of the disease, osteolytic or diffuse sclerosing zones at the posterior region of the mandible are observed.

Treatment consists of muscle relaxants, nonsteroidal anti-inflammatory drugs, antibiotics, diazepam, etc., though with questionable results.
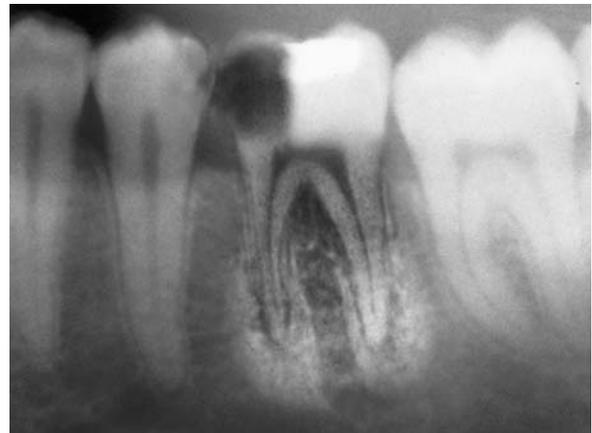
Fig. 16.4. Periapical radiograph of a case of chronic focal sclerosing osteomyelitis at apical region of the mandibular first molar
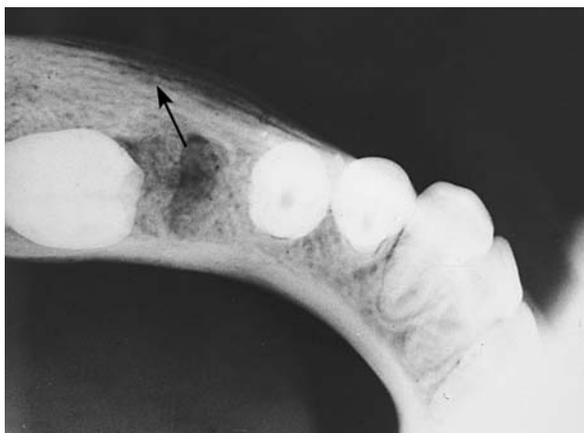
Fig. 16.5. Radiograph of a case of proliferative periostitis in a child, showing localized expansion of the periosteum (onion skin appearance) with peripheral reactive formation of bone

Fig. 16.6. Clinical photograph showing actinomycosis. Note draining sinus tracts

16.3.2
Proliferative Periostitis

Chronic osteomyelitis with proliferative periostitis, formerly known as Garré's osteomyelitis, is characterized by the formation of new bone beneath the periosteum at the surface of the cortex, which covers an inflammatory area of spongiosa (Fig. 16.5). Common pathogens include staphylococci and streptococci. The lesion is seen in persons less than 30 years of age, usually children, and is characterized by nontender swelling at the inferior border of the mandible. The skin as well as the mucosa has a normal appearance.

Treatment consists of extraction of the tooth, while the administration of antibiotics is a subject of controversy. Remission of the lesion is expected within 2–6 months.

16.3.3
Osteoradionecrosis

Osteoradionecrosis is regarded as a severe disease that is observed after high radiation doses resulting in ischemia of the bone, which leads to necrosis in the case of infection. The cardinal cause of the disease is tooth extraction a short while after the radiotherapy, a period during which the body cannot achieve satisfactory healing. The clinical presentation includes odontalgia and rapid spread of the lesion to a large part of the bone.

Management consists of combined surgical and pharmaceutical treatment, while the use of hyperbaric oxygen is beneficial.

16.4
Actinomycosis

Actinomycosis is usually a chronic bacterial infection, caused by the Gram-positive, anaerobic bacteria *Actinomyces israelii*. This microorganism lies dormant in the oral cavity and may become activated under certain circumstances. Portals of entry include root canals of infected teeth, postextraction sockets, etc. A hard, slightly painful lesion characterizes the clinical presentation, with reddish overlying skin, on which sinus tracts are often observed (Fig. 16.6). Sulfur granules are found in the pus discharged from the sinus tracts, which are composed of colonies of the microorganism. Either the skin alone or the bone as well may be involved in the infection.

Treatment consists of surgical incision and drainage with excision of sinus tracts, and administration of penicillin for several months (up to a year), depending on the severity of the disease.

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