15

Extrusive Luxation and Lateral Luxation

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Definition

Extrusive luxation (peripheral dislocation, partial avulsion)

Partial displacement of the tooth out of its socket. (Fig. 15.1)

Lateral luxation

Displacement of the tooth in a direction other than axially. This is accompanied by comminution or fracture of the alveolar socket. (Fig. 15.2)

Frequency

The frequency of extrusive and lateral luxation han been found to be 7% and 11% among traumatized permanent teeth examined at a major trauma center (7).

Healing and pathology

In these cases there is a complete rupture of the neurovascular supply to the pulp and severance of periodontal ligament fibers leading to extrusion. In case of lateral luxation the periodontal injury is accompanied by a fracture of the labial bone plate as well as contusion injury to the lingual cervical periodontal ligament.

In a recent study in rats the pulp response after extrusion was found to be separation of the odontoblast layer especially in the coronal part of the pulp; furthermore interstitial bleeding was found. After 4 and 8 weeks irregular dentin formation took place (8).

Clinical findings

Extrusion

Extruded teeth appear elongated and most often with lingual deviation of the crown, as the tooth is suspended only by the palatinal gingiva (Fig. 15.1). There is always bleeding from the periodontal ligament. The percussion sound is dull.

Lateral luxation

The crowns of laterally luxated teeth are in most cases displaced lingually and are usually associated with fractures of the vestibular part of the socket wall (Fig. 15.2). Displacement of teeth after lateral luxation is normally evident by visual inspection. However, in case of marked inclination of maxillary teeth, it can be difficult to decide whether the trauma has caused minor abnormalities in tooth position. In such cases, occlusion should be checked. Due to the frequently locked position of the tooth in the alveolus, clinical findings revealed by percussion and mobility tests are identical with those found in intruded teeth (see Chapter 13, Table 13.1).

Radiographic findings

Extruded teeth show an expanded periodontal space especially apically (Fig. 15.3). This will be evident in both occlusal and orthoradial exposures (Fig. 15.3).

Likewise, a *laterally luxated tooth* shows an increased periodontal space apically when the apex is displaced labially. However, this will usually be seen only in an occlusal or eccentric exposure. An orthoradial exposure will give little

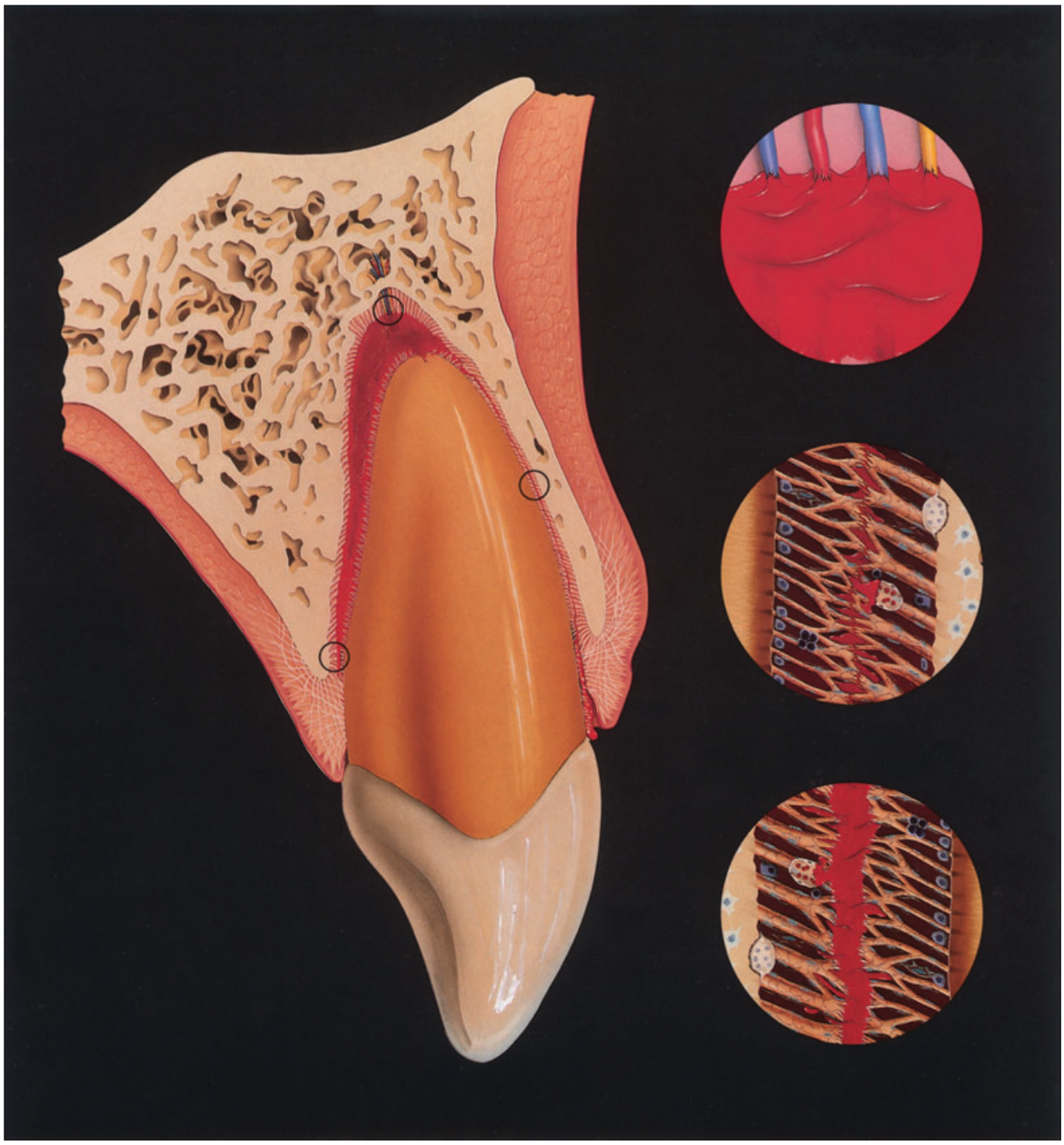


Fig. 15.1 Pathogenesis of extrusive luxation. Oblique forces displace the tooth out of its socket. Only the palatal gingival fibers prevent the tooth from being avulsed. Both the PDL and the neurovascular supply to the pulp are ruptured.

or no evidence of displacement. The radiographic picture, which imitates extrusive luxation, is explained by the relation between the dislocation and direction of the central beam (1) (Fig. 15.4).

Treatment

The treatment of *extruded* permanent teeth seen soon after injury consists of careful repositioning, whereby the coagulum formed between the displaced root and socket wall will be slowly pressed out along the gingival crevice (Fig. 15.5). Administration of local anesthetic is generally not necessary. As the repositioned tooth often has a tendency to migrate incisally, a flexible splint should be applied for 2–3 weeks (see later) (Fig. 15.6).

In case of *lateral luxation*, repositioning is usually a very forceful and, therefore, a traumatogenic procedure (Figs 15.7 and 15.8). Prior to this procedure, it is necessary to anesthetize the area. An infraorbital regional block anesthesia on the appropriate side of the maxilla is the most effec-

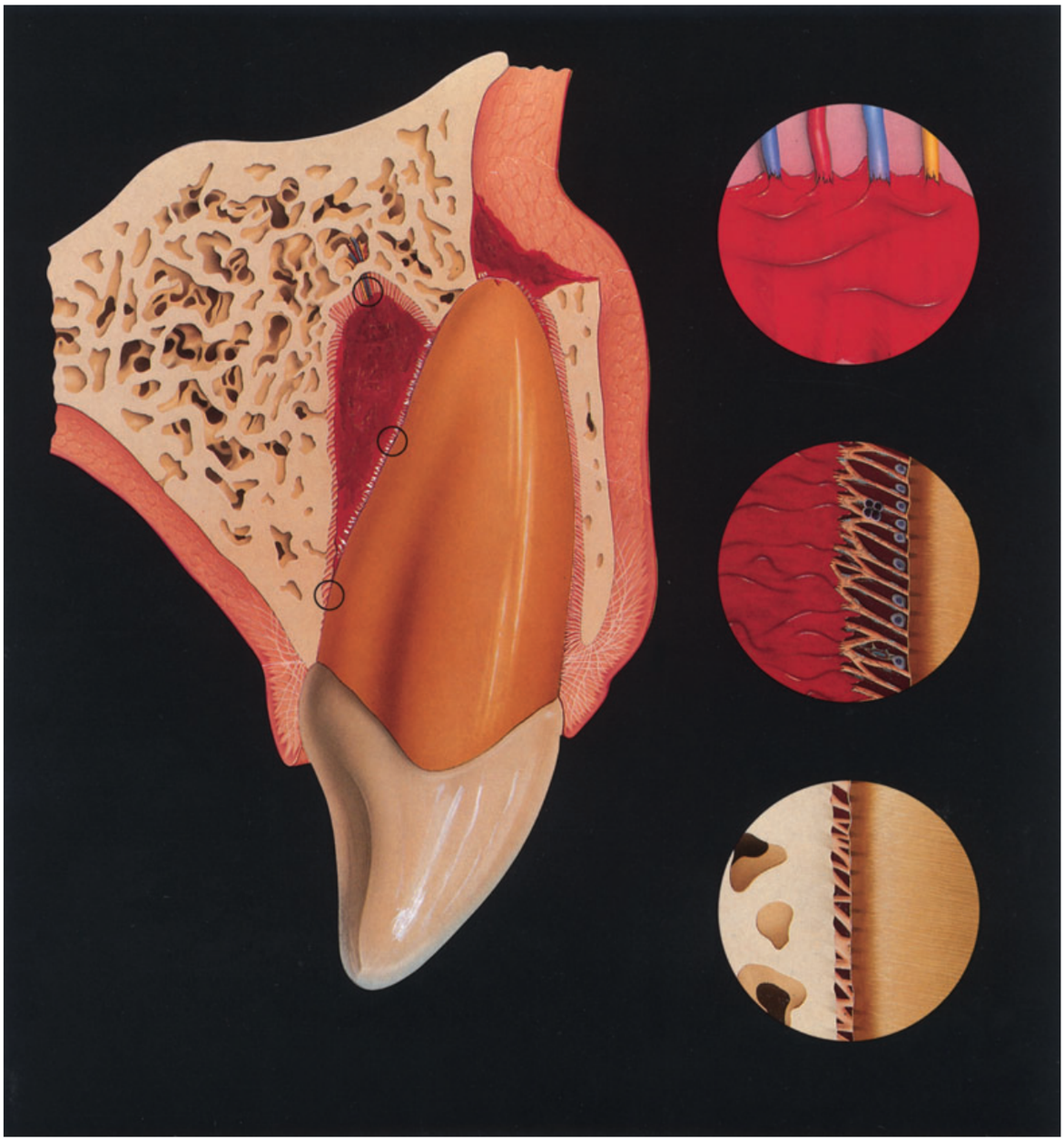


Fig. 15.2 Pathogenesis of lateral luxation. Horizontal forces displace the crown palatally and the root apex facially. Apart from rupture of the PDL and the pulpal neurovascular supply, compression of the PDL is seen on the palatal aspect of the root.

tive. As indicated, this type of luxation is characterized by the forceful displacement of the root tip through the facial alveolar wall, which complicates the repositioning procedure. In order to dislodge the root tip from its bony lock, firm digital pressure in an incisal direction must first be applied immediately over the displaced root, which can be localized by palpating the corresponding bulge in the sulcular fold. Once the tooth is dislodged, it can be maneuvered apically into its correct position.

If manual repositioning is not possible, a forceps can be applied, whereby the tooth is first slightly extruded past the bony alveolar lock and then directed back into its correct position.

Once the tooth is repositioned, the labial and palatal bone plates should also be compressed, to ensure complete repositioning and to facilitate periodontal healing. Lacerated gingiva should then be re-adapted to the neck of the tooth and sutured. The tooth should be splinted in its normal position. A radiograph is then taken to verify repositioning and to register the level of the alveolar bone for later

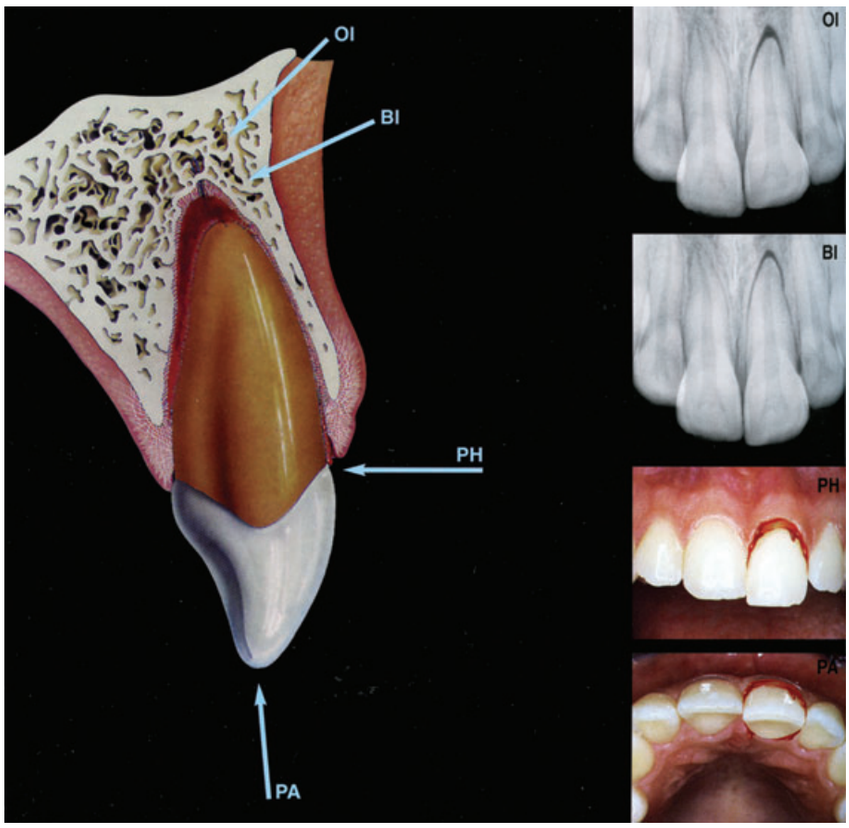


Fig. 15.3 Clinical and radiographic features of extrusive luxation. The standard bisecting angle periapical radiographic technique is more useful than a steep occlusal exposure in revealing axial displacement. From ANDREASEN & ANDREASEN (1) 1985.

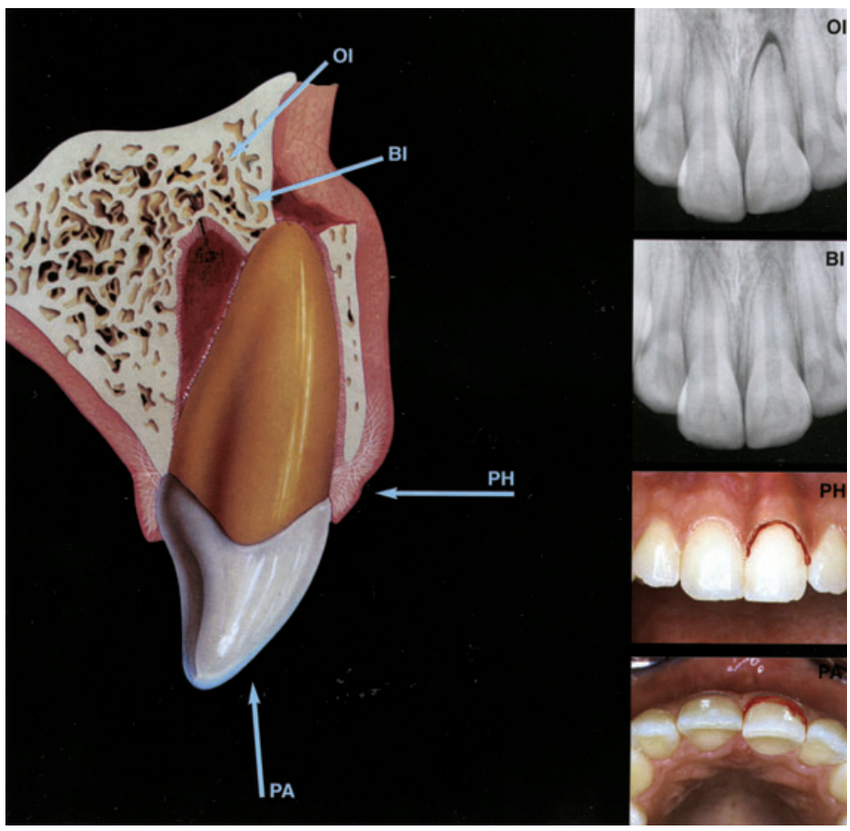


Fig. 15.4 Clinical and radiographic features of lateral luxation. The steep occlusal radiographic exposure or an eccentric periapical bisecting angle exposure are more useful than an orthoradial bisecting technique in revealing lateral displacement. From ANDREASEN & ANDREASEN (1) 1985.

comparison. This is recommended in order to monitor eventual loss of marginal bone support in the follow-up period (see later).

If treatment of a laterally luxated or extruded permanent tooth is delayed (i.e. more than 3–4 days), it is usually found that the tooth is difficult to reposition. Recent studies seem to indicate that reduction procedures should be deferred and the tooth allowed to realign itself or that this should be accomplished orthodontically (2).

In young children, where the laterally luxated tooth does not interfere with occlusion, it might be indicated to await spontaneous repositioning (Fig. 15.9).

Prognosis

Very few studies have been performed on the prognosis of extrusive and lateral luxation. In Tables 15.1 and 15.2, the frequencies of complications such as pulp necrosis, pulp canal obliteration, root resorption and marginal breakdown are given. In the studies reported by the Copenhagen group (2, 4) and the Toronto group (5, 6) it should be noted that the latter group was confined to a pediatric population (children and adolescents).

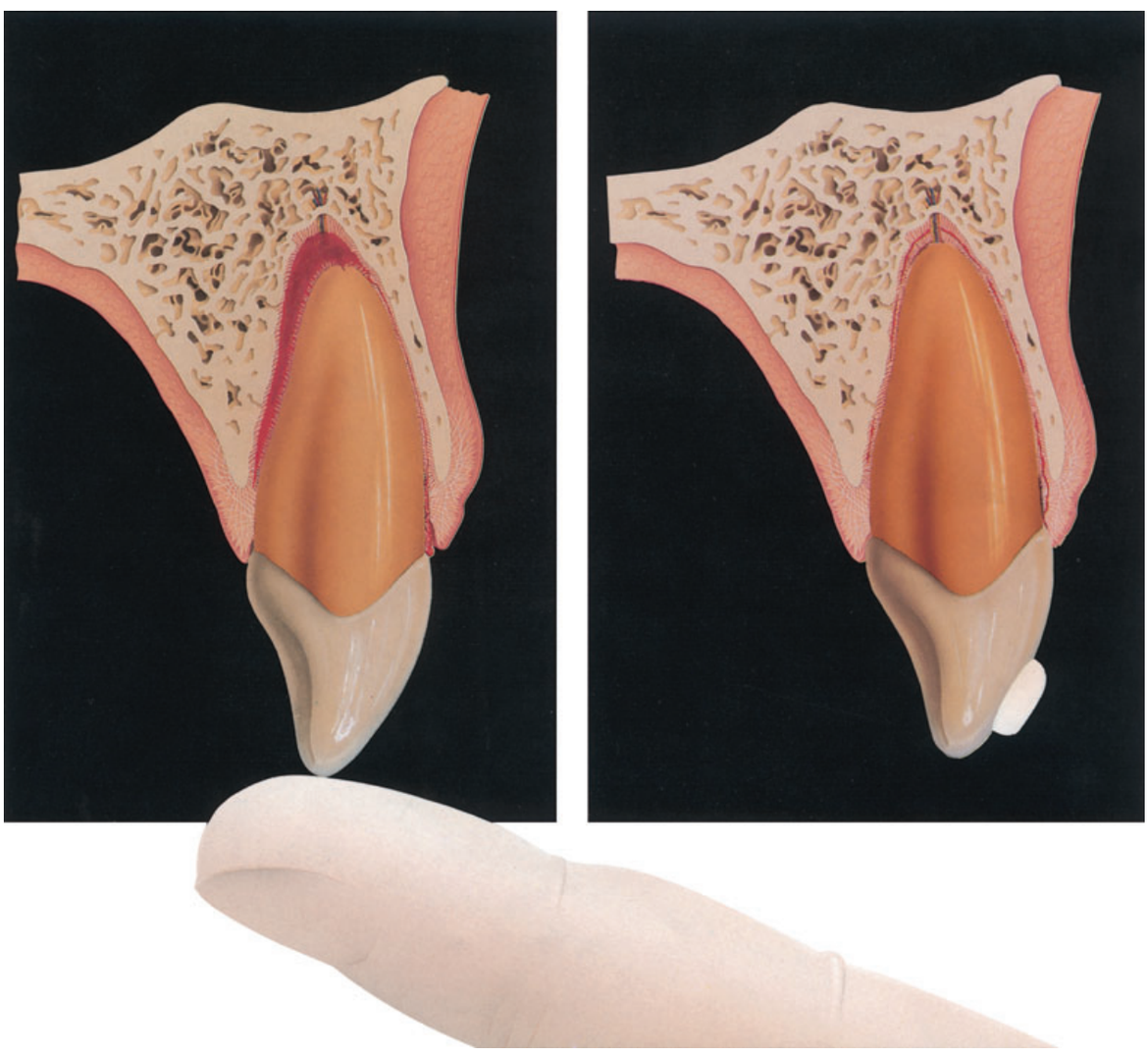
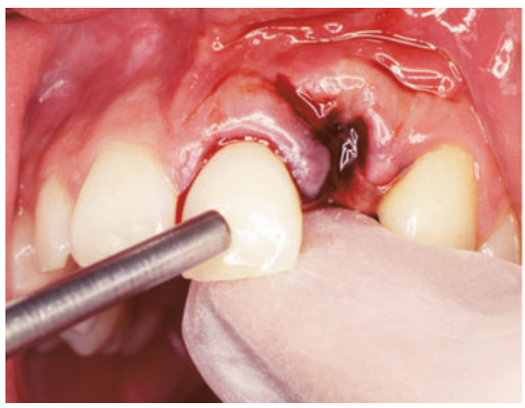
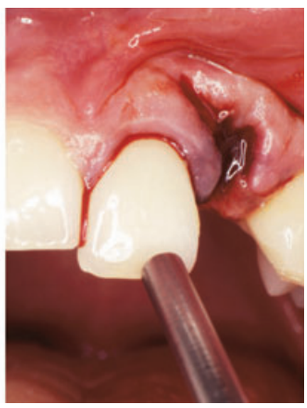


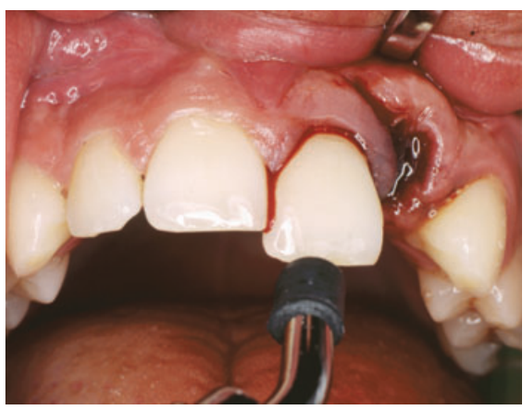
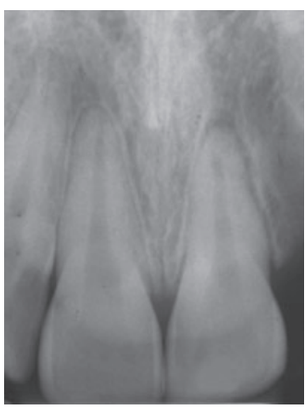
Fig. 15.5 Treatment of extrusive luxation. The extruded tooth should be gently repositioned using axial finger pressure on the incisal edge and the tooth splinted.

Fig. 15.6 Diagnosis and treatment of extrusive luxation
This 17-year-old man has extruded the left central incisor and avulsed the lateral incisor, which could not be retrieved.

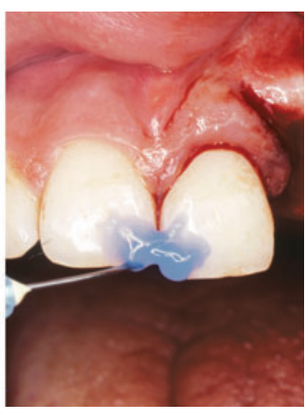

Mobility and percussion test
The tooth is very mobile and can be moved in horizontal and axial direction. The percussion test reveals slight tenderness and there is a dull percussion tone.

Sensibility testing and radiographic examination
The tooth does not respond to sensibility testing. The radiograph reveals coronal displacement of the tooth.

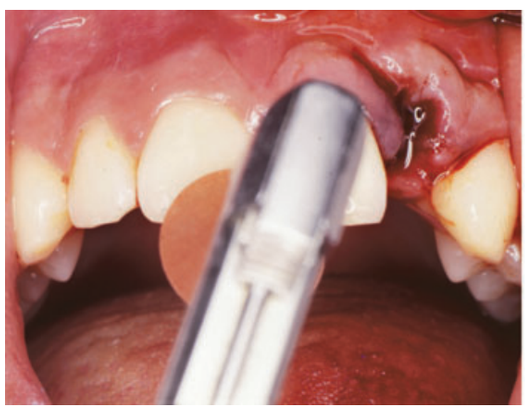



Repositioning
The tooth is gently pushed back into its socket. Thereafter the labial surfaces of both central incisors are etched in preparation for the splinting material.

Applying splinting material
After rinsing the labial surfaces with a water spray and drying with compressed air, the splinting material (Protemp®, Espe Corp.) is applied.

Polishing the splint
The surface of the splint is smoothed with abrasive discs and contact with gingival removed with a straight scalpel blade.



The finished splint
Note that the splint allows optimal oral hygiene in the gingival region, which is the most likely port of entry for bacteria that may complicate periodontal and pulpal healing.

Suturing the gingival wound
The gingival wound is closed with interrupted silk sutures. The final radiograph confirms optimal repositioning of the tooth.

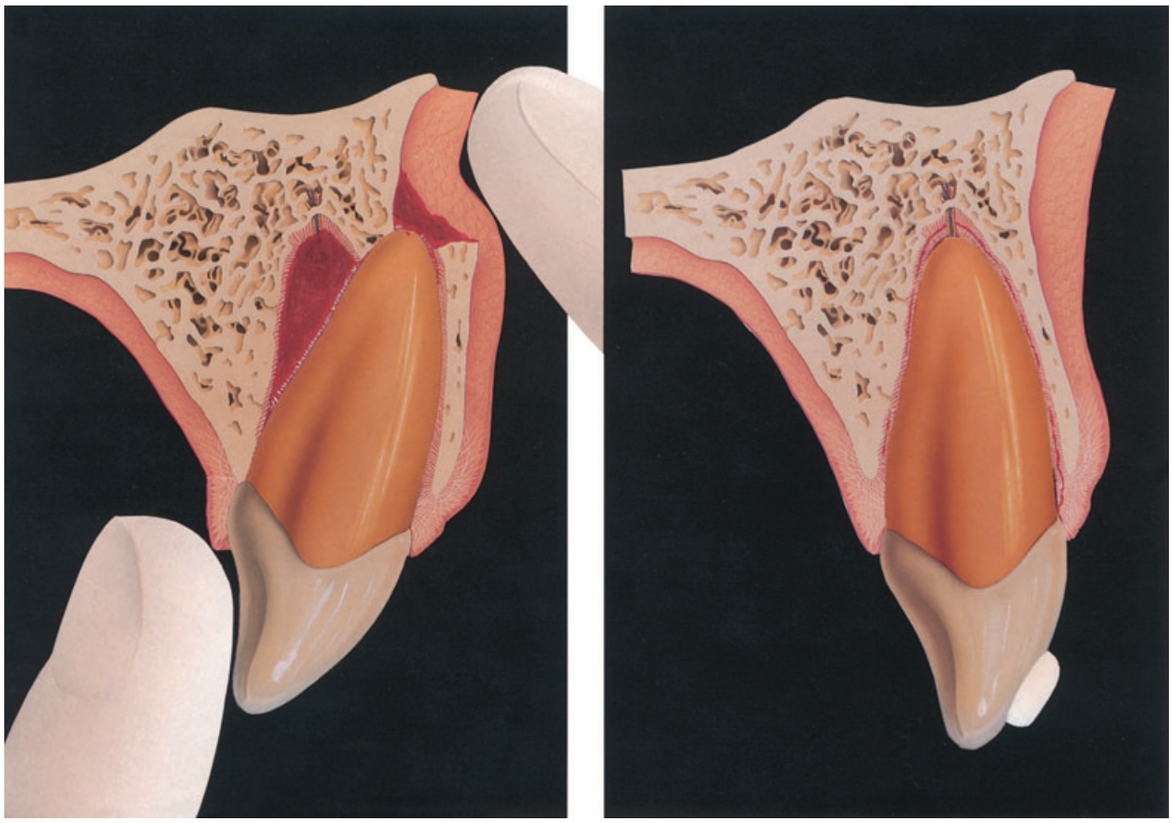


Fig. 15.7 Treatment principles for extrusive luxation: repositioning and splinting.

Pulp necrosis

Extrusion

This complication appeared to be very dependent upon root development in the Copenhagen study, where immature root development had a superior healing potential compared to more mature root development (2, 4). (Table 15.1, Fig. 15.10)

Lateral luxation

The same finding was made in regard to pulp necrosis (2, 4) (Table 15.2, Fig. 15.11).

Pulp canal obliteration

Extrusion

In cases where the pulp becomes revascularized, pulp canal obliteration was almost always a standard sequel to injury.

Lateral luxation

The same finding was found as for extrusion.

Root resorption (external)

Extrusion

Surface resorption was quite common, inflammatory resorption rare. Ankylosis was not seen (2) (Fig. 15.12).

Lateral luxation

The resorption pattern was quite similar to extrusions (Fig. 15.13). Ankylosis resorption was exceedingly rare and in these instances located to the cervical region, i.e. where the compression zones are located (2, 3) (Fig. 15.14).

Moreover, the frequent shortening of the root tips (i.e. surface resorption) appears to be related to the apical compression zone.

Marginal bone loss

Extrusion

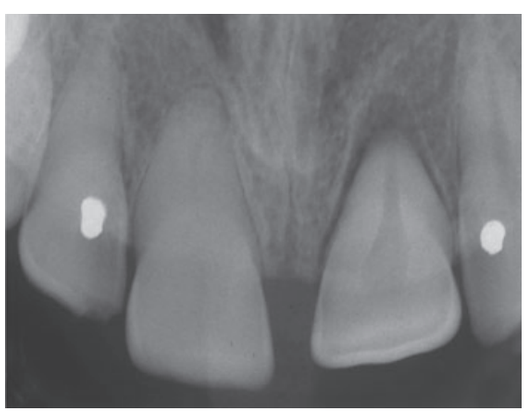
As expected this trauma group showed no loss of marginal bone due to the limited nature of the injury (i.e. rupture of periodontal ligament) (Table 15.1).

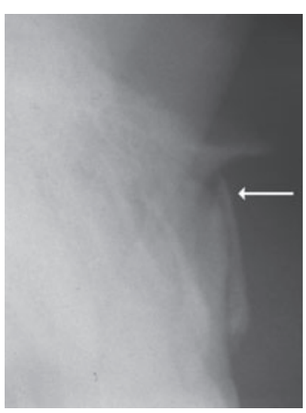
Fig. 15.8 Diagnosis and treatment of lateral luxation
This 23-year-old man suffered a lateral luxation of the left central incisor.

Percussion test
Percussion of the injured tooth reveals a high metallic sound.

Mobility and sensibility testing
Mobility testing, using either digital pressure or alternating pressure of two instrument handles facially and orally, discloses no mobility of the injured tooth. There is no response to pulpal sensibility testing.

Radiographic examination
A steep occlusal radiographic exposure revealed, as expected, more displacement than the bisecting angle technique. A lateral radiograph reveals the associated fracture of the labial bone plate (arrow).

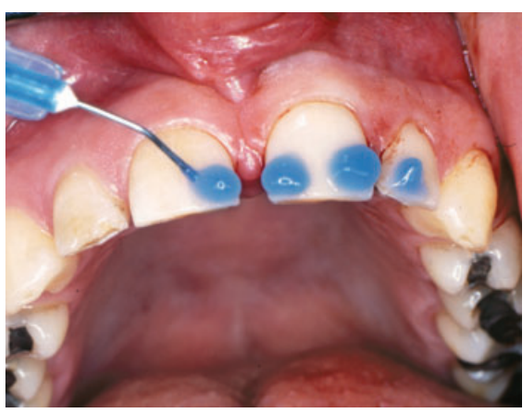




Anesthesia
An infraorbital regional block is placed and supplemented with anesthesia of the nasopalatinal nerve.

Repositioning
The tooth is repositioned initially by forcing the displaced apex past the labial bone lock and thereby disengaging the root. Thereafter, axial pressure apically will bring the tooth back to its original position. It should be remembered that the palatal aspect of the marginal bone has also been displaced at the time of impact. This, too, must be repositioned with digital pressure to ensure optimal periodontal healing.

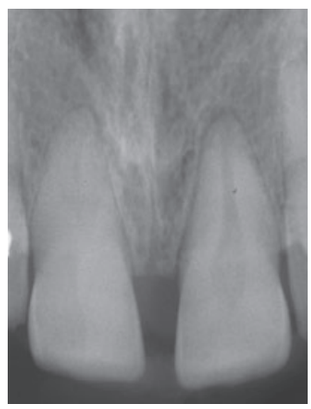
Verifying repositioning and splinting with the acid-etch technique
Occlusion is checked and a radiograph taken to verify adequate repositioning. The incisal one-third of the labial aspect of the injured and adjacent teeth is acid-etched (30 seconds) with phosphoric acid gel.



Preparing the splinting material
The etchant is removed with a 20-second water spray. The labial enamel is dried with compressed air, revealing the matte, etched surface.

Applying the splinting material
A temporary crown and bridge material (e.g. Protemp®) is then applied. Surplus material can be removed after polymerization using a straight scalpel blade or abrasive discs.

Three weeks after injury
At this examination, a radiograph is taken to evaluate periodontal and pulpal healing. That is, neither periapical radiolucency nor breakdown of supporting marginal bone, as compared to the radiograph taken after repositioning.



Splint removal
The splint is removed using fissure burs, by reducing the splinting material interproximally and thereafter thinning the splint uniformly across its total span. Once thinned, the splint can be removed using a sharp explorer.

Six months after injury
After 6 months, there is a slight sensibility reaction and normal radiographic conditions.

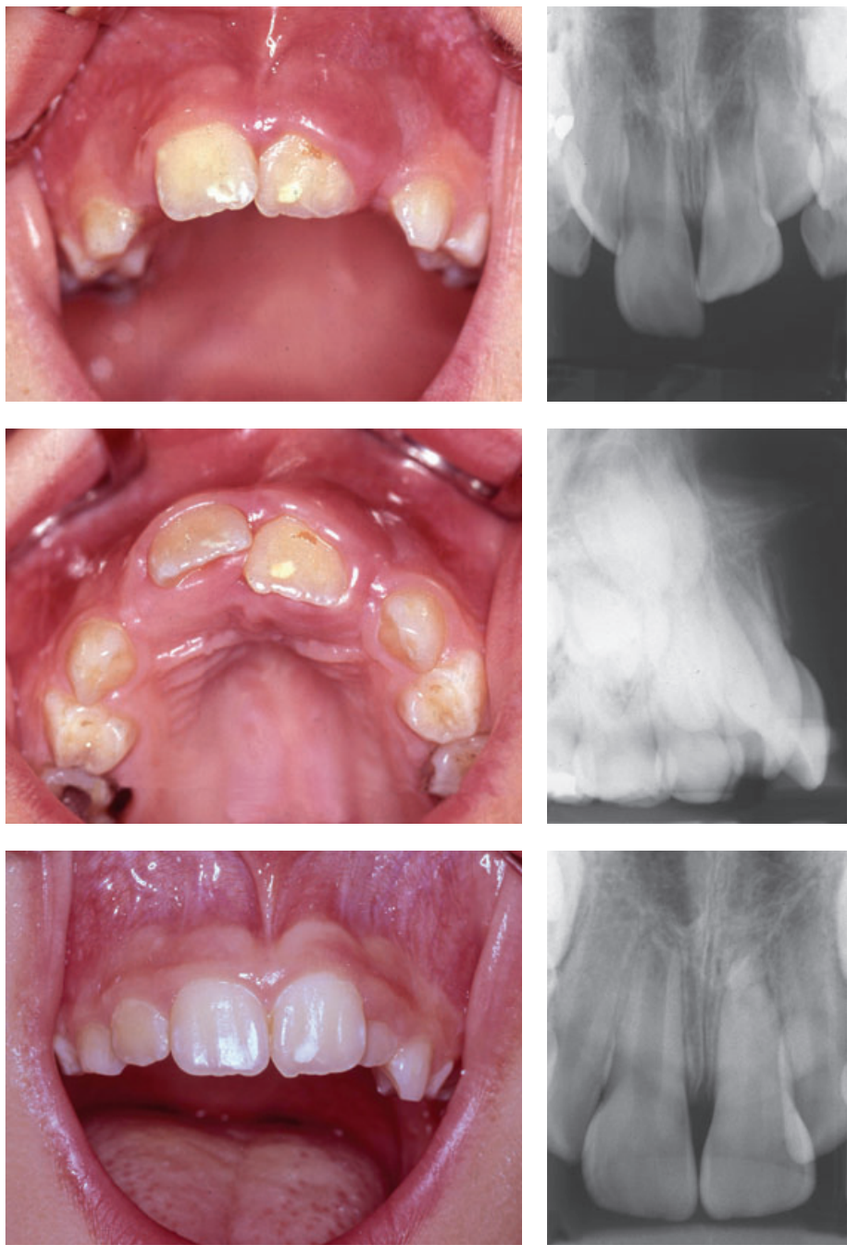


Fig. 15.9 Non-repositioning of a laterally luxated central incisor which did not interfere with occlusion with spontaneous reposition. Time of injury. Note the lingually displaced crown.

Axial clinical view and lateral radiograph

Follow up One year later, the tooth in its normal position. There is pulp canal obliteration.

Table 15.1 Pulp and periodontal healing complications following extrusive luxation.

Author	Stage of root development	No. of teeth	Pulp necrosis	Pulp canal obliteration	Pulp survival	Root resorption	Marginal breakdown
Andreasen & Vestergaard Petersen (2) 1985	Open apex	34	3 (9%)	20 (61%)	10 (30%)	4 (12%)	3 (6%)**
Andreasen (3) 1995	Closed apex	20	11 (55%)	4 (20%)	15 (25%)	4 (20%)	
Lee et al. (6)* 2003	Open + closed apex	54	23 (42%)	19 (35%)	12 (23%)	3 (6%)	?

* Only children and adolescents. ** Open and closed apices.

Table 15.2 Pulp and periodontal healing complications following lateral luxation.

Author	Stage of root development	No. of teeth	Pulp necrosis	Pulp canal obliteration	Pulp survival	Root resorption	Marginal breakdown
Andreasen & Vestergaard Petersen (2) 1985	Open apex	34	3 (9%)	24 (71%)	7 (20%)	3 (9%)	9 (7%)**
Andreasen (3) 1995	Closed apex	88	68 (77%)	10 (11%)	10 (11%)	34 (39%)	
Nikoui et al. (5)* 2003	Open + closed apex	58	23 (40%)	23 (40%)	12 (20%)	?	?

* Only children and adolescents. ** Open and closed apices.

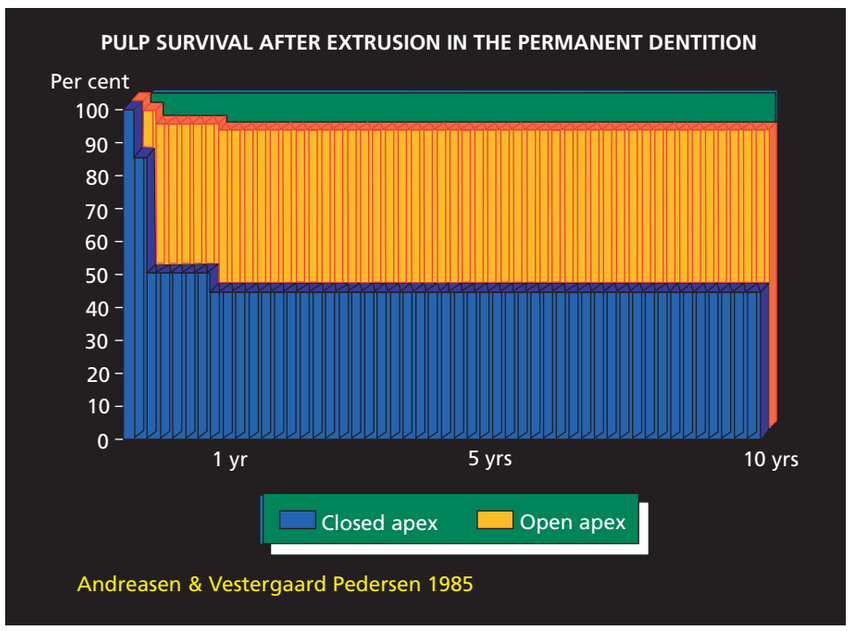


Fig. 15.10 Pulpal healing after extrusive luxation. After ANDREASEN & VESTERGARD PEDERSEN (2) 1985.

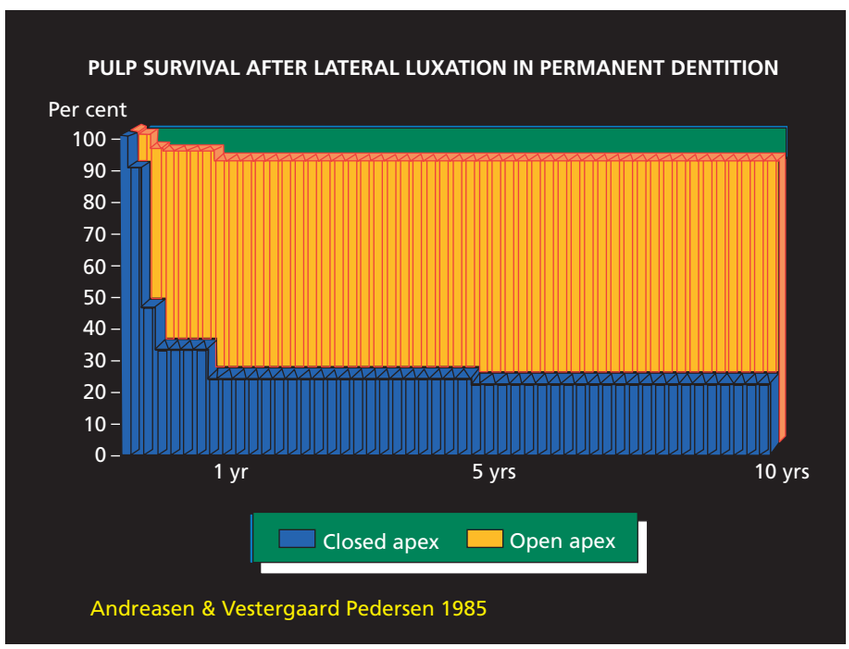


Fig. 15.11 Pulpal healing after lateral luxation. After ANDREASEN & VESTERGARD PEDERSEN (2) 1985.

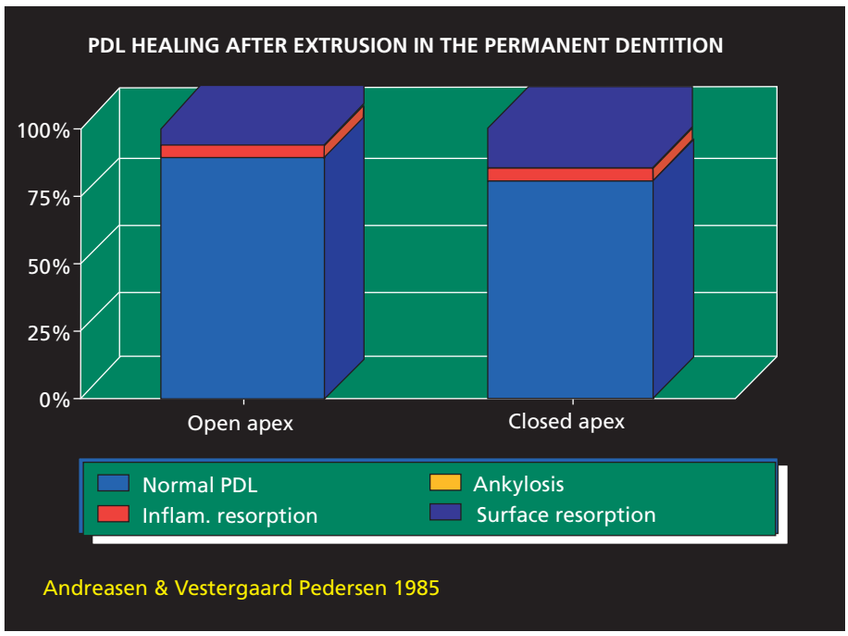


Fig. 15.12 Periodontal healing after extrusive luxation. After ANDREASEN & VESTERGARD PEDERSEN (2) 1985.

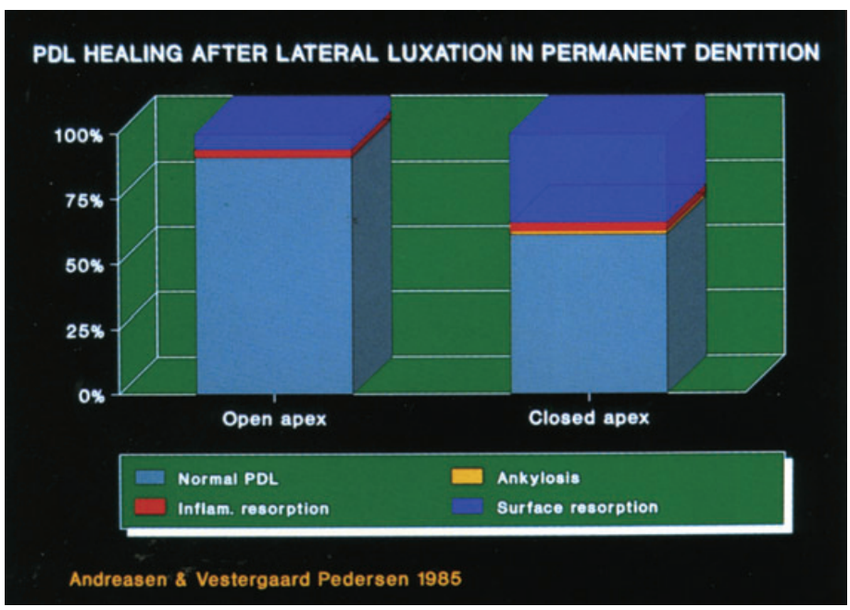


Fig. 15.13 Periodontal healing after lateral luxation. After ANDREASEN & VESTERGARD PEDERSEN (2) 1985.

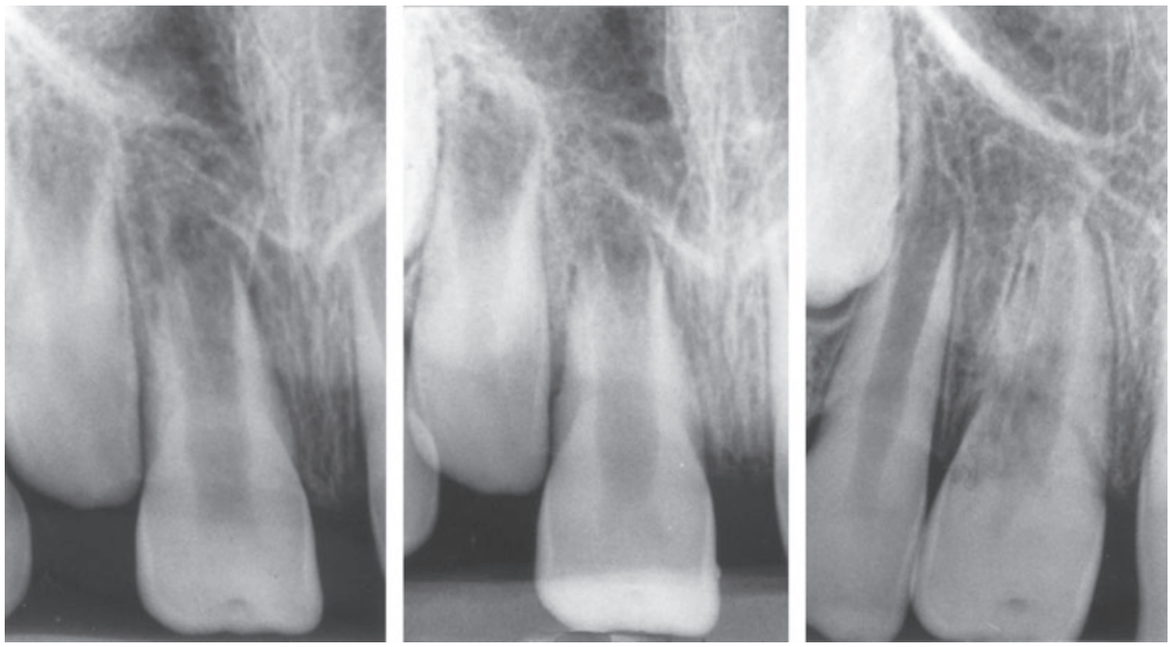


Fig. 15.14 External replacement resorption of a central incisor as a sequel to lateral luxation. At the time of splint removal, one month after injury, there is no evidence of root resorption. At the one-year follow-up, ankylosis is evident distally.

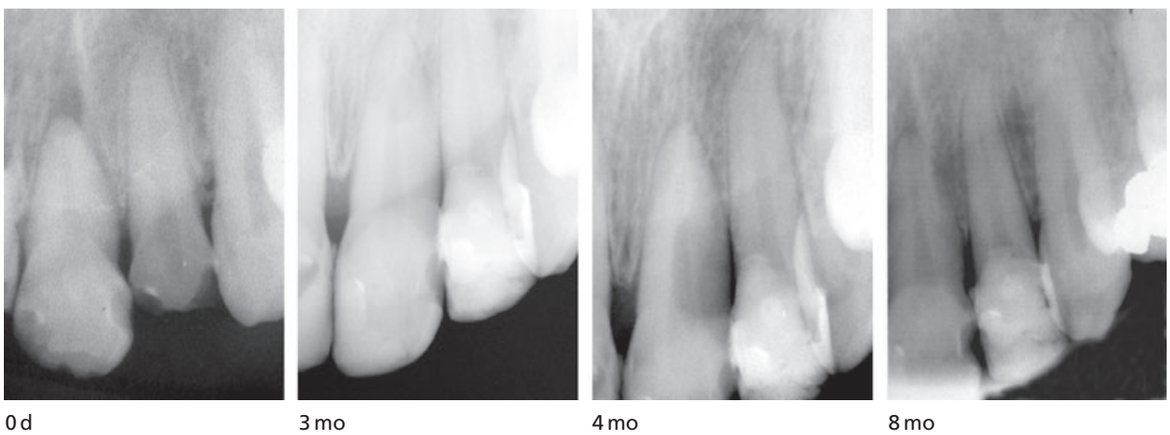


Fig. 15.15 Transient marginal breakdown in a 46-year-old male who suffered lateral luxation of the left central incisor. Three months after reposition there is no sign of pathology. Four months after reposition a marked breakdown of bone is found between the central and the lateral incisor. Four months later the interdental bone has been reformed. Courtesy of Dr H LUND, Kolding, Denmark.

Lateral luxation

In this trauma group loss of marginal bone was seen, which is explained by the compressive type of the injury in the cervical region (Table 15.2, and Fig. 15.15).

Predictors of healing

In a multivariate analysis, the only significant factors appeared to be the stage of root development (2, 3). The relation to root development could be further refined by measuring the apical diameter (4). Moreover, it was found that increased age after completed root development was significantly related to pulp necrosis (2, 3). Figs 15.16 and 15.17 present the healing predictors for *extrusion* and *lateral luxation*.

Tooth survival

It appears from two clinical studies that excellent long-term survival can be expected for extrusions and lateral luxations (98% and 100% respectively) (5, 6).

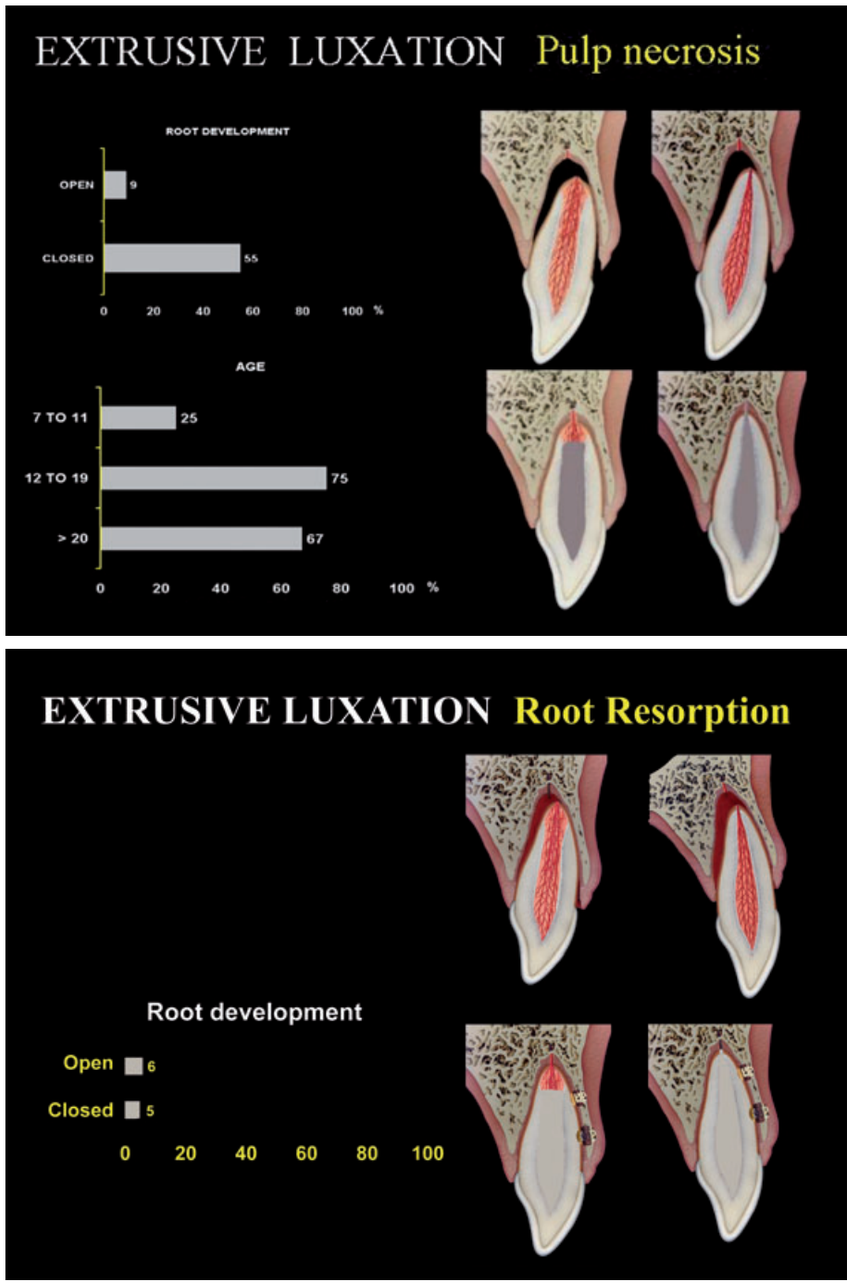


Fig. 15.16 Predictors for healing outcome after extrusive luxation.

Essentials

Extrusive and lateral luxation

(1) Administer local anesthesia if forceful repositioning is anticipated (i.e. lateral luxation).
(2) Reposition the tooth into normal position (Figs. 15.6 and 15.8). In case of delayed treatment, the teeth should be allowed to realign spontaneously into normal position or be moved orthodontically.
(3) Splint the tooth with an acid-etch/resin splint.
(4) Monitor the tooth radiographically.
(4) Splinting period:
    — Extrusion: 2–3 weeks.
    — Lateral luxation: 3 weeks. In case of marginal bone breakdown, extend fixation period to 6–8 weeks.
(5) Follow-up period: minimum 1 year.

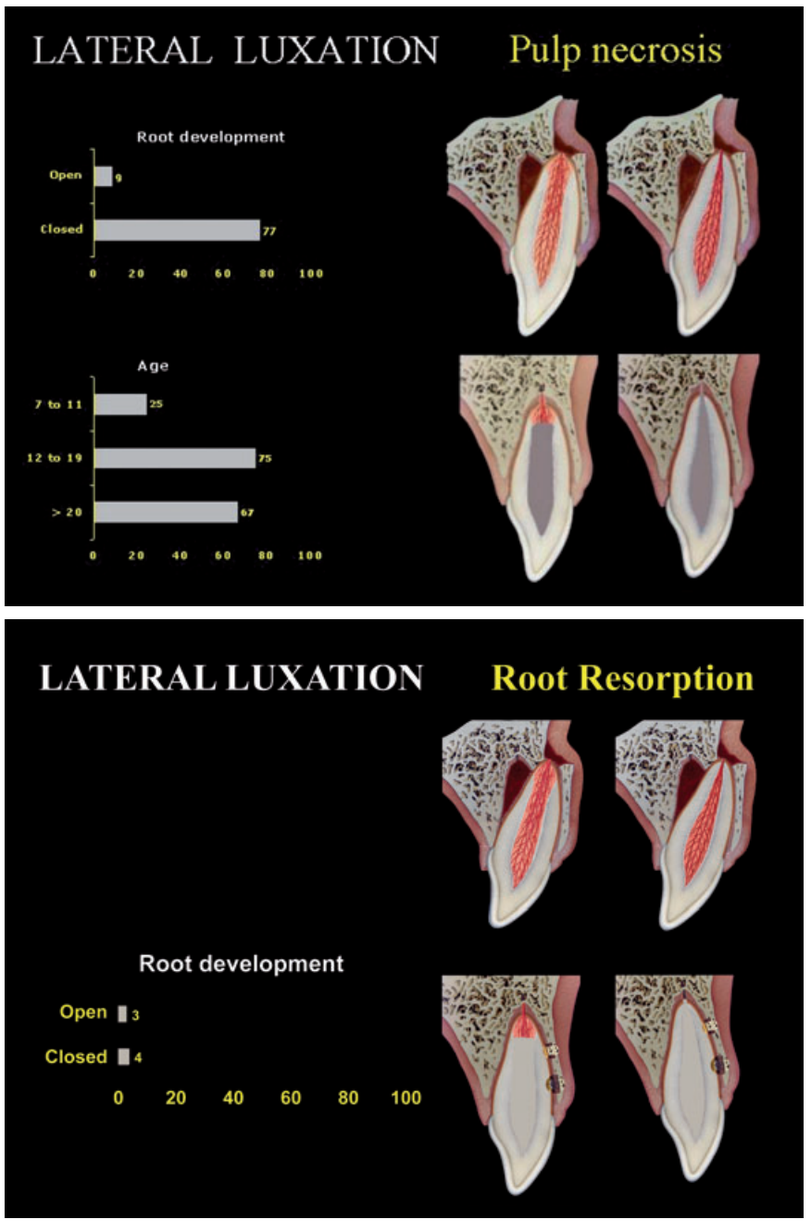


Fig. 15.17 Predictors for healing outcome after lateral luxation.

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21
Soft Tissue Injuries

L. Andersson, J. O. Andreasen

Terminology, frequency and etiology

A large number of dental traumas are associated with injuries to the lip, gingiva and oral mucosa. One third of all patients treated for oral injuries in dental emergency settings and more than half of all patients treated in a hospital emergency setting are associated with soft tissue injury (1–4).

The dentition is shielded by the lips covering the teeth in case of impact to the lips (Fig. 21.1). Trauma energy will be absorbed in the soft tissue resulting in less severe tooth injuries. However, this will result in various types of soft tissue trauma depending on the direction of force, shape and size of object, and energy (See Chapter 8).

Moreover, when a patient is subjected to trauma, the teeth may also cause injury to the surrounding soft tissue, most commonly penetrating into the lips but sometimes also the cheeks and tongue. When teeth are dislocated the gingiva will sometimes be lacerated.

Incorrect primary treatment may result in unesthetic scarring (Fig. 21.2).

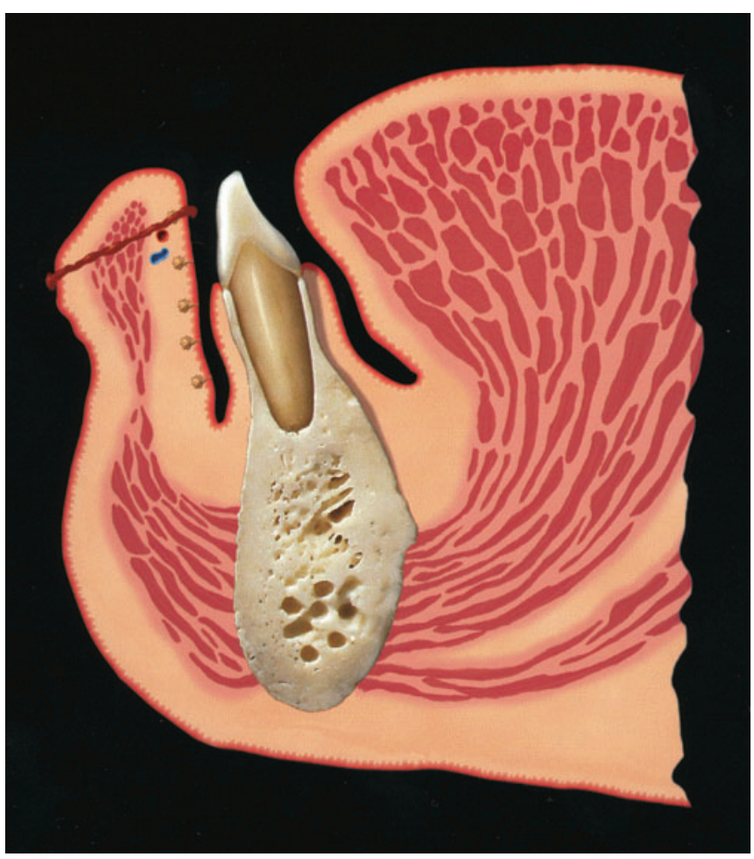


Fig. 21.1 Section through a human lower lip in the midline. Note the composite structure of the lip, with musculature, salivary glands and hair follicles. Most of the musculature is oriented parallel to the vermilion border.

Fig. 21.2 Scarring subsequent to a penetrating wound in the lower lip
A 3-cm wide laceration of the cutaneous and mucosal aspects of the lower lip in a 9-year-old girl. Suturing of the cutaneous aspect of the wound was the only treatment provided.

Condition after 1 week
Note saliva seepage and non-closure of the wound.

Follow-up
Healing has resulted in extreme scarring of the skin, whereas the wound on the mucosa is hardly noticeable.

Types of soft tissue trauma

Soft tissue injuries are usually classified into the following groups and their characteristics are described below. They can be seen extra-orally (skin) as well as intra-orally (gingiva and oral mucosa).

Abrasion

An abrasion is a superficial wound produced by rubbing and scraping of the skin or mucosa leaving a raw, bleeding surface (Fig. 21.3). This injury is usually seen on knees and elbows in children and in the oral region the lips, chin, cheek or tip of the nose are frequently affected. The friction between the object and the surface of the soft tissue removes the epithelial layer and papillary layer of the dermis, and the reticular layer of the dermis is exposed. Superficial abrasions can be quite painful because terminal nerve endings are exposed.

Contusion

A contusion is a bruise usually produced by impact with a blunt object and not accompanied by a break in the skin or mucosa but usually causing subcutaneous or submucosal hemorrhage in the tissue (Figs 21.4. and 21.5). Contusions may also be caused by the disrupting effect of fractured bone in maxillofacial injuries. Contusions may therefore indicate an underlying bone fracture.

Fig. 21.3 Abrasion of the upper and lower lip.

Fig. 21.4 Periorbital haematoma indicating contusion injury after road traffic accident. Clinical and radiographical examination revealed underlying bone fracture.

Fig. 21.5 Haematoma of soft tissue in right premolar region. Perimandibular haematoma is strongly indicative of mandibular fracture and radiographic examination revealed a mandibular fracture.

Laceration

A laceration is a shallow or deep wound in the skin or mucosa resulting from a tear and is usually produced by a sharp object or by teeth penetrating into the soft tissue (Figs 21.6 and 21.7). Laceration involves epithelial and subepithelial tissues and if deeper may disrupt blood vessels, nerves, muscles and involve salivary glands. The most frequent lacerations in the oral region caused by trauma are seen in lips, oral mucosa and gingiva. More seldom the tongue is involved.

Avulsion

Avulsion (tissue loss) injuries are rare but seen with bite injuries or deep abrasions (Fig. 21.8). These are complex injuries from a treatment point of view in the emergency phase because a decision has to be made whether to excise and primary close the defect with flaps or grafts (large defects) or wait for spontaneous healing (small defects).

Emergency management

After the diagnosis has been established, the extent and contamination of the lesion is examined. Ascertainment of the extent of tissue damage demands thorough exploration after administration of local anesthesia. Soft tissue injuries are often seen together with dental injuries and bone fractures. A systematic approach is recommended. If the soft tissue injuries are sutured first, before intraoral treatment of teeth and bone fractures, the sutures will most likely make the tissue rupture when later intraoral manipulation is taking place. This will also result in the tissue margins being more difficult to close in a second suturing. For this reason it is important to plan the emergency treatment so that intraoral treatment is performed first, and extraoral suturing of lips after the intraoral treatment. This is in contrast to the examination procedure where we start with extraoral examination before we perform intraoral examination. A golden rule: '*Examine from outside towards inside – treat from inside towards outside*' may help one to remember the examination and treatment sequences.

Local anesthetics should be used to allow manipulation of the tissue without pain. Topical anesthetics are preferable, and recent reports have indicated that those containing a combination of prilocaine/lidocaine are effective in reducing pain from needle stick injury, so that it may be possible to close minor lacerations without injection (70).

There are four major steps in the emergency management of soft tissue injuries: *cleansing*, *debridement*, *hemostasis* and *closure* (5). One of the aims of wound cleansing is to remove or neutralize microorganisms, which contaminate the wound surface, in order to prevent infection. Wound detergents reduce the bioburden (6). However, the fact remains that almost all common wound disinfectants have been shown to have a detrimental effect upon wound

Fig. 21.6 (Left) Laceration of lip after road traffic accident.
Fig. 21.7 (Right) Intra-oral laceration of the upper lip. The blood around the anterior teeth originated from this laceration and not from any dental injuries.

Fig. 21.8 Avulsion injury of lower lip. Note the loss of soft tissue. Nevertheless this was left for spontaneous healing without flaps or grafts. Note the final result one year after trauma. A normal contour of the lip is seen. Scar tissue is seen centrally in a circular area at the vermillion border with a 9 mm diameter.

healing (7). Physiologic saline or Ringers solution appear to be without a harmful effect upon cells in the wound. Even water can be used for rinsing. The volume of fluid seems to be more important than if saline or water is used (8).

The presence of foreign bodies in the wound significantly increases the risk of infection (9) and retards healing, even in wounds free of infection (10) (see Chapter 1, p. ••). Foreign bodies also contribute to extensive scarring and tattooing of tissues. This finding emphasizes the importance of adequate removal of all foreign particles prior to suturing.

Abrasion

It is important to remove all dirt, gravel, asphalt and other foreign bodies to avoid future permanent tattoo and scarring in the skin (Fig. 21.9). This is very time consuming but extremely important (Fig. 21.10). There is only one chance to clean the abrasion properly and that is during the emergency phase. After administration of local anesthesia, the wound and surroundings are thoroughly rinsed and washed with saline. A scrub brush, gauze swabs or even a soft toothbrush may be used. If the contamination is severe a mild

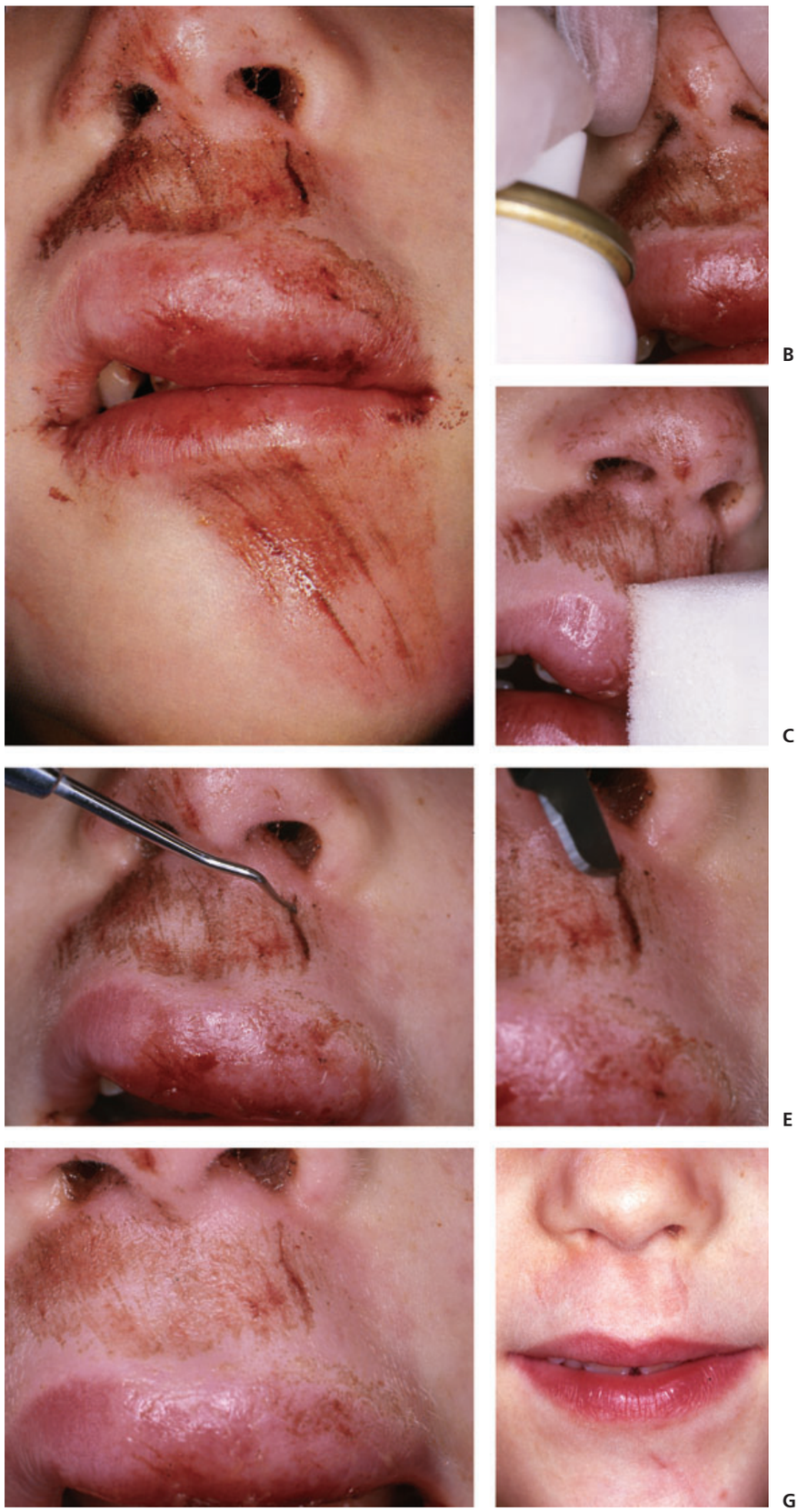


Fig. 21.9 Cleansing of a skin wound containing asphalt particles. A, B. In order to adequately cleanse the abrasions, a topical anesthetic is necessary. In this case, a lidocain spray was used. Note that the nostrils are held closed to reduce discomfort from the spray entering the nose. C. Washing the wounds. The lips are washed with surgical sponges or gauze swabs soaked in a wound detergent.

Removing asphalt particles
D and E. The impacted foreign bodies cannot be adequately removed by scrubbing or washing; but should be removed with a small excavator or a surgical blade held perpendicular to the direction of the abrasions.

Cleaned wound and follow-up
F and G. Two weeks after injury, the soft tissue wounds have healed without scarring.

soapy solution may be used (Fig. 21.9). Thereafter, all foreign bodies are removed with a small excavator or a surgical blade which is placed perpendicular to the cutaneous surface in order to prevent it from cutting into the tissue. Finally irrigation with saline should be performed. The wound is usually left open without any applications but may be covered with a bandage. The patient should avoid excessive sunlight during the first 6 months to decrease risk of permanent hyperpigmentation. Intraoral abrasions do not have to be treated but limited to removal of any foreign bodies.

Fig. 21.10 Extensive asphalt tattoo. The patient suffered an injury years earlier. Inadequate wound debridement resulted in extensive asphalt tattooing. Courtesy of Dr. S. BOLUND, University Hospital, Copenhagen.

Contusion

Swelling and bruising may indicate a deeper injury; usually only bleeding but sometimes bone fractures are the causes of contusions (Figs 21.4 and 21.5). Radiographic examination is therefore indicated. Care should be taken to extend the clinical examination also to indirect trauma related areas such as palpation and radiographic examination of the condyles when a bruise is seen in the chin region. Make sure that there is no ongoing bleeding if the swelling is located in a sensitive area for the airways such as the floor of the mouth or the tongue. No treatment is necessary for contusions when the injury is limited to soft tissue injury.

Laceration

The possibility of contamination of the wound requires inspection for foreign bodies or tooth fragments. In deeper wounds, clinical inspection should be supplemented with a radiographic examination which can reveal at least some of the contaminating foreign bodies.

The removal of foreign bodies in facial and oral tissues after laceration is known to be a difficult and time-consuming procedure (11). A syringe with saline under high pressure, a scrub brush or gauze swabs soaked in saline can be used to remove foreign bodies. If this is not effective, a surgical scalpel blade or a small spoon excavator may be

Fig. 21.11 Treatment of horizontal gingival laceration with tissue displacement in the permanent dentition
Due to an impact the gingiva has been lacerated and displaced whereas the central incisors are left intact.

The displaced attached gingiva is repositioned and sutured
Postoperatively a scan is seen midroot in the left incisor region

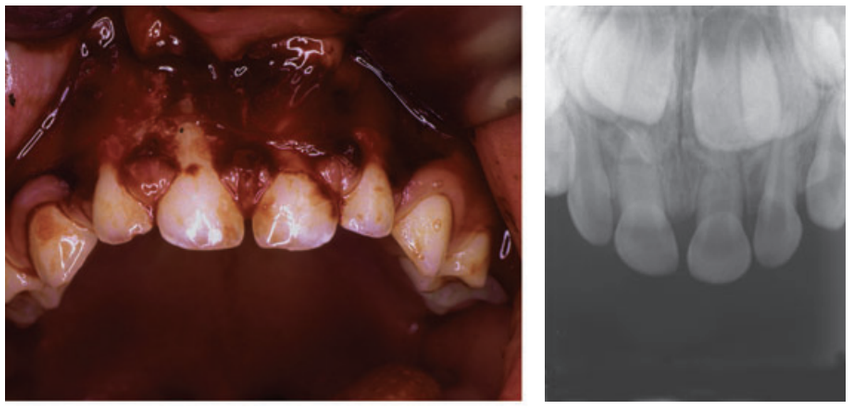
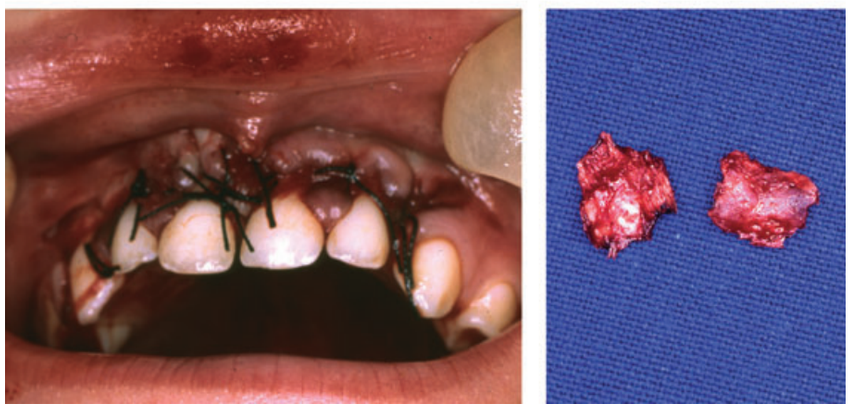


Fig. 21.12 Treatment of a gingival laceration with exposure of bone in the primary dentition
Due to a fall against an object, the gingiva has been displaced into the labial sulcus and bone is exposed whereas the incisors are left intact.



Repositioning and suturing of the gingiva
The condition immediately after gingival repositioning and suturing. Loose labial bone fragments have been removed.

Fig. 21.13 Gingival tissue loss. The central incisor has been avulsed and lost. There is tissue loss with exposure of labial bone. A flap is raised and the periosteum incised, whereby it is possible to cover the denuded bone.

used. Complete removal of all foreign bodies is important, to prevent infection and also to prevent disfiguring scarring or tattooing in the skin.

Devitalized soft tissue serves to enhance infection by at least three mechanisms: first, as a culture medium that can promote bacterial growth; second, by inhibiting leukocyte migration, phagocytosis and subsequent bacterial kill; and third, by limiting leukocyte function due to the anaerobic environment within devitalized tissue (i.e. low oxygen tension impairs killing of bacteria) (9, 12, 13) (see Chapter 1). However, the maxillofacial region has a rich blood supply. For this reason debridement should be kept to a minimum. However, severely contused and ischemic tissue should be removed in order to facilitate healing (14, 15).

Gingival and vestibular lacerations

After administration of a local anesthetic, the wound is cleansed with saline, and foreign bodies removed. The lacerated gingiva is brought back into normal position, implying that displaced teeth have been repositioned (Figs 21.11 and 21.12). After repositioning of the gingiva, the necessary numbers of thin sutures are placed to prevent displacement of tissue. A minimum number of sutures should be used. The patient is then placed on an oral hygiene regimen using 0.1% chlorhexidine for 4–5 days, whereafter the sutures are removed. In cases of loss of gingival tissue, a gingivoplasty should be performed whereby flaps are elongated by placement of periosteal incision (Fig. 21.13). If tissue loss has occurred in the region of erupting teeth, it is important to

Fig. 21.14 Gingival loss in an erupting permanent central incisor. In erupting teeth, gingival displacement or tissue loss should be assessed in relation to the position of the cemento-enamel junction. In this case of a 12-year-old boy, trauma resulted in tissue loss not extending beyond the cemento-enamel junction of the left central incisor. At a follow-up examination 5 years later, there is almost complete gingival symmetry.

Fig. 21.15 Gingival laceration with spontaneous regeneration. The marginal gingiva in this 9-year-old girl was displaced apically and not repositioned. At the 1-month follow-up examination, normal gingival relations could be observed.

consider whether tissue loss has exposed the cemento-enamel junction. If this is not the case, further eruption and physiologic gingival retraction will normalize the clinical appearance with time (Fig. 21.14). With minor displacements, gingival regeneration amounting to approximately 1 mm will usually occur (68) (Fig. 21.15).

A trauma force parallel to the front of the maxilla or the mandible will result in complete displacement of the labial mucosa into the sulcus area (67) (Fig. 21.16). Vestibular laceration with denuding of soft tissue from the bone is sometimes accompanied by severe contamination (Fig. 21.17). Wound cleansing and removal of all foreign bodies is very important before closure with sutures. Wound closure and primary healing is the main objective in these injuries and should aim at covering of bone. Later wound dehiscence with exposure of sequestred bone is sometimes seen and secondary healing with the loss of a thin superficial layer of the exposed bone will take place over a long time (Fig. 21.18). In that case daily rinsing is necessary to keep the area clean and support healing. The scarring from this secondary healing can be accepted because it is intraorally located and does not have any esthetic consequences for the patient.

Lip lacerations

In cases of a frontal impact, the labial surfaces of protruding incisors may act as a bayonet, resulting in a sagittal split of the lip (Fig. 21.19). Because of the circumferential orientation of the orbicularis oris muscles, these wounds will usually gape, with initially intense arterial bleeding due to the rich vasculature in the region. Hemorrhage is usually soon spontaneously arrested due to vasoconstriction and coagulation but with manipulation of tissue bleeding may start again. Sometimes electrocoagulation may be necessary but it should be borne in mind that extensive use of electrocoagulation in the lip should be avoided.

If the direction of impact is more vertical, parallel to the axis of either the maxillary or mandibular incisors, the incisal edges may penetrate the entire thickness of the lip. When the incisal edges hit the impacting object, fracture of the crown usually occurs.

To find foreign bodies a thorough exploration of the laceration is important. Radiographic examination adds to the information and may show a variety of typical foreign bodies, such as tooth fragments, calculus, gravel, glass and fragments of paint (Fig. 21.20). However, other typical foreign bodies such as cloth and wood cannot be seen (69).

The radiographic technique consists of placing a dental film between the lip and the alveolar process. In cases of a wide lesion, orientation of images is facilitated by placing a small metal indicator (e.g. a piece of lead foil) in the midline of the vermillion border in order to locate possible foreign bodies. The exposure should be made at a low kilovoltage (to increase contrast), and the exposure time should be kept at the lowest value to be able to reveal particles with low radiographic contrast. If the intraoral film discloses foreign

Fig. 21.16 Vestibular laceration in the mandibular front region. This laceration was caused by a bicycle accident with degloving of the lower lip and vestibular tissue from the alveolar bone.

Fig. 21.17 Severely contaminated vestibular laceration. This was caused by a football player falling on the chin in the grass resulting in degloving of the soft tissue from the bone. All soil and foreign bodies have to be removed before closure can take place.

Fig. 21.18 Vestibular laceration with exposed bone. In spite of meticulous cleaning and closure and suturing in the emergency phase this laceration opened up and bone was exposed 2 weeks after trauma. This exposure was treated by daily rinsing by the patient and weekly follow up visits with irrigations at the clinic. A superficial sequestration was seen after 3 weeks. Completed healing is seen 7 weeks after trauma.

Fig. 21.19 Split lip due to a frontal impact. This patient was hit in the face with a bottle, resulting in a split lip and lateral luxation of the right central incisor. The vermilion border is sutured first, whereafter the rest of the laceration is closed with interrupted sutures (e.g. Prolene® 6.0).

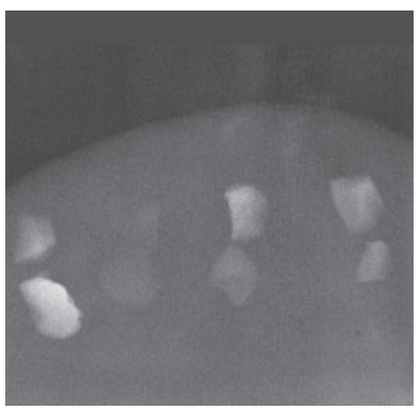
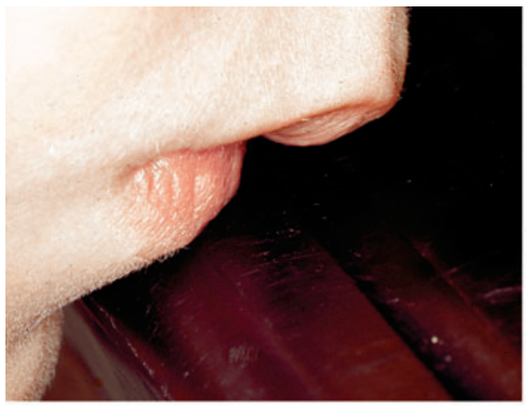


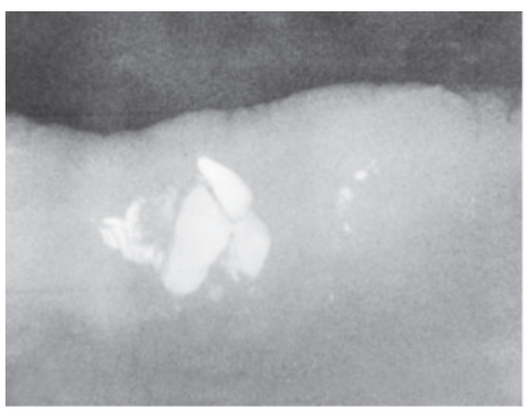
Fig. 21.20 Radiographic appearance of typical foreign bodies. From left to right, the following types of foreign body are seen: tooth fragment, composite resin filling material, gravel, glass and paint. The different objects vary in radioopacity.

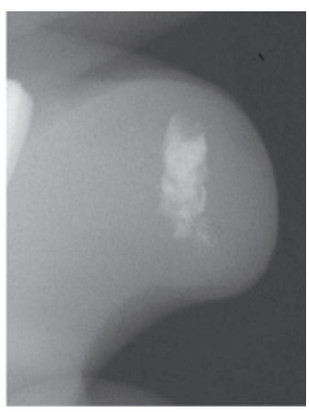
Fig. 21.21 Penetrating lip lesion with embedded foreign body
This 8-year-old boy fell against a staircase, whereby the maxillary incisors penetrated the prolabium of the lower lip. Parallel lesions are found corresponding to each penetrating incisor.



Radiographic investigation
A dental film was placed between the lip and the dental arch. Exposure time is 1/4 of that for conventional dental radiographs. A large occlusal film is placed on the cheek and a lateral exposure taken using half the normal exposure time.

Radiographic demonstration of multiple foreign bodies in the lower lip
Orthoradial and lateral exposures show multiple fragments in lower lip. The lateral exposure could demonstrate that the fragments are equally distributed from the cutaneous to the mucosal aspect of the lip.





Retrieved dental fragments
The lip lesion is sutured after removal of tooth fragments, foreign bodies such as tooth fragments, plaque, calculus, and fragments from the impacting object usually become trapped within the lip.

bodies, a lateral exposure may verify their position in a sagittal plane (Fig. 21.21).

In the case of narrow penetrating wounds, a special technique of opening up the wound, as illustrated in Fig. 21.22 is recommended. Management of a broad penetrating lip lesion is seen in Fig. 21.23. Treatment starts by cleansing the wound and surrounding tissue. The wound edges are elevated and foreign bodies are found and retrieved. It is essential to consider that foreign bodies are usually contained within a small sac within the wound. When all fragments that have been registered on radiographs have been retrieved, the wound is debrided for contused muscle and salivary gland tissue. The anatomy of the wound should be respected. Never excise wounds to make long straight scars which invariably are more visible. Thereafter the wound is carefully rinsed with saline; and a check is made to ensure that bleeding has been arrested.

When suturing the lip special attention must be paid to carefully approximate the transition of skin to mucosa (vermillion border) as any inaccuracy in wound closure will be very esthetically apparent. A minimum of sutures should be used, as deep sutures in contaminated wounds have been shown to increase the risk of infection (9). In penetrating lesions the mucosal side of the wound is first sutured so that no saliva can enter the wound (Fig. 21.23). A few resorbable 5.0 sutures are placed in the musculature to reduce tension on the cutaneous sutures. Thereafter, the cutaneous part of the wound is closed with 6.0 sutures. Magnifying lenses, e.g. ordinary spectacles with 4 × loupes can be used to ensure meticulous suturing. Intracutaneous sutures may be used for cutaneous closure in estehtically sensitive areas (Fig. 21.24). Adhesive tape/strips may be used in addition to relieve tension (Fig. 21.25).

Tongue lacerations

Other than in patients suffering from epilepsy, tongue lesions due to trauma are rare. In the former instance, bite lesions may occur along the lateral part of the tongue during seizures. Furthermore, following an impact to the chin with the tongue protruding, a wound may be caused by incisor penetration through the apex of the tongue.

A wound located on the dorsal surface of the tongue should always be examined for a ventral counterpart (Fig. 21.26). If there are concomitant crown fractures, fragments may be located within the wound. These fragments can be revealed by a radiographic examination (see above).

Treatment principles include cleansing of the wound, removal of foreign bodies and suturing of the dorsal and ventral aspects of the lesion. After administration of anesthesia (local, regional or general), foreign bodies are retrieved, the wound cleansed with saline, and the wound entrances sutured tightly (Fig. 21.26). Deep lacerations in the tongue will increase the risk of postoperative bleeding and some of these patients should be observed postoperatively so that continuing deep bleeding in the tongue and floor of the mouth with life threatening occlusion of airways can be prevented.

Avulsion of tissue

Tissue loss may be seen intra- and extraorally. In case of loss of gingival tissue, a gingivoplasty should be performed whereby flaps are elongated by the placement of periosteal incisions (Fig. 21.13).

Tissue losses on the skin side are complex injuries from a treatment point of view in the emergency phase. There is a high risk for extensive scar contraction resulting in esthetic failure if not properly handled by an experienced specialist. Minor injuries in young individuals may be left for secondary healing and possible later reconstruction (Fig. 21.8). With larger avulsion injuries secondary healing should be avoided due to excessive scar formation and local flaps or skin grafts should be used in the early treatment of these cases (16–18).

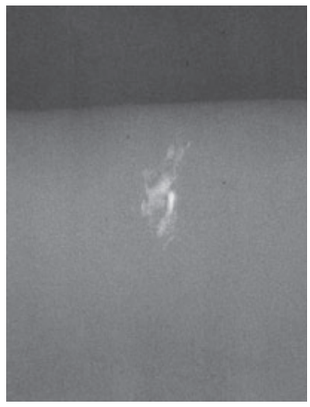
Tissue losses are sometimes seen with animal bites to the face and are usually caused by dogs (19–21). Because of contamination from the dog's saliva the main concern is infection. Copious irrigation by saline and debridement should be performed. Antibiotics should always be administered regardless of duration. Rabies vaccine should be considered depending on the status of the dog. Ideally the animal should be caught and observed. Fluorescine antibody test should be performed to see if the animal has rabies. The incubation period of rabies is 2–8 weeks in humans and the patient can be treated within this period with a rabies vaccination protocol.

Wound closure materials and principles

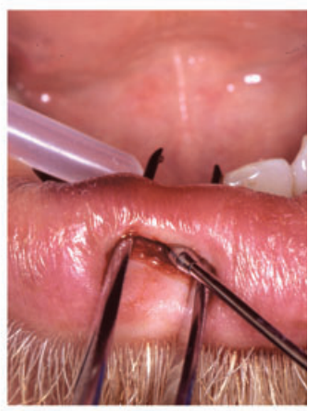
The management of facial soft tissue wounds is not a well-documented area and wound healing often leads to scarring (69). Sutures and tapes/strips are the traditional methods for closure of wounds in the skin of the face. Strips can be used together with sutures to relieve tension (Fig. 21.25). Strips can also be used alone to close small superficial wounds. Tissue adhesives e.g. cyanoacrylate or fibrine glue, have been used in emergency rooms (22–25). The advantage is that the closure procedure can be performed in less time and with less pain as compared to suturing. There are some reports comparing tissue adhesive and sutures in pediatric facial lacerations (23, 26, 27). The results showed comparable esthetic results between tissue adhesives and suturing. However it should be borne in mind that lip lacerations were excluded from these studies. There may also be problems associated with this location, such as the child licking or biting off the glue. Moreover a statistically significant increase in wound dehiscence has been found with tissue adhesives (28). Further studies are needed to learn more about the indications for tissue adhesives in lip injuries before they are generally applied (29, 30).

A general principle in wound treatment is the approximation of wound edges in order to reduce the distance for the wound healing module and thereby increase the speed of healing. This principle has, unfortunately, not been supported by animal experiments in which sutures were used to approximate wound edges (27, 30–35). The explanation for

Fig. 21.22 Treatment of narrow penetrating lip lesion
This 27-year-old man fell, causing the right central incisor to penetrate the lower lip and fracture. A radiograph shows that multiple tooth fragments are buried in the lip.



Removing foreign bodies from the lip
After administration of local anesthesia the narrow penetrating wound is opened using a pincette. When the pincette is open, a rectangular wound is formed whereby two sides of the wound become clearly visible. Foreign bodies are removed and the wound cleansed with saline.



Repeating the cleansing procedure
The pincette is turned 90° and the procedure is repeated.

Suturing the wound
The wound is sutured with interrupted 6.0 silk sutures. A radiograph shows that all fragments have been removed.

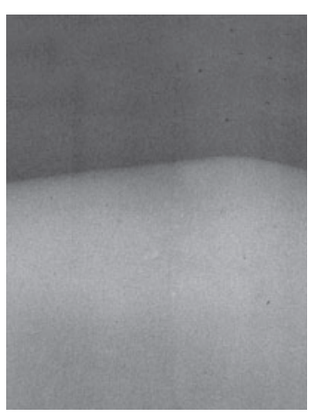
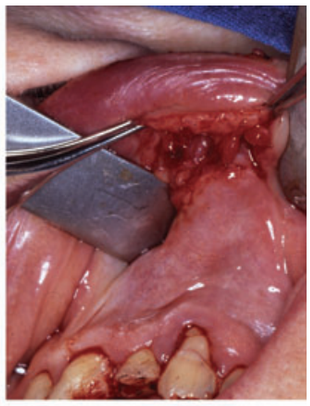
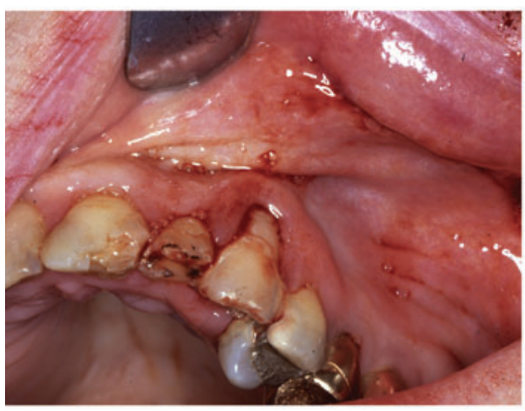
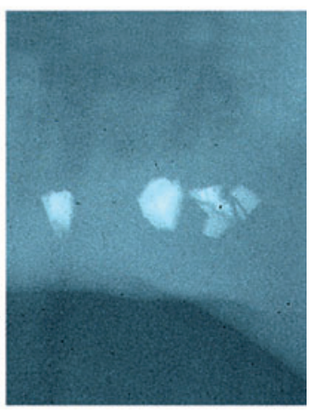


Fig. 21.23 Treatment of a broad penetrating lip lesion
Penetrating lesion of the upper lip in a 66-year-old woman due to a fall. Clinical appearance 4 hours after injury.

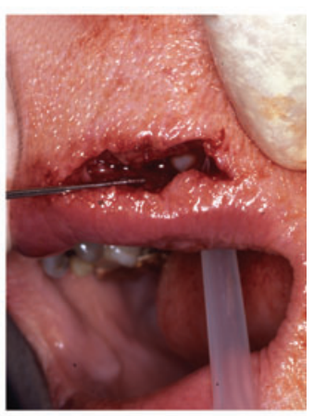


Dental injuries
The crown of the left central and lateral incisors and canine have been fractured while the lateral incisor and canine have been intruded. Soft tissue radiographs demonstrate multiple foreign bodies in the upper lip.

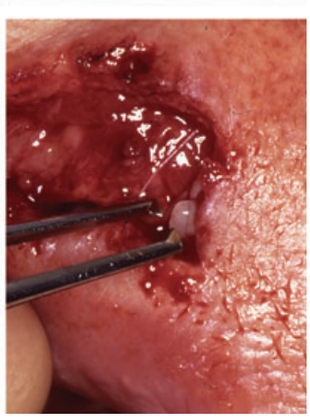




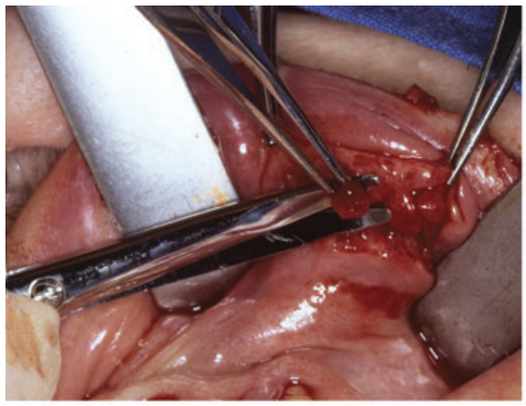
Wound cleansing
The cutaneous and mucosal aspects of the wounds are cleansed with a surgical detergent followed by saline.

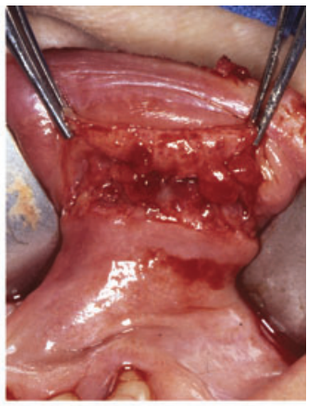


Removal of foreign bodies
All radiographically demonstrated tooth fragments are located and removed.

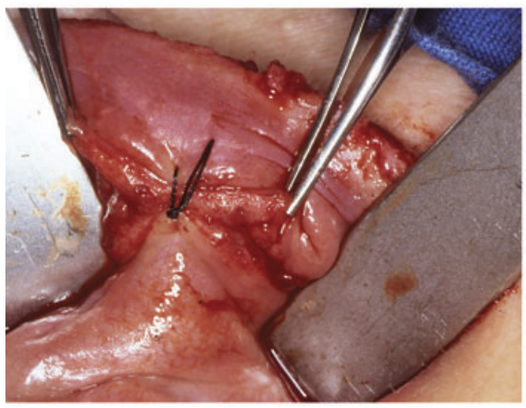


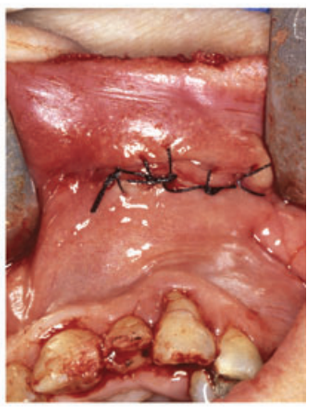
Wound debridement
Traumatized salivary glands are excised in order to promote rapid healing.



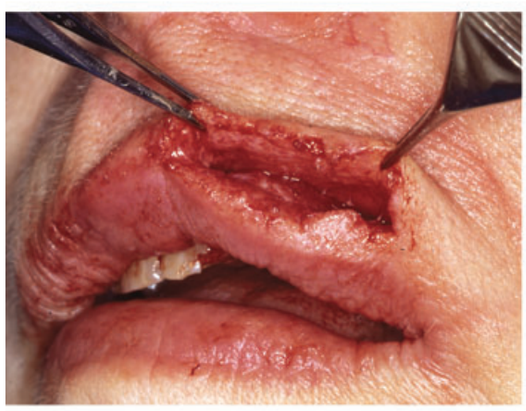


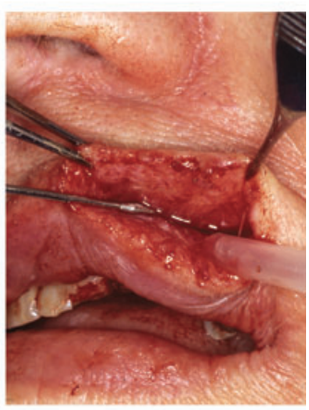
Wound closure
The oral wound is closed with interrupted 4.0 silk sutures.



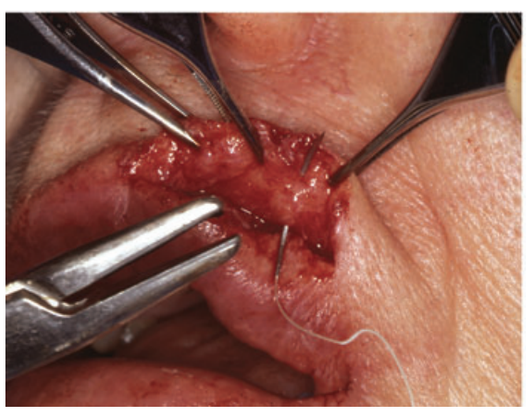


Repeated cleansing of the cutaneous wound
The cutaneous aspect of the wound is cleansed with saline to minimize contamination from closure of the mucosal wound.



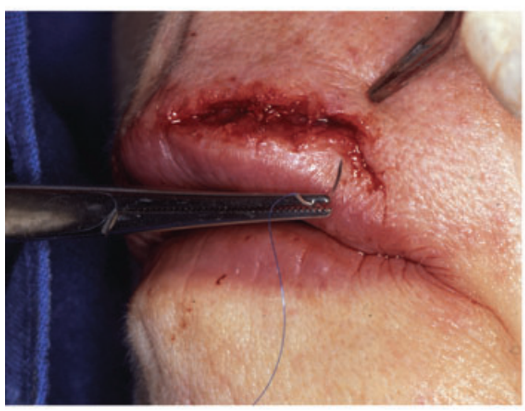


Buried sutures
As a matter of principle, buried sutures should be kept to a minimum number; and, when indicated, be resorbed over a short period of time (e.g. Vicryl® sutures). The point of entry of the needle should be remote from the oral and cutaneous wound surfaces in order to place the knot (i.e. the most infection-prone part of the suture) far from the wound edges; that is, at approximately one-half the total thickness of the lip.



Assessing cutaneous wound closure
After closing the muscular tissue, the cutaneous part of the wound is evaluated. It is important that after muscular approximation, the wound edges can be approximated without tension. If this is not possible, approximation of the muscular part of the wound must be revised.

Suturing the cutaneous wound
Wound closure is principally begun at the vermilion border. In cases where the wound is parallel to the vermilion border, the first suture is placed at a site where irregularities of the wound edge ensure an anatomically correct closure. The wound is closed with fine, monofilament interrupted sutures (Prolene® 6.0), under magnification (i.e. using spectacles with a 2 or 4 × magnification).



Suturing completed
The wound is now fully closed and antibiotics administered (i.e. penicillin, 1 million Units × 4, for 2 days).

Healing 6 weeks after injury
There is a minimum of scarring.

these findings could be that, as well as approximating the wound edges, suturing also induces ischemia of wound edges and acts as a wick, leading bacteria into the wound. Thus, the placement of just a single suture, however, significantly decreases the number of bacteria needed to cause wound infection (32) (see Chapter 1).

The tissue response to various types of sutures in the oral mucosa has been studied extensively in animals (36–42) and in humans (43, 44), and a vigorous inflammatory reaction around the sutures could be demonstrated. The general findings in these experimental studies have been that silk and catgut sutures (plain or chromic) elicited a very intense clinical and histological inflammatory reaction after 3, 5 and 7 days; whereas polyglycolic acid showed considerably less clinical and histological reaction (42).

The greatest part of the inflammatory reaction is probably related to the presence of bacteria within the interstices of multifilament suture materials (34, 37–40). Thus the impregnation of multifilament sutures with antibiotics has been shown to decrease the resultant tissue response (40). A further finding has been that monofilament sutures (e.g. nylon) display a significant reduction of adverse reactions compared to multifilament sutures, a finding possibly related to a reduced wick effect of monofilament sutures (41–45).

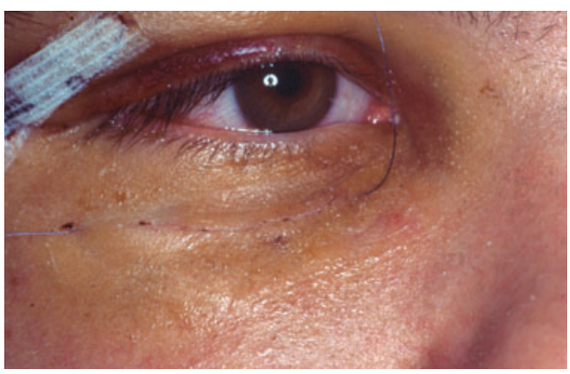


Fig. 21.24 Intracutaneous suture of an infraorbital soft tissue wound. Note the excellent adaptation of tissue without stitch marks 5 days after suturing.

Monofilament suture material has been developed from a very inert and tissue compatible biomaterial made of polytetrafluoroethylene (PTFE). A comparison between the tissue response in oral mucosa between this material and silk sutures shows definitively less tissue response in the former (46).

Finally, it should be borne in mind that it has been shown experimentally that there is an increased risk of infection with both increased suture diameter and submucosal/subcutaneous suture length (9).

The essential lesson of all these experiments in suturing and subsequent wound healing is therefore that suturing is still the best overall method to use intra- and extra-orally, using a minimal number of sutures with a small diameter, preferably monofilament and, finally, instituting early suture removal (i.e. after 3–4 days in oral tissues), eventually in two stages, i.e. 3 and 6 days.

The choice of sutures varies with the surgeon. There is an ongoing development to use synthetic absorbable sutures in the mucosa such as polyglycolic acid (Dexon®) polyglactic acid (Vicryl®) or polydioxanone (PDS®). Although absorbable sutures can also be used for skin closure, many surgeons prefer non-absorbable sutures such as nylon (Dermalon®, Ethilon®), polypropylene (Prolene®) or polybutester (Novofil®) for skin closure. Tape/strips may be used for skin closure in addition to sutures to relieve tension or used as an alternative to sutures for closing shallow, small wounds. The use of tissue adhesives/glue in the perioral region is not yet sufficiently evidence based.

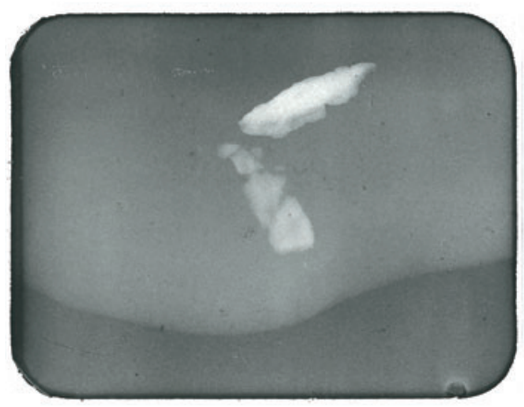
Antibiotic prophylaxis

It is surprising that the benefit of antibiotic therapy in oral soft tissue injuries has only been sparsely documented. Due to their pathogenesis, almost all of these injuries can be considered contaminated with microorganisms and sometimes with foreign bodies. Based on this assumption, it has been proposed that the surgical treatment of mucosal and cutaneous wounds should always be supported by prophylactic antibiotic coverage (47). However, clinical evidence for the

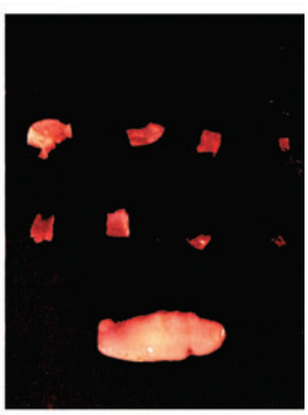
Fig. 21.25 Laceration of the lower lip. This laceration was closed by intracutaneous suturing. To relieve tension two supplementary separate sutures were placed at the angles of the Z shaped laceration. To cover the sutured wound and to further relieve tension a tape was finally placed.

Fig. 21.26 Treatment of a penetrating tongue lesion
This 10 year-old girl suffered a penetrating tongue lesion. Note the parallel lacerations on the dorsal and ventral surfaces of the tongue.

Radiographic examination
A dental film is placed under the extended tongue and exposed at $^{1}/_{4}$ the normal exposure time. The exposure demonstrated several tooth fragments embedded within the tongue.



Removal of tooth fragments
After administration of regional anesthestic, all tooth fragments were retrieved. It is important that all radiographically demonstrated fragments are also retrieved in order to prevent infection and/or scar formation.



Suturing the tongue wound
After all foreign bodies have been removed, the wound is cleansed and sutured on the dorsal and ventral surfaces.

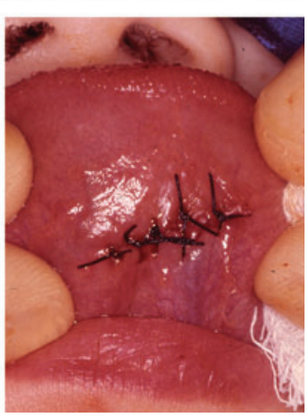


Table 21.1 Effect of systematic antibiotic treatment subsequent to various combinations of cutaneous and oral mucosal wounds. After GOLDBERG (48) 1965.

Type of lesion	Antibiotic treatment	No. of cases	Frequency of infection	Probability level*
Mucosal wounds	–	32	4 (13%)	0.66
	+	17	2 (12%)	
Mucosal and penetrating wounds (penetrating lesions)	–	33	11 (33%)	0.16
	+	24	4 (17%)	

* Probability level based on Fisher's exact test.

Table 21.2 Effect of systemic antibiotic treatment subsequent to various combinations of facial cutaneous and oral mucosal wounds. After PATERSON et al. (49) 1970.

Type of lesion	Antibiotic treatment	No. of cases	Frequency of infection	Probability level*
Mucosal wounds	–	23	0 (0%)	1.0
	+	12	0 (0%)	
Cutaneous wounds	–	85	2 (2%)	0.06
	+	51	6 (12%)	
Mucosal and cutaneous wounds	–	21	0 (0%)	1.0
	+	23	0 (0%)	
Mucosal and penetrating wounds (penetrating lesions)	–	24	3 (13%)	0.08
	+	48	15 (31%)	

* Probability level based on Fisher's exact test.

benefit of this treatment is presently tenuous (48–52) (Table 21.1). Thus, no effect of antibiotic therapy could be shown on the rate of infection in cutaneous and/or mucosal wounds. In penetrating wounds to the oral cavity, conflicting results have been reported (48, 49) (Table 21.2).

Based on these findings it seems reasonable – until further studies are presented – to restrict the prophylactic use of antibiotics in soft tissue wounds to the following situations:

- When the wound is heavily contaminated and wound debridement is not optimal (e.g. impacted foreign bodies or otherwise compromised wound cleansing).
- When wound debridement has been delayed (i.e. more than 24 hours) (41).
- Penetrating lesions through the full substance of the lip (5).
- When open reduction of jaw fractures is part of the treatment. In these situations, the benefit of short-term antibiotic coverage preceding and following osteosynthesis has been documented (47, 53–55). (see also Chapter 18). This relationship is in contrast to the lack of effect of antibiotic treatment in relation to 'clean' orthognathic surgery (56–59).
- When the general defense system of the patient is compromised (e.g. insulin dependent diabetes, alcohol abuse, immunocompromised patients, patients with prosthetic cardiac valves, cardiac surgical reconstructions, valvar dysfunction or malformations, or history of endocarditis (5).
- Human or animal bite wounds (60–62).

If prophylactic antibiotic coverage is decided upon, early institution is very important. Thus, experimental studies have shown that the first 3 hours after trauma are critical; i.e. to obtain an optimal effect from the antibiotics, they should be administered within this period (see Chapter 1). If delayed, contaminating bacteria may multiply and invade the wound (12–14). Antibiotics should therefore be administered before surgery and maintained for 24 hours (63). Prolonged administration does not optimize healing (64–66), and has a serious effect upon the ecology of the oral microflora. The antibiotic of first choice is penicillin (phenoxymethyl penicillin). The dosage (adults) should be: 2 million units (= 1.2 g) orally at once followed by 2 million units (1.2 g) 3 times for 1 day. For children the dosage is given in relation to body weight. If the patient is allergic to penicillin, clindamycin should be administered. The dosage (adults) should be: 600 mg orally at once followed by 300 mg 3 times for 1 day. In children the dosage is 15 mg/kg body weight given 3 times for 1 day.

Tetanus prophylaxis

Tetanus prophylaxis should always be considered in the case of contaminated wounds. In a previously immunized patient (i.e. longer than 10 years previous to injury), a dose of 0.5 ml tetanus toxoid should be given (booster injection). In unimmunized patients, passive immunization should be provided.

Essentials

Type of soft tissue lesion

- Abrasion
- Laceration
- Contusion (including hematoma)
- Tissue loss (avulsion)

General treatment principles

- Contusions need not be treated but may indicate an underlying bone fracture.
- Abrasions and lacerations should be thoroughly cleansed and all foreign bodies removed.
- Larger avulsion injuries should be treated by specialists.

Gingival lacerations (Figs 21.11–21.14)

- Rinse the wound and surroundings with a wound detergent.
- Reposition displaced gingiva.
- Place a few fine sutures (4.0 or 5.0 Vicryl®, Dexon® or PDS®).
- Instruct in good oral hygiene including daily mouth rinse with 0.1% chlorhexidine.
- Remove sutures after 4–5 days.

Lip lacerations

Establish whether the injury is a penetrating wound of the lip or a laceration of the vermilion border (split-lip lesion).

Penetrating lip wounds (Figs 21.22 and 21.23)

- Administer antibiotics if indicated (see Antibiotic prophylaxis).
- Take a radiograph of the lip with decreased exposure time.
- Use regional anesthesia.
- Rinse the wound and surroundings with a wound detergent.
- Remove foreign bodies and contused muscle and salivary gland tissue.
- Suture the labial mucosa (4.0 or 5.0 Vicryl®, Dexon®, PDS®).
- Rinse the wound again with saline.
- Suture the cutaneous wound with fine sutures (6.0 nylon or Prolene®). Take special consideration of the vermillion border.
- Remove sutures after 4–5 days.

Split lip wounds (Fig. 21.9)

Use the same procedure as for penetrating lip lesions. However, in this case a few buried resorbable sutures are indicated (e.g. Dexon® 4.0/5.0).

Tongue lacerations

Examine whether the injury is a penetrating wound or a lesion of the lateral border.

Penetrating tongue wounds (Fig. 21.26)

- Administer antibiotics if indicated (see Antibiotic prophylaxis).
- Take a radiograph of the tongue with decreased exposure time.
- Use a regional or general anesthesia.
- Rinse the wound with saline.
- Remove foreign bodies.
- Rinse the wound again with saline.
- Suture the mucosal wounds.
- Remove sutures after 4–5 days.

Lateral tongue border wounds

After administration of a regional anesthetic the wound is rinsed and sutured. Buried resorbable sutures are sometimes indicated in order to approximate the wound edges and relieve tension on the mucosal sutures.

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