GENERAL DENTISTRY

Initial management of dental trauma: musts, shoulds, and cans

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When dental trauma occurs, initial management on the day of injury has a determining influence on healing and thus on the prognosis of the affected teeth. Improper, delayed, and/or inconsistent treatment often has far-reaching consequences that cannot be reversed later, even with great effort, especially in children and adolescents. In most cases, it is unrealistic or impossible for the patient to get to a specialized dental trauma facility in time. Therefore, it is every dental practitioner's duty to provide adequate initial diagnosis and treatment of dental trauma at their dental practice, even if they do not have routine experience in this area. This article serves as a guide to the initial management of dental trauma. It utilizes a three-tiered approach to illustrate which initial management measures are absolutely essential (MUSTS), which should ideally be performed (SHOULDS), and which are not top priorities but can be performed (CANS) if the necessary time, training and experience, and equipment and facilities are available. For further treatment, dental practitioners should realistically assess the limits of their ability to treat complex dental trauma cases and, if necessary, they should refer the patient to a specialist or specialized treatment center. *(Quintessence Int 2020;51: 763–774; doi: 10.3290/j.qi.a45103*; modified from a previously published article (in German) Quintessenz 2019;70(9):990–1002)

Key words: dental trauma, emergency treatment, initial management

The prognosis of traumatic dental injuries depends on both the severity of the injuries and on the treatment received. In addition to first responses at the scene of the accident, the initial treatment measures initiated by the dental practitioner who first manages the case have a particularly decisive influence on the subsequent healing process.[1] Therefore, clinicians must be able to make quick and competent decisions regarding a wide range of patterns of dental trauma during the initial management phase. These initial decisions form the basis for later treatment steps. The dental practitioner must select treatments so as to avoid negative effects on jaw growth on the one hand, while taking the high life expectancy of these mostly young patients into account on the other.[2]

This article focuses exclusively on the requirements for the initial management of traumatic dental injuries, to be performed at initial presentation on the day of injury. Since dental trauma patients usually arrive at the dental office unannounced and the number of appointments kept open for emergency cases is generally limited, the practitioner must decide what treatment is absolutely necessary and what can be omitted without compromising the prognosis of the injured structures. A three-tiered approach is utilized to illustrate which measures are absolutely essential (MUSTS), which should ideally be performed (SHOULDS), and which are not top priorities but can be performed (CANS) if the necessary time, training and experience, and equipment and facilities are available (Table 1).

Initial diagnosis of dental trauma

During the initial diagnosis of dental trauma (Table 2), it is of utmost importance to exclude traumatic brain injury. Fractures of the alveolar process, mandible, and midface as well as other possibly more serious non-odontogenic injuries must also be excluded. The patient's tetanus immunization status must be

Table 1 Three-tiered approach to the initial management of dental trauma

Classification of measures for initial management of dental trauma	
MUSTS	Basic measures that must be performed immediately, and failure to do so would likely have a negative impact on the prognosis
SHOULDS	Measures that should ideally be performed if training and experience and equipment and facilities allow
CANS	Additional treatment measures that are not essential for immediate care, but which may also be performed during initial management if time, training and experience, and equipment and facilities allow

Table 2 Initial diagnosis of dental trauma

Classification of measures for initial diagnosis of dental trauma	
MUSTS	Exclude the presence of traumatic brain injury
	Check tetanus immunization status
	Exclude the presence of maxillofacial fractures
	Exclude injuries of non-odontogenic origin
	Careful (clinical and radiologic) examination of all potentially injured teeth (pulp, periodontium, and hard dental tissues) and injuries associated with the oral soft tissues and alveolar bone
	Documentation
SHOULDS	Photographic documentation
CANS	Cone-beam computed tomography in special cases (strict indication criteria, small field of view)

checked. For forensic reasons, it must be documented that an evaluation of these important general medical aspects took place. Before performing the actual dental examination, the dental practitioner must ensure that any avulsed teeth brought to the dental office are placed in a tooth rescue box immediately.

Traumatic dentoalveolar injuries can potentially involve five types of tissues: hard dental tissues, pulp, periodontal tissues, alveolar bone, and oral mucosa/gingiva. Thorough individual diagnosis of all tissues concerned is required for an overall assessment of the extent of injury and adequate treatment.[3,4]

The clinical examination includes examination of the teeth for abnormal mobility, displacement, assessment of soft tissue injuries, as well as sensitivity percussion tests. Although sensitivity tests performed immediately after dental trauma can provide information regarding the severity of pulp injury, this has no bearing on treatment choices on the day of injury.

A radiologic examination of the potentially involved teeth is performed after the clinical examination. Two-dimensional radiographs are sufficient in most cases. If there is tooth displacement, there is a risk that traumatic alveolar enlargement might be mistaken for an apical lesion.[5] Cone-beam computed tomography (CBCT) can provide valuable additional information for later treatment decision-making in complex cases (visualize the fracture lines of subgingival tooth fractures, etc),[6,7] but this usually has no influence on initial trauma management on the day of injury. Combined injuries frequently occur so it is important to ensure not to overlook any less obvious injuries such as concomitant minor luxations of fractured teeth or of adjacent or opposing teeth. Clear and complete recording and documentation of the examination findings is crucial for establishing the correct diagnosis and deciding which treatment steps are necessary.[8]

Initial management of crown fracture without pulp involvement

Measures related to the initial management of crown fractures without pulp exposure (Table 3) consist of preventing infection of the pulp via exposed dentinal tubules (Fig 1). A hard-setting calcium hydroxide cement provides acceptable short-term dentin wound coverage (for a few days), but dentin sealing with a dental adhesive and flowable composite is more reliable.[9,10] If tooth fragments are available and not dehydrated, they can be adhesively reattached. Dehydrated fragments

Table 3 Initial management of crown fracture without pulp involvement

Classification of measures for crown fracture without pulp involvement	
MUSTS	Cover the exposed dentin with a calcium hydroxide cement
	Tooth fragments, if available, should be stored in water
	Refer for further treatment, which should be carried out soon (ideally, on the next day)
SHOULDS	Seal the exposed dentin with a dental adhesive and flowable composite*
	Refer for further treatment, which should be carried out soon (within 2 weeks)
CANS	Composite buildup as definitive restoration
	Immediate reattachment of available fragments if not dehydrated

*If a fragment is to be reattached, initial treatment should be with a calcium hydroxide cement instead of a bonded material.

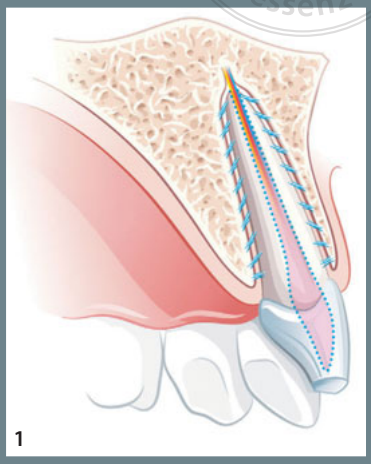

Fig 1 Enamel or enamel-dentin fracture without pulp exposure.

should be placed in water and allowed to rehydrate overnight before performing reattachment on the next day. Interim rehydration of the fragment improves both shade adaptation and bond strength to the tooth.[9] If a fragment is to be reattached on the following day, an adhesive sealing with composite should not be used to cover the dentin during the initial treatment period because adhesive sealings are difficult to remove completely and can thus impair the accuracy of fragment reattachment. Hard-setting calcium hydroxide materials are easier to remove and should be used instead.[10]

Initial management of crown fracture with pulp involvement

Initial treatment of crown fractured teeth with pulp exposure (Table 4 and Fig 2) should aim at maintaining pulp vitality, independent of patient age. To reach this goal, partial pulpotomy is a highly predictable treatment approach.[11,12] Unlike direct capping, partial pulpotomy enables the clinician to successfully manage even those cases with broad or longer-term exposure within the first few days after trauma. Partial pulpotomy can but must not necessarily be performed in the scope of initial trauma management. It can also be carried out as a secondary treatment within a few days after pulp coverage, provided that the exposed area (pulp and dentin) has been adequately sealed during primary treatment.[13]

Initial management of crown-root fracture

Restoration of teeth with crown-root fractures (Table 5 and Fig 3) is often a challenge. Deep subgingival fracture lines greatly reduce the long-term survival of these teeth.[9,14] Notwithstanding, initial management of teeth with crown-root fractures is comparable with the initial treatment of crown-fractured teeth. However, the mobile coronal fragment, which is often still attached to the gingiva, must be removed for fracture line assessment. This usually provokes bleeding, further complicating primary treatment which usually consists of sealing the exposed pulp-dentin complex.

Adhesive fixation of the mobile but still attached coronal fragment in the generally accessible labial region is a simple and time-saving alternative primary treatment modality. This treatment is regarded as a compromise due to the unreliable seal against bacterial ingress, but it eliminates the symptoms originating from the mobile fragment in the majority of cases. Due to the extremely limited durability of the fragment fixation, the patient should receive further treatment soon (ideally, on the following day).[10]

Table 4 Initial management of crown fracture with pulp involvement

Classification of measures for crown fracture with pulp involvement	
MUSTS	Cover the exposed pulp and dentin with a calcium hydroxide cement
	Tooth fragments, if available, should be stored in water
	Refer for further treatment, which should be carried soon (ideally, on the next day)
SHOULDS	First cover the exposed pulp with calcium hydroxide, then seal the exposed dentin with a dental adhesive and flowable composite*
	Refer for further treatment (partial pulpotomy), which should be carried out soon (within a few days)
CANS	Immediate partial pulpotomy and adhesive restoration (composite buildup or fragment reattachment)

*If a fragment is to be reattached, initial treatment should be with a calcium hydroxide cement instead of a bonded material.

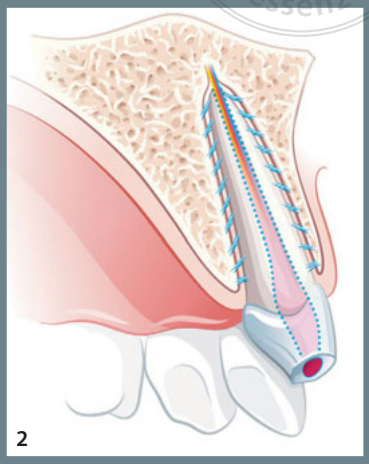

Fig 2 Enamel-dentin fracture with pulp exposure.

Table 5 Initial management of crown-root fracture

Classification of measures for crown-root fracture	
MUSTS	Adhesive fixation of the mobile but still attached coronal fragment for immediate pain relief
	Refer for further treatment, which should be carried out soon (ideally, on the next day)
SHOULDS	Loose fragment removal and fracture line assessment
	First cover the exposed pulp with calcium hydroxide, then seal the exposed dentin with a dental adhesive and flowable composite*
	Refer for further treatment, which should be carried out soon (within a few days)
CANS	Immediate partial pulpotomy in teeth with pulp exposure and adhesive restoration (composite buildup or fragment reattachment) if it seems possible to restore the defect without additional procedures (such as surgical crown lengthening, orthodontic extrusion, and intra-alveolar transplantation)

*If a fragment is to be reattached, initial treatment should be with a calcium hydroxide cement instead of a bonded material.

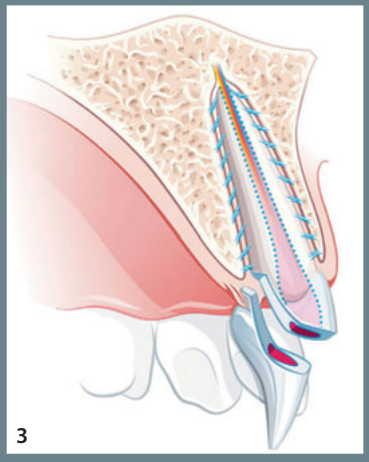

Fig 3 Crown fracture extending into the root: mobile crown fragment that often is still attached to the gingiva; pulp exposure is often but not necessarily present.

Table 6 Initial management of crown-root fracture

Classification of measures for crown-root fracture	
MUSTS	Correctly reposition the coronal fragment (if dislocated) and splint
	Refer for further treatment, which should be carried out soon
SHOULDS	
CANS	

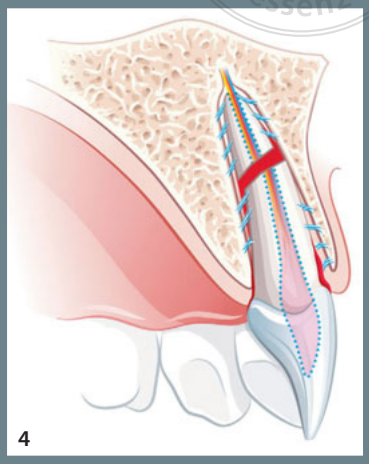

Fig 4 Horizontal or diagonal root fracture. Increased mobility of the coronal fragment is common, and luxation may be present. Communication with the oral cavity via the sulcus is possible, depending on the location of the fracture line.

Table 7 Initial management of concussion

Classification of measures for concussion	
MUSTS	
SHOULDS	
CANS	Flexible splint
	Refer for further treatment, which should be carried out soon (within a week)

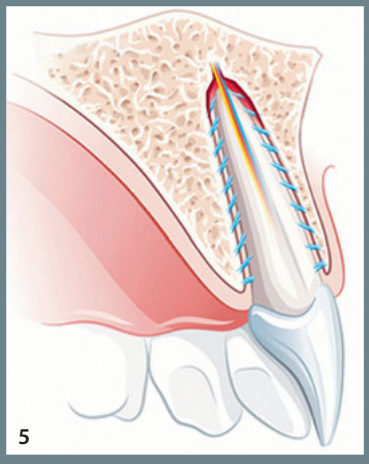

Fig 5 Concussion: touch sensitivity of the affected tooth, no signs of increased mobility, no signs of luxation, edema and bleeding in the periodontium and apex.

Table 8 Initial management of subluxation

Classification of measures for subluxation	
MUSTS	
SHOULDS	Flexible splint
	Refer for further treatment, which should be carried out soon (within 1 week)
CANS	

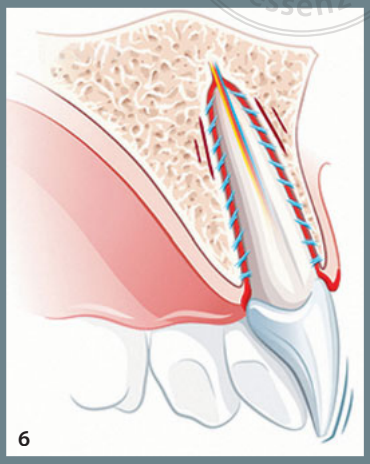

Fig 6 Subluxation: increased mobility, periodontal fibers are partially torn, bleeding from the periodontal ligament space, pulp irritation at the apex of the tooth.

Initial management of root fracture

Initial management of teeth with intra-alveolar root fractures (Table 6 and Fig 4) is simple and limited to correct repositioning of the coronal fragment and subsequent splinting.[15,16] These patients should receive further treatment without delay, particularly if it is not possible to exclude communication between the fracture line and the oral cavity via the sulcus based on the primary diagnostic workup.

Initial management of concussion

Concussed teeth do not have to be treated during the initial management phase because this probably would not affect the prognosis of these teeth, which is already very good (Table 7 and Fig 5).[16] Nevertheless, the use of a flexible splint offers the patient the advantage of reducing the touch sensitivity of the affected teeth, which helps to make chewing more comfortable.

Initial management of subluxation

Because subluxation of a tooth may lead to a widening of the alveolar socket, splinting is recommended for reducing tooth mobility (Table 8 and Fig 6).[16]

Initial management of lateral luxation

Laterally displaced teeth must be promptly repositioned and splinted (Table 9 and Fig 7). The root tip of the dislocated tooth is often wedged into the alveolar bone so tightly that it must be loosened carefully. Lateral luxation is frequently associated with fracture of the thin labial socket wall, which is also treated by repositioning and splinting of the teeth.[16] If initial treatment is delayed for too long, a hardened blood clot may form, making it difficult to correctly and gently reposition the tooth. The displacement of the tooth at the apex determines the fate of the pulp. In traumatized teeth with complete root development, rupture of the neurovascular supply to the pulp can be assumed if the tooth is displaced by more than 1 mm from its original position. Moreover, due to the small diameter of the apical foramen in mature teeth, regeneration of the pulp is unlikely and infection of the endodontic system (via the dentinal tubules) must be expected, even if the crown of the tooth is intact. Therefore, it is advisable to determine if there is a need for endodontic treatment on the day of injury, even if the treatment does not have to be performed immediately.

Table 9 Initial management of lateral luxation

Classification of measures for lateral luxation	
MUSTS	Correctly reposition the tooth and splint
	Refer for further treatment, which should be carried out soon (within a few days)
SHOULDS	
CANS	In case of rupture of the neurovascular supply in teeth with complete root development, pulpectomy, and intracanal medication

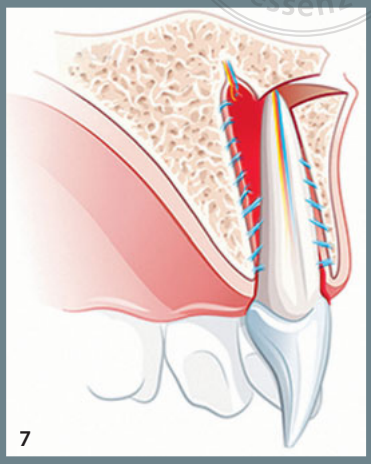

Fig 7 In maxillary incisors, lateral luxation generally leads to a palatal displacement of the crown. Fracture of the thin labial socket wall may be present. The tooth is often "wedged" in this position or shows significantly increased mobility and enlargement of the alveolus. Apical periodontal ligament with palatal tearing and vestibular compression. Presumably there is rupture of the neurovascular supply to the pulp in mature teeth with displacement of more than 1 mm.

Initial management of extrusion

Initial treatment of traumatic tooth extrusion (Table 10 and Fig 8) is basically the same as that for lateral luxation. However, it is usually much easier to reposition extruded teeth as long as repositioning is done promptly and is not impeded by the presence of an organized blood clot.

Initial management of intrusion

Initial management of intrusive luxation must be consistent and thorough (Table 11 and Fig 9). The extensive damage to the cementum associated with this injury results in a high risk of resorption. Additionally, neither survival nor regeneration of the pulp is likely if the apex is already fully formed. Therefore, root canal treatment of intruded teeth with mature roots should be performed soon and has a decisive impact on preventing infection-related root resorption. Immediate surgical repositioning provides better conditions for an early initiation of root canal treatment compared to orthodontic extrusion, particularly in severely intruded teeth.[8] Antiresorptive intracanal medicaments containing an antibiotic-corticosteroid paste, such as Ledermix (Riemser) can be recommended in these cases.[17] Awaiting spontaneous re-eruption should be reserved for slightly intruded teeth with an open apex or to intruded primary teeth, and requires frequent recall for close monitoring.

Initial management of avulsed teeth (with favorable extraoral storage)

As a general rule, an avulsed tooth should be placed in a tooth rescue box immediately after the patient's arrival at the dental office or clinic (if this was not done already) because there is generally a time delay before replantation (diagnosis, patient education, and patient preparation must be done beforehand) (Table 12 and Fig 10).

Commercial tooth rescue boxes such as Dentosafe (Medice), SOS Tooth Box (Miradent), or EMT Tooth Saver (Biochrom) contain a special cell culture medium including amino acids, vitamins, and glucose.[18,19] Soaking the tooth in such a medium for 30 minutes prior to replantation also serves to promote the regeneration of damaged PDL cells. Antiresorptive supplements (1 mg tetracycline + 1 mg dexamethasone) for the tooth rescue box are thought to enhance this effect and additionally encourage the revascularization of teeth with an open apex. Topical application of Emdogain (Straumann) (without prior ethylenediaminetetraacetic acid [EDTA] PrefGel [Straumann] root conditioning) immediately prior to replantation may be performed as an additional treatment to promote periodontal healing. However, there is no clear evidence regarding the actual clinical benefit of such treatment.

The root surface should be carefully rinsed with physiologic saline solution before replantation. This is followed by suction removal of any consolidated blood clot, rinsing with physio-

Table 10 Initial management of extrusion

Classification of measures for extrusion	
MUSTS	Correctly reposition the tooth and splint
	Refer for further treatment, which should be carried out soon (within a few days)
SHOULDS	
CANS	In case of rupture of the neurovascular supply in teeth with complete root development, pulpectomy, and intracanal medication

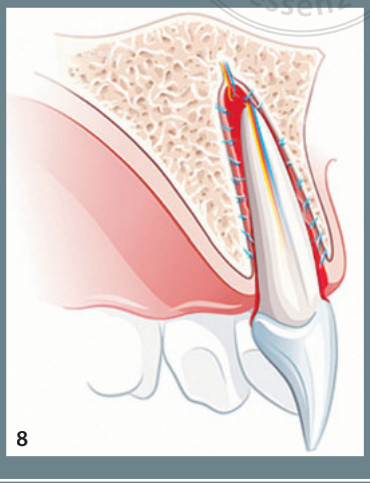

Fig 8 Extrusion. Tooth appears elongated and is mobile. Periodontal ligament fibers are largely torn. There is bleeding from the periodontal space. The pulp is stretched or detached.

Table 11 Initial management of intrusion

Classification of measures for intrusion	
MUSTS	Immediate treatment must be performed unless the dental practitioner does not feel competent or confident enough to do so
	Ensure that the patient receives further treatment (from an experienced dental practitioner) within the next few hours
SHOULDS	Immediate surgical repositioning and splinting (except in slightly intruded teeth with an open apex)
	Bone repositioning and soft tissue treatment generally are also necessary
	Systemic doxycycline administration
	Refer for further treatment (endodontic treatment of teeth with mature roots), which should be carried out soon (within a few days)
CANS	For severely intruded teeth, extract and soak the tooth in culture medium in a tooth rescue box (with an antiresorptive supplement*) for 30 minutes for antiresorptive treatment prior to replantation with Emdogain
	For teeth with complete root development: immediate antiresorptive intracanal medication using an antibiotic-corticosteroid paste

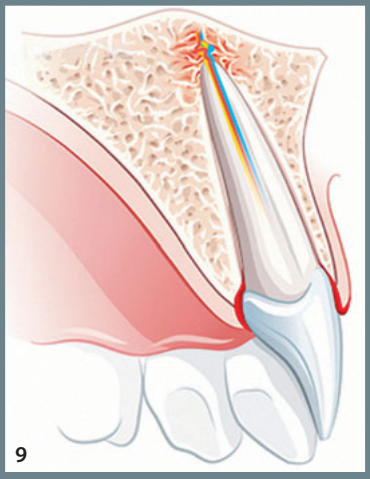

Fig 9 Intrusion: tooth appears shortened; tooth is wedged in the alveolar bone and has a metallic percussion sound; broad periodontal ligament damage; radiographic absence of periodontal ligament space.

*1 mg tetracycline + 1 mg dexamethasone.

logic saline, and inspection of the socket. Any obstacles to gentle replantation must be identified. For example, if there is a fracture of the (labial) socket wall, it may be necessary to carefully reposition it with a suitable blunt instrument. The tooth is replanted slowly with slight pressure to avoid additional damage to the root cement. After replantation, the tooth is stabilized with a flexible splint.[20] An early antiresorptive intracanal medication using an antibiotic-corticosteroid paste, such as Ledermix is recommended.[17] This can be done immediately after replantation and splinting on the day of injury.

Table 12 Initial management of avulsed teeth (with favorable extraoral storage)

Classification of measures for avulsed teeth (with favorable extraoral storage)	
MUSTS	Store tooth in a tooth rescue box
	Ensure that the patient receives further treatment (from an experienced dental practitioner) within the next few hours
SHOULDS	Soak the tooth in culture medium in a tooth rescue box (with an antiresorptive supplement*) for 30 minutes
	Correct replantation and splinting
	Systemic doxycycline administration
	Refer for further treatment (endodontic treatment of teeth with mature roots), which should be carried out soon (within a few days)
CANS	Application of Emdogain on the root surface before replantation
	For teeth with complete root development: immediate antiresorptive intracanal medication using an antibiotic-corticosteroid paste

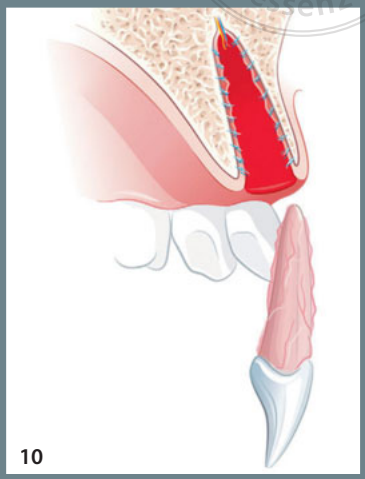

Fig 10 Examples of favorable storage conditions in which periodontal healing seems still possible: immediate replantation at the scene of the accident; tooth rescue box, cling film; cold UHT milk; (physiologic saline, saliva).

*1 mg tetracycline + 1 mg dexamethasone.

Initial management of avulsed teeth (after unfavorable extraoral storage)

If extraoral storage conditions were so adverse that periodontal healing is unlikely and ankylosis must be expected, the necrotic periodontal ligament tissue should be mechanically removed from the root surface and the tooth should be stored in a fluoride solution before replantation (Table 13 and Fig 11). This is thought to slow down the process of root resorption.[20] Because improper storage eliminates the chances of periodontal healing, the use of Emdogain cannot be expected to have a positive effect on healing in this case either. However, Emdogain may be able to prevent the occurrence of invasive cervical resorption as an additional complication in teeth with ankylosis and osseous replacement.

In these cases, the required endodontic treatment, including root canal filling, can be performed extraorally. Unlike teeth with vital periodontal tissues, there is no concern that extraoral manipulation will cause further damage to these teeth. Replantation of improperly stored teeth with incomplete root development leads to ankylosis, which results in localized disruption of jaw growth and infraposition of the tooth. Even so, replantation and tooth preservation are still recommended for esthetic, functional, and psychologic reasons until the most suitable long-term multidisciplinary treatment approach is defined.[17,20,21]

Initial management of trauma to primary teeth

From a biologic point of view, the principles for initial management of dental trauma to primary teeth are the same as those for permanent teeth, except in the case of avulsion (where replantation is not indicated).

However, the individual treatment and stress tolerance of the injured child determines and often limits the possibilities for consistent initial management of dental trauma. For this reason and to prevent (further) damage to the permanent tooth germ, primary teeth with deep fractures, severe mobility, or displacement are usually extracted.[22] Waiting for spontaneous re-eruption of intruded primary teeth is justified if the accident resulted in labial displacement relative to the permanent tooth germ and therefore is unlikely to have an effect on it. However, if intrusion does have an effect on the tooth germ, extraction is indicated as a damage control measure.[23,24]

Minimum equipment for initial treatment of dental trauma

Every dental office should have on hand the minimum equipment required for initial management of dental trauma (Table 14).

Table 13 Initial management of avulsed teeth (after unfavorable extraoral storage)

Classification of measures for avulsed teeth (after unfavorable extraoral storage)	
MUSTS	Ensure that the patient receives further treatment (tooth replantation) within the next days
SHOULDS	Remove attached necrotic soft tissue from the root surface
	Soak the tooth in fluoride solution for 20 minutes
	Correctly replant the tooth and splint
CANS	Extraoral root canal filling

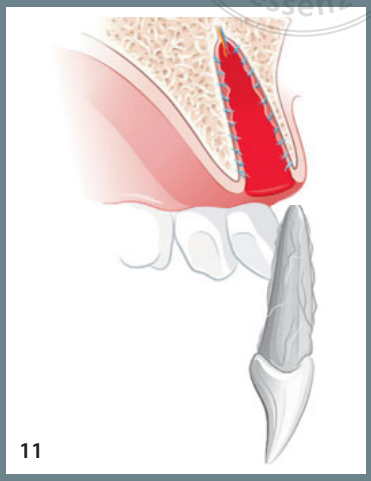

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Fig 11 Examples of unfavorable storage conditions in which periodontal healing seems impossible: dry storage time of more than 1 hour; several hours of storage in a suboptimal storage medium, such as tap water.

Table 14 Equipment for initial treatment of dental trauma

Minimum equipment for initial treatment of dental trauma	
MUSTS	Tooth rescue box
	Suture materials
	Calcium hydroxide cement
	Universal adhesive and flowable composite resin
	Splint (eg, Titanium Trauma Splint, TTS)
SHOULDS	Antibiotic-corticosteroid intracanal paste (eg, Odontopaste or Ledermix)
CANS	Antiresorptive supplement for the tooth rescue box (1 mg tetracycline + 1 mg dexamethasone)
	Emdogain

Only a few materials are required, and most of them are already part of the basic equipment. The most crucial element is a tooth rescue box containing a cell culture storage medium, which should be kept in a place where it can be accessed quickly in case of an emergency.

Systemic doxycycline administration

Systemic doxycycline administration is recommended for the treatment of severe luxation injuries to permanent teeth (especially avulsion and intrusion). Due to the antiresorptive properties of tetracycline derivates, the likelihood of periodontal healing is expected to increase,[20] although clinical evidence is inconclusive.[25] Since tetracyclines are incorporated into tissues that are calcifying at the time of their administration, the risk of tooth discoloration should be considered.[26] After the age of 8 years calcification of the crowns of permanent teeth is completed, with the exception of the third molar, and clinically relevant discoloration resulting from a short-term tetracycline administration is unlikely.

Systemic doxycycline is administered for 7 days starting on the day of replantation. The dosage is 100 mg per day for adults and adolescents with a body weight of over 50 kg, and 2 mg/kg per day for children 8 years of age and older who weigh less than 50 kg; all patients receive a double dose on the first day.

Further treatment

Even if initial management of dental trauma was ideal, suboptimal or delayed further treatment can compromise the later outcome of treatment. In particular, prompt root canal treatment is crucial for teeth with severe luxation injuries, to prevent infection-related root resorption. In order to be able to make correct decisions regarding endodontic treatment, the dental practitioner providing further treatment must rely on the initial diagnostic findings (particularly regarding the extent of dislocation) documented in the patient records. Therefore, the referring practitioner must make the utmost effort to ensure that the patient receives adequate further treatment and that the patient and/or the clinician providing further treatment receives all important information of relevance to treatment.

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