

## REVIEW ARTICLE

# The Treatment of Anterior Dental Trauma

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## SUMMARY

**Background:** Avulsed frontal teeth often cannot be saved because of improper or lack of initial treatment. The result is a need for multiple interventions over the patient's lifetime, which also carry a high financial cost.

**Methods:** We explored the subject of lost anterior teeth in young patients with a PubMed search based on the term "prevalence of traumatic dental injuries" over the time period 2000–2010. In this article, we selectively review the publications retrieved by the search and give case examples to illustrate the proper initial treatment of children and adolescents (ages 6 to 17) with broken anterior teeth.

**Results:** The search retrieved 138 articles. Here, we review retrospective clinical studies of dental trauma between the ages of 6 and 17: only 6 adequately designed studies of this type were found. The estimated prevalence of anterior dental trauma in this age group ranged from 6.4% to 37.9%. The recommended initial steps for the preservation of traumatized teeth are easy to take. Avulsed teeth can and should be replanted at once. If there is no time, or if the patient simultaneously has other, life-threatening injuries, the avulsed teeth can be stored in a special nutrient medium until they can be replanted. Commercially available tooth rescue boxes enable replantation to be performed up to 24 hours after the injury.

**Conclusion:** The authors of the selected studies agree that dental trauma is often improperly treated. Timely treatment of injured anterior teeth prevents much further damage and expensive treatment for the affected young patients.

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**A**nterior dental trauma is a common injury pattern of the dentoalveolar system in which appropriate first aid is important. When children and adolescents suffer an anterior dental trauma, the challenge is to preserve the tooth in this esthetically important area and minimize subsequent damage. Lack of treatment or improper treatment can lead to a lifelong need for dental care.

There are many causes of anterior dental trauma. At the age of one and two years, it is mainly caused by falls when learning to walk. At preschool age, between two and six years, many such injuries are caused by falls resulting from lack of attention when engaging in physical play. The highest incidence of anterior dental trauma occurs between seven and twelve years of age (1–4). The leading cause is the increase in sporting activities and in confrontations with others of the same age. After traffic accidents and physical fights, sporting injuries are one of the main causes of anterior dental trauma (5, 6), and the prevalence of these injuries varies between different types of sport (7–10). Anterior dental trauma during school sports classes accounts for 2.3% of all sports accidents in Germany (7).

Because of the high frequency of dental trauma and the expensive, lengthy care it can require, the German Dental Association (BZÄK, Bundeszahnärztekammer) recommends that all kindergartens, schools, sports centers, dental practices, and medical institutions should keep a stock of tooth rescue boxes (5).

Because anterior dental trauma is often caused by accidents that also cause limb fractures, concussion, or life-threatening injuries (11), it is frequently overlooked, as emergency care initially concentrates on more important issues. As a result, it often becomes impossible to provide appropriate treatment that would allow the affected front tooth to be saved. At the same time, the preservation of an intact permanent tooth, which unlike deciduous teeth will not be naturally replaced by the body, is extremely important to the further psychological development of the affected person (12). Various studies involving surveys have shown that the loss of a front tooth in children and adolescents is evaluated unfavorably in both psychological and social terms. These problems include both exclusion by peers because of the visible flaw, which can lead to social deprivation (13), and a feeling of embarrassment

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**TABLE 1**

**WHO classification of dental trauma**

WHO classification	Trauma	Signs
1	Enamel fracture	Tooth not painful, no color change but rough edges
2	Crown fracture without pulpal involvement	Fracture runs through enamel and dentin layer. Tooth sensitive to touch and airflow
3	Crown fracture with pulpal involvement	Fracture runs through enamel and dentin layer, nerve exposed. Tooth highly sensitive. Pulp tissue shows pink in the center of the tooth, or bleeding in the center of the tooth
4	Root fracture	Only visible on X-ray. Tooth may be loosened
5	Crown root fracture	Crown may have fracture lines
6	Fracture of tooth, unspecified	
7	Tooth luxation	Increased mobility of tooth
8	Intrusion or extrusion	Change in axial height. Intruded teeth are more deeply embedded and seem ankylotic. Extruded teeth seem longer and are highly mobile
9	Avulsion	The tooth is completely outside the alveolus
10	Other injuries associated with laceration of the oral soft tissues	

when laughing and avoidance of contact with peers (13, 14). However, there are also practical reasons for providing immediate care for anterior dental trauma in order to avoid subsequent interventions: If a front tooth is lost before the jaw has finished growing, it cannot be replaced with an artificial implant, as implants heal ankylotically. This would lead to the alveolar process developing further around the implant as the jaw grew, leading to an esthetically displeasing result in the long term following crown treatment. If left untreated, the loss of a permanent tooth causes severe damage to the alveolar process that subsequently requires extensive surgeries to repair, in order to achieve an esthetically and functionally satisfactory result.

**Methods**

This article presents the results of a selective review of the literature on the subject “loss of permanent teeth in children and adolescents” in the PubMed database. As a comparison of the numbers of cases, the search term “prevalence of traumatic dental injuries” yielded a total of 138 articles from the period 2000 to 2010. Of these, retrospective clinical studies in children and adolescents aged 6 to 17 with anterior dental trauma were included in the review. Only six articles could be directly compared with each other because of study design, and also because of study design only three of these could be included in our research (2–4). In order to expand the subject area, the search term “traumatic dental injuries” was also used. This yielded a total of 1050 hits for the period 1953 to 2010. Of these, only articles with statements and studies concerning modern treatments such as autotransplantation and splinting, works on anterior dental trauma in sports medicine, and papers on psychosocial consequences for those affected were included in the evaluation.

**Results**

**Prevalence**

Data on the frequency of anterior dental trauma between the ages of 6 and 17 tend to vary greatly in the literature (1). The prevalence rates in this age group in the six included cross-sectional studies were between 6.4% and 37.9% (2–4).

**Classification of anterior dental trauma**

There are various ways to classify anterior dental trauma (15, 16). The most well-known is the WHO classification (Table 1). Anterior dental trauma can also be divided, for example, into injuries that affect only the dental hard tissue, peridontium, alveolar process, or a combination of these anatomical structures (Table 2). Each of these injury patterns requires specific treatment. In general, anterior dental trauma requires immediate appropriate treatment. If a permanent tooth suffers such trauma while the jaw is still growing, in other words between the ages of 6 and 17, it is essential to preserve it, because a fixed implant cannot be optimally inserted until after the jaw has finished growing.

**TABLE 2**

**Simplified overview of possible injury types, signs, and possible action in the event of dental trauma**

Type of injury	Visible signs	How to proceed
<b>Injuries to dental hard tissue</b>		
Enamel-dentin fracture without pulpal involvement	Minor surface flaws	Referral to dentist as soon as overall condition permits
Enamel-dentin fracture with pulpal involvement	Surface flaws, nerve tissue showing pink in the center of the lesion	Examination by a dental specialist to prevent pulpitis, provided no life-saving treatment is needed
Crown fracture	Parts of visible tooth missing	Referral to dentist as soon as overall condition permits
Root fracture	Tooth excessively mobile	Splinting by a dental specialist as soon as overall condition permits
<b>Injuries to peridontium</b>		
Luxation	Tooth excessively mobile and displaced (in palatine, vestibular, etc. direction)	If necessary, replanting and splinting by a dental specialist as soon as overall condition permits
Intrusion	Tooth appears too short and is immobile/wedged	Extrusion and splinting by a dental specialist as soon as overall condition permits
Extrusion	Tooth is excessively mobile and appears too long	Replanting and splinting by a dental specialist as soon as overall condition permits
Avulsion	Tooth lost	Find tooth, replant immediately or store in tooth rescue box; replanting and splinting by a dental specialist as soon as overall condition permits
<b>Injuries to alveolar process</b>		
Alveolar process fracture		Replanting and splinting by a dental specialist as soon as overall condition permits

**Initial diagnosis**

It is very important to provide first aid for injuries to the dentoalveolar system in children and adolescents. This concerns the collection of data on how the trauma occurred on the one hand—this should also include monitoring for any evidence of domestic violence (17)—and information from the patient’s medical history regarding current immunization status (tetanus) and signs of concussion (amnesia, autonomic symptoms) on the other.

Next, the stomatognathic system should be examined for injuries, checking particularly for any direct or indirect signs of fractures to the jawbone. Teeth should also be examined for abnormal mobility, displacement, and sensitivity (using cold spray and a cotton wool ball). The alveolar process should also be palpated to search for irregularities or discontinuities.

Information on various dental injury patterns is provided in the following section and in *Tables 1 and 2*.

X-rays must always be performed during initial diagnosis, in order to rule out fractures. For this purpose, a dentist or oral and maxillofacial surgeon takes a panoramic X-ray and if necessary also images of the front teeth alone.

**Diagnosis and treatment of specific injuries**

**Enamel fracture**

An enamel fracture (*Table 1*) can be identified by fine chalky-white flaws on the surface of the affected tooth. The surface of the tooth generally feels smooth. This injury pattern does not require any immediate action.

**Crown fracture**

Crown fractures involve loss of dental hard tissue. Either isolated pieces of enamel may be missing or larger pieces may have been knocked out, but without exposing the dental nerve (crown fracture without pulpal involvement, *Table 1*). As the dentin is still connected to the dental nerve, patients with fractured teeth must be referred to a dentist so that the dentist can take action to keep the pulp alive.

This is particularly important when parts of the dental nerve are exposed; this occurs with hematoma or bleeding in the center of the tooth (crown fracture with pulpal involvement, *Table 1*).

**Root fracture**

Root fractures can occur when the visible part of the tooth is knocked out, with partial loss of dental hard

**Figure:  
Alveolom  
following the loss  
of tooth 9 (top)**

The tooth was brought in by the patient in a tooth rescue box, cleaned with saline solution, and immediately replanted (middle). One year later, the tooth is esthetically and functionally rehabilitated in the row of teeth (bottom)



tissue, or with displacement. Alternatively, there may be no outward signs at all, in which case it can only be identified due to slightly increased tooth mobility. A root fracture can usually only be conclusively confirmed by X-ray.

Treatment of root fractures depends on the position of the fracture line and the course it takes through the root. Intra-alveolar fractures can usually be treated using splinting and endodontic treatment of the coronal fragment. Root fractures connected to the oral cavity usually result in the loss of the affected tooth due to bacterial invasion and subsequent inflammation. If a root fracture is suspected, the patient should be referred to a dentist as soon as possible.

#### **Tooth luxation**

The usual sign of tooth luxation is a significant increase in the mobility of the affected tooth. Luxated deciduous teeth are usually removed or not replanted, provided X-ray confirms the presence of a permanent tooth under the luxated tooth.

Luxated permanent teeth that have not been displaced by the injury may not require treatment, depending on how severely the tooth is loosened, as teeth loosened by trauma generally become secure again if protected. However, displaced luxated permanent teeth require careful replanting in the correct axial position and splinting with a wire-composite splint for seven days (*Figure*). Intruded teeth (tooth displaced into the jaw, crown unnaturally short) and extruded teeth (tooth appears unnaturally long) require the same treatment. If

the tooth is located entirely outside the alveolom, this is an avulsion and the tooth must be appropriately replanted and splinted if it is a permanent tooth.

#### **Tooth avulsion**

While injuries to the visible dental hard tissue such as enamel-dentin fractures without pulpal involvement don't require immediate treatment, injuries to the dental root, peridontium, or alveolar process require swift action. In particular, the avulsion of a tooth, i.e. a tooth knocked completely out of its socket by a direct or indirect blow, must be treated as quickly as possible.

Clinical and experimental studies have shown that even when teeth were replanted immediately, after a maximum of five minutes outside the alveolom, only 73% had normal desmodontal tissue after healing was complete. After 10 minutes outside the alveolom, optimum healing was observed in only 50% of cases (15, 16, 18). Teeth that have been knocked out of the alveolom should therefore be replanted immediately after appropriate cleaning with isotonic saline solution. It is absolutely essential to avoid bruising or touching the surface of the root.

The tooth is then fixed in this position using wire and composite (by a dentist). If no wire or composite is available, a makeshift splint made from aluminum foil can be placed around the teeth. If the physician providing first aid is unable to replant the tooth immediately, the tooth should be stored in what is known as a tooth rescue box. Tooth rescue boxes allow teeth to be replanted after up to 24 hours. An advantage of tooth rescue boxes is that if the tooth is stored immediately there is plenty of time after the accident to provide the necessary diagnosis and treatment.

Tooth rescue boxes contain a nutrient medium so that cells can be kept alive for up to 24 hours. They also contain a color indicator that changes from pink to yellow as the pH decreases. The medium in an unopened box can be kept for at least three years, but should not be exposed to temperatures above 40°C. However, placing a tooth in a refrigerated solution can also worsen the chances of preserving it.

As a less ideal alternative, teeth can also be kept in milk (preferably UHT milk). They should only be stored in saline solution or saliva from the patient's mouth if absolutely essential. This leads to cell death on the surface of the root in less than an hour.

Dry storage and storage in tap water are never recommended (15). If the tooth is stored in a tooth rescue box, it can be replanted at an emergency care facility up to 24 hours later, after necessary first aid has been provided, by a dental specialist (e.g. a dentist who specializes in oral surgery or an oral and maxillofacial surgeon), on a scheduled basis and after any necessary delays.

Front teeth that have been knocked out can and should be replanted in their original positions if they have been stored correctly, in order to prevent patients from needing lifelong expensive, bothersome follow-up treatment wherever possible.

In subsequent treatment of patients who have been referred, avulsed teeth must be correctly stored immediately following avulsion, or immediately replanted. What should someone providing first aid do on identifying the loss of a tooth? According to the current literature, replanting the tooth immediately provides the best prognosis (15–17), for the following reasons: The surface of the dental root is surrounded by cementum and stromal cells. For successful healing, it is important that as many of these cells as possible remain alive. The most numerous cells in the desmodont are fibroblasts. These account for approximately 25% of all desmodontal cells (16). Luxation or avulsion causes a tearing of the desmodontal tissue and the onset of blood clotting and wound healing. The fibroblasts present perform most of the repair process at this stage, and this is associated with substantial multiplication of these cells (19). During this phase of healing it is determined whether regular desmodontal tissue is formed or whether scar tissue is formed, together with resorption or ankylosis (19, 20). Dead fibroblasts on the surface of the root are eliminated by macrophages. The presence of macrophages can lead to the formation of resorptive scar tissue. This can give rise to ankylosis of the tooth and external resorption, which it turn may result in the loss of the tooth (18, 21). In order to minimize the chemotaxis of macrophages and other immunocompetent cells, the best first aid for an avulsed tooth is therefore immediate replantation and, if necessary, removal of necrotic pulp tissue either extraorally at the same time or subsequently.

### Summary

The various authors cited in the literature (10, 11) agree that public awareness of the best action to take following anterior dental trauma can be considered unsatisfactory. Astoundingly, in view of the high incidence of anterior dental trauma, the appropriate care for this idiosyncratic type of wound is also inadequately performed in medical institutions (10). It is particularly noticeable that teeth that have been knocked out are stored dry and then cannot be replanted, or replanting is rejected. Other therapeutic action for anterior dental trauma is also taken either late or not at all. The reason for this may be a knowledge barrier between physicians and dentists (11). The necessary first aid, however, is quite simple and does not require substantial specialized knowledge.

Emergency facilities should keep a stock of tooth rescue boxes, so that appropriate subsequent care can be provided for teeth that have been knocked out, after patients have received first aid. In children and adolescents, a tooth that is not replanted cannot be replaced with a fixed prosthesis. This often results in lifelong, not inconsiderable subsequent costs and operations due to a lack of treatment or improper treatment. Teeth should therefore ideally be replanted in the alveolus immediately, or stored using an appropriate alternative method and then be replanted at an appropriate specialized facility (22).

### Conflict of interest statement

The authors declare that no conflict of interest exists.

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