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Chapter

Orthodontic Approach in Facial and Dental Trauma

Sanaz Sadry

Abstract

In this review, the prevalence of dental trauma, prevention and diagnosis of traumatic injuries, the effects of dental trauma in patients in need of orthodontic treatment, orthodontic intervention to dental traumatized teeth, and treatment options for poor anterior teeth due to trauma are discussed. Dental trauma is a condition that is frequently encountered in dentistry. When orthodontic treatment of traumatized teeth is planned, the orthodontist should be considered before orthodontic treatment and during orthodontic treatment. Prognosis is divided into two types as treatment options of bad anterior teeth, retaining the tooth in the mouth or pulling the tooth and restoration of the opening. The multidisciplinary teamwork and the role of the orthodontist in this team are important in order to achieve optimal results in the clinical intervention of these cases. Autotransplantation, orthodontic closure, or opening of the space are discussed when tooth extraction and toothless space restoration are required. It is very important to decide if orthodontic forces should be applied or not, and if orthodontic force is necessary, when should it be applied. Information on orthodontic forces applied to traumatized teeth was given in this chapter.

Keywords: orthodontic approach, dental trauma, tooth movement, autotransplantation, orthodontic space closure

1. Introduction

Dental trauma (traumatic dental injury) affects the teeth and soft and hard tissues around the oral cavity. According to research worldwide, dental trauma is often seen as a result of sporting activities, falls, traffic accidents, and fights and often requires emergency intervention [1, 2]. Because of the high rate of trauma in patients presenting with orthodontic treatment today, the orthodontist should plan how to perform dental movements in these patients and consider the long-term prognosis of these teeth before starting treatment. The orthodontists in the multidisciplinary team who intervenes in the trauma have a major role in obtaining optimal results in the traumatic tooth [3]. While interfering with dental trauma cases, treatment guidelines may not be applicable as standard for each patient. Each case should be evaluated and treated accordingly. General health of the patient, severity and type of the trauma, chronological and dental age of the patient, dental and anatomical development status, and whether the patient carries a device in the mouth during trauma are some of the factors determining the treatment. It is important to decide whether orthodontic force can be applied to dental traumatized teeth, and if it is to be applied, it will be applied after the trauma. Excessive amount of orthodontic force on dental teeth

can cause undesirable effects such as root resorption [4, 5]. Patients with orthodontic attachments at the mouth during orthodontic treatment may also be exposed to dental trauma. When dental trauma occurs during orthodontic treatment, the path to be followed for treatment is based on clinical experience and individual case reports presented in the literature [3, 6, 7]. Dental injuries vary widely from simple enamel fractures to complicated fractures and often require complicated treatment of more than one type of injury. The knowledge and skills of the physician are very important in cases where such emergency treatment is required, and the first treatment is extremely important on prognosis [8].

2. Prevalence

Most of the dental trauma data available have been collected retrospectively from cross-sectional studies or from longitudinal studies of patient records. The prospective studies are based on subpopulations such as school children [9–12], children presenting to a pediatric dental service, or patients presenting to an accident and emergency department [13–15]. Permanent incisors of children that sustain damage by accident in the United Kingdom increases with age from 5% at age 8 to 11% by age 12, and injuries are more frequent in males than females [16–19]. Two comprehensive national studies conducted in the United States reported that one of six adolescents and one of four adults suffered traumatic dental injuries [20]. The majority of permanent tooth injuries occur in the age group of 6–15 and especially between the ages of 8 and 11 years. The upper teeth, especially the central incisors, are affected more by the lower teeth. This occurs more in boys than girls [21].

The researchers found that the injuries were mostly caused by traffic accidents, sports, and violence as a result of the incidents, and mostly due to falling in girls; they reported an uncomplicated crown fracture (55.4%), fracture (8.6%), complicated crown fracture (5.5%), luxation (4.3%), and avulsion (2.0%). Although the oral region of the human body constitutes 1% of the whole body, the statistics indicate that one fourth of the school age children and one third of the adults suffer from trauma [22].

3. Etiology

1. Human behavior: risk taking, problems experienced in relations with relatives, hyperactivity, and stress

2. Environmental factors: deprivation and overcrowding

3. Unconscious injuries: fall and crash, physical activities, traffic accidents, unsuitable teeth uses, and biting hard objects

4. Conscious injuries: physical exertion and iatrogenic procedures.

5. Predisposing factors: occlusal relationship, increased overjet amount, insufficient lip closure, history of previous trauma, and socioeconomic level [22].

The risk of trauma was found to increase as the amount of overjet increased. Incidence of trauma in the maxillary incisors was four times higher than the mandibular incisors. When the overbite was 0 mm, the risk of trauma in the mandibular incisors was the highest [23].

4. Classification

The WHO system was modified by Andreasen and Andreasen to further clarify the luxation and intrusion groups. This classification is as follows:

- Injuries involving hard tissues and pulp: Incomplete fracture of the crown, uncomplicated crown fracture, complicated crown fracture, and root fracture
- Supportive tissue injuries: Alveolar socket involvement (observed with intrusion and lateral luxation). Alveolar process fracture and maxilla mandibular fracture
- Gingiva or oral mucosa injuries: Gingiva or oral mucosa rupture, gingiva or oral mucosa injury, and abrasion of the gingiva or oral mucosa

The treatment plan for patients with traumatized tooth is evaluated in two parts as the prognosis of the traumatized tooth and the treatment of possible malocclusion [24].

5. Examination and diagnosis

Before an orthodontic treatment, a thorough anamnesis must be taken to determine whether the patient has suffered dental injuries. Before the examination, a comprehensive patient history is taken. The general health status of the patient, time of injury, and direct or indirect trauma are determined. In order to determine the state of the healing capacity of the tissues, whether the patient has been traumatized in the same area before, if any treatment has been performed in which the area, the tooth showing the damage in the support tissues or pulp, the sensitivity to spontaneous toothache, and hot-cold and sweet-sour foods are questioned. In the clinical examination, extraoral tissues, intraocular tissue, periodontal tissues, alveolar bone, and teeth are examined carefully. Abnormalities in the occlusion indicate a fracture in the alveolar and jaw. Sensitivity of the teeth during contact and whether the teeth are luxated are determined. According to the localization of the root fractures, there is luxation in the teeth. The mobility of the root fracture increases as the fracture line approaches the crown. Sensitivity to percussion refers to injuries in periodontal fibers. Thermal tests and vitalometer applications are used to determine the vitality of pulp in teeth injured due to trauma.

It is not always possible for the patient to remember whether he has had a dental injury, so that the patient should be evaluated clinically and radiographically prior to the treatment, and this evaluation should include the following:

The tooth should be checked for coloration and recorded. Crown yellow colorations, pulp canal obliteration; dark coloring may be a sign of pulpal hemorrhage or necrosis. It should be examined whether there is mobility in horizontal and vertical direction. With palpation, the apical area of the teeth should be checked for sensitivity. Percussion should be examined. In percussion, metallic sounds may be a sign of ankylosis, and blunt sounds may be a sign of root fracture. Thermal and electrical pulp tests and pulp response should be considered. Thermal tests were used to determine the neurovascular support of the traumatic tooth pulp; electrical pulp test plays an important role in determining the pulp necrosis of the tooth.

Radiographs are an important factor in the diagnosis of traumatic dental injuries. Depending on the type of malposition (e.g., lateral luxation) and the type of fracture (specimen, root fracture), it is important to take periapical film from various angles to perform an accurate examination.

Unexpectedly developing dental trauma may affect the oral function and psychology of the patient. It is necessary to eliminate the negative effects of pain and trauma on the teeth and periodontal tissues as soon as possible after dental trauma occurs in individuals receiving fixed orthodontic treatment. Regardless of the stage of fixed orthodontic treatment, dental trauma during treatment disrupts the routine functioning of active orthodontic treatment. The first emergency intervention in the trauma area is relieving of the pain, and the orthodontic force is rapidly removed from the teeth in the trauma area. Then, according to the severity of dental trauma, treatment is carried out with an individual approach that includes multidisciplinary treatment methods [20].

Brin et al. reported that increased overjet and insufficient lip closure were the greatest risk factors for dental trauma and that early orthodontic treatment to reduce overjet would reduce the risk of dental trauma. The use of mouthguard in individuals interested in contact sports is also an application that reduces the risk of dental injury [23, 24]. Bauss et al. reported different treatment approaches according to the type of dental trauma in patients with dental trauma during orthodontic treatment [7].

6. Treatment sequence and timing

Orthodontic treatment should usually be initiated during mixed dentition. When trauma occurs at an early age, the treatment will be shorter and less complicated, given the age, dental and skeletal development, and maturity of the patient [20].

7. Observation periods before orthodontic treatment

7.1 Crown and crown-root fractures

If crowns and crown-root fractures without pulp are treated appropriately, their prognosis is good. Before the orthodontic treatment, the 3-month observation period is sufficient. Crown and crown-root fractures containing the pulp can be treated orthodontically after partial pulpectomy and hard tissue barrier formation. Hard tissue barrier is observed radiographically 3 months after treatment [20].

This type of fracture includes enamel, dentin, and cement. Pulp may or may not be exposed. As a result of the traumatic forces that come out of the teeth, crown-root fractures are frequently encountered [25]. It has been reported that vertical crown-root fractures should be extracted. In diagonal crown-root fractures, the broken tooth must be orthodontically extruded to expose the subgingival fracture line [26]. The distance of healthy gingival tissue on the alveolar bone is defined as the biological width. This width is ideally considered to be equal to the sum of the connective tissue attachment (1 mm) to the sum of the epithelial attachment (1 mm). The extraction of the fractured tooth by obtaining the biological width is important for the ideal restoration of the tooth [25].

7.2 Luxated teeth

Clinical experiences showed that light injuries such as confusion and subluxation require at least a 3-month observation period. The need for endodontic treatment usually arises after moderate to severe limb injuries. Radiographic improvement revealed that orthodontic treatment should be postponed until it is out.

7.3 Endodontically treated teeth

Wickwire and colleagues compared root resorption of endodontically treated teeth with vital teeth after orthodontic treatment, and more root resorption was found in devital teeth [27]. Mirabella and Arthun suggested that endodontic application is a protective treatment and that root canal-filled teeth are resorbed for unknown reasons [28]. Hunter and colleagues in their study showed no difference between the vitality of vital and devital teeth root resorption after orthodontic treatment [29]. Hamilton and Gutman stated that if the root canal filling is properly shaped three dimensionally and cleaned, minimal resorption will be seen during the movement of orthodontic teeth [28].

7.4 Root canal calcified teeth

Calcification of the root canal is usually seen after autotransplantation of immature teeth, and these teeth can be moved in a limited manner. However, closely monitoring the root canal calcified teeth during orthodontic treatment is extremely important [20].

8. Special treatment principles in various trauma types

It is essential that radiographic examination is performed before starting orthodontic treatment, even in light injuries such as uncomplicated crown fracture. If the vitality of pulp is suspected, it is recommended to undergo a 3-month observation period before orthodontic treatment [20].

- Crown-root extrusion and cervical root fracture: This type of fracture includes enamel, dentin, and cement. Pulp may or may not be exposed. As a result of the traumatic forces that come out of the teeth, crown-root fractures are frequently encountered [30]. It has been reported that vertical crown-root fractures should be extracted. In diagonal crown-root fractures, the broken tooth must be orthodontically extruded to expose the subgingival fracture line [26]. The distance of healthy gingival tissue on the alveolar bone is defined as the biological width. This width is ideally considered to be equal to the sum of the connective tissue attachment (1 mm) and to the sum of the epithelial attachment (1 mm). The extraction of the broken tooth by obtaining the biological width is important for the ideal restoration of the tooth [30]. In crown-cervical or cervical root fractures, it may be necessary to orthodontically extrude the fractured root piece during restoration of the tooth. The fast extrusion technique has been developed to save these teeth. A hook is placed in the root canal with this technique, and the root is extruded in the axial direction [31]. Relapse may occur after orthodontic extrusion. Fibrotomy should be performed at least 3–4 weeks before the retention period to avoid relapse [32].

- Slow orthodontic extrusion: It is the extraction of the tooth with slow forces (20–30 gr). Biodiversity cannot be achieved by orthodontic extrusion only, because the movement of the teeth formed by orthodontic extrusion follows the gingiva and the alveolar bone. Orthodontic extrusion takes 4–5 months and then 12 weeks of retention. After orthodontic movement, periodontal surgery is needed to reshape the gingiva. Periodontal fibers can be cut to prevent recurrence (fiberotomy), and prosthesis can be applied 2–3 months later [30].

- Fast orthodontic extrusion: Under normal conditions, bone and gingival movement is performed by lightweight extrusive forces. When stronger pulling forces (> 50gr) are applied, rapid movement will exceed the physiological capacity of the tissues, and the movement in the support tissues is very low. After rapid extrusion is performed, a retention phase is required to adapt the periodontium to the new position of the tooth and allow the bone to be reshaped. The researchers reported that radiographs and histological analyzes revealed rare resorption in the root after rapid orthodontic extrusion [33].

- Root fractures: Dentin is broken into cement and pulp. Root fracture and luxation injuries can occur simultaneously; attention should be paid to root fractures. Post-traumatic root fractures are not frequently seen, and the incidence of post-traumatic root fractures in continuous teeth ranges from 0.5 to 7%. Horizontal root fractures are usually seen in the middle 1/3 of the root, followed by apical and coronal in the remaining 2/3 parts. Horizontal fractures are frequently seen in maxillary anterior teeth and in men aged 11–20 years. In general, root fractures have completed the continuation of the apex, and the teeth are affected. Simple fractures away from the cervical line have better prognosis [34]. In cases close to the cervical line, the fracture fragment can be excised with rapid extrusion, and crown restoration is possible [35]. If the granulation tissue and the coronal fragment are found to have necrosis among the fragments, endodontic treatment should be performed on the coronal fragment before orthodontic treatment. Following a successful canal treatment, the healing of the fracture line is caused by connective tissue. A 2-year observation period is recommended prior to orthodontic movement in teeth with root fracture, but this period can be reduced to 1 year if there is no complication [36].

Observation period prior to orthodontic treatment of the teeth with root fracture is determined as 2 years. Clinical experience has shown that most complications, such as pulp necrosis, occur 1 year after trauma. If no complication occurs, the observation period may be shortened. There are two types of treatment options, orthodontic or surgical extrusion, in teeth with complicated crown-root or cervical root fracture [20]. The orthodontic success of teeth with root fractures depends on the localization of the fracture and the type of healing. Radiographic and histological examinations showed that different types of healing are seen after root fractures: (1) Recovery with calcified tissues, (2) connective healing, and (3) improvement of bone growth between fractures. Healing with calcified tissues is the healing of the fracture with dentin and cement. Full interlocking of the fracture may not be completed, but the fracture has been combined. The orthodontic movement of the teeth with a hard tissue callus and a fractured root fracture can occur without the fracture line. The fracture margins are covered with cement and periodontal ligaments in the healing of the intervening tissues. Orthodontic movement of teeth with root fractures and broken pieces is separated from the connective tissue to move away from each other. In the orthodontic treatment plan of fractured teeth root with intervening connective tissues, the tooth should be seen as a short-rooted. This means that the teeth broken from apical one third have sufficient periodontal support for orthodontic tooth movement [37].

- Luxated teeth: In clinical examinations, it was found that if there was no resorption in the luxated teeth, it showed the same prognosis with non-traumatized teeth [38].

- Avulse teeth: In order to achieve a complete improvement in the avulsion injuries that occur in permanent teeth, the tooth must be inserted into the socket as

soon as possible. Storing the avulsed tooth in milk for more than 60 minutes or 30 minutes dry causes ankylosis in the tooth after reimplantation [38, 39]. Orthodontic movement of the tooth is not recommended until after the reimplantation periodontal recovery is complete (6 months). It should be emphasized that the tooth may be ankylosis if orthodontic force is not performed as expected [3]. Replantation is considered primarily when the avulsed tooth is intact. Replantation is the insertion of the avulsed tooth into the alveoli with acute trauma. The loss of the permanent tooth after trauma is a condition that requires an orthodontic treatment plan. The main question is whether the cavity will be preserved for dental autotransplantation, implant placement, or bridge. Autotransplantation can be performed with both mature and immature teeth. However, in most cases with autotransplantation, the best prognosis is observed if the 3/4 of the tooth germ is formed or if the entire root is formed, but the apex is open. At this stage, the pulp maintains its vitality and continues its root development. Transplanted teeth lose only a small portion of the root length [21]. Bone-supported implants have been widely used instead of lost anterior teeth in recent years. Implants are fixated within the jaw and do not erupt during dental and alveolar development. For this reason, growth and development must be completed before implant placement [20].

- Space closure: Space formed of loss maxillary lateral incisors can be closed by positioning the maxillary canine in the lateral cutting region. Rather than the tooth that has been lost, rather than a prosthetic lateral tooth, the closure of the lateral tooth leads to more esthetic results periodontally. Canines are bled, to achieve more esthetic results. The length of the clinical crown can be changed through gingivectomy [40]. Following the orthodontic closure of the lost central tooth, if the shifted teeth are decided to be reshaped, the lateral tooth intrusion and the canine tooth are extruded to obtain the gingival contour of the central and lateral teeth [41]. In cases where the maxillary central teeth are lost, it is a complex condition where the lateral tooth is replaced by the mesial movement of the central tooth. The space is not fully closed, which poses risk. In cases where laterals are replacing the centrals, the lateral cutter should be raised in the mesiodistal direction, and the buccal root torque is required [42]. Extrusion of the canine tooth and intrusion of premolar teeth are performed in order to obtain the optimum gingival marginal contour of the anterior teeth. Lateral root torque is applied to the canine tooth and canine root torque to the repositioned premolar. Canine tooth is worn as composite or porcelain (porcelain veneers are more suitable and preferable) and restored to give it lateral form. The width of the canine tooth is reduced to provide optimal esthetic and functional occlusion by increasing the length and width of the first premolar teeth that are extruded and mesialized by composite restorations. The canine tooth with a more yellow color is bleached after its mesialization to the lateral tooth position [41].

In cases where the incisors are lost, the esthetic and functional results cannot be obtained by closing the space, and the completion of jaw growth should be expected. In this case, space should be maintained, and set-up models should be studied for different alternatives of tooth positions [43].

- Maintaining the space: The space can be maintained if it is not suitable. In patients with normal occlusion and dysesthesia with poorly aligned normal occlusion if more than one incisor is lost in the same arch, in class II division or class III patients who have lost one tooth in the upper jaw, there is a large discrepancy between the crowns of the central and lateral incisors and the space may be maintained in

patients with lip deficiency [44]. Various space maintainers can be used to protect the space. The best option is to use the traumatized tooth as space maintainer when the prognosis is poor. But teeth should be checked. In case of ankylosing, it should be extracted without a severe infraocclusion [45].

- Opening of the space with orthodontic treatment: In their study, Kokich and Crabill applied an orthodontic site development technique to a 7-year-old patient who lost the central tooth due to avulsion. The researchers reported that the ongoing teeth would move massively instead of rolling over to the space and would carry the alveolar bone here. The neighboring teeth are allowed to move in the toothless space by applying a space maintainer until the tooth is complete. Since there was no stenosis in the patient, it was decided to reopen the toothless cavity, which was closed after the teeth, and place the implant. This technique is called "orthodontic site development." When the teeth are taken back to their original place, the missing tooth's cavity is filled with bone. With orthodontic site development, researchers have reported that bone does not undergo any resorption or contraction over time, thus providing a suitable site for implant placement [46].

- Autotransplantation: 43 years ago, Slagsvold and Bjercke developed a new method by transplanting partially formed teeth. In these teeth, endodontic treatment is usually not required after application. Most traumatic injuries are between 7 and 10 years of age, which makes it possible for autotransplantation of developing premolar. Dental autotransplantation has been reported to be a highly successful technique. Pediatric patients with orthodontic tooth extraction are suitable for autotransplantation [47]. Due to root anatomy, mandibular premolar teeth are preferred for this procedure. The most appropriate time for transplantation is when the 2/3 part of the root of the tooth is formed and has a larger apical opening of 1 mm. One hundred eighteen unfinished teeth were examined for 1–13 years, and in this period, 96% of the pulp regeneration rate was observed in the transplantation process [41]. Vilhjalmsson et al. [48] reported their success rate in autotransplantation as 80.5% in 2011. As the root growth of the tooth continues and normal periodontal ligament formation is observed, these teeth can be moved orthodontically without being different from the other teeth. It is recommended that the tooth be observed for 3–4 months before orthodontic movement [48].

- Crown and root malformations: Malformations of permanent teeth due to traumatic injuries sometimes cause permanent teeth to remain buried. If the root development of the tooth is sufficient, the tooth can be placed in the appropriate position by means of surgery and orthodontics [49].

- Intrusive teeth: In intrusion injuries, the tooth is displaced in the apical direction. Intrusion injuries are a type of trauma that is frequently encountered. Intrusion injuries lead to serious damage to the tooth, periodontium, and pulp. Ankylosis, pulp necrosis, and pulp calcification are among the most common adverse effects of traumatic intrusion. Special attention should be paid to these teeth during orthodontic treatment [30]. In severe intrusion injuries, periodontal ligament regeneration may occur, but a rapid progressive replacement resorption, marginal bone loss, inflammatory root resorption, ankylosis, and pulp necrosis may occur in less severe intrusion injuries [3].

The incidence of replacement resorption in intrusive cutters varies between 5 and 31%. The relationship between the severity of the intrusion and the type of root

resorption was examined, and a significantly higher rate of replacement resorption was seen in the severely intrusive apex closed teeth [33].

Treatment: In the case of closed and severely intramedullary apex closed teeth, the tooth should be immediately placed in the previous alveolar position (early orthodontic extrusion) to allow the extirpation of non-vital pulp and to prevent the formation of inflammatory resorption. Since active surgery or orthodontic extrusion will cause a secondary trauma in the periodontal ligament, the teeth should be spontaneously re-erupted in individuals under 17 years of age who have suffered low and moderate trauma [39]. In 2 weeks, active extrusion may be considered if no movement occurs in the tooth. A serious intrusion force may compress the tooth in alveolus, thus the tooth can be lightly luxated prior to orthodontic extrusion [3].

Early orthodontic extrusion: For orthodontic extrusion of 1–2 teeth that have been intrinsic, extrusion force may be applied by using a movable apparatus and vertical elasticities between the teeth attached to the tooth. With this application, the reactive forces are aimed to be absorbed by the palatal mucosa under the acrylic instead of the adjacent teeth [50]. It is important to avoid anchoring from the neighboring teeth as much as possible in the treatment of a tooth affected by the intrusion. The use of conventional brackets and wire methods is not suitable in such cases, since the extent of the trauma that affected these teeth is unknown [50].

Success rate: early orthodontic extrusion prevents ankylosis [51].

- Immature teeth: If the intrusion and root end are not closed and the intrusion is too severe, it can be left to eruption or can be opened slightly by finger pressure. An orthodontic extrusion force is required if the intrusion is too severe or if the tooth does not start within 2–4 weeks [44].

- Replanted teeth: Most of the root resorption after replantation occurred within 1 year after the trauma. During this time, if there is no complication, the replanted tooth can be moved. Replanted and intrusive teeth show good prognosis in early recovery in 5 or 10 years after trauma and slow resorption can be seen [52].

- Ankylosis: In the adolescent growth phase, ankylosis causes the formation of an infraocclusion in the tooth. A metallic sound is detected in the ankylosis percussion by the absence of periodontal cavity. A clinically ankylosing tooth cannot be moved with orthodontic forces. Surgical luxation of the ankylosing tooth and leaving it for eruption or orthodontically extruding it is a successful method. In this technique, surgical luxation and ankylosing area are aimed to create connective tissue attachment and to move the tooth orthodontically [53]. Recently, good results have been reported in the case reports that the tooth was moved within a few weeks with the alveolar osteotomy and distraction osteogenesis of the ankylosing tooth [54–56]. Replanted avulse teeth often suffer from ankylosis. The root of the replanted tooth is gradually resorbed and replaced by bone. Ankylosis tooth growth in the developmental period does not follow the development of occlusion. In this phase, the tooth should be pulled, or the root should be left as space maintainer until it is resorbed [57]. When the alveolar growth is about to be completed, distraction osteogenesis and surgical block osteotomy can be performed to bring the tooth to the appropriate vertical position on the dental arch. The purpose of this method is to make the bone level suitable to facilitate subsequent prosthetic procedures. During this period, it should not be forgotten that the process of ankylosis continues [58, 59]. The progression of the infarction varies from individual to individual, depending on age, growth rate, and growth direction of the jaws. If the patient has a growth model, the infraposition is more severe. Severe infraposition, especially ankylosis with rapid alveolar growth,

occurs if it occurs between the ages of 10 and 12. In such cases, the ankylosing tooth should be removed after 2 to 3 weeks following diagnosis [45].

- Extraction of ankylosing incisors: Decoronation technique has been developed to prevent bone loss in the extraction of ankylosing teeth. The crown of the ankylosing tooth is removed, and the stem is left in the alveoli. In children, a new marginal bone is formed to resorb the coronal root. Thus, the height of the alveolar bone increases vertically and is also preserved faciolingually [60].

9. The effect of orthodontic tooth movements on traumatized teeth

- Pulp vitality: In a study, Brin et al. stated that, in traumatic teeth, there was mostly no response to vitality tests following orthodontic treatment. Since there are few studies on this subject, it is not yet clear whether orthodontic dental movements increase the risk of pulp necrosis in traumatic teeth [61].

- Root resorption: If 20% of the root surface is affected by ankylosis, a metallic sound can be detected in percussion [38]. This is the first indication that ankylosis has begun to occur. Ankylosis usually begins to form on the buccal and palatal surfaces in the first stage, so it cannot be observed in conventional radiographs for up to 1 year. Following an injury, a 4–5-month observation period was recommended before any orthodontic force was applied [62]. Linge et al. reported that after orthodontic treatment, 1.07 mm resorption was observed in trauma teeth and 0.64 mm in unstressed teeth [62]. In patients who had trauma and root resorption, periapical radiographs should be taken 6–9 months after starting orthodontic treatment. If minor root resorption is seen and if it is decided to continue treatment, a radiograph should be taken again after 3 months, and the prognosis of resorption should be examined. If severe root resorption is observed, treatment should be ceased for 3 months. In maxillary incisor teeth with severe root resorption, permanent tooth mobility has been reported in cases where root length is less than 9 mm or equal to 9 mm [64, 65].

9.1 Prognosis

In mild to moderate luxation injuries (such as confusion or subluxation) of the teeth, if the orthodontic treatment is performed carefully, the risk of root resorption is reduced. After severe luxation (extrusion, lateral luxation, intrusion, and replantation), it is more dangerous to move the tooth. Orthodontic treatment is important to assess the risk of root resorption 6 months after onset. If progressive resorption is observed at this stage, treatment may be interrupted for 3 months to reduce the risk of severe resorption [66].

In conclusion, the prognosis of the whole treatment can be summarized as follows;

1. The prognosis of the traumatized tooth is good, and the prognosis of malocclusion is good: Treatment procedures for malocclusion are the same as untreated teeth the treatment procedures [20].

2. Good prognosis of traumatic tooth but poor prognosis of malocclusion: Orthodontic treatment is complex. It requires a long treatment period, and there are serious anchorage problems. In order not to overload the traumatized tooth, sometimes limited therapeutic purposes should be considered [20].

3. Poor prognosis of traumatic tooth but good prognosis of malocclusion: Traumatic tooth must be extracted but may be left as a space maintainer until the start of orthodontic treatment. The prognosis of orthodontic treatment is good, and optimal results are obtained [67].

4. Malignancy of the traumatized tooth is poor, and the prognosis of malocclusion is poor: Traumatic tooth must be extracted but can sometimes be left as space maintainer. Depending on the patient's age, the treatment options may include the use of prosthesis, implant, or the autotransplantation of premolar teeth [68, 69]. Orthognathic treatments may also be a treatment option [20].

9.2 Retention

During treatment, closure or preservation of the space is decided according to the retention period. Retention plan can be divided into three groups: group with limited retention and partial permanent retention. The need for retention of patients who are traumatically injured and undergoing orthodontic treatment depends on many factors. The most important ones [20] are the elimination of the cause of malocclusion, appropriate occlusion, reconstruction and reorganization of soft tissues and bone around placed teeth, and correcting skeletal deviations during growth development period. The need for retention is limited if these goals are achieved.

10. Result

Dental injuries are considered an emergency in dentistry. Increased overjet reduction and the use of mouthguard are protective applications that reduce the risk of dental trauma. The knowledge of the physician is of paramount importance in cases of dental trauma that require urgent treatment, and the first treatment is extremely important on prognosis. In trauma cases, the prognosis of traumatized tooth with existing malocclusion should be evaluated. After the treatment of traumatized teeth, the teeth should be evaluated clinically and radiographically at the end of the observation period required for orthodontic treatment. Dental trauma is generally seen in individuals who continue to grow and develop, and orthodontic treatment, which is a conservative method in the treatment of traumatized teeth, is an ideal treatment option that meets the esthetic and functional needs of patients.

Author details

Sanaz Sadry
Department of Orthodontics, Dentistry Faculty of Istanbul Aydin University, Istanbul, Turkey

*Address all correspondence to: sanazsadry@aydin.edu.tr

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