



Orthodontic Considerations for Traumatized Permanent Teeth

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Authors' contributions

This work was carried out in collaboration between both authors. Author AR designed the study, author MJ wrote the protocol and wrote the first draft of the manuscript. Author AR managed the literature searches and both authors managed the experimental process. Both authors read and approved the final manuscript.

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ABSTRACT

Objectives: The aim of this article is to shed the light on the recommendations for orthodontic movement of traumatized teeth since traumatic dental injuries forms a challenge to the orthodontists worldwide. We tried to create a kind of treatment protocol in different kinds of traumas depending on available case reports and text books in this field.

Materials and Methods: Searching included dental text books and electronic searching (pubmed, medline, embase and central databases). Inclusion criteria were: Dental, oral and maxillofacial trauma oriented articles and text books.

Results: 56 articles and text books met the searching criteria.

Limitation: This article is basically depending on case reports. It is obvious that there is no clinical randomized studies in third field, because it depends on accidents and trauma, thus the reader will not find a discussion or a part in this article to compare between the different findings and opinions.

Conclusion: Generally, minor traumatic injuries require at least three months observation period before starting orthodontic movement. When the trauma is of greater severity at least six months

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observation period is needed as a minimum. Teeth with horizontal root fracture should be observed for one to two years before starting orthodontic movement. More research should be done in this field.

Clinical Significance: Dental traumatic injuries have a high prevalence worldwide, and it affects children, adolescents and adults. Since orthodontic tooth movement is principally a periodontal ligament phenomenon, the orthodontist should be able to deal with the periodontal ligament injuries that might happen before or during the course of orthodontic treatment.

Keywords: Dental traumatic injuries; crown fracture; luxation injuries; tooth splinting.

1. INTRODUCTION

Dental traumatic injuries has a high prevalence worldwide [1], and it affects children ,adolescents and adults. Traumatic dental injuries represents about 5% of all injuries. Boys are generally more affected than girls since they practice more in sports and contact games [2].

Some people are more affected than others due to the presence of certain risk factors that make them much more prone to dental traumatic injuries. These factors do include increased overjet; incompetent lips and short upper lip [3-10].

Usually the anterior teeth are the most affected with the central incisors being at the highest risk for developing dental trauma [11,12]. The maxillary arch is involved in a higher percentage of trauma cases (95.72%). Falling down is being the most common etiologic factor (67.34%).

About 33% of adults have experienced traumatic injury to the permanent dentition, with the majority of injuries occurring before age nineteen years [13]. In the permanent dentition, fracture of enamel and dentin without pulpal involvement (uncomplicated crown fracture) is most common (50.5%) [14]. Other forms of traumatic dental injuries (concussion, subluxation) are less common [15].

Since orthodontic tooth movement is principally a periodontal ligament phenomenon, the orthodontist should be able to deal with the periodontal ligament injuries that might happen before or during the course of orthodontic treatment.

The aim of this article is to shed the light on the recommendations for orthodontic movement of traumatized teeth since traumatic dental injuries forms a challenge to the orthodontists worldwide. For this reason, thorough diagnosis, treatment

planning and follow up are mandatory to assure a favorable orthodontic result.

2. ORTHODONTIC CONSIDERATIONS FOR DIFFERENT TRAUMA CATEGORIES

In the upcoming section, the authors will shed the light on the different trauma categories and the orthodontic considerations regarding each of them.

2.1 Crown Fracture

Crown fracture forms 26-76% of the dental injuries affecting the permanent dentition [16,17]. Whether the pulp is involved or not, it can be either a complicated (with pulpal involvement) or uncomplicated crown fracture (without pulpal involvement).

The most common form of traumatic dental injury affecting the permanent teeth is the uncomplicated crown fracture which happens in about 50.5% [14]. In this case, the fracture affects enamel or enamel and dentin (Fig. 1). Before starting or commencing orthodontic movement of such affected teeth, it is necessary to perform sensibility and radiographic examinations. If there is no complication in the first three months following the traumatic injury, orthodontic movement can be initiated, but if the orthodontist is in doubt, the observation period can be extended. For traumatized teeth with incomplete root development, it is recommended not to start orthodontic movement before the root development is regained [18].

In the case of complicated crown fracture, the pulp should be covered with pulp capping material in order to form a hard tissue barrier overlying the exposed pulp tissue. These teeth should not be moved orthodontically till the appearance of the hard tissue barrier overlying the exposed pulp tissue. This process requires at

least three months in order to be observed radiographically [18].



Fig. 1. Enamel dentin fracture [33]

Then clinical and radiographic tests should be taken after 6 months, one year and 2 years following the start of orthodontic treatment [18].

2.1.1 Crown-root fracture

It is defined as a fracture involving enamel, dentin and cementum. The pulp can be involved (complicated crown – root fracture) (Fig. 2) or not involved (uncomplicated crown – root fracture). It forms about 5% of permanent teeth injuries [19].



At the time of injury 10 years follow up

Fig. 2. Complicated crown root fracture [56]

Usually partial pulpectomy is needed in cases of complicated crown-root fracture, and orthodontic treatment should not be initiated till the hard tissue barrier has been formed over the exposed pulp, these needs three months to be seen on diagnostic radiographs. Likewise teeth with uncomplicated crown – root fractures have to be observed for at least three months before being moved orthodontically, if there is no complication orthodontic treatment can be started, if the

orthodontist is in doubt, the observation period can be extended.

In order to restore these teeth, the orthodontist should move the fracture line to a more supra-gingival position. Orthodontic extrusion for the apical fragment was introduced by Heithersay in 1973 [20]. Before extruding the tooth endodontic treatment should be performed for the root portion, and then rapid extrusion is performed aiming to move the fracture line coronally without moving the marginal bone coronally. This will minimize the need for marginal bone reshaping. 3-5 millimeters of extrusion can be gained within three to four weeks. Following the extrusion process, fibrotomy has to be performed in order to avoid any relapse. Following the fibrotomy, a three to four week retention period is recommended [18].

Regarding root resorption following orthodontic tooth extrusion of crown-root fractured teeth, clinical and histological studies have revealed a very rare occurrence [21-24].

3. CONCUSSION AND SUBLUXATION

Concussion injury can be defined as an injury to the tooth supporting structures with neither mobility nor displacement of the injured tooth. There is an edema or lacerations in the periodontal ligament. The tooth becomes tender to percussion without any gingival bleeding. Lee et al. [25,26] reported a 23% frequency for concussion injury. A three month observation period is needed prior to starting or continuing the already started orthodontic movement; this is to monitor any periodontal healing complication that might happen [27-29].

Subluxation can be defined as an injury to the tooth supporting structures that results in abnormal loosening within the socket. Lee et al. [25,26] reported 21% frequency for this form of tooth injury. Healing complications may occur in the form of repair-related resorption (surface resorption), infection-related resorption (inflammatory resorption), replacement-related resorption (ankylosis), marginal bone loss or tooth loss. Splinting of these teeth is not necessary unless there is multiple teeth injury [18]. Although the risk of periodontal healing complications is very minimal following this minor form of traumatic dental injury, a three month observation period is required before beginning or continuing orthodontic tooth movement [27-29].

3.1 Extrusion Luxation

According to Borum and Andreasen [26], extrusive luxation injury (partial displacement of the tooth out of its socket) affects about 7% of traumatized permanent teeth.

Soon following the injury, extruded teeth should be repositioned into the tooth socket and Stabilized for two weeks using a flexible splint. If the teeth are not repositioned at an early stage, periapical clot becomes organized and increases the difficulty of extruding the tooth [30].

A very high incidence of pulp necrosis was reported following this form of traumatic dental injury. Root canal treatment is indicated if the pulp of the affected tooth is necrotic [30,31]. In their study, Gorur et al. [32] evaluated the effect of low-level laser therapy on the pulp of traumatized permanent teeth with extrusive luxation, they concluded that the laser therapy may be considered as an alternative to endodontic therapy for teeth with more than two millimeters of extrusion luxation.

If the traumatized teeth were not repositioned soon following the trauma because the patient ignores the need for immediate treatment, periodontal complications in the form of reduced bony support and poor crown to root ratio will develop if orthodontic intrusion is carried out. This is enough to make applying orthodontic intrusive forces on these teeth a poor plan [33]. These teeth may benefit from other treatment alternative than orthodontically intruding them. One of the alternatives is reshaping of the elongated crowns of such extruded teeth. Another treatment option for these extruded teeth is intentional replantation, in this technique the extruded tooth is extracted and then reinserted within its own socket. Many reports have shown favorable treatment outcomes following intentional replantation. This technique is contraindicated if there is periodontal disease in the affected teeth [33-35].

If previously extruded teeth are to be moved orthodontically, at least three to six months observation period should pass before attempting orthodontic movement; in order to minimize any negative effects following the traumatic dental injury [27,28].

3.2 Intrusion Luxation

It is the type of traumatic injury that leads to displacement of the tooth deeper into the

alveolar bone, it frequently affects the maxillary front teeth and it is usually accompanied with fracture of the alveolar bone [36] (Fig. 3).



Fig. 3. Intrusion luxation

Intrusive luxation injury happens less frequently in the permanent dentition compared to the primary dentition. It is a severe form of injury that produces severe complications including pulp necrosis, inflammatory root resorption, replacement resorption and marginal bone loss [18].

Management of these traumatized teeth differs according to the root apex maturity. In case of intruded immature teeth, these teeth are given the chance to erupt spontaneously assuming the intrusion is not too much severe in nature [37-39]. The scenario is different in case of severe intrusive luxation or if the intruded immature tooth does not erupt by itself within the first two to four weeks.

Intruded mature teeth 100% will develop pulp necrosis [40]. This is why intruded mature teeth should be repositioned (even partially) within the first three weeks following intrusion to create an easy access for endodontic treatment to extirpate the necrotic pulp that may lead to external root resorption.

If the intrusion is severe and is accompanied by alveolar bone fracture, the intruded tooth can be surgically repositioned whereby the fractured labial bone plate is also repositioned into its original position.

Many authors tried to move ankylosed teeth (following intrusive luxation). Surgical luxation of ankylosed teeth has been tried as a method of breaking the ankylosis sites to allow orthodontic extrusion of the ankylosed teeth [41]. Turley et al. [42] found that the immediate application of

orthodontic force after luxation has resulted in tooth ankylosis in many cases. Takahashi et al. [43] concluded that orthodontic traction following surgical luxation of ankylosed teeth can be an effective approach which needs long-term monitoring of stability and periodontal health. They concluded also that the result of orthodontic repositioning might vary from case to case and cannot be predicted based on the clinical appearance or extent of tooth injury.

On the other hand, Bauss et al. [44] examined the effect of intrusive orthodontic forces on previously traumatized teeth and they found that traumatized maxillary incisors have a higher susceptibility to develop pulp necrosis following orthodontic intrusion (using utility archwire) compared to non traumatized incisors.

3.3 Avulsion and Replantation

Avulsion is the total displacement of the tooth from its socket. Luckily this type of traumatic injury occurs less frequently in permanent teeth (up to 3% only). The upper central incisors are the most affected teeth with this type of traumatic injury [45].

Replanted teeth may heal either with normal periodontal ligament, surface resorption, replacement resorption or with inflammatory resorption.

Except in some cases where the root is not completely formed, pulp necrosis is an end result following replantation [46]. Periodontal healing occurs more frequently in immature teeth than in mature teeth [47].

Although some clinical and experimental studies had shown that severe root resorption can result following orthodontic movement of previously avulsed and replanted teeth [48]. Stastny et al. [49] was able to move a replanted maxillary incisor successfully and without deleterious effects.

Following replantation, most root resorption occurs during the first year following replantation, so replanted teeth should be observed for at least one year before being moved orthodontically [50]. Boyd et al. [51] Kiriros et al. [52] had suggested longer observation period (1000 days) before starting orthodontic tooth movement of replanted teeth to insure no deleterious effects.

3.4 Horizontal Root Fracture

It is relatively uncommon type of traumatic dental injuries with a frequency of less than 1% among the affected permanent teeth [53].

Orthodontic management of root fractured teeth relies on two important factors: the site of fracture and the type of healing at the fracture site. Healing could happen via hard tissue formation, connective tissue formation or granulation tissue formation.

Healing with hard tissue means formation of dentin and cementum at the fracture site. This ensures normal tooth mobility since there is consolidation at the fracture site, these teeth can be moved orthodontically without separating the coronal and apical parts after an observation period of one to two years [18].

In their case report Hovland et al. [54], had successfully applied intrusive and palatal orthodontic forces on a maxillary central incisor with healed horizontal root fracture. The tooth was followed up clinically and radiographically for eight years, and all the radiographic and clinical tests have revealed that the apical and coronal fragments were moved together without any separation, and the tooth was symptom free and in normal occlusion.

Healy et al. [55] had successfully moved two maxillary central incisors with horizontal root fractures that healed with hard tissue after an observation period of two years. A five year follow up for the case revealed that there was no separation between the apical and coronal parts of the root with good consolidation.

Mendoza et al. [56], had observed an immature maxillary central incisor with a horizontal root fracture for two years, the root became completely formed, the pulp was vital, and the fracture line was healed. Then the tooth was subjected to orthodontic forces to treat angle class I malocclusion. Over 10 years of follow up, the tooth was totally free of any pulpal or periodontal problems.

Teeth healed with cementum and connective tissue, periodontal ligament at the fracture site, can be moved orthodontically after an observation period of two years but taking into consideration the separation between the apical and coronal parts of the root which results in a tooth with short root at the end of orthodontic

treatment. For this reason teeth with fracture in the apical third will have better periodontal support following orthodontic movement compared to teeth with horizontal root fracture in the middle third.

Teeth with horizontal root fractures that healed with granulation tissue are not good candidates for orthodontic movement [18].

4. CONCLUSION

Dental traumatic injuries have a high prevalence worldwide, and it affects children, adolescents and adults. Since orthodontic tooth movement is principally a periodontal ligament phenomenon, the orthodontist should be able to deal with the periodontal ligament injuries that might happen before or during the course of orthodontic treatment. Despite the limitations of this article and it depends mainly on case reports and thus the authors of these articles opinions are preponderant, generally, in minor traumatic injuries require at least three months observation period before starting orthodontic movement. When the trauma is of greater severity at least six months observation period is needed as a minimum. Teeth with horizontal root fracture should be observed for one to two years before starting orthodontic movement. More research should be done in this field.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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