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Late reposition of a lateral luxated maxillary incisor with an immature apex

CASE REPORT

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Abstract – Here we describe an unusual trauma case. A recently erupted permanent upper-right incisor sustained a lateral luxation when a 5-year-old girl on a playground climbing net dropped off, catching the right upper incisor in the net. The tooth was laterally luxated in vestibular direction, and no other signs of injury occurred. A dental practitioner could not reposition the bony locked tooth. Four days later, the girl came to our clinic, and we performed an incomplete repositioning of the tooth and made a flexible splint. Controls were made at 1, 6, and 12 weeks and at 6, 12, 18, and 24 months later. The 24-month follow-up clinical examination revealed the patient to be asymptomatic and the tooth to be completely functional, and the recall radiograph showed further apical root growth. The implications of a late incomplete reposition of laterally luxated permanent teeth with immature apices are discussed.

Introduction

Luxations in the permanent dentition most commonly involve one or more maxillary incisors and occur mainly between the ages of 7 and 12 years while these teeth are still in eruption with immature root apices (1–3). In preschool children dental injuries come to 18% of all injuries which need treatment (2). Amongst all facial injuries, dental injuries are the most common of which crown fractures and luxations occur most frequently (2).

Lateral luxations are rare events (1, 4) in which traumatic injuries displace the tooth but do not force it completely out of its socket. Lateral luxations often occur in teeth with immature root apices and can lead to bony lock of the injured tooth (5). These displaced teeth become fixated in their position and therefore immobile (Fig. 1). The bony lock results in a possibly more complicated tooth reposition.

Thus, an appropriate treatment plan after an injury is important for a good, long-term prognosis. According to treatment guidelines for luxation injuries (2), the injured tooth should be repositioned into its original location and stabilized with a flexible splint for 4 weeks. The pulpal condition should be monitored, and if the pulp becomes necrotic, a root canal treatment (with apexification) is indicated (2).

In still undeveloped teeth, pulpal revascularization usually occurs because of the widely open apical foramen (6). The long-term pulpal vitality of luxated teeth can be evaluated radiographically by assessment of further root growth and root canal obliteration and possibly by positive sensibility testing (4). Only in fully developed teeth does a continuous lack of response to sensibility testing indicate a pulp necrosis coming along with a periapical rarification and sometimes tooth discoloration. Andreasen et al. found for extruded and laterally luxated teeth that pulp necrosis is strongly dependent on the radiographic apical diameter of the immature root and the type of luxation injury. They identified probability values for necrosis in immature teeth with a lateral luxation between 78% (apical root diameter 1.0 mm) and 0% (apical root diameter greater than 3.1 mm) (6).

The following case report describes the lateral luxation of a right maxillary central incisor with incomplete root formation, an incomplete repositioning after a 4-day delay, and a 24-month follow-up with continuing root formation and persistent pulp sensibility.

Case report

A 5-year-old Caucasian female visited the Dental Clinic 1-Operative Dentistry and Periodontology in Erlangen, Germany, on August 2006, accompanied by her father. The recently erupted upper-right permanent incisor was laterally luxated in a labial direction and fixed in that displaced position (Figs 2 and 3). The traumatic injury had occurred 4 days previously. On the day of the injury, they had visited their family dentist for therapy, but he was unable to reposition the tooth because of its immobility. Because there were no other injuries, they waited four days before visiting the Dental Clinic.

The child's health history was non-contributory: she was not taking any medications and had no known drug allergies or systemic illness. Her tetanus immunization was current. Extra-oral examination showed no other injuries of the lip or nose. The injury occurred as a result

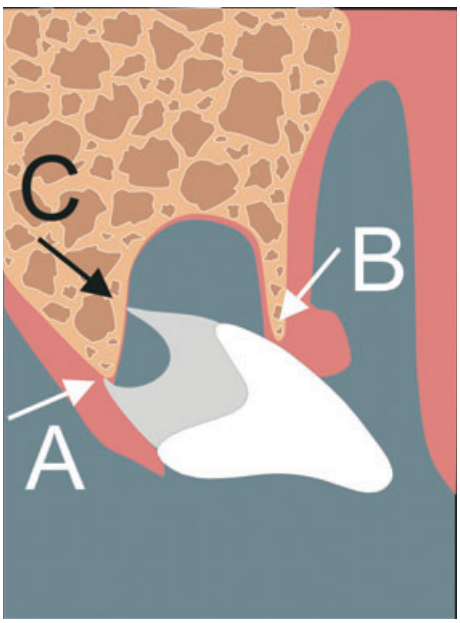

Fig. 1. Schematic drawing showing the mechanism of bony lock. Because of the lateral luxation in the labial direction, the root is in contact with the palatinal alveolar bone. The luxation of the palatinal root apex over the bone crest results in a locked position supported by three supporting points (arrows A–C). For removal of this bony lock, the tooth has to be moved in an anterior direction prior to rotating it back into its alveolar socket.

Fig. 2. Vestibular view at the first appointment in the Dental Clinic 1 in August 2006. The right upper permanent incisor was laterally luxated and labially dislocated. The surrounding gingiva was swollen and inflamed. The incisor on the left side was in eruption.

of a fall within a climbing net on a playground. The tooth was entangled in the net and was displaced in the labial direction during the fall. The clinical examination showed an immobile upper-right central incisor that could not been displaced by digital pressure (Figs 2 and 3). The tooth showed a positive reaction on testing with carbon dioxide snow. The left central incisor was erupting as well, mesially of a remnant carious primary front tooth. Thus, it could be assumed that the complete crown of the affected right tooth was displaced by the traumatic injury. The radiograph (Fig. 4) showed a

Fig. 3. Palatinal view at the first appointment. The incisor was labially dislocated to an almost 90° horizontal position.

permanent upper-right incisor with an incomplete root growth almost completely displaced out of its alveolar socket with a widely open apical foramen approximately 4 mm in diameter (Fig. 4). The upper-left incisor was the same size and in a comparable stage of root development. We assumed that both teeth erupted simultaneously. Because of the immobility, we suspected a bony lock of the apical end of the growing root with the palatinal alveolar bone crest (Figs 1 and 4).

The bony lock and the long period that had elapsed since the injury made it impossible to completely reposition the tooth with the immature apex in its original position. The father was informed about the possible risks of tooth repositioning, and a careful repositioning into a shallower socked was tried under local anesthesia.

The tooth was repositioned with forceps to elevate and disengage it from its bony lock and gently reset into an elongated straight position (Fig. 5). Because of the

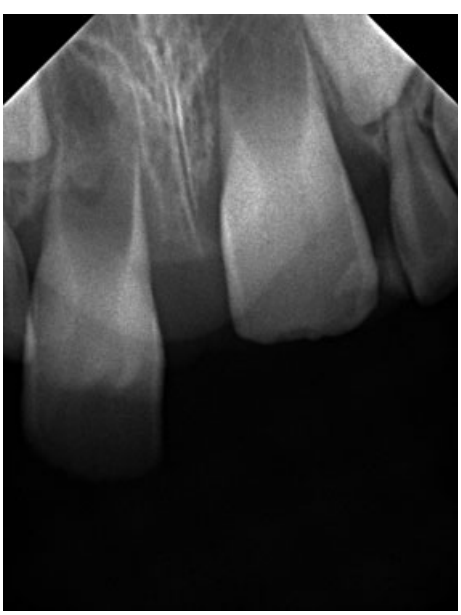

Fig. 4. Radiograph. The right permanent incisor was almost completely dislocated out of its alveolar socket. In combination with the lateral luxation, a bony lock resulted.

Fig. 5. Vestibular view 2 weeks after incomplete repositioning and fixation with a semi-rigid composite-wire splint. The vestibular enamel was not covered by gingival tissue, and the inflammation at the gingival margin slowly disappeared.

stabilization of the hematoma during the four days since the traumatic injury, it was not possible to reset the tooth into its original vertical position. The tooth was straightened and fixated in its elongated position for 4 weeks using a semi-rigid splint (Fig. 5). The splint was constructed from 0.7 mm round orthodontic wire and extended from the primary maxillary left lateral incisor to the primary maxillary right lateral incisor to hold the tooth in place while allowing stimulation of the periodontal ligament (PDL). Oral hygiene instructions were given, and the patient was scheduled for a follow-up appointment. The patient did not complain of postoperative symptoms.

At the second appointment 1 month later, the flexible splint was removed (Fig. 6). The left incisor continued eruption whereas the right incisor showed a stabilized periodontal condition without signs of inflammation. At the same time, the carious remnant of the left primary incisor was extracted. The repositioned tooth reacted sensitive to carbon dioxide snow, and we identified no striking features related to the elongated tooth position.

Fig. 6. Three months after the traumatic injury. The vestibular enamel was still uncovered with gingival tissue. The eruption status of the injured right incisor was only a little further along compared to the left incisor.

In November 2006, 3 months after the traumatic injury, the next control was made, and no changes in sensitivity or any tooth discoloration were identified (Fig. 6). In comparison to the left incisor, the dislocated and repositioned right incisor showed a slight extrusion without occlusal interference. The vestibular enamel of the crown was completely exposed whereas the enamel of the left incisor was still covered with gingival tissue. The traumatized tooth was asymptomatic and not discolored, and the gingiva around the tooth was healthy in appearance. The mobility of the tooth was not greater than class I. A radiograph showed apical healing around the repositioned tooth and further root development (Fig. 7).

On September 2008, the patient returned for a 24-month follow-up appointment. The traumatized tooth was without clinical symptoms. There was no percussion, palpation, or chewing tenderness, and no swelling was present. The surrounding gingiva appeared healthy (Fig. 8). The tooth was physiologically mobile, and there were no probing depths greater than 3 mm. A periapical radiograph showed complete apical healing of the repositioned tooth with a nearly mature apex in comparison to the neighboring left incisor (Fig. 9). In the apical third, a small radiopacity was present, possibly a first sign of pulpal obliteration. The patient was scheduled for further follow-up.

Discussion

The decision to reposition the lateral luxated and bony-locked permanent central incisor 4 days after the injury was based on the fact that the apex of the incisor was not mature and was widely open with an apical diameter of over 4 mm. In a study of 400 avulsed permanent incisors, Andreasen et al. found that 34% of all completely

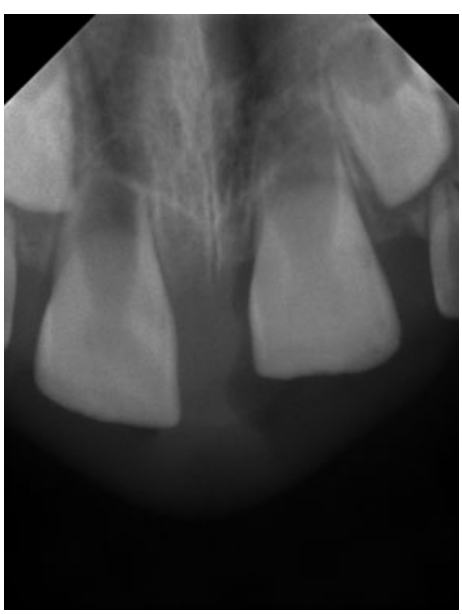

Fig. 7. Radiograph 3 months after the injury. No signs of apical inflammation could be observed. The injured tooth remained in its elongated position.

Fig. 8. At 24 months after the injury. The eruption status of both incisors was nearly identical. No differences in sensitivity or tooth color could be observed. The vestibular gingival recession persisted at the upper-right permanent incisor.

Fig. 9. Radiograph 24 months after the first visit. Root formation is still ongoing as a sign of vital pulp tissue. The radiopacity in the apical third may be the first sign of a root canal obliteration.

luxated and replanted teeth with immature apices achieved pulpal revascularization (7). In another study, for laterally luxated teeth, Andreasen et al. found a dependence of pulp necrosis on the apical diameter of the injured tooth. Apical diameters of more than 3 mm showed no pulp necrosis (6). Our case showed an apical foramen with a diameter of more than 4 mm. The theoretical chance of tooth repositioning and maintaining pulp vitality with further root development was very high shortly after the accident.

Knowledge is limited about the time window for a successful tooth reposition. Andreasen et al. showed that a delay of 24 h for repositioning had no significant influence on pulp vitality for intruded teeth (8). The general outcome is very dependent on the stage of root formation and the type of injury. Thus, pulpal and periodontal ligament healing complications are the most frequent in teeth with completed root formations (vs. incomplete root formation). Robertson et al. found that pulp necrosis is strongly dependent on root developmental status (9). No special data are published about a long delay (>48 h) for repositioning of laterally luxated and bony-locked teeth. Because of the bony lock, a localized ischemia may have been present by rupture of the pulpal neurovascular supply. In addition, a compression of the root surface PDL could occur cervically and a compression and laceration of the PDL apically (Fig. 1) (10). In the current case, the injured tooth was laterally luxated and remained in that labially displaced position for four days. Based on our findings and those of Andreasen et al., the tooth remained vital after the late reposition mainly because of the widely open apical foramen (11). The assumption that a long period of bony lock would have supported pulpal tissue damage could not be confirmed. The positive response to sensitivity testing with carbon dioxide snow at the first appointment in our clinic was a certain sign of pulpal vitality. This positive reaction was the main cause for the treatment decision of careful repositioning of the tooth into an elongated straight position.

The bony lock depends on the position of the luxated tooth to the surrounding alveolar bone. Fixations primarily occur on lateral luxated teeth with immature apices and seldom on lateral luxated teeth with mature apices with surrounding bone fractures. The direct bone–tooth contacts (Fig. 1A–C) lead to damage of the periodontal ligament cells and the root-forming tissue cells in those root areas. This damage would increase the risk for root resorption, ankylosis, and root development abnormities. Whether a delayed removal of the bony lock may influence those abnormalities is unknown.

The latest guidelines by Flores et al. (2007) are the basis for the management of luxation injuries for the majority of clinicians (2). Lateral luxation injuries should be managed by a combination of fracture reduction, splinting, clinical and radiographic observation and, when required, endodontic treatment or extraction. However, because of the high extent of dislocation of over 6 mm in the labial direction, the bony lock, and the long delay until reposition, the clinical procedure in this case was slightly altered. The basic assumption was that the injured apical tissues had already reorganized and therefore getting the tooth completely back into its original vertical position would be impossible. It would have been necessary instead to extract the tooth, to remove the organized tissues, and to put the tooth back into its original socket. This approach would have been an alternative treatment option with the disadvantage of an additional injury without improved prognosis. A second disadvantage of this option would have been the difficulty of splinting in the original tooth position. As a result of these disadvantages, we chose an incomplete reposition in an elongated position.

Thus, in this case, the bony lock was carefully removed by lifting the tooth with forceps in anterior

direction, rotating the crown in the oral direction and slowly putting the tooth in a straight elongated position. In this position, the tooth was splinted as recommended by the treatment guidelines. The results show that this procedure was successful although a problematic development would not be unexpected. The repositioned tooth should be held in place with a semi-rigid splint, for example made with a passive orthodontic wire (size 0.4–0.8 mm). Composite resin is a good luting material. This type of splint allows the stimulation of the PDL during healing and reduces the incidence of ankylosis. A splinting time of four weeks is generally recommended for lateral luxated teeth (2).

Strobl et al. showed that lateral luxations had less influence on the pulpal blood flow than other types of injury (12). The outcome of this clinical case may support these findings. When compared to other traumatic injuries, lateral luxations carry the best clinical prognosis for pulp vitality and tooth preservation (6, 12, 13). For example, Nikoui et al. (2003) showed that the survival and pathological outcomes for laterally luxated teeth are far better than those for other displacement injuries. Among the complications of lateral luxation, pulp necrosis is the most frequent, followed by external root resorption (14, 15). However, there is currently no preventive treatment for inflammatory root resorption that will produce predictable regeneration of functional PDL for the injured teeth (13). Until this problem is overcome, clinicians will have to be prepared for the eventual loss of a few teeth that have sustained lateral luxations and the prosthetic rehabilitation that will follow.

Long-term outcome depends on further development of the immature root and the vitality of the pulp tissue. In immature, developing teeth, revascularization can be confirmed radiographically by evidence of continued root formation and possibly by positive sensibility testing. In most of such cases a pulpal obliteration will occur (13). In fully formed teeth, a continued lack of response to sensibility testing indicates pulp necrosis, which may also be accompanied by periapical rarification and sometimes crown discoloration (15). A lateral luxated and repositioned tooth with an immature apex should be controlled closely as evidence of pulp necrosis and root resorption can be seen as early as 2–3 weeks post injury. At the first sign of apical pathosis, endodontic therapy should be initiated (2). At our last appointment, the radiograph showed a faster root development with an uncertain apical radiopacity, which might be the first sign of a beginning pulpal obliteration.

Conclusions

In many cases, a bony lock may hinder an easy repositioning of traumatically lateral luxated teeth. This case describes a lateral luxated tooth with an immature apex despite bony lock that remained vital after a four days delayed incomplete reposition, with continued root development. Lateral luxations with bony lock of immature teeth often have good prognoses because of the wide open apices of the immature roots. The treatment delay seems to have been of minor importance compared to the status of the root development.

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