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A combined approach with passive and active repositioning of a traumatically intruded immature permanent incisor

ABSTRACT

Background *Severe damage to the tooth, periodontal ligament, and pulpal tissue often occurs with intrusive luxation, and outcomes are quite unpredictable because of the variable ways in which the injury may occur, which influences both the choice of treatment and prognosis.*

Case report *This case presents a novel method for the management of an intruded permanent maxillary central incisor with an immature apex. At first, watchful waiting for spontaneous re-eruption was the chosen treatment option. A palatal gingivectomy was performed and endodontic access was established, following which, an intracanal medicament of calcium hydroxide was applied. A root canal treatment was completed, and apexification with mineral trioxide aggregate was performed. Re-eruption failed to reach completion, so complete repositioning was performed with the aid of orthodontics for two months.*

Conclusion *The present case illustrates the partial re-eruption of a severely intruded immature permanent tooth with the use of interim medication in the root canal. This case also shows complete re-eruption with the aid of timely orthodontic repositioning after apexification.*

Keywords *Immature permanent tooth; Intrusive luxation; Re-eruption; Trauma.*

Introduction

Intrusive luxation of permanent teeth is one of the most complicated and controversial dental injuries, and usually occurs in children aged 6–12 years [Andreasen et al., 2006b]. Pulpal necrosis, pulp canal obliteration, inflammatory root resorption, alveolar bone loss, and ankylosis related to resorption are all commonly reported complications. Therefore, a thorough knowledge of the stages of root canal development and the appropriate treatment options in immature teeth is very important for successful outcomes.

Adequate supporting data from clinical research is lacking, thus, there are differing opinions on what constitutes the best treatment for intrusion injuries [McTigue, 2013]. Therefore, managing intrusion injuries in immature permanent teeth can be challenging to the clinician. Treatment for this type of trauma can be performed actively, by repositioning (surgical or orthodontic extrusion), or passively, by waiting for spontaneous re-eruption. Given that infection is better controlled using endodontic therapy, it seems that spontaneous eruption results in the fewest complications in immature teeth, regardless of the degree of intrusion [AlKhalifa and AlAzemi, 2014].

Although some studies have reported re-eruption in intruded, immature permanent teeth [Faria et al., 2004; Chacko and Pradhan, 2014; Altun et al., 2009; Saroğlu et al., 2006], to our knowledge, few studies have described combined therapy with delayed orthodontic treatment (active repositioning) [Umesan et al., 2014]. Additionally, none of these studies reported a period of spontaneous re-eruption during endodontic treatment and apexification with MTA, followed by repositioning with orthodontics to complete the process. Current guidelines for the treatment of intrusive luxations are not based on strong evidence. Therefore, it is important to report the outcomes of different treatment strategies to improve the knowledge base and offer more evidence-based guidelines [Tsilingaridis et al., 2012]. Our case report describes the spontaneous re-eruption of an intruded maxillary central incisor with an immature apex, followed by orthodontic treatment.

Case Report

A 9-year-old girl was referred from a private dental clinic for treatment of a traumatised maxillary central incisor. The patient was reported to have fallen down at home one month prior. There was no history of

neurological complications, and her medical history was noncontributory. The right maxillary central incisor appeared to be fractured and intruded, with only 1 mm of the incisal edge clinically visible. A diagnostic periapical radiograph of the intruded tooth was taken (Fig. 1). The radiograph showed widening of the periodontal ligament space in relation to the adjacent left maxillary central incisor and full root formation with a half-closed apex [Andreasen et al., 2006b]. The upper central incisors did not respond to the electric pulp test or cold test. Depth of intrusion, measured from the mesial fractured incisal edge of the intruded tooth to the incisal edge of the adjacent central incisor, was 5.5 mm. According to the clinical and radiographic examination, the patient's condition was diagnosed as crown fracture and intrusive luxation of the right maxillary central incisor. Endodontic treatment was recommended but was not initiated on the first visit. To protect the exposed dentin from additional bacterial invasion, and to make a protective barrier for future endodontic treatment, a temporary restoration with light-cured glass ionomer cement (Fuji II LC, GC, Tokyo, Japan) was performed. At the initial visit, to help accelerate spontaneous re-eruption, a fibronectomy was performed on the labial side, and a gingivectomy was performed on the palatal side. Postoperatively, the patient was instructed to rinse her mouth twice a day with 0.1% chlorhexidine solution (Hexamedine, Bukwang Pharmaceuticals, Seoul, Korea) for five days. At the second visit, slight improvement in re-eruption of the right maxillary incisor was seen (Fig. 2). To attempt apexification and to prevent root resorption, the pulp chamber of the right central incisor was opened using a carbide bur after the tooth was isolated with a rubber dam, followed by irrigation with 2.5% sodium hypochlorite. The root canal was instrumented, dried with paper points, and filled with calcium hydroxide (Calcipex II, Nishika, Shimonoseki, Japan). On the third visit, two months after the initial visit, the calcium hydroxide was changed (Fig. 3). After two more weeks, a mineral trioxide aggregate (MTA) (ProRoot MTA, Dentsply Tulsa Dental Specialties, Tulsa, OK, USA) was mixed with sterile water following the manufacturer's instructions for apexification. Under a microscope, a MTA gun and a paper point were used to make the MTA condensation for the apical plug. The tooth was temporarily sealed with wet cotton and zinc oxide-eugenol. After 24 h, the canal was filled with gutta-percha and sealer (AH Plus; Dentsply DeTrey, Konstanz, Germany), and the tooth was restored with composite resin. Then, the patient returned for follow-up at regular intervals to assess for further spontaneous re-eruption. Over a five-month span, continuous improvement in re-eruption was seen. It showed 4-mm of re-eruption, which was compared and measured on clinical photos and subsequent radiographs based on the level of the fractured mesial incisal edge (Fig. 4). The tooth remained immobile, there was no external inflammatory root resorption, and the radiolucent image around the root apex decreased, indicating initial healing of the periapical lesion (Fig. 5). The patient returned monthly for three months to



FIG. 1 Periapical radiograph of the intruded permanent right maxillary central incisor obtained at the initial visit.



FIG. 2 Intraoral labial view of the intruded tooth one week after fibronectomy. Slight re-eruption of the right central incisor was verified clinically. The labially displaced tooth is also noted.



FIG. 3 Periapical radiograph taken after calcium hydroxide dressing of the right maxillary central incisor. Note the spontaneous re-eruption during the root canal treatment two months from the initial visit.



FIG. 4 Five-month follow-up intraoral view showing partial re-eruption of the permanent maxillary right central incisor and temporary resin restoration.

monitor the re-eruption process, and the tooth showed little additional re-eruption (< 1 mm). The tooth showed no more improvement in re-eruption at the nine-month follow up. At this time, the periradicular lamina dura appeared to be intact with a normal periodontal ligament (PDL) width, except in the periapical region. Because of this stasis in re-eruption, the patient was referred to the orthodontist for repositioning by extrusion. Forced eruption was performed with a 0.012 nickel-titanium wire and a mini-round tube-type bracket. In order to balance the gingival line with the neighboring teeth, the bracket on the intruded tooth was positioned more gingivally. During the forced eruption, the temporary incisal restoration was adjusted with a high-speed diamond bur. In order to compensate for possible relapse due to the rebound phenomenon, the tooth was over-extruded orthodontically by approximately 1 mm (Fig. 6). After aligning the gingival and incisor edge line appropriately, the patient underwent a retention period of 6 weeks (Fig. 7). To assess for any remaining radiolucency of the apical lamina dura of the repositioned tooth, the patient underwent periodic clinical and radiographic follow-ups on a long-term basis. A follow-up visit after 2-year revealed no signs of complications such as resorption or apical periodontitis (Fig. 8). Upon the patient's request, the fractured incisal part of the tooth was restored using composite resin (Fig. 9). Being the increased overjet and inadequate lip coverage as risk factors for upper incisor trauma [Fields and Christensen, 2013], the patient was also advised to be careful of additional trauma.



FIG. 5 Radiograph showing apexification and root canal filling with MTA and gutta-percha.



FIG. 6 Radiograph after orthodontic treatment for two months.



FIG. 7 Clinical appearance after orthodontic treatment for 2 months.



FIG. 8 Radiograph at 2-year follow-up.

Discussion

In intrusive luxation, many discrepancies exist in the available treatment recommendations. With these discrepancies, treatment of intrusive luxation is based on several factors. Among these factors, the stage of tooth development should be considered first. If the tooth is immature (incomplete root formation), it is suggested to monitor the tooth and wait for spontaneous re-eruption [Andreasen et al., 2006a]. In our patient, since the adjacent tooth had an open apex, we assumed that the intruded tooth would be at a similar developmental stage. In cases of moderate intrusion (3–6 mm) with an incomplete apex, teeth may re-erupt, or alternatively, these teeth may require orthodontic repositioning. Many investigators have suggested that intruded immature teeth do re-erupt spontaneously [Shapira et al., 1986]. Thus, in this case, we did not actively intervene, but we



FIG. 9 Intraoral view at 2-year follow-up.

followed the patient at regular intervals to monitor for spontaneous re-eruption.

Some authors have reported an accelerated re-eruption process following gingivectomy and root canal treatment with a calcium hydroxide-based material [Tronstad et al., 1986]. This accelerated re-eruption process has been attributed to the removal of eruption-obstructing gingival tissue. Additionally, access for endodontic treatment during spontaneous re-eruption can also be obtained by gingivectomy, even in cases of very deep intrusion [Neto et al., 2009]. Clinicians who opt to wait for passive repositioning of intruded teeth (between 3 and 6 mm) should ensure endodontic access in order to remove inflamed pulp and prevent the development of inflammatory root resorption. In the present case, even though the extent of gingivectomy was small, there was accelerated re-eruption once the gingivectomy on the palatal side was combined with the fibronectomy on the labial side.

Andreasen and Pedersen [1985] established a relationship between the stage of root development and the occurrence of pulpal necrosis after dental intrusion. They found the greatest risk to be teeth with fully completed root formation. They found that pulp necrosis was significantly associated with the diameter of the apical foramen (1.2 mm vs. 0.7 mm), and they found pulp necrosis in 63% of immature intruded permanent teeth. Another factor affecting the frequency of pulp necrosis is the severity of the intrusion. It was reported that the pulp tissue of severely intruded incisors had a lower survival rate [Humphrey et al., 2003]. Chaushu et al. [2004] also reported that 45.5% of moderately-intruded teeth with open apices remained vital after emergency orthodontic treatment, but all severely-intruded teeth lost viability by the end of the follow-up period. Considering the high risk of pulp loss and possible root resorption of severely-intruded permanent teeth with relatively small apical foramens as in our case, we decided to perform a root canal at the second visi, as soon as endodontic access was obtained after gingivectomy.

Luxation tends to damage the cemental protection of the root surfaces, allowing dentinal tubules to become pathways for bacterial toxins within the canal to trigger osteoclastic activity externally. Therefore, in the presence of inflammatory root resorption during the monitoring period, non-setting calcium hydroxide paste was applied to disinfect the dentinal tubules and was appropriately replaced in the canal until the resorption process was ceased. The intruded tooth remained completely asymptomatic at the follow-up visits, so MTA was then used as a filling material. Some authors [Oliveira et al., 2008; El Meligy and Avery, 2006] have suggested that using MTA avoids some of the drawbacks of using calcium hydroxide in the long-term [Andreasen et al., 2002]. Bakland et al. [2012] described the success of MTA in immature teeth with pulp necrosis to be related to two features: 1) MTA's extraordinary cementum and PDL-inducing potential, and 2) MTA's bacteria-tight sealing capacity when placed in the apical part of the root canal.

We successfully facilitated re-emergence of the tooth beyond 5 mm after re-eruption had been continued slowly for nine months in our case. However, complete gingival harmony was not achieved. Presumably, the intrusive trauma slightly dislodged the root of the right central incisor in the labial direction, and over time, the attached gingival line followed the labial re-eruption pattern of the crown, ending up higher than the left central incisor. In other words, re-eruption in the present case continued for a longer period of time than in other studies [Tsilingaridis et al., 2012; Andreasen et al., 2006a], but did not reach complete re-eruption. This incomplete re-eruption was probably due to several factors. For example, the givngival tissue was not removed for quite some time after the trauma, which can be an obstacle. In addition, the stage of root development and the pulpal state may also have contributed to incomplete re-eruption. Teeth with open apices, in contrast to teeth with partially closed apices, have shown the best prognosis for PDL healing [Al-Badri et al., 2002].

The timespan from the beginning of re-eruption to the completion of re-eruption is different depending on individual reports. For example, Faria et al. [2004] reported that spontaneous re-eruption started 15 days after root canal treatment. Meanwhile, several studies reported complete re-eruption in immature intruded permanent teeth in 6-10 months. However, these teeth were treated immediately after the trauma [Chacko and Pradhan, 2014] or were in younger patients with vital pulp tissue and open apices [Oliveira et al., 2008; Umesan et al., 2014; Saroğlu et al., 2006]. Altun et al. [2008] reported complete spontaneous re-eruption, but it was assumed that gingival disharmony remained. Moreover, the severity of the intrusion in these reports varied from mild to severe.

In the present case, orthodontic repositioning of the tooth was recommended when the tooth did not show any further signs of spontaneous re-eruption by nine months after treatment initiation. With timely orthodontic repositioning, full re-eruption was achieved within two months without space loss, which often occurs with migration into the space originally occupied by the intruded tooth [Neto et al., 2009]. Providing adequate spontaneous re-eruption time has some advantages, including relief of compression zones in the periradicular area and facilitation of healing by cemental deposition rather than ankylosis [Chaushu et al., 2004]. Furthermore, allowing for longer re-eruption times leads to shortened orthodontic treatment courses, and thus, less discomfort associated with the orthodontic devices. Altun et al. [2009] recommends orthodontic treatment at later stages, since the orthodontic forces could initiate root resorption.

Currently, the main question regarding dental trauma and orthodontic re-positioning relates to the optimal

timing for initiating orthodontic extrusion after the injury. Generally, orthodontic re-positioning after trauma is recommended to initiate within three weeks of the traumatic episode. However, to our knowledge, combined approaches with passive and active repositioning of a traumatically intruded immature permanent incisor have not been reported in many studies. Overall, the outcome of this case highlights the possibility to obtain full re-eruption of intruded immature permanent teeth using interim medications (calcium hydroxide) in the root canal, subsequent apexification, and timely orthodontic positioning at a later stage. This 2-year follow-up outcome shows that this combined approach does not negatively affect the prognosis.

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