A Novel Multidisciplinary Approach for the Treatment of an Intruded Immature Permanent Incisor

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Abstract

The optimal treatment for intruded permanent teeth has not yet been determined. The ideal treatment option is the one with the lowest probability of developing complications such as external root resorption and marginal bone loss. Each case should be considered individually, bearing in mind the severity of the intrusion, the stage of root development, and tooth mobility. Management of an intruded permanent tooth may consist of: (1) observation for spontaneous eruption; (2) surgical crown uncovering; (3) orthodontic extrusion (with or without prior luxation of the intruded tooth); (4) and partial surgical extrusion, immediately followed by orthodontic extrusion and surgical repositioning. The purpose of this article was to review the treatment options for intruded immature permanent incisors, and to present a new modality of an elective internal strengthening of the immature root weakened by external root resorption. A case of an intrusive luxation injury in a 7 1/2-year-old child and the resulting complications utilizing this technique is described. This is the first known report in the pediatric dentistry literature of performing an elective (preventive) internal strengthening of an immature root weakened by severe external inflammatory resorption. The child was followed for 5 years with an excellent clinical outcome. This technique should be considered for treatment of immature permanent teeth with thin cervical root dentin and external or internal root resorption due to trauma or caries. (*Pediatr Dent.* 2004;26:421-425)

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Dental trauma in children is a frequent event,[1] and may involve functional, esthetic, and orthodontic complications.[2,3] Proper management of dental trauma implies prompt diagnosis and treatment. A long-term follow-up is usually necessary.[2]

Intrusive luxation is defined as "displacement of the tooth, deeper into the alveolar bone."[2] It is not a common injury, comprising 3% of the dental injuries in the permanent dentition,[1] and it is more frequent in younger children than in adults.[2]

Pulp necrosis, external or internal root resorption, partial or total pulp canal obliteration, marginal bone loss, disturbance to the continued development of the root, and gingival recession are common complications following intrusive luxation.[4-6]

The optimal treatment for intruded permanent teeth has not yet been determined.[2] The ideal treatment option is the one with the lowest probability of developing problems such as external root resorption and marginal bone loss.[2] Each case should be considered individually, bearing in mind the severity of the intrusion and tooth mobility.[7,8]

Management of an intruded permanent tooth may consist of:

1. observation for spontaneous eruption;
2. surgical crown uncovering;
3. orthodontic extrusion (with or without prior luxation of the intruded tooth);
4. partial surgical extrusion—immediately followed by orthodontic extrusion and surgical repositioning.

Observation for spontaneous eruption is based on the empiric finding that intruded immature teeth frequently erupt spontaneously in a few months.[9,10] This conservative management spares the child from overtreatment and enables periodontal healing. If pulp necrosis is diagnosed

Figure 1. Intraoral view of the severely intruded left central maxillary incisor (tooth no. 9) 3 days after trauma. Notice the swelling of the gingiva around this tooth.

before re-eruption, however, endodontic access is not always achievable.[2] It was also suggested that delay in applying extrusive forces on the tooth might increase the likelihood of developing ankylosis in the intruded position.[7] The probability of a tooth deeply embedded in the bone to erupt spontaneously is minimal.[2,7] Therefore, observation for spontaneous eruption is recommended only in very mild intrusions.

Surgical crown uncovering was reported to accelerate the eruption of intruded teeth.[8,9] This approach is seldom recommended, as it may interfere with periodontal healing.[2] Partial surgical extrusion immediately followed by orthodontic extrusion is suggested in cases of total intrusion where there is not enough access for an orthodontic appliance.[2]

Surgical repositioning was first introduced by Skieler in 1960, and good results were reported with this technique.[11,12] It is inexpensive, and provides prompt solution for the management of teeth that are deeply embedded in the bone. Bone reduction is facilitated if alveolar bone fracture has occurred.[11,12] This technique, however, is rarely recommended due to the high rate of complications involved, including: (1) pulp necrosis; (2) external root resorption; (3) ankylosis; (4) marginal bone loss; (5) contamination; and (6) infection. In immature young teeth, there is also a risk of root fractures and iatrogenic exarticulation.[2,8]

Orthodontic extrusion with or without prior luxation of the intruded tooth is recommended in most cases, since it is believed to facilitate remodeling of the supporting tissues and provides an early endodontic access.[2,13]

The purpose of this article was to review the treatment options for an intruded immature permanent incisor. A case of an intrusive luxation injury in a 7 1/2-year-old child and the resulting complications is described. A new modality of an elective internal strengthening of an immature root weakened by external root resorption is introduced.

Case report

A healthy 7 1/2-year-old girl was referred to the Emergency Clinic of the Department of Pediatric Dentistry at the Hadassah School of Dental Medicine in Jerusalem. She had

Figure 2. Periapical radiograph of the intruded tooth 3 days post trauma showing the proximity of the fracture line to the pulp and the incomplete root development (stage 5, according to Moorees[14]).

fallen 3 days before, and the maxillary left central incisor (no. 9) was totally intruded. No previous dental trauma was reported, and there was no history of neurological complications. The medical history was noncontributory. Extraoral findings included: (1) enlarged bilateral submandibular glands; (2) incompetent lips; and (3) trapped lower lip.

Intraoral examination revealed (Figure 1) an early mixed dentition with enlarged overjet (8 mm) and Angle Class II Division 1 dental relations. The gingiva around tooth no. 9 was red and swollen. Teeth nos. 8 and 10 were sensitive to percussion, and tooth no. 9 was deeply intruded (the distance from the incisal edge of tooth no. 9 to that of tooth no. 8 was 6 mm) and slightly mobile, and had an uncomplicated deep crown fracture.

Radiographic examination included lateral extraoral and intraoral periapical views. The lateral radiograph did not reveal alveolar bone fracture or penetration of the root of tooth no. 9 into the floor of the nose. The periapical film (Figure 2) demonstrated that the crown fracture was close to the pulp, and root development was classified as stage 5 in accordance with Moorees et al.[14] The diagnosis was severe intrusion with concomitant uncomplicated crown fracture of tooth no. 9 and concussion of teeth nos. 8 and 10.

The immediate treatment consisted of: (1) oral hygiene instructions; (2) cleaning the teeth with chlorhexidine; and (3) soft diet for a week. It was decided to observe the tooth over the next week for signs of spontaneous re-eruption. As there was no sign of re-eruption 2 weeks later, orthodontic extrusion with a modified Hawley appliance was initiated. A week later, the child complained of pain and the tooth was tender to percussion, mobile, and grayish in color. A periapical radiograph revealed widening of the periodontal ligament (PDL). Pulp necrosis was suspected, and the diagnosis was confirmed by a test cavity. The pulp was extirpated, and the canal was debrided and filled with a calcium hydroxide paste (Calxyl, Co-Preparate, Dirmskin, Germany). Two weeks later, a follow-up periapical radiograph revealed severe external inflammatory root resorption and marginal bone breakdown (Figure 3). After 5 weeks of orthodontic extrusion, the tooth was retained in its position for 2 more weeks and restored with composite Z-100 and Single-Bond (both 3M Co., St. Paul, Minn) and an Odus celluloid crown (Odus Dental Ag. Dietikon, Zurich-Schweiz).

Six months following trauma, a periapical radiograph suggested that the apexification was completed. Following

clinical confirmation by an endodontic file, the canal was obturated by gutta percha (GC Dental Industrial Corp, Tokyo, Japan) and root canal sealer (AH-26).

Two months later, the final restoration was placed. The coronal third of the root canal was cleared of the gutta percha up to 3 mm under the cementoenamel junction (CEJ). Vitrebond (RMGIC-3M Vitrebond, 3M ESP, St. Paul, Minn) was applied to the gutta percha. The canal was etched with 37% phosphoric etching gel for 20 seconds, flushed with copious amounts of water for 20 seconds, and dried without desiccation. Single-Bond was applied and cured for 30 seconds. The canal was filled with composite Z-100, and a Luminex clear post was introduced into the canal. The composite was cured for 40 seconds, and the Luminex clear post (Dentatus USA Ltd, NY) was left in the canal. The crown was restored with composite Z-100, employing an Odus celluloid crown form.

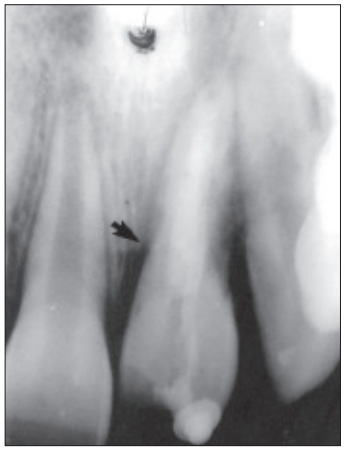

Figure 3. Radiograph of tooth no. 9, 2 weeks after debridement and filling with calcium hydroxide paste. Severe external inflammatory root resorption and marginal bone breakdown is evident (arrow).

After a year of uneventful follow-up, orthodontic forces could be initiated. Light forces were applied to tooth no. 9, with 6-month clinical and radiographic follow-up visits.

Until the orthodontic treatment was completed, the child was at high risk for new trauma, since she had an enlarged overjet.[15] Recurrent trauma is frequent in children who were reported to have had dental trauma in the past.[16] The child was encouraged to use a mouthguard to decrease the possibility of new dental trauma.

After 5 years of follow-up, the authors reported excellent results. Tooth no. 9 is now functional and, for the past year, is undergoing orthodontic treatment with no adverse reaction (Figures 4 and 5).

Discussion

The selected treatment option in the present case was orthodontic extrusion of tooth no. 9. The following factors influenced this decision:

1. depth of intrusion;[7,8]
2. stage of root development;[9]
3. presence and extent of crown fracture;[2,17]
4. tooth mobility;[7,8]
5. absence of alveolar bone fracture,[2] minimizing the chance for further complications;[2]
6. the time elapsed since the trauma;[2,18]
7. the child's and parents' compliance and motivation.[11]

The possible late complications after severe intrusion are:

Figure 4. Clinical appearance of tooth no. 9, 5 years after restoration, showing acceptable esthetics and function.

1. cervical root fracture;
2. external cervical inflammatory root resorption;
3. ankylosis;
4. internal resorption;
5. recurrent trauma;
6. external root resorption following orthodontic treatment.

Cervical root fracture following endodontic treatment is by far the most frequent complication.[19,20] As a rule, cervical root fracture is the consequence of light forces and thin dentinal walls around the root cervix.[19] Resin restoration may increase the tooth's resistance to fracture even in a tooth that had root canal treatment.[21] The application of modern bonding systems may strengthen the tooth to a level resembling an intact tooth.[22] The Luminex post system enables resin to cure inside the root canal to a depth of 11 mm.[23] This technique has improved tooth resistance to horizontal and vertical fractures in vitro when compared to a control.[24,25]

The use of the Luminex post system seemed to be the appropriate way of improving the prognosis of the immature tooth no. 9, which was compromised by severe external resorption. The lightest shade of composite was chosen to improve the curing depth and to contrast the dentin's yellow color.[2]

The clear post was left inside the canal, as opposed to filling the whole canal with composite or metal post, for several reasons:

1. Filling the canal with composite might affect the quality of the condensation and compromise the curing in the canal's deeper parts.
2. Curing composite in bulk might increase polymerization shrinkage and, consequently, increase

Figure 5. Five years postoperative radiograph of the completed restoration showing the Luminex post in position and a normal radiographic appearance.

the shearing forces on the root walls and marginal leakage.

3. The use of a clear post enables good adaptation of the composite to the root dentin and composite curing.
4. If a traumatic fracture occurs when the whole canal is filled with composite, the site of fracture is not clear. An in vitro study demonstrated that when a Luminex metal post was used, the resistance of the tooth to fracture was higher than when the clear post (plastic) was left in the canal. As the fracture occurred in a more apical level, however, tooth restoration was impossible.[24]
5. The use of the clear post enables easy access to the root canal, in case it is necessary to redo the root filling.
6. The mechanical properties of a root canal filled only with composite may be inferior to those of a canal filled with flexible Luminex clear post.

Internal resorption is a rare complication—it may even occur in root canal-treated teeth through connection between the PDL and accessory canals.[2] The etching of the internal root was found to clear the smear layer and decrease marginal leakage.[26] Thickening the internal root walls via composite reduces the risk of this complication by improving the root seal.

From the present report, a question may arise: would it have been wiser to prophylactically extirpate the pulp earlier? This could have prevented the severe inflammatory resorption and improved the tooth's long-term prognosis. Based on the literature review[2-4,7,8,17,27,28] and the author's experience, the authors suggest that observation may be the only realistic option, and it may be justified to await revascularization if and when:

1. intrusion is less than 2 to 3 mm;
2. there is no crown fracture or a small crown fracture is present;
3. root development is less than or equal to stage 5, according to Moorrees;[14]
4. there is no alternative endodontic way of treating the tooth (stage 4 or less, according to Moorrees[14]).

Survival of a tooth after intrusion is dependent on the root development stage and on the severity of trauma.[2,27] Revascularization can provide root development continuation and root dentin apposition, leading to a better prognosis than prophylactic extirpation of the pulp. Otherwise, as in the present case when there was only a minimal opportunity for revascularization, the authors recommend prophylactic extirpation of the pulp as early as possible.

The main reason for the pulp necrosis in the present case could have been the severity of the trauma, since there is a high rate of pulp necrosis even in those cases with no orthodontic intervention.[5] The possibility that orthodontic extrusion has interfered with revascularization and contributed to the development of pulp necrosis, however, cannot be ruled out.

Conclusions

The present case presents some of the severe complications that may be a consequence of intrusion of an immature permanent incisor. This is the first known report in the pediatric dentistry literature of performing an elective internal strengthening of an immature root weakened by severe external inflammatory root resorption. The child was followed-up for 5 years with an excellent clinical outcome. The authors suggest considering this technique for the treatment of young permanent teeth with thin cervical root dentin due to immaturity, external or internal root resorption, trauma, or caries.

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Abstract of the Scientific Literature

Effectiveness in Correcting Class II Malocclusion With a Fixed Twin-block Appliance

Compliance is critical to successfully treat a removable functional appliance. To increase patient's cooperation, several traditional removable appliances have been modified and transformed to fixed therapy. This prospective cohort study evaluated the effectiveness of a fixed twin-block appliance in 32 children with Class II Division I malocclusion over a 2-year period. Assessment of the study casts and cephalometric radiographs indicated that the modified clip-on twin-block appliance is an effective and rapid method of treating Class II malocclusion. A substantially improved treatment completion rate was observed.

Comments: The authors demonstrated an increase of patient's compliance rate and treatment success with slight modification of a functional appliance. Techniques on appliance fabrication and placement were meticulously described in the materials and methods section. An apparent strength of this clinical investigation was the prospective nature of the study. **BL**

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Read MJF, Deacon S, O'Brien K. A prospective cohort study of a clip-on fixed functional appliance. *Am J Orthod Dentofacial Orthop.* 2004;125:444-449.

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