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The diagnostic and treatment challenges associated with traumatized intruded permanent incisors: A case report

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Intrusions are considered among the most severe forms of dental trauma and are associated with severe late complications. Usually general dental practitioners are the first to see and treat these children. The present case describes the challenges associated with the diagnosis and treatment of late complications of complete intruded maxillary incisors accompanied by profound buccal displacement in an 8-year-old patient. The treatments performed included root-canal treatment of right central incisor using mineral trioxide aggregate (MTA) and a combination of surgical and orthodontic repositioning of the intruded left incisor. Clinical and radiographic examinations at 2 years' follow-up revealed intact lamina dura and no sign of ankylosis in both incisors, apexogenesis of the right central incisor, and positive response to pulp testing of the left central incisor. The present report emphasizes the need to follow a child with severe dental injury and to consult with trained specialists when needed. *(Quintessence Int 2015;46:309–315; doi: 10.3290/j.qi.a33401)*

Key words: inflammatory resorption, intrusion, splint, surgical orthodontic retraction, traumatic injury

Severely traumatized teeth are usually associated with various complications that develop during the follow-up periods. Some cases necessitate immediate intervention in order to improve the prognosis of the traumatized tooth, especially in young children.

Intrusion injuries are considered among the most severe forms of dental trauma with a reported incidence varying between 0.3% and 3% of all dental injuries.[1-3] These injured teeth have a tendency for pulpal necrosis, rapid inflammatory root resorption (IRR), tooth ankylosis associated with replacement root resorption, and loss of marginal bone support.[1] The four common treatment options for intruded teeth are: a "watchful waiting" approach to permit passive re-eruption; orthodontic extrusion; surgical repositioning; or a combination of surgical and orthodontic treatments.[3-6] However, the ideal treatment option for a traumatically intruded immature incisor remains controversial.

The International Association of Dental Traumatology (IADT) recommends considering the type of treatment for intrusion luxations on an individual basis, with regards to the intrusion's severity, stage of root development, and types of complication occurring during the follow-up period.[4] Accordingly, immature teeth

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Fig 1a Panoramic radiograph performed immediately after the injury (16 August 2012).



Fig 1b Occlusal oblique radiograph of incisors immediately after injury (16 August 2012).



Fig 1c Clinical view of the anterior teeth immediately after receiving first aid in Germany (16 August 2012).

with an intrusion of over 7 mm (severe intrusion) should be immediately surgically or orthodontically repositioned.[4-6] This would allow early endodontic access and may also minimize the risk of ankylosis and/or IRR.

When IRR is diagnosed, immediate endodontic intervention is required, especially when the intruded tooth is immature with thin root-walls, in which the course of the resorption is extremely rapid. Prolonged endodontic treatment with calcium hydroxide increases the risk for cervical crown fracture following additional traumatic injury, especially in immature teeth.[7] Therefore, a root canal treatment and creation of an artificial mineral trioxide aggregate (MTA) apical stop followed by composite reinforcement of the root is the preferred treatment.[8]

Another important aspect that should be taken into consideration is the major psychologic impact of the dental injury on both the parents and the young child. Apart from the pain and discomfort due to the injury, the child's changed appearance may make him a target for ridicule from other children. It was previously shown in the literature[8-10] that the four most common physical features leading to teasing and harassment among children are teeth, hair, weight, and height. Accordingly, dentists must not avoid treating a tooth even when the prognosis seems to be compromised. In a young child, the presence of a tooth, even for a short period of time, can significantly improve his quality of life.

The aim of the present report is to describe the diagnostic and treatment challenges and cooperation between multidisciplinary dentists associated with restoration of a young child's smile after complete intrusive luxation of his permanent maxillary immature incisors.

CASE PRESENTATION

An 8-year-old Caucasian boy was admitted to a private pediatric dental clinic (on 2 September 2012) following a severe dental injury which occurred 2 weeks earlier at a waterpark in Germany, on 16 August 2012. Immediately following the injury, the child was referred to a local hospital and diagnosed with complete intrusion of his maxillary permanent central incisors associated with lip laceration (Fig 1). The emergency treatment consisted of suturing the gingival margins and oral antibiotic treatment (oral phenoxymethylpenicillin).

Extraoral examination performed on 2 September 2012 was unremarkable. A clinical intraoral examination revealed an early mixed dentition. The maxillary right central incisor was associated with uncomplicated crown fracture and was re-erupting buccally (with 2 mm of the crowns' incisal edge exposed). The left central incisor was still in complete intrusion. The associated gingiva was edematous and sensitive. According to the father, the maxillary lateral incisors had not yet erupted at the time of the dental injury. Periapical radiographs revealed intrusion of maxillary right and left central permanent incisors accompanied by crown fractures. Both incisors were immature with partially developed roots. The mesial surface of the maxillary right incisor root appeared serrated with suspicion of

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Fig 2a Periapical radiographs taken 2 weeks after the injury (2 September 2012).



Fig 2b Clinical view of the anterior teeth 4 weeks after the injury (24 September 2012) showing absorption of the gingival edema surrounding the maxillary left incisor and exposure of about 1 mm of its incisal edge.



Fig 2c Periapical radiograph taken 4 weeks after the first appointment and 7 weeks after the injury. Notice progressive resorption of the apical half at the mesial aspect of the root of the maxillary right incisor.

IRR (Fig 2a). Radiographic absence of the typical diffused bone resorption, adjacent to the absorbed serrated root surface, was interpreted by the fact that the IRR initially developed at the buccal aspect of the root, since the tooth was dislocated buccally. Therefore, the incisal edge of the right incisor was covered by glass ionomer and the child was referred to an endodontic specialist for initiation of root canal treatment. The patient was instructed to maintain meticulous oral hygiene by brushing twice a day with a soft toothbrush, and was invited for follow-up after 2 weeks.

The clinical examination performed at 2 weeks' follow-up (24 September 2012) revealed absorption of the gingival edema surrounding the maxillary left incisor and exposure of about 1 mm of the incisal edge (Fig 2b). A percussion test, performed to clarify whether the exposure of the incisal edge resulted from tooth eruption or from absorption of the gingival edema, produced a metallic sound. Therefore, the incisal edge was covered by glass ionomer and the child was referred to an oral surgeon for a partial surgical repositioning.

According to the father, the endodontic specialist performed an additional periapical radiograph and decided to take a "watchful waiting" approach, delaying the root canal treatment. The endodontic specialist claimed that endodontic treatment to the right central incisor will result in loss of the tooth, and the only chance to preserve the tooth is to speculate on spontaneous revascularization, and he invited the child for a follow-up after 1 month.

On 1 October 2012, the oral surgeon performed partial repositioning of the maxillary left central incisor, and the child was immediately referred to the pediatric dentist who performed a flexible splint with a 0.7-mm orthodontic wire. Since the maxillary left and right lateral incisors had not yet erupted, and the maxillary right central incisor was dislocated apically and buccally, the repositioned tooth was splinted only to the maxillary left primary canine and left primary first molar. Two weeks later, the splint was removed, and the maxillary left central incisor regained normal percussion sound but with rotation of the crown to the left side. Radiographically, the lamina dura appeared intact with normal width of the periodontal ligament (PDL) and without evidence of root resorption. Four weeks after the first appointment (3 October 2012), an additional periapical radiograph of the maxillary central incisors (Fig 2c) revealed progressive resorption of the apical half at the mesial aspect of the root, but without the typical diffuse radiolucency in the adjacent alveolar bone resorption. Nevertheless, the endodontic specialist decided to continue follow-up without any interven-

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Fig 2d Periapical radiograph taken 1 month after root canal initiation with calcium hydroxide, showing cessation of the inflammatory root resorption.

Fig 2e Periapical radiograph taken immediately after root canal obturation and reinforcement.

tion. The father consulted with the pediatric dentist, who disagreed and recommended immediate intervention to treat the existing IRR process, thus referring the parents to receive a second opinion from another enododontic specialist, who agreed to perform immediate endodontic treatment at the recommendation of the pediatric dentist. The pulp was extirpated, the root canal was irrigated with 2.5% hypochlorite, dried with paper points (Maillefer), and dressed with diluted calcium hydroxide 1 mm short of the working length (17 mm) (UltraCalXS, Ultradent), followed by a glass-ionomer temporary filling (eouiaFil, GC Corporation). Microscopic evaluation of the root canal revealed resorption at the buccal wall of the root confirmed by examination with a paper point that consistently came out with a red spot when it touched the buccal surface.

The periapical radiograph taken at 1 month follow-up (7 November 2012) showed cessation of the IRR (Fig 2d).

Radiographs taken on 1 May 2013 showed partial resorption of the calcium hydroxide at the mid-root level. No treatment was performed at that time. The next follow-up (25 August 2013) revealed no sign of ankylosis; the radiograph revealed total disappearance of the calcium hydroxide. The tooth was reopened and an apical stop was felt; the endodontic specialist performed an apical root canal filling using MTA. The root canal was obturated by a 3-mm apical plaque of MTA (ProRootMTA, Maillefer). The root was further reinforced with a fiber post and luting cement (D T Light-Post and DUO-LINK, Bisco) (Fig 2e). Following the endodontic treatment, the maxillary right central incisor underwent discoloration.

On 21 March 2013, orthodontic treatment was commenced for final repositioning of the maxillary right (following ectopic re-eruption) and left central incisors (following partial surgical repositioning) and for improving the esthetic appearance by applying gentle force via the self-ligation approach. Bands were inserted on maxillary permanent first molars and bondable brackets (Forestadent) were inserted onto maxillary central incisors, primary canines, and molars, and on the lateral incisors as soon as they erupted. The orthodontic treatment continued for 9 months (Fig 3).

A fixed orthodontic retainer was applied at the palatal surface of the permanent central incisors for retention and for preventing relapse of the rotated left central incisor. However, the gingival margin of the maxillary right incisor remained apically positioned as compared to the left incisors (Fig 3d). During and immediately after the orthodontic treatment, the left incisor showed normal response to electrical and percussion tests. When the prognosis of the teeth improved, simultaneously to orthodontic debonding, a decision was made to replace the temporary composite restorations of the maxillary incisors to more esthetic ones.

Clinical examinations performed at 2 years' follow-up (8 September 2014) revealed stable results: both

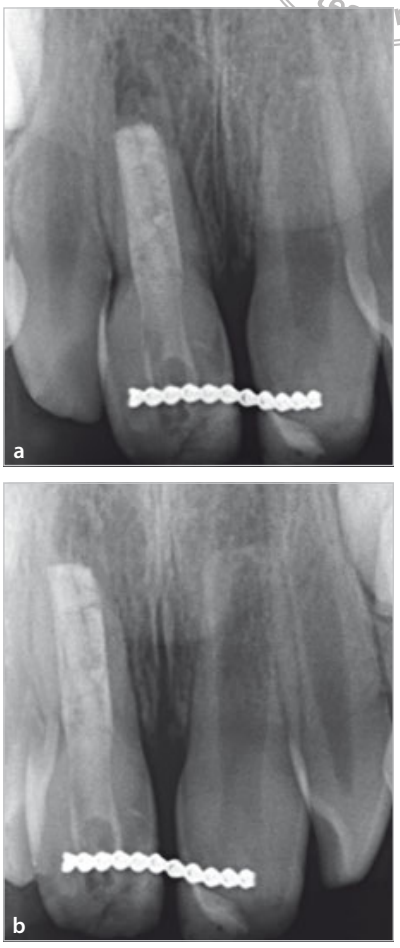
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Figs 3a and 3b *(a)* Occlusal and *(b)* anterior views before the orthodontic treatment.



Figs 3c and 3d *(a)* Occlusal and *(b)* anterior views after the orthodontic treatment.



Figs 4a and 4b Periapical radiographs taken 2 years after the traumatic injury (8 September 2014), showing stable results with normal marginal bone height and apexogenesis of the right central incisor.

incisors were at their original position with normal mobility and normal proximal marginal bone height. Radiographically, no signs of ankylosis or continued root resorption were observed (Fig 4). The left central incisor underwent apexification and responded positively to pulp testing.

DISCUSSION

Spontaneous re-eruption of a traumatically intruded immature permanent tooth is more likely if the degree of intrusion is mild.[11-17] If passive-eruption fails to occur within 3 weeks after the trauma, orthodontic extrusion is recommended.[4,15-16]

In the present case, the left intruded central incisor did not erupt 3 weeks after injury. However, orthodontic traction could not be carried out, since the intrusion was complete. Therefore, it was decided to combine partial surgical repositioning followed by orthodontic repositioning, to advance the development of the marginal bone as much as possible.[9,17,18] Nevertheless, it should be emphasized that the optimal treatment in this case would have been at least partial repositioning of the intruded teeth on the day of the traumatic injury.[4] This course of action should have been taken in order to relieve the compressive forces on the periodontal ligament cells, to create a distance between the root surface and the contused bone socket to favor

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cemental healing instead of ankylosis, and to enable immediate access to the pulp chamber in the case of development of IRR.[5,16-18]

Despite the delay in the repositioning of the tooth, at follow up 2 years later, the clinical and radiographic outcomes of the treatments were favorable as confirmed by the continuous root development, the intact lamina dura, normal marginal bone height, and no evident signs of active resorption.

According to Oulis et al,[3] the splint should include, in addition to the injured teeth, one or two extra teeth on each side, to form a multiple semi-rigid splint unit. In the present case, adjacent teeth to the right side were not available for splinting; therefore the tooth was splinted only to the adjacent teeth on the left side. Consequently, the extruded tooth was rotated to the left.

Pulpal necrosis occurs in a significantly large number of intrusive luxations ranging from 57% to 89% of the teeth.[1,5,14,17,18] These luxations are also associated with damage to the cementum; therefore, they are at high risk for developing IRR. Since the course of IRR is very rapid, endodontic treatment should be initiated almost immediately. The early intervention by endodontic treatment is even more crucial when treating immature teeth, in which the dentinal root walls are thin, the dentinal tubules are wide, and the basal metabolic rate is high. In the present case, disagreement existed regarding the nature of the root resorption diagnosed radiographically. The differential diagnosis included surface resorption, replacement resorption, and transient periapical breakdown. Surface resorption and periapical breakdown usually occur after mild to moderate traumatic injuries, and in most cases the surface root resorption lacunae are superficial and are confined to the cementum.[5] The incidence of transient periapical breakdown is relatively low (4.2%) and was reported exclusively in teeth with fully developed roots and closed or almost closed apices. Moreover, no case of transient non-infected apical breakdown has been reported following severe intrusive luxation.[19,20] Replacement root resorption can usually be diagnosed clinically by a percussion test after 4 to 8 weeks, whereas radiographic evidence of root resorption usually requires a year.[5,21] Moreover, clinically the ankylosed tooth is immobile, and the high percussion tone clearly differs from adjacent non-injured teeth.[5] In the present case, IRR of the maxillary right incisor was diagnosed 2 weeks after the dental injury, and 1 month later the resorption had increased significantly. The tooth was immature with thin walls and open apex, with normal mobility and normal percussion sound. In this case, regardless of the unclear diagnosis, root canal treatment should have been performed immediately, since postponing the intervention could have risked resorption of the entire root. Moreover, it should be taken into consideration that resorption can initiate at the buccal or palatal surface which cannot be detected by periapical radiography, at least in the first stage of the disease. Indeed, cone beam computed tomography (CBCT) could have assisted in the diagnosis; however, exposing a young child to such radiation is questionable. Therefore, in cases of uncertain diagnosis, the pros of intervention (ie, stopping the rapid inflammatory process that may result in severe root resorption and tooth loss) surpass the cons (performing unnecessary root canal treatment), and thus should be taken into consideration.

The role of the general practitioner in treating children with severely traumatized teeth is significant since about half of these patients are initially referred to a general dental practice.[22] Sherwood[23] found that although many general dental practitioners were able to detect severe periapical pathology, most of them missed more subtle radiographic findings of periapical changes and external root resorption, while none detected PDL width changes and lamina dura changes. These results are in accordance with Cinar et al,[24] who concluded that both specialized and general practitioners have a low level of knowledge regarding traumatic dental injury treatment protocols, and there is a need to improve their knowledge.[24]

Since both accurate diagnosis and undelayed treatment of traumatized dental injury depend largely upon correct interpretation of the radiographs, clinicians must be trained to identify normal anatomical landmarks as well as variations owing to pathology in a

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radiograph. Complicated cases should be consulted with well-trained authorities in dental traumatology.

CONCLUSION

In cases of lateral luxations, root resorption may start to develop at the buccal or palatal surface, consequently altering the typical radiographic appearance of the pathology. Treatment of severe traumatic injuries is complicated and requires involvement of many dental disciplines. The case presented demonstrates the importance of accurate radiographic diagnosis to improve the prognosis of a compromised tooth, and the benefit of a multidisciplinary approach. The pediatric dentist managed the case by referring the patient to skillful specialists, including an endodontic specialist, an oral surgeon, and an orthodontist, all of whom collaborated, contributing their own field to restore the lost smile of a young boy.

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