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Multidisciplinary trauma management: a case report

CASE REPORT

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Abstract – This case report documents the dental management of two permanent maxillary central incisors with a severe intrusive labial luxation injury in conjunction with one complicated and one uncomplicated crown fracture. Additionally, there was a fracture of the labial cortical plate which remained attached to the overlying soft tissue. The two affected teeth and fractured labial plate of bone were surgically repositioned and splinted. Endodontic therapy was completed on the two incisors and the two crown fragments, which had been maintained wet, were re-attached. The report describes a multidisciplinary approach to trauma management and case progress over a 20-month period.

Intrusive injuries to permanent teeth are rare and represent only 0.3–2% of traumas involving the permanent dentition. The majority of them are associated with either enamel or enamel–dentin crown fractures (1–3). The most common age group for intrusion injuries is 6–12 years of age and boys are more commonly affected. Injury that exerts an axial-labial force often displaces the tooth in an axial-labial direction and may result in fracture of the labial plate of bone and injury to the periodontium.

Intrusions associated with crown fractures that involve the dentin result in more frequent pulp necrosis of the injured tooth (4). It is suggested that this finding is related to bacterial penetration into the pulp through the dentinal tubules (4). A more mature root or one with a closed apex is at greater risk of developing pulp necrosis when compared to immature teeth with open apices (4).

Treatment of intruded teeth usually includes one of three options: (i) apply no immediate repositioning pressure and permit the tooth to spontaneously re-erupt, (ii) surgically reposition the tooth and splint it or, (iii) use orthodontics to gradually return the tooth to its original position. There appears to be no consensus as to which procedure is most successful (5–9). However, a history of previous intrusions of the affected tooth, root development, and the extent and severity of displacement may influence treatment choice. Andreasen et al. (10) reported that non-repositioned teeth had an overall better chance of avoiding pulp necrosis, root resorption, and marginal periodontal bone loss. Healing was not affected by the type of splint utilized (flexible, semi-rigid or rigid) or splinting time when the affected tooth was surgically repositioned.

After a severe traumatic injury to the periodontal ligament, replacement root resorption may occur as a consequence of the absence of vital periodontal ligament cells on the root surface. Replacement root resorption, or ankylosis, is a process in which dental tissue is replaced by bone. In children and adolescents, negative sequelae of ankylosis include tooth infra-positioning, tilting of adjacent teeth, and arrested horizontal growth of the alveolar bone. Treatment options for replacement root resorption include surgical extraction or decoronation of the affected tooth (11–13).

Management of replacement root resorption is complicated by the limitations of two dimensional conventional radiology to diagnose the extent of the resorption. This makes it difficult to develop an appropriate

endodontic treatment plan. Furthermore, clinical signs of ankylosis may not present until it has progressed to an advanced stage. However, the development of cone beam computed tomography (CBCT) now allows for three dimensional visualization of the root surface. Identification of the extent and location of replacement root resorption aids in diagnosis and suitable, timely treatment planning (12, 14).

Re-attachment of fractured coronal tooth fragments following trauma may provide the best esthetic result. Techniques utilizing bonding agents and composite overcontouring around the fracture line and the use of an internal dentinal groove prior to composite resin placement and bonding are equally successful (15). It is important for bond strength that the coronal fragments be adequately wetted for 24 h prior to bonding to the remaining tooth structure (16, 17).

We report a case that includes intruded, labially luxated permanent maxillary incisors with a labial cortical bone fracture and both uncomplicated and complicated crown fractures. Treatment was documented over a 20 months period that includes periodontics, radiology, endodontics and restorative care.

Case report

A 12-year-old white female sustained significant dento-alveolar and oral soft tissue trauma at approximately 3:00 pm after falling face forward on a school stadium bleacher. Initial triage was completed at a local community hospital and an IV was started to minimize the potential for dehydration and to provide an avenue for drug administration if necessary. After an initial neurological examination was completed, the patient was transported to the University of North Carolina Hospitals emergency department for management of the injury. The oral and maxillofacial surgery resident on-call was the first dental responder. His clinical and radiographic examination ruled out nasal or maxillary fractures. The patient had no history of medical concerns and no known drug allergies were reported; her tetanus status was current. Pediatric dentistry was consulted to manage the dento–alveolar trauma at approximately midnight of the same day.

An oral examination supported by both panoramic and periapical radiographs confirmed that there was significant dental trauma and a suspected maxillary labial plate fracture (Fig. 1). Clinical, radiographic and physical assessment of the injured site revealed no evidence of foreign body embedment. The patient's upper lip was swollen and soft tissue lacerations extended from the vestibule to the lip but did not cross the vermillion border (Fig. 2).

The permanent maxillary central incisors had a severe intrusive-labial displacement and the maxillary right lateral incisor was subluxated. Both central incisors had complete root development with closed apices. The right central incisor had sustained an uncomplicated crown fracture and the left central incisor had a complicated crown fracture. The crown fragments had been placed in Hank's Balanced Salt Solution (HBSS, Save-A-Tooth®; Phoenix-Lazerus, Inc., Shartlesville, PA, USA) by the referring community hospital staff immediately following the accident and were in the parent's possession. The use of HBSS was not necessary since the tooth fragments did not have viable cells, but did meet the need to keep the fragments wet.

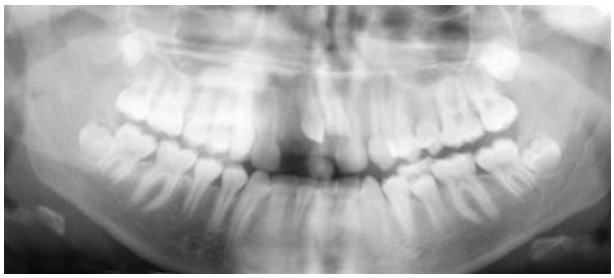

Fig. 1. Panoramic radiograph revealed severely intruded permanent maxillary central incisors. No evidence of nasal or maxillary bone fractures.

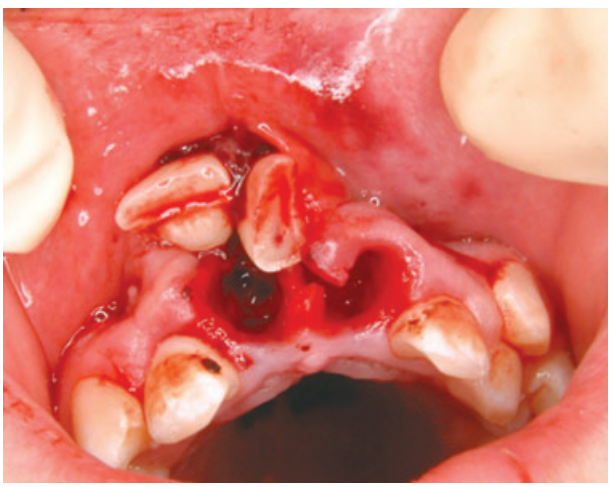

Fig. 2. The two maxillary central incisors were intruded and labially displaced following trauma.

Description of treatment

Initial

Following medical clearance, three angled radiographs (18, 19) and a panoramic radiograph were obtained to rule out root and jaw fractures. Five and one-fourth milliliters of 2% lidocaine with 1:100 000 epinephrine was infiltrated around the injured area. The teeth, soft tissue and bone were irrigated with sterile saline for 5 min to remove blood clots and improve visual assessment of the bony architecture. Surgically repositioning of the teeth was chosen over orthodontic tooth movement due to the severity of the injury including suspected alveolar labial bone fracture and it provided a more favorable esthetic result. The maxillary central incisors were gently ex-articulated and immediately repositioned into their sockets. The fractured labial cortical plate, which was still attached to soft tissue, was repositioned

and sutured into place using seven 3-0 chromic sutures. A flexible monofilament splint was placed from the maxillary right primary cuspid to the maxillary left primary cuspid and secured with flowable composite resin to each tooth (20) (Fig. 3). A postoperative periapical radiograph was obtained to document tooth repositioning (Fig. 4). Postoperative instructions and prescriptions for penicillin-K (250 mg q 6 h × 10 days), hydrocodone and acetaminophen (2.5 mg/500 mg q 4–6 h po prn pain), and 2% chlorhexidine oral rinse were given to the patient. Postoperative instructions included the need to maintain meticulous oral hygiene and remain on a soft diet. A return appointment was made for 10 days later.

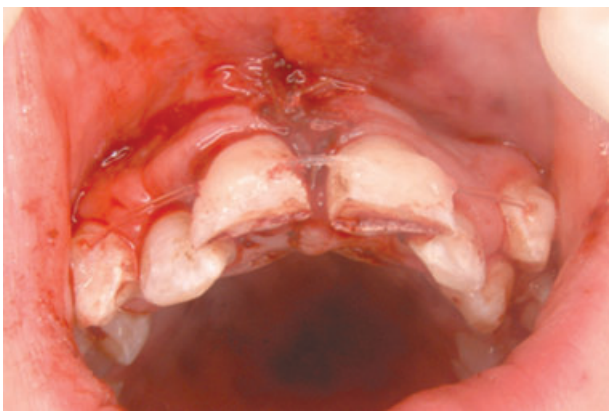

Fig. 3. The central incisors have been surgically repositioned, soft tissue and attached labial bone approximated and a flexible monofilament splint placed.

Postoperative appointment #1 (10 days post-trauma)

The remaining sutures were removed but the splint was left to support the repositioned cortical plate and because the teeth still exhibited mobility. The traumatized teeth tested positive for cold but the maxillary left central incisor did not respond to an electric pulp test. However, the electric pulp test is not as reliable an indicator of pulp vitality as a cold test in young teeth immediately following a traumatic dental injury (21, 22). Both maxillary central incisors were positive for percussion sensitivity and degree two (1.5 mm) mobility was present. A periapical radiograph revealed a widened periodontal ligament around the two traumatized teeth and the maxillary left central incisor was slightly extruded either due to formation of a periapical blood clot, inflammation or because it had not originally been fully repositioned in its socket or a combination of all variables (Fig. 5). Periodontal pocket depths ranged from 3–10 mm around the teeth. A total of 2.7 ml of 2% lidocaine with 1:100 000 epinephrine was administered

Fig. 4. Periapical radiograph showed central incisors reimplanted into their sockets.

Fig. 5. Periapical radiograph ten days post-trauma showed a widened periodontal ligament and slight coronal displacement of the left central incisor from its socket.

and gross pulpal debridement of the two central incisors was completed under rubber dam isolation since revascularization was unlikely due to the severity of the periodontal injury and because both incisors had closed root apices (23, 24). The root canals were instrumented, irrigated with sodium hypochlorite, filled with a mixture of calcium hydroxide and chlorhexidine slurry and sealed with a reinforced zinc oxide and eugenol cement (IRM®, The LD Caulk Division, Dentsply International Inc., Milford, DE, USA). The importance of remaining on a soft diet, meticulous oral hygiene and rinsing with the chlorhexidine oral rinse was re-emphasized.

Postoperative appointment #2 (23 days post-trauma)

The soft tissue had healed well with no evidence of inflammation. There was no purulent exudate or other clinical evidence of infection around the affected teeth. Under rubber dam isolation, the root canals of the maxillary central incisors were further instrumented, irrigated with sodium hypochlorite, and again filled with the calcium hydroxide and chlorhexidine slurry and sealed with reinforced zinc oxide and eugenol. The gutta percha root canal fill was not completed at this time in order to avoid potential displacement of the healing bone fracture and periodontium.

Postoperative appointment #3 (33 days post-trauma)

There continued to be no evidence of inflammation or exudate from around the traumatized central incisors. Periodontal pocket depths were 3 mm or less, and the teeth were not percussion sensitive. The gingiva bled slightly upon probing because of the patient's failure to maintain ideal oral hygiene. A consult from a periodontist was obtained relative to maintenance of the splint. It was recommended that the splint be maintained for three months to support healing of the repositioned labial plate of bone. Also, re-attachment of the coronal tooth fragments or restoration of the teeth with composite resin at this time was not recommended secondary to possible displacement of the healing bone and periodontium. Under rubber dam isolation, the root canal therapy on the maxillary incisors was completed and a reinforced zinc oxide and eugenol interim restoration was placed (Fig. 6).

Postoperative appointment #4 (37 days post-trauma)

The decision was made to re-attach the tooth fragments rather than restoring with the lost tooth structure with composite resin. The maxillary central incisor fragments fit the remaining tooth structure well and the fragments had been maintained in a moist media. Following splint detachment, the interim restorations were removed and the endodontic accesses were restored with etched and bonded composite resins. Stained dentin on the tooth fragments was removed with a small round bur and a light enamel bevel was placed on both the remaining tooth structure and coronal fragments with a diamond bur. The tooth fragments were bonded to remaining tooth structure using a flowable composite resin under rubber dam isolation. A faint line of restorative material was visible where the tooth fragments and tooth structure bonded together (Fig. 7). A nickel–titanium splint was attached with flowable composite resin from the maxillary right primary cuspid to the maxillary left primary cuspid as previously recommended by the periodontist.

Postoperative appointment #5 (96 days post-trauma)

A periapical radiograph showed no evidence of pathology and the periodontal probings around the affected teeth were < 2 mm (Fig. 8). There was no percussion sensitivity, no abnormal mobility of the teeth and the surrounding soft tissue appeared to be within normal

Fig. 7. The two coronal root fragments were re-attached to the remaining tooth structure.

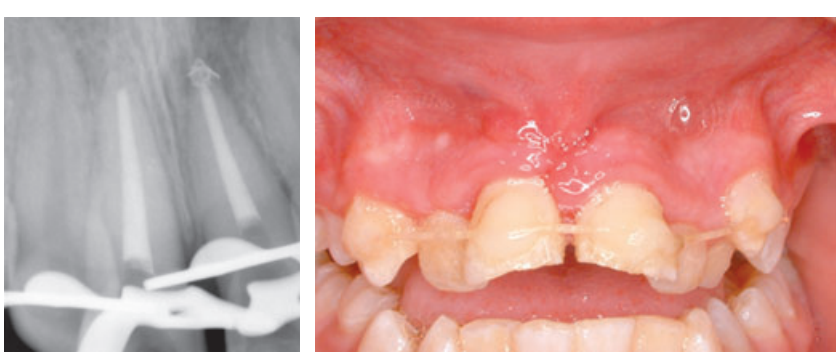

Fig. 6. Root canal therapy was completed on the two central incisors. The splint was still in place.

Fig. 8. A periapical radiograph 96 days post-trauma revealed no pathology.

Fig. 9. A periapical radiograph at 1 year/243 days post-trauma showed evidence of root surface irregularity at the junction of the middle and apical thirds of the right central incisor.

limits. The splint had been dislodged the previous day. It was not replaced because there was no more than normal physiologic mobility of the teeth and three months had passed since the initial injury.

Postoperative appointment #6 (20 months post-trauma)

The patient remained asymptomatic. A periapical radiograph showed no evidence of periapical pathology. There was some evidence of irregularity on the root surface of the maxillary right central incisor at the junction of the middle and apical thirds (Fig. 9). Upon percussion, the right central incisor exhibited a high-pitched resonance; it had decreased physiologic mobility. This tooth appeared to be more apically positioned than the maxillary left central incisor. The evidence suggested that the maxillary right central incisor was ankylosed. Tomographic evaluation was recommended to reassess the labial bone as it had been fractured at the time of the original trauma and to confirm the diagnosis of ankylosis.

The NewTom 3G Dental CT scanner (QR-MIM s.r.l. Verona, Italy) was used to acquire images 360 degrees around the patient, from which axial slices were reconstructed with a slice thickness of 1 mm (25). Subsequently, cross-sectional and panoramic images with a variety of slice thicknesses were generated. The most relevant images were selected and placed in the patient's record.

The cortical contours were well defined. Cortical bone overlying the roots of the maxillary central incisors was extremely thin and indistinguishable from the root surfaces in the apical half of the roots. A well defined 1–2 mm defect was visible at the distal lingual aspect of the mid-root area of the maxillary right central incisor; this was consistent with postavulsion replacement root resorption (Fig. 10).

The case was reviewed and the recommendation to decoronate the right maxillary central incisor and place a transitional prosthetic appliance was discussed with the parent. An implant and permanent replacement would be necessary following completion of growth in the patient. The parent wished to delay making this decision and stated that she would contact us if the decision was to go forward with this recommendation.

Discussion

Pediatric dentistry was consulted for initial trauma management and a treatment plan was implemented to surgically reposition the two central incisors and cortical plate of bone with placement of a flexible monofilament splint. The left central incisor has remained asymptomatic during the 20 months follow-up period. Regular periodontal examination showed evidence of healing and probing depths that were all within normal limits. The CBCT scan confirmed the presence of thin cortical bone over the root. Surgical repositioning was successful in preserving the teeth and surrounding alveolar bone.

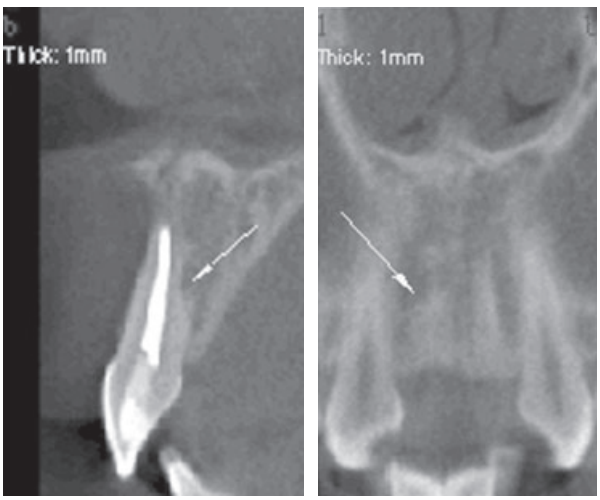

Fig. 10. Tomogram images revealed a thin labial bony plate. A resorption defect was noted on the distal lingual of the right central incisor root.

The right central incisor developed replacement root resorption. This diagnosis was established with the development of infra-positioning, a metallic sound upon percussion and confirmed with a CBCT scan of the area. Mild infra-positioning ($<1/8$th of the crown height of the neighboring tooth) should be monitored regularly if ankylosis develops during the adolescent growth spurt. No active treatment is required as long as the adjacent teeth do not tilt and the extent of the infra-position is mild or stable. Decoronation is recommended when infra-positioning is moderate ($\geq 1/8$th but $<1/4$th of neighboring crown height) (26). Determination of the degree of infra-positioning of the right central incisor was complicated because the left central incisor had also been traumatized and became slightly extruded after initial surgical repositioning. However, in addition to preserving natural esthetics, re-attachment of the patient's coronal tooth fragments aided in the diagnosis of ankylosis by the infra-occlusion evident after restoring the original crown height dimensions of the teeth.

Because the right central incisor demonstrated a moderate degree of infra-positioning, the recommendation of decoronation was made to the patient. Extraction of the tooth would cause a bony defect and compromise delivery of optimal prosthetic treatment. On the other hand, decoronation requires elevation of a full-thickness muco-periosteal flap, subcrestal crown removal, and leaving the root to be replaced by bone. Any pre-existing root canal filling material is removed and bleeding is instigated to promote root replacement with bone from the internal portion of the tooth. The benefits of this procedure include maintaining existing bone and adjacent horizontal bone levels as well as enabling vertical bone growth to help optimize the outcome for possible future implant placement [11].

Emdogain® (Institut Straumann AG, Basel, Switzerland) is a resorbable gel containing amelogenin proteins derived from developing porcine embryonal dental enamel (27, 28). It has been shown to enhance cell proliferation and protein production. Clinically, Emdogain® is used to promote regeneration of periodontal ligament, acellular cementum and alveolar bone following periodontal surgery (29–31). The value of Emdogain® in the treatment of avulsed permanent incisors has been investigated (32, 33). These studies have focused on avulsed teeth that have had dry time exceeding 15 min. Although the periodontal ligament was not regenerated, none of the replanted teeth exhibited inflammatory root resorption.

The clinicians of this case report did not have access to Emdogain® at the time. In addition to the intrusive-labial displacement, the teeth had sustained crown fractures and there was a fractured labial plate which may have compromised the potential for success in our treatment. There was virtually no time outside of the mouth as the surgically ex-articulated teeth were immediately replaced back into their sockets. Although the periodontal ligament cells on both the tooth and socket were traumatized, they had remained within their damaged sockets. Whether the use of Emdogain® would have improved the results is debatable. There is no compelling evidence to suggest that the results would have been different if the intruded teeth had been repositioned orthodontically rather than surgically.

Therefore, an outcome of ankylosis toward the end of growth after a traumatic dental injury is not necessarily a negative treatment result. Managing the initial intrusive luxation injury with surgical repositioning of the central incisors helped maintain esthetics, conserved the alveolar bone, and preserved the option of future decoronation for the patient. In the long term, preventing a bony ridge defect is paramount in managing anterior tooth trauma in a growing patient. Although the incisor may ultimately be lost, preservation of bone is critical for a good future prosthetic outcome.

Conclusion

The most severe forms of luxation/intrusions yield the poorest prognosis and require very complex treatment. There is no consensus on the optimal treatment approach. Surgical repositioning of teeth has been opposed by some because it may increase the risk of replacement root resorption, but studies have not supported that concern (26). Root resorption appears to be most related to the time interval from injury to repositioning (34). In this case the teeth were repositioned surgically and were replanted almost immediately. The initial extensive damage to the periodontal ligament at the time of injury may have influenced the outcome.

The key factor in the successful management of this complex dental trauma was care by multiple specialty disciplines in a coordinated effort. One of the two intruded and surgically repositioned teeth became ankylosed but treatment was successful in retaining both teeth in the arch, preserving esthetics, maintaining alveolar bone and permitting additional physiologic maturation. The patient was lost to recall just short of two years post-trauma.

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