Pulp Revascularization after Repositioning of Impacted Incisor with a Dilacerated Root and a Detached Apex

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Abstract

Severely impacted and dilacerated incisors are rarely considered for surgical exposure because they may not respond favorably to orthodontic extrusion. These incisors are often extracted, resulting in the need for tooth replacement; however, prosthetic solutions are limited in growing patients. Transalveolar autotransplantation of an impacted incisor may be the only method to preserve the natural tooth and maintain the shape of the alveolus. The severely impacted upper central incisor (#9) with a developing root was diagnosed in a 9-year-old girl. The unfavorable tooth position and dilaceration of its root made orthodontic extrusion of the impacted incisor impossible. Initial orthodontic space opening at the recipient site was performed before the surgery. Transalveolar transplantation of the impacted incisor to its normal position was performed to avoid tooth extraction. The incisor was later aligned using fixed orthodontic appliances. The 5-year follow-up, the transplanted incisor presented features that were typical of a revascularized tooth (ie, obliteration of root canal but a positive response to vitality tests). Healthy periodontal tissues and continued root development were also noted. However, the root apex, which separated from the transplant at the time of the surgery, continued formation in its initial position. Transalveolar transplantation of an unfavorably impacted upper central incisor with a dilacerated root is a successful treatment, which stands the test of time. The early stage of root development allowed revascularization of the tooth despite dilaceration of the root and detachment of its apex. (J Endod 2015;41:974–979)

Key Words

Central incisor, impacted tooth, revascularization, root dilaceration, tooth autotransplantation

The incidence of impaction of upper central incisors was reported to be 0.06%–0.2%. Most impacted central incisors have crown or root dilacertaions (1). Steward (2) reported that more than 70% of dilacerated incisors had a developmental etiology, 22% could result from trauma, and <10% were accompanied by supernumerary teeth or follicular cysts. Topouzelis et al (3) considered dilacerations of upper central incisors as a direct result of damage from traumatized primary incisors. However, Andreasen et al (1) stated that most of the root angulations of impacted incisors are not directly related to trauma but rather the change of their eruption path because of the presence of an obstacle.

Systematic studies (2) and literature reviews (3, 4) describing the management of impacted central incisors with dilacerated roots are very rare. Available treatment options include removal of an obstruction (ie, odontomas [5] or supernumerary teeth [6]), surgical exposure followed by orthodontic traction (7–12), tooth extraction (13), or seldom transalveolar transplantation usually followed with root canal treatment (surgical uprighting) (14–16).

In the present report, we have described a viable treatment option for a severely impacted, dilacerated upper central incisor in a growing patient. The main objective of the treatment was to perform early autotransplantation of the impacted incisor before completion of its root development to promote pulp revascularization. This aimed to preserve the tooth vitality and additionally the functional and esthetic integrity of the dental arch in a young child.

Case Report

A 9-year-old girl with a missing upper left central incisor and negative overjet attended an orthodontic consultation in July 2008. The panoramic radiograph revealed impaction of tooth #9. The long axis of the crown was tilted mesially and labially about 150° (Fig. 1A). The developing root of the impacted incisor (#9) was located palatally to the root of the left lateral incisor (#10) and deflected in a labial dilaceration. The patient had a history of trauma to the deciduous incisors at the age of 6 years. An unsuccessful attempt of orthodontic extrusion of the impacted incisor had been performed a year earlier. The alternative treatment plan included space opening at the site of the impacted incisor and transalveolar autotransplantation (surgical uprighting) of the developing impacted incisor to its normal position.

Two months after bonding of fixed orthodontic appliances, the patient experienced further trauma at the swimming pool and hit her upper right central incisor (#8) against the floor. The patient and parents considered the accident insignificant because of the presence of an intact crown and the absence of tooth displacement. For that reason, they did not report this episode to a dentist or the orthodontist providing treatment.
It took 12 months before the surgery to provide adequate width for performing the transalveolar transplantation. During orthodontic treatment, no spontaneous eruption or change in the position of the impacted tooth (#9) was observed. Additionally, a lack of further root development and apex completion of the contralateral right central incisor (#8) was noted before the surgery (Fig. 1B). Tooth #8 did not respond to the electric and thermal pulp tests. Only at the presurgical examination did the patient's parents confirm the second trauma, and tooth #8 was identified as nonvital. Complete debridement of the pulp chamber and root canal was performed followed by temporary filling with calcium hydroxide. It was decided to complete the root canal treatment of tooth #8 after the transplantation of the impacted left incisor (#9).

Surgical Procedure

Surgery was performed under general anesthesia in November 2009. A midcrestal incision was made within the keratinized gingiva at the edentulous ridge, which corresponded to the impacted incisor’s area. This incision extended to intrasulcular incisions along the vestibular side of teeth #8 and #9. A full-thickness flap was then raised labially to gain access to the impaction site (Fig. 2A and B). The labial cortical plate was carefully removed using surgical burs and elevators to avoid any damage to the periodontal ligament and the developing root of the impacted incisor (Fig. 2C). Tooth #9 was gently removed from its initial position using forceps applied only to its crown. Great effort was made to avoid any damage whatsoever to the periodontal ligament and the root cementum during tooth removal. The soft tissues of the follicle connected to the cervical margin were kept intact. After removal, the tooth was kept in a saline solution for 2 minutes. The bone defect was inspected for the presence of any sharp edges, and it was reshaped to accommodate the incisor in its normal position (Fig. 2D). There was no initial stability when the transplant (#9) was placed within the bone defect with its developing apex facing the labial aspect of the crypt (Fig. 2E); therefore, an orthodontic bracket was bonded to the labial surface of the crown. A steel ligature, which connected the bracket to the orthodontic wire, provided semirigid stabilization for the transplanted incisor during healing (Fig. 2F). Nonresorbable sutures were placed to seal the flap around the tooth.

Treatment Outcomes

The transplanted incisor was examined clinically (mobility, pocket probing, and electric pulp testing) and radiographically (intraoral radiographs) at 1, 3, 6, 12, and 18 months and then every year after autotransplantation. The endodontic treatment of the right central incisor (#8) was successfully completed 1 month after transplantation of tooth #9. Orthodontic treatment was completed 3 years after the surgery. A normal overjet and overbite were obtained, and the transplanted tooth was well aligned in the upper arch. The occlusion was stable during the observation period.

Five years after the transplantation, the final clinical and radiologic examinations were performed. Tooth #9 presented stage 1 mobility assessed according to the Mühlemann Index (17) and responded to the electric and thermal pulp tests. The endodontic treatment was completed 1 month after transplantation of tooth #9. Orthodontic treatment was completed 3 years after the surgery. A normal overjet and overbite were obtained, and the transplanted tooth was well aligned in the upper arch. The occlusion was stable during the observation period.

Figure 1. Panoramic radiographs: (A) before treatment (July 2008) and (B) after orthodontic space reopening before the surgery (August 2009).
thermal and electric pulp testing (Electric Pulp Tester; Denjoy Dental Co, Ltd, Hunan, China). A clinical examination revealed normal periodontal tissues at the transplanted and adjacent teeth (probing depths <3 mm) and an adequate width of the attached gingiva (Fig. 3A). No loss of clinical attachment was detected, and the interdental papillae were normal. A slight asymmetry of the incisive papilla was found (Fig. 3B).

Radiographic examinations were performed at follow-up visits to monitor both central incisors. The progressive obliteration of the root canal of the transplanted incisor was present on intraoral radiographs.

Figure 2. The surgery (August 2009): (A) the front maxilla before flap preparation, (B) the bone covering the impacted tooth (#9) after flap elevation and before removal of labial cortical plate, (C) the impacted incisor in its initial position after removal of the labial plate, (D) the bone defect after removal of the labial plate and the impacted incisor, (E) the incisor after positioning within the bone defect with its dilacerated root directed labially, the sutured flap, and (F) the transplanted incisor with orthodontic attachment bonded to the labial surface of the crown and stabilized using steel ligature.

Figure 3. The dental arches at the final follow-up: the (A) labial and (B) palatal view of the transplanted left central incisor (#9) and right central incisor (#8), which had a root canal treatment.
No signs of pathology of the transplanted incisor (#9), the traumatized incisor (#8), or adjacent alveolar bone were detected on radiographs. The presence of lamina dura surrounding the entire tooth socket of the transplant was identified on intraoral radiographs 3 months after the surgery and did not change during the observation time (Fig. 4B and C). The cone-beam computed tomographic (CBCT) scans performed at the 4-year follow-up to evaluate the volume of the alveolar bone in the anterior maxilla confirmed the continuity of the alveolar process. The dilacerated root of transplanted tooth #9 was located within the alveolus and was completely covered with the labial cortical plate (Fig. 4D and E). Additionally, the CBCT examination (performed in March 2014) revealed apex completion of the transplanted tooth, which was found at its initial position (i.e., some distance from the final position of the transplanted incisor) (Fig. 4E).

Treatment possibilities include orthodontic or surgical uprighting of an affected incisor or its extraction. The decision depends on the position of the impacted tooth, its angulation, the stage of root development, the presence of root dilaceration, and the experience of the dental team.

Forced orthodontic eruption of a dilacerated central incisor is the treatment of choice. Closed orthodontic exposure (7, 8, 10–12) or open exposure and tooth alignment (9) are recommended in most cases. Esthetic problems associated with orthodontic eruption of an ectopic incisor (e.g., lack of keratinized tissue) can be solved using various mucogingival procedures (11). In severe cases of impaction with root dilaceration, root canal treatment or apicoectomy is necessary to complete treatment during orthodontic alignment (11, 18).

Transalveolar transplantation, which is a surgical uprighting of an impacted tooth, seems to be an attractive option to save the affected incisor and shorten the treatment time. The protocol for autotransplantation of developing teeth, especially premolars, was introduced in Scandinavia (19–21) and proved to be predictable in long-term studies (22). Autotransplanted developing teeth underwent pulp revascularization, preserved normal periodontal tissues, and continued root growth after surgery (23–25). Additionally, normal periodontal healing and eruption promoted alveolar bone development at the recipient site (26, 27). Despite difficult surgical access, transalveolar transplantation of developing impacted premolars has proven to be a predictable method to preserve the natural teeth (28). However, teeth with dilacerated roots may not be optimal candidates for autotransplantation because of even more difficult surgical access and a higher risk of complications including progressive inflammatory root

Discussion

Treatment of incisor impaction is challenging, especially if the impacted tooth has root dilaceration. Missing anterior teeth are a major concern for orthodontic patients. Early initiation of treatment addresses potential psychological concerns related to the absence of front teeth. The initial diagnosis of impaction is usually confirmed using conventional panoramic radiographs. Impacted incisors can be further localized using the vertical or horizontal parallax or lateral cephalometric radiography. CBCT imaging offers greater possibilities for diagnosing the impaction and recognizing the extent of dilaceration and the stage of root development.

Figure 4. The radiographic examination. Intraoral radiographs of maxillary incisors: the transplanted dilacerated incisor (#9) 3 weeks after the surgery. (A) There are no radiologic signs of the mineralized apex of the tooth; 18 months after the surgery, partial obliteration of the pulp of the transplanted incisor. (B) Contralateral incisor (#8) had a root canal treatment completed 1 month after transplantation of tooth #9; (C) 5 years after the surgery, the complete obliteration of the pulp of transplanted incisor is visible; and (D and E) the CBCT scans (March 2014) show the apex formation a few millimeters away from the transplant.
resorption, ankylosis, and arrested root development. Transalveolar transplantation of impacted, dilacerated incisors followed by root canal treatment has been previously described (15). However, Choi (16) questioned routine endodontic treatment because of the risk of root perforation (29). The severity and direction of root dilacerations play an important role in planning the surgery. Lateral dilaceration may complicate accommodation of the incisor between the adjacent teeth. Labial dilaceration can cause the apical part of the root to extend labially out of the alveolar process after surgical uprighting.

If extraction of the impacted incisor is inevitable, the treatment options to replace the missing tooth include orthodontic space closure (30, 31), autotransplantation of a tooth from another part of the mouth, or prosthetic replacements (13). Dental implants are generally contraindicated in growing patients because of their negative effects on alveolar bone development and progressive infraposition of implant-supported crowns related to the passive eruption of adjacent teeth (32). However, the major concern regarding extraction of an impacted tooth is the alveolar bone deficiency at the extraction sites. If alveolar bone defects develop in children, they usually become more pronounced with time and eventually may even preclude treatment with dental implant and jeopardize the periodontal status of adjacent teeth in adulthood.

The presented case involved the multidisciplinary approach of an orthodontist, a pedodontist, an oral surgeon, and an endodontist as well as previous consultations of a speech therapist and a psychologist. In this case, orthodontic space closure in the anterior maxilla was contraindicated because of existing class III malocclusion. Therefore, the objective of the treatment was to avoid tooth extraction in the upper arch and to preserve the dilacerated tooth (#9). The autotransplantation of the impacted incisor was scheduled before completion of root development to promote pulp revascularization after the surgery. Concerns regarding patient’s cooperation and complexity of the procedure were the main reason to perform the surgery under general anesthesia. Root dilaceration and severe impaction of the incisor resulted in difficult surgical access. As a consequence, the developing apex of the root (which at that time mainly comprised soft tissues) was unintentionally detached and thus left undetected in its initial position.

The 5-year follow-up of the transplanted incisor revealed successful healing. Tooth #9 was considered to be vital because, despite progressive pulp obliteration, there were no signs of periapical pathology and it responded to electric and thermal pulp testing. Revascularization of the pulp is a typical sequela after autotransplantation of developing teeth. Skoglund et al (23) described the ingrowth of the new vessels from the apical bone through the apex of the transplanted developing tooth (33). Pulp obliteration is regarded as scar tissue, which accompanies revascularization and indicates successful healing of the pulp (34, 35).

The periodontal tissues of the transplanted incisor healed normally. Ankylosis (replacement resorption), which was a potential complication of periodontal healing, was not present because the tooth erupted into occlusion, responded to the orthodontic treatment, and presented normal mobility. The root of the transplanted incisor accommodated well within the alveolar bone. The detached developing apex continued its development and mineralization at its initial position.

Conclusions

In the presented case, the transalveolar transplantation of the impacted incisor resulted in saving the natural tooth. The incisor preserved vitality despite root dilaceration and detachment of its developing apex during the surgery. Normal periodontal healing and assisted orthodontic forced eruption allowed alignment of the tooth within the dental arch. This observation adds a valid option to the treatment of growing patients with severe impaction of incisors with dilacerated roots.

Acknowledgments

The authors deny any conflicts of interest related to this study.

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