Treatment of Dilacerated Incisors in Early and Late Stages of Root Development

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Although a dilacerated incisor (DI) is rarely encountered, such an anomaly makes it particularly demanding to restore facial esthetics. Treatment requires a well-synchronized, multidisciplinary approach. Among all the modalities targeting impacted and dilacerated upper incisors—including extraction followed by space closure or a fixed bridge, surgical repositioning, autotransplantation, apicectomy with root-canal therapy, and surgical exposure followed by orthodontic traction—the last is the most widely used. Because labially impacted upper central incisors still have some potential for further root development, however, early orthodontic intervention is advisable.

This article compares the results of orthodontic traction in a series of patients presenting with DIs in the early and later stages of dental root formation.

Methodology

All patients in this study were referred to the Hospital of Stomatology, Fujian Medical University, Fujian, China, for orthodontic consultation between 2004 and 2014. Nolla’s method was utilized to determine each patient’s dental age. A tooth with only one-third (stage 7) or two-thirds (stage 8) of its root formation was assigned to the early dental-age group; a tooth with an almost complete root but an open apex (stage 9), or with a complete apical end (stage 10), was assigned to the late dental-age group.

Orthodontic traction was successful in extruding 12 of the 13 early-stage DIs in our sample, with no need for root-canal therapy or apicectomy. On the other hand, eight of the 15 DIs in the late group had to be extracted due to crowding or severe crown-root angulations.
Fig. 1  Case 1. 8-year-old female patient with delayed eruption of upper left central incisor.  A. After injury at age 4.  B. One year after injury.  C. Immediately before treatment, showing labially rotated, impacted, and dilacerated upper left central incisor.  D. Cone-beam computed tomography (CBCT), showing root one-half its full length.
The following reports, describing two cases in the early group (before full root formation) and two cases in the late group (after full root formation), demonstrate that early intervention not only improves the success rate of orthodontic traction, but also produces longer roots with better conformation.

Case 1

An 8-year-old female was referred to the oral and maxillofacial surgery department for surgical removal of a DI, and the patient was then referred to the orthodontic department for consultation. Her parents reported an accidental injury to the upper lip and front teeth at age 4; the medical record noted a chipped crown, sulcular bleeding, and no obvious mobility of the deciduous upper left central incisor. A radiograph taken at that time did not show any obvious abnormalities (Fig. 1A), nor did a follow-up x-ray taken one year later (Fig. 1B). At age 8, the patient went to a dental office complaining of delayed eruption of the upper left central incisor.

Clinical examination found a healthy periodontium and mild caries. The patient was in the mixed dentition. Lateral cephalometric and panoramic radiographs revealed that the upper left central incisor was impacted, with its crown rotated more than 100° labially and its incisal tip just below the floor of the nose (Fig. 1C). The palatal surface of the crown was facing forward like the hand of a traffic policeman. Cone-beam computed tomography (CBCT) confirmed the presence of an impacted central incisor with a labially rotated crown at the base of the nose (Fig. 1D). A sagittal section showed that the impacted incisor was in early formation (stage 8), with the root only half its full length and the open apex contacting the cortical plate of the palatal vault.

Since the root of the impacted incisor showed no obvious dilaceration and was only half the length of its contralateral counterpart, orthodontic intervention was undertaken to prevent further crown-root angulation.

Fig. 2 Case 1. Flap surgery to expose palatal surface of impacted incisor.

Fig. 3 Case 1. Eruption of impacted incisor with .012" superelastic nickel titanium archwire.

Fig. 4 Case 1. Progress of incisor eruption after nine months of treatment.
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After two months, sufficient eruption space for the impacted incisor had been gained with a nickel titanium open-coil spring. A flap was then raised to expose just enough of its palatal surface to minimize the risk of surgical injury (Fig. 2). The palatal surface of the incisor was acid-etched for bonding of a lingual button, and a ligature wire was tied to the button. The incision was sutured to promote gingival recovery.

An .012” superelastic nickel titanium archwire was used to exert light, continuous force for eruption of the impacted incisor (Fig. 3). An .018” stainless steel wire was then placed to stabilize the arch. After nine months of treatment, the impact-

Fig. 5 Case 1. Patient after one year of treatment.

Fig. 6 Case 2. A. 6-year-old male patient six months before treatment, showing labially rotated, impacted, and dilacerated upper left central incisor. B. Immediately before treatment, after eruption of normal upper right central incisor.
ed incisor was almost in proper position (Fig. 4).

Orthodontic traction was completed in one year, leaving the incisor with an appropriate crown shape, nearly normal attached gingiva, and satisfactory alignment (Fig. 5). The root was not palpable labially; the panoramic radiograph showed that it was almost normal in shape, but still 20% shorter than its contralateral counterpart.

Case 2

A 6-year-old male with no history of dental trauma was referred to the orthodontic department for a follow-up examination. Clinical examination indicated severe caries and premature loss of some deciduous teeth, but the four first permanent molars and both lower central permanent incisors had erupted (Fig. 6A). Cephalometric and panoramic radiographs showed the crown of the upper left central incisor rotated nearly 120° toward the nose. Since the root of the normal upper right central incisor was less than half its full length and the impacted incisor was only at stage 6, we elected to avoid unnecessary radiation exposure from CBCT imaging.

Orthodontic intervention was delayed until the upper right central incisor had erupted, six months later (Fig. 6B). A flap was then raised to expose a minimum palatal surface of the impacted incisor; a lingual button was bonded and tied with a ligature wire, and the incision was sutured (Fig. 7).
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Fig. 11 Case 2. Patient after one year of treatment.

Fig. 12 Case 3. A. 11-year-old male patient with delayed eruption of impacted upper left central incisor one year before treatment. B. Immediately before treatment, showing labially rotated, impacted, and dilacerated upper left central incisor.
An .012" superelastic nickel titanium archwire was placed to exert light, continuous force on the impacted incisor, with the deciduous teeth providing anchorage and the right central incisor left unbracketed (Fig. 8). Four months later, the bulge of the impacted incisor could be seen in the vestibule, demonstrating that the rotation was being corrected. In another three months, once enough of the labial surface had been exposed, the bonded button was moved from the palatal to the labial side (Fig. 9). After 10 months of treatment, both central incisors were bonded for final alignment (Fig. 10).

After one year of traction, the impacted incisor had been brought into normal occlusion with no adverse effect on the adjacent central incisor (Fig. 11). The panoramic radiograph showed that both central incisors still had open root apices, with the root of the impacted incisor nearly the same length and shape as its counterpart.

Case 3

An 11-year-old male presented with his parents’ chief complaint of delayed eruption of the upper left central incisor. Although the parents did not recall any severe dental trauma at an early age, this did not preclude the possibility of moderate injury to the upper deciduous teeth. A panoramic x-ray taken one year earlier showed impaction of the upper left central incisor and incomplete root development of the other three upper incisors (Fig. 12A). Our clinical examination found a severe midline shift and reduced overbite and overjet (Fig. 12B). Radiographs revealed that the crown of the impacted incisor was rotated 100° labially and that the root apices of the three normally erupted incisors were closed.

Because enough space could be opened for incisor eruption, the parents chose to try orthodontic traction. If that failed, the incisor would be extracted and the space maintained for later implant placement.

After three months of treatment, sufficient space had been created, and a lingual button was bonded to the exposed palatal surface of the impacted incisor. An .012" superelastic nickel titanium archwire was then used to bring the tooth into the arch (Fig. 13).

After 24 months of treatment, the impacted incisor had been aligned into normal occlusion, but its gingiva displayed some swelling and redness (Fig. 14A). The root was 20% shorter than that of the adjacent central incisor, with a mesiodistal bend in the median portion.

One year later, the swelling and redness were somewhat lessened (Fig. 14B). After five years of fixed retention, the gingival swelling had almost disappeared (Fig. 14C). The corrected incisor showed no mobility or root resorption.

Case 4

A 10-year-old female presented with her parents’ chief complaint of failed eruption of the upper right central incisor. The patient had experienced a moderate injury to her upper front teeth at age 4; the deciduous incisors were partly chipped, but no mobility was noted. Cephalometric and panoramic radiographs showed the upper right central incisor to be impacted, with its crown rotated 120° labially (Fig. 15A). CBCT indicated that the root was only one-third to one-half its full length, but that the apex was almost closed, in a late stage 9 (Fig. 15B). There was inadequate space for eruption of the impacted incisor, and the midline was shifted to the right.

Because adequate space could be gained for the DI, the parents elected orthodontic traction. Even a dilacerated tooth with a root one-third to
one-half its normal length could restore facial esthetics and maintain the alveolar bone. If traction failed, the space would be maintained for future implant placement.

Four months later, after enough space had been opened with a nickel titanium open-coil spring (Fig. 16), a lingual button was bonded to the lingual surface of the impacted incisor. The tooth was moved mesially with power chain, then an .012" superelastic nickel titanium archwire was ligated for alignment. Once enough of the facial surface was exposed, after nine months of treatment, the button was moved to the labial side for further traction (Fig. 17). Three months later, the right central incisor was bracketed for final alignment (Fig. 18).

The impacted incisor was brought into normal occlusion in 20 months of treatment; the patient demonstrated satisfactory facial esthetics, with no bulge of the root in the vestibule (Fig. 19). The panoramic radiograph indicated that the root of the corrected incisor was still only half the length of the adjacent central incisor’s.

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Fig. 15 Case 4. A. 10-year-old female patient with labially rotated, impacted, and dilacerated upper right central incisor before treatment. B. Sagittal section of CBCT, showing almost complete formation of root one-third to one-half its full length.

Fig. 16 Case 4. Space opening with nickel titanium open-coil spring; lingual button bonded to impacted incisor for traction.

Fig. 17 Case 4. Impacted incisor brought into arch with .012" superelastic nickel titanium wire; button moved from palatal to labial surface.
Discussion

The etiology of dilaceration is not fully understood. Although it is commonly accepted that mechanical trauma to the calcified portion of a developing tooth in the deciduous dentition is the most likely cause, the effect of trauma depends on the age of the patient and the cause and type of injury.17 Dilaceration frequently follows the avulsion or intrusion of an overlying deciduous predecessor, usually before age 4.18

Some researchers contend that the etiology of DIs is idiopathic. For example, Stewart reported that only nine of 41 patients (22%) with DIs had experienced dental injuries.19 Although our Cases 1 and 4 showed a history of dental trauma, others did not. It should be noted, however, that because the parents might not remember moderate dental injuries, any study is likely to reflect a lower percentage of trauma-related DIs than may have actually occurred. Howe argued that an injury transmitted to the crown of an unerupted upper central incisor would result in an unusual orientation, with the crown facing upward and labially, unless the tooth germ of the permanent successor had already been displaced before the trauma.20 Nevertheless, it is possible that the mechanism of dilaceration may not be the exertion of a direct force on the tooth germ, but rather the disruption of a normal environment for eruption.

Whether an impacted DI can be successfully erupted and aligned depends on the degree of dilaceration and root formation.12 In our study, the roots of the DIs were significantly shorter than their contralateral counterparts, as observed in a study by Sun and colleagues.14 Cases 1 and 2 show that longer roots with better conformation can be obtained at an early dental age with incomplete root growth (stage 7 or 8); Cases 3 and 4 demonstrate that patients at a late dental age with nearly complete root development (stage 9 or 10) may end up with compromised tooth length and shape, emphasizing the importance of early intervention.

Two theories have been advanced to explain the compromised root development of DIs. One is that an injury to the permanent tooth germ during odontogenesis may disrupt the growth of the Hertwig epithelial root sheath, thus inhibiting root development.21 The second is that a labial rotation of the crown brings the Hertwig epithelial root sheath too close to the palatal cortical bone, limiting the space for root development14 (Fig. 1D).

Fig. 18 Case 4. Progress of incisor eruption after 12 months of treatment.

Fig. 19 Case 4. Patient after 20 months of treatment.
In the latter case, it would be beneficial to correct the rotation as early as possible.

It was once thought that after dental trauma, the injured Hertwig epithelial root sheath continued to produce dentin and cementum at a normal rate. In our Cases 1 and 2, however, the root formation of the injured incisors lagged behind that of its counterparts. Such delayed root development may be the result of a temporary inhibition by traumatic force, after which upward root growth may resume, resulting in a severe crown-root angulation.

If an impacted incisor is not treated at an early stage of development, adverse changes such as migration of the adjacent teeth and a consequent midline shift could make it impossible to open enough space for later eruption of the impacted tooth. In our study, eight of the 15 DIs in a late stage of development had to be extracted due to severe dilaceration or crowding. The extraction of an upper central incisor will definitely compromise facial esthetics. On the other hand, diagnosis of an impacted DI in the early mixed dentition will allow orthodontic treatment to create enough space and time for normal root development, ensuring a higher rate of success.

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