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Management of root dilaceration of an impacted maxillary central incisor following orthodontic treatment: an unusual therapeutic outcome

CASE REPORT

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Abstract – There are rare cases of impacted permanent central incisors with dilaceration, a dental deformity characterized by pronounced angulation of the longitudinal tooth axis. This paper presents the orthodontic alignment of a permanent maxillary left central incisor in a 7.5-year-old boy, which appeared impacted radiologically and displayed root dilaceration. Following surgical exposure with the closed-eruption technique and appropriate orthodontic traction, the tooth was successfully aligned into the dental arch and the root was radiologically shown to be straightened and relatively well developed.

Dilaceration, defined as the abrupt deviation of the long axis of the crown or root portion of a tooth (1, 2), results from the non-axial traumatic displacement of already formed hard tissue relative to the developing soft tissue. The most frequently encountered dilaceration type is root angulation of the maxillary incisors when the crowns are inverted, because of their close topographic relationship with the frequently injured primary teeth (3–6). The palatal crown surfaces of such teeth acquire a labial orientation, 'like the hand of a traffic policeman,' and the tooth usually remains impacted (7–11). The etiology of dilaceration is not fully understood and there is no consensus among researchers, although there are two prevailing explanations. The first and more acceptable explanation considers acute mechanical trauma on the deciduous predecessor as the cause of dilaceration to the underlying developing permanent tooth (5, 8, 12–15). The second explanation considers idiopathic developmental disturbances as possible etiological factors in cases where there is no clear sign of traumatic injury (1, 12, 16, 17). Andreasen et al. (1) suggests that the most probable developmental abnormality is ectopic tooth germ development.

Radiographic examination is essential for dilaceration diagnosis (17–19). If dilaceration follows a palatolabial axis, then the X-ray beam is parallel to the deviating part of the root. This results in the deviating part appearing at the end of the non-deviating root part as a dark, radiopaque region with a dark translucent center spot, indicating the apical foramen and designated as the 'Bull's eye' (17, 20, 21). Various treatment schemes have been reported, with the most popular including tooth extraction and implant placement, or closing the space using orthodontic traction, a fixed bridge, or partial denture. The technique most commonly implemented is surgical exposure of the tooth by a periodontist, followed by orthodontic alignment into the dental arch (22–24). Endodontic treatment and/or apicoectomy might also be necessary (11, 22, 23, 25). The success of tooth alignment within the dental arch depends on the degree of dilaceration, tooth position and orientation, and degree of root formation. A dilacerated tooth with an obtuse inclination angle in a low position and incomplete root formation has a better prognosis (23, 26).

The aim of this article is to present (i) the successful orthodontic treatment of a patient whose permanent maxillary central incisor was impacted and presented root dilaceration and (ii) the resulting unusually successful tooth alignment in the dental arch, in which the root appeared radiographically straightened and relatively well developed.

Case report

Diagnosis and etiology

A 7.5-year-old boy was brought in for orthodontic treatment because of a delay in the eruption of his

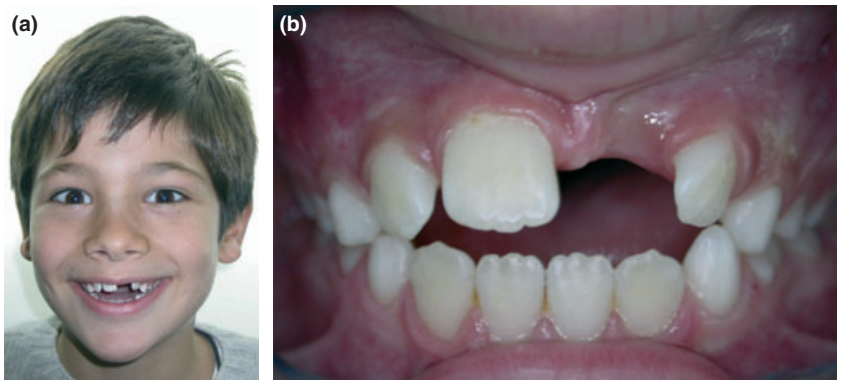

Fig. 1. Clinical appearance of the 7.5-year-old patient before treatment: facial (a) and intraoral photograph (b).

permanent maxillary left central incisor (Fig. 1a,b). The medical history of the patient revealed good general health. The boy had suffered a traumatic injury to the anterior region of the oral cavity at 4.5 years of age, which resulted in the loss of the primary maxillary left central incisor.

Clinical examination revealed that the patient had a symmetric face and brachyfacial type. All teeth were vital, with normal morphology. Intraoral examination revealed an angle class I molar relationship, while developmentally the patient was in the early mixed dentition period. Moyers' analysis of the mixed dentition dental casts forecasted sufficient space for the regular oncoming alignment of permanent teeth. Except for the permanent maxillary left central incisor, all the permanent first molars and incisors had erupted (27). Consequently, the adjacent teeth, including the permanent maxillary left lateral incisor and permanent maxillary right central incisor, had slightly drifted mesially (Fig. 1b). An oral habit of tongue sucking had resulted in anterior spacing, with a resulting 2-mm overjet and 3-mm overbite. The mandibular midline of the patient coincided with the facial midline.

Cephalometric, panoramic, periapical, and occlusal radiographs revealed that the permanent maxillary left central incisor was impacted and displayed root dilaceration. Its apical foramen appeared as a circular radiopaque area with a dark radiolucent spot in the center, known as the 'Bull's eye' characteristic (Fig. 2a,b).

Treatment progress

Treatment to break the tongue-sucking habit followed a simple therapeutic method. The patient was asked to record in a calendar exactly when and for how long he sucked his tongue. The aim was to help him become aware of what he was doing unconsciously and so learn to control and finally give up this habit. The child stopped tongue sucking after 30 days.

Surgical exposure of the permanent maxillary left central incisor ensued with the closed-eruption technique, so that a tube could be bonded onto the palatal tooth surface (Fig. 3a). The closed-eruption technique is the best choice in cases where the impacted tooth is located labially, especially when it lies high above the mucogingival junction or deep within the alveolar bone. In such cases, it is very difficult or even impossible to apply the technique using an apically positioned flap (28, 29). The greatest advantage of the closed-eruption technique is that the attached gingiva remains intact. A semilunar incision was made in the keratinized gingival in the area of the permanent maxillary left central incisor and was extended above the mucogingival junction. A full-thickness labial flap was lifted under local anesthesia, and a minimal amount of alveolar bone was removed along with the follicular tissue. A tube with an attached 0.010-inch ligature wire was then bonded to the palatal side of the exposed tooth crown, using a light-cured adhesive for maximum strength. The other free

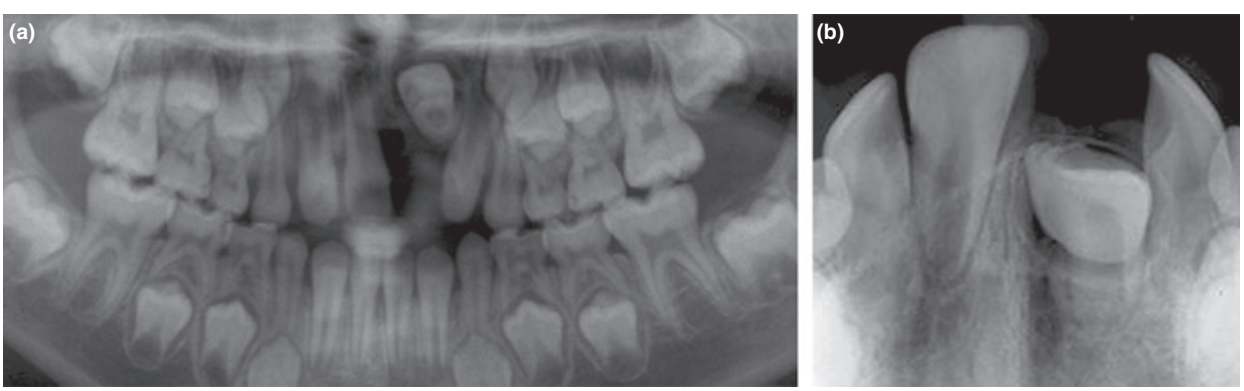

Fig. 2. Radiographic images before treatment. Panoramic (a) and occlusal (b) view. The characteristic radiographic finding known as 'Bull's eye' is discernible.

end of the wire was bent around the neck of the permanent maxillary left lateral incisor. The flap was fully returned to its former place and closed with simple, interrupted silk sutures (Fig. 3b).

The surgical exposure confirmed that the impacted permanent maxillary left central incisor presented labio-palatal root dilaceration and that the palatal surface of its crown was inverted toward the oral vestibule. Additionally, the incisal edge of the permanent maxillary left central incisor was nasally oriented. Orthodontic traction of the permanent maxillary left central incisor was accomplished by attaching the ligature wire to archwires (prefabricated Ni–Ti, round section, 0.012 and 0.014-inch), which were used to level the maxillary anterior teeth and to ensure anterior spacing (Fig. 4a). Archwires were applied to brackets (0.018 × 0.025-inch slot straight wire appliances). Traction was activated through the ligature wire every 4 weeks until the crown of permanent maxillary left central incisor appeared properly oriented (i.e., with the palatal crown surface facing the palate) in the oral cavity. The traction force was 60 g. This treatment stage lasted 6 months.

Next, the tube was removed from the palatal surface of the permanent maxillary left central incisor and a bracket was bonded on its labial surface. Prefabricated round section Ni–Ti archwires with a 0.012, 0.014 and 0.016 inches were used, in sequence, on the upper teeth. After that, a rectangular 0.016 × 0.022-inch archwire was used for the total alignment of the permanent maxillary left central incisor (Fig. 4b,c). Treatment ended with a 0.018 × 0.022-inch stainless steel wire. This second stage of the final alignment of the permanent maxillary left central incisor lasted 5 months. Permanent retention followed with a multistranded passive wire, which was bonded to the palatal surfaces of the maxillary anterior teeth (Fig. 4d). At the end of the treatment, the free and attached gingiva of the dilacerated tooth appeared compromised, and further mucogingival surgery was recommended. However, both the patient and his parents considered the result acceptable and did not want to proceed with full correction (Fig. 5a,b).

Radiographic images of the tooth at the various treatment stages are shown in Fig. 6a–c.

The anterior teeth were initially shown in openbite. The final clinical examination indicated that the overjet and overbite were normal.

The patient was followed up every 6 months. At 3.5 years after treatment, clinical examination was normal (Fig. 7a,b) and the panoramic radiographs (Fig. 8) were unchanged from those taken at the end of treatment.

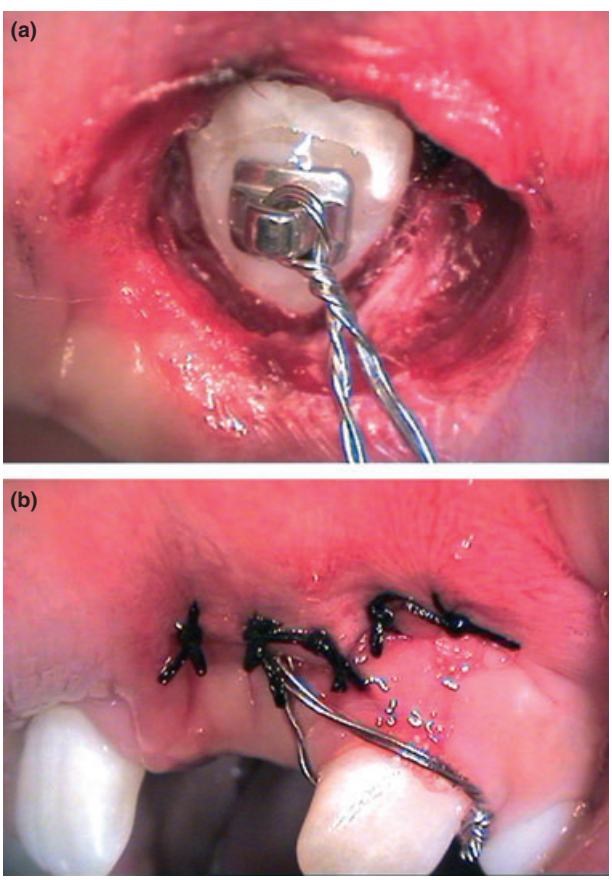

Fig. 3. Surgical crown exposure of the tooth using the closed-eruption technique. Bonding of the tube (a). Sutures in place (b).

Discussion

Dilacerated impacted teeth can be properly aligned in the dental arch by appropriate treatment, which frequently requires cooperation among orthodontists, periodontists, pedodontists, endodontists, and/or prosthodontists (8, 9, 11, 22, 23, 26, 30). Most studies of dilacerations have concerned the maxillary central incisors, as was the case in the present study. Uematsu et al. (25) and McNamara et al. (8) successfully aligned dilacerated maxillary central incisors using a plan that incorporated endodontic treatment and apicoectomy. In the present study, there were no complications that necessitated endodontic treatment or apicoectomy during or after treatment, as has sometimes been required in similar cases (9, 23). Nevertheless, the root of the permanent maxillary left central incisor was shorter and thinner than that of the adjacent permanent maxillary right central incisor, probably due to external resorption caused by significant tooth movement (23, 25). Similar findings were also reported previously (11). Radiographically, the root appeared straightened and relatively well developed. Lin et al. also observed a straight root in the radiographs following the alignment of a similar tooth into the dental arch (23).

Root shortening probably arose from labiopalatal curvature of the root of the permanent maxillary left central incisor during the time period following injury and before orthodontic traction, which would have shortened the straight line root length. Subsequent orthodontic treatment might have reoriented the calcified tooth parts (i.e., crown and already shaped root) but not the non-calcified developing root, which later developed normally. Microscopically, this reorientation takes place relative to Hertwig's epithelial root sheath, which plays an important role in root development. Therefore,

Fig. 4. Stages of orthodontic tooth alignment. Orthodontic traction and alignment of the tooth (a–c). Permanent retention of the tooth in the upper dental arch (d).

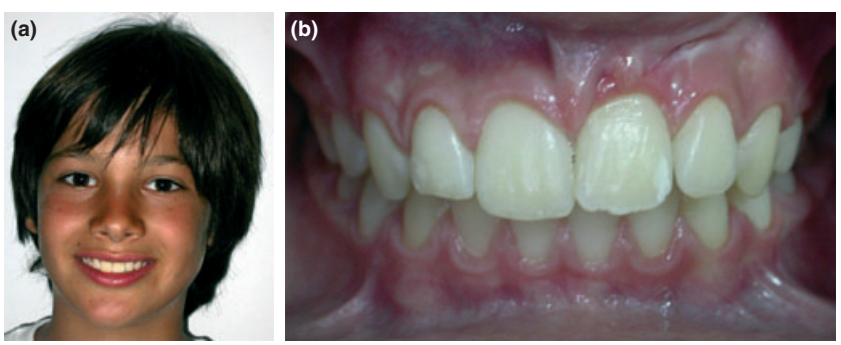

Fig. 5. Clinical appearance of patient following treatment. Facial (a) and intraoral photograph (b).

orthodontic treatment and more specifically orthodontic traction of the impacted tooth are generally intended to accomplish early. This ensures that the calcified and not-yet-calcified dental tissues are reoriented relative to Hertwig's sheath, allowing the root to grow in the proper direction relative to the crown and the already formed root (8). Hertwig's sheath does not move during normal root formation or tooth injury, instead remaining in a stable position (1, 2). This is perhaps why dilacerated impacted teeth subjected to orthodontic traction can straighten, as has been observed both previously and in the present case.

The most important factors associated with the successful straightening of dilacerated maxillary central incisors are the time of deciduous tooth injury, age at his first orthodontic visit, and time that orthodontic treatment is begun (i.e., exact time of orthodontic traction of the dilacerated tooth). These factors are important because it is vital to know the developmental stage of the successor tooth at the time of injury, and orthodontic traction must be applied before the root has fully grown (age 10–11 years). In the present case, these two factors were favorable and led to a successful treatment outcome.

Conclusions

1 The cooperation of various specialists, especially of an orthodontist with a periodontist, is essential to properly treat dilacerated impacted maxillary central incisors.
2 Impacted maxillary central incisors presenting root dilaceration can be properly aligned in the dental arch and are likely to appear straightened and well

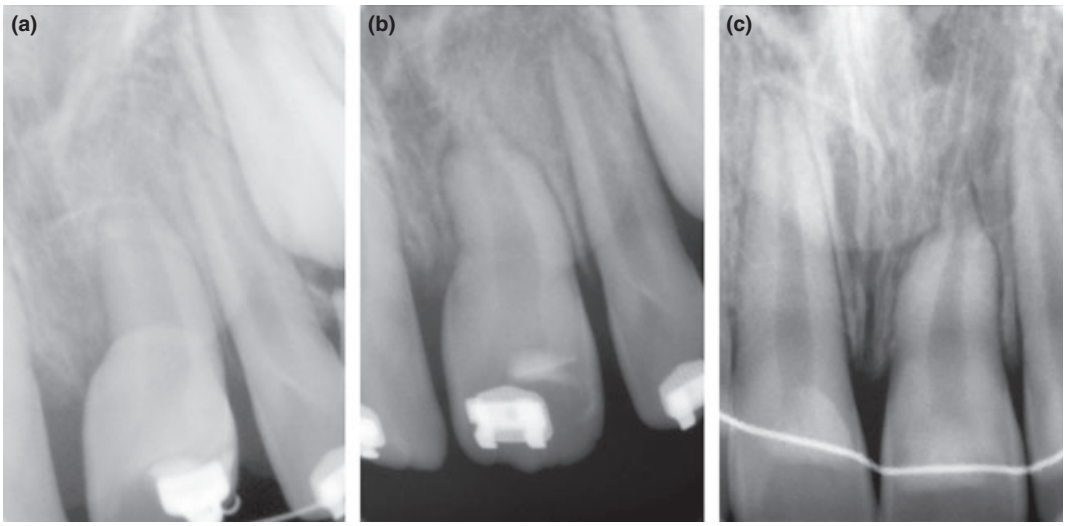

Fig. 6. Radiographic image of the tooth at the various treatment stages. (a) Radiographic view of intraoral photograph 4a. (b) Radiographic view of intraoral photograph 4b. (c) Intraoral 4d, final radiographic image: the root is shorter and straightened with external resorption.

Fig. 7. Clinical appearance at 3.5-year follow up, when the patient was aged 11.5 years: facial (a) and intraoral photograph (b).

Fig. 8. Radiographic appearance at 3.5-year follow up, when the patient was aged 11.5 years.

developed in radiographs, provided that orthodontic traction starts at the right age, well before the tooth root has fully formed.

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