Periodontal implications of surgical-orthodontic treatment of an impacted dilacerated maxillary incisor: A case report with a 2-year follow-up

Giliana Zuccati Clauser,[a] Tommaso Clauser,[b] Cosimo Nardi,[c] and Debora Franceschi[c]
Florence and Milan, Italy

The treatment of an 8-year-old girl with a dilacerated maxillary incisor began in the mixed dentition; a modified palatal arch attached to the molars served as anchorage for the forced eruption of the dilacerated tooth to prevent the intrusion of the adjacent teeth and reduce the risk of root resorption. Two surgical sessions were planned: the first to permit the closed eruption; the second was an apically positioned flap to add attached gingiva to the labial side of the erupting tooth. The result was an optimal periodontal outcome; moreover, the roots of the adjacent teeth did not show any sign of resorption at the end of the forced eruption. The tooth was vital at the end of the treatment, and the apex covered by alveolar mucosa. The root developed normally throughout the treatment, and the periodontium was healthy and esthetically acceptable at the 2-year follow-up. Further study is needed to assess the advantages of the combined surgical-orthodontic treatment. (Am J Orthod Dentofacial Orthop 2020;■:■-■)

Tooth dilaceration is a dental deformity characterized by noticeable angulation of the longitudinal axis of the tooth. The diagnosis is usually made early because the space for the unerupted dilacerated incisor is completely or partially lost when the contralateral permanent central incisor and lateral incisors erupt, around the age of 8-10 years. The frequency of maxillary central incisor impaction ranges between 0.006% and 0.2% in the general population[1,2] and in 1%-2% of orthodontic patients.[3] In a sample of 64 impacted central incisors, Chaushu et al[4] reported that 42% of the patients had impaction because of root dilaceration. A dilacerated incisor is a clinical challenge because the goal of the treatment is to restore facial aesthetics without impairing the adjacent teeth and surrounding tissues.

[a]Private practice, Florence, Milan, Italy.
[b]Department of Biomedical, Surgical, and Dental Sciences, University of Milan, Milan, Italy.
[c]Department of Experimental and Clinical Biomedical Sciences, University of Florence, Florence, Italy
All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.
Address correspondence to: Giliana Zuccati Clauser, Private practice, Via Masaccio, 173, Florence 50132, Italy; e-mail, gilianazuccati@gmail.com.
Submitted, January 2020; revised and accepted, March 2020.
0889-5406/$36.00

https://doi.org/10.1016/j.ajodo.2020.06.005

Early orthodontic intervention is indicated because labially impacted maxillary central incisors still have some potential for further root development if their position is corrected.[5,6] In a sample of 12 patients who had cone-beam computed tomography (CBCT) data after treatment and long-term follow-up, the inversely impacted maxillary central incisors treated had continuous and similar growth as did the mature nondilacerated incisors.[7] The roots of the teeth treated showed increased length and a favorable apical change.[8]

An effective multidisciplinary approach requires appropriate timing alternating surgical and orthodontic intervention. Surgical exposure followed by orthodontic traction is the most widely used approach. Although the successful alignment of the dilacerated teeth has been reported, concerns have been raised about the long-term prognosis for the dilacerated teeth that may need endodontic treatment with or without apicoectomy.[9]

Possible dental damage includes inadequate labial gingiva and root resorption. Even after a successfully guided eruption, unattractive gingiva could occur, requiring further periodontal surgery. Multiple surgeries to improve the health and aesthetics of gingival tissues have been reported.[4,10]

A dilacerated root makes traction complicated and can require complex orthodontic mechanotherapy; moreover, considerable anchorage is required.[11] The

shortened roots of the dilacerated tooth and adjacent teeth at the end of a successful alignment may make it impossible to proceed with the second phase of orthodontics, which may be necessary.[12,13]

This case report presents a horizontally impacted, dilacerated maxillary left incisor treated in the early mixed dentition. The impacted incisor was successfully moved into the proper position with healthy gingiva without root resorption of the adjacent teeth using reinforced anchorage orthodontic mechanics and 2-stage surgical crown exposure. The periodontal surgical procedures and the orthodontic strategies for treating the impacted dilacerated maxillary central incisor are discussed.

CASE REPORT

An 8-year-old girl was referred for orthodontic consultation regarding an unerupted permanent maxillary left central incisor. The patient was in the early mixed dentition, with a Class II Division 1 malocclusion. There was space loss with the drift of the right incisor toward the region of the unerupted tooth, causing a midline deviation; crossbite was evident on the left side (Fig 1).

The child was physically healthy and had no history of systemic conditions or dental trauma. There was no sign of caries or periodontal disease.

A panoramic x-ray and lateral cephalogram revealed that the permanent maxillary left incisor was dilacerated, positioned horizontally with the crown being inverted; its incisal edge was near the apex of the right central incisor and just below the nasal cavity (Fig 2).

The parents were informed of the treatment plan, the duration of treatment, the risk of failure, and the possible need for additional surgery.

A rapid maxillary expander (RME) was placed; the bands were cemented to the deciduous maxillary second molars, which had complete root formation. RME was maintained for 6 months. Fixed appliances were bonded to the incisors, deciduous canines, and deciduous molars. An 0.014-in nickel–titanium archwire, then an 0.018-in stainless steel wire, and a nickel–titanium open-coil spring were applied between the maxillary right central incisor and the left lateral incisor for initial alignment. The duration of this phase was 9 months and made it possible to correct the crossbite, to center the midline and obtain adequate space for the dilacerated incisor.

CBCT imaging was done to ascertain the relationship between the impacted tooth and the neighboring apex. The dilacerated incisor was horizontal, situated below the floor of the left nasal cavity, with its incisal edge just ahead of the anterior nasal spine, about 5 mm beyond the labial cortical bone. The pulp canal was wide open at the root apex, showing a tooth still in formation. The root of the impacted incisor was short in comparison with the maxillary right central incisor, with the apical third of the root dilacerated near the palatal cortical bone (100° crown-root angle). No alterations were found in the neighboring teeth, although contact between the impacted incisor and the maxillary left lateral incisor was observed (Fig 3).

Once the alignment was complete, and space had been gained, a mucoperiosteal flap was raised after a crestal incision, and the palatal side of the crown of the dilacerated tooth was exposed under local anesthesia. A gold bracket with an attached chain was bonded to the palatal surface of the tooth. The gold chain was secured to the maxillary arch. A ligature wire was tied to the main archwire with an elastic thread. The flap was repositioned and closed with absorbable synthetic surgical sutures (Fig 4).

Elastic traction was applied to the initial archwire for 3 weeks. The anchorage was reinforced by a fixed 0.080-in stainless steel palatal arch with a loop bent at the center of the created space. The palatal arch was soldered to the palatal surfaces of the bands on the maxillary first molars (Fig 5).

The closed-eruption technique was performed from the buttonhole toward the alveolar crest to promote a physiological pattern of eruption. An elastic thread was tied to the bent loop on the soldered arch and replaced every 15 days. A light force of approximately 60 g was applied. No segmental or continuous arches were used on the lateral and central incisors during the extrusive phase.

Even though the deciduous molars and canines were exfoliating, the gold chain remained attached to the palatal arch. Tooth movement and soft-tissue status were monitored every 2 weeks.

The incisal edge of the dilacerated tooth was visible through the alveolar mucosa, although it had not been perforated 5 months after surgery (Fig 5).

A second surgery was performed when the mucosa overlying the incisal edge became excessively transparent because of the risk of perforation of the alveolar mucosa: a combined full and/or partial-thickness flap was raised. The gingiva was transferred over the crown of the dilacerated tooth and secured to the periosteum in the partial-thickness portion apically to the incisal margin of the impacted tooth (Fig 6). A button was bonded to the facial surface of the crown, and a vertical metallic chain attached.

Traction was continued for 12 months while the deciduous teeth exfoliated, and the permanent premolars and canines erupted (Fig 7).

Fig 1. Pretreatment records of an 8-year-old girl with an unerupted maxillary left central incisor.

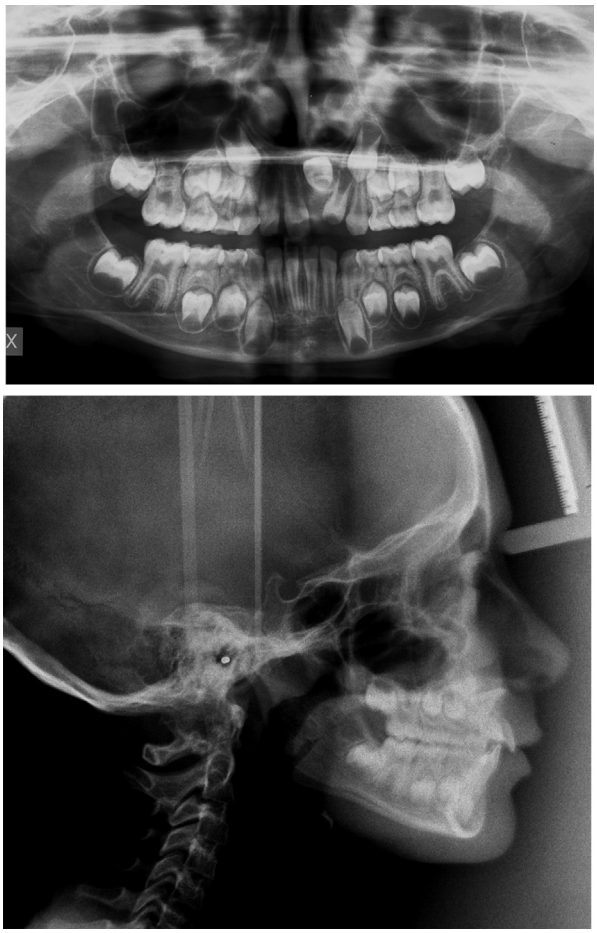

Fig 2. A, panoramic radiograph; **B,** lateral cephalogram.

Maxillary and mandibular brackets were bonded to the permanent teeth as soon as they erupted. Class II elastics were inserted to correct the Class II malocclusion, enhance the anchorage for the maxillary arch, and avoid the Class II moment of the maxillary arch produced by molar tipping. A final arch allowed for tooth alignment and correction of the dilacerated tooth torque.

At the end of the forced traction, the dilacerated root apex perforated the labial cortical plate and was palpable in the alveolar mucosa. The final alignment was completed with a twin bracket bonded to the dilacerated tooth and nickel–titanium wires. The apicopalatal torque was increased, and the apex remained covered by the alveolar mucosa. When the alignment was completed and the dilacerated root was no longer palpable, the fixed appliances were removed, and the patient was given a retainer.

The total treatment time was 34 months.

The impacted maxillary left central incisor was successfully guided into proper alignment with an acceptable gingival contour through a 2-stage crown exposure surgery and orthodontic traction (Fig 8). The final appearance of the tooth was esthetically pleasing, with the same gingival margins level as the contralateral central incisor and similar clinical crown sizes. No adverse effects such as pulp pathology, color change, or mobility were observed at 2-year posttreatment examination. X-rays showed that the root of the incisor was properly aligned, and the lengths of the adjacent teeth appeared normal. The root of the dilacerated incisor continued to mature during the posttreatment phase.

Although the hooked apex prevented a thorough evaluation of the apical third of the root on the panoramic x-ray, its development appeared normal 2 years after treatment. The width of the keratinized gingiva was 3 mm, and clinical probing depth ranged from 1 to 2 mm (Fig 9).

DISCUSSION

The etiology of dilaceration is not fully understood when there is no sign or history of injury or idiopathic developmental disturbance.[1,14] In this case, no one in the family recalled the child having suffered any dental trauma.

The suspicion of dilacerated teeth is generally clinical, but radiographic images play a decisive role in the diagnosis.

CBCT is not considered a standard diagnostic method in orthodontics, but it is justified when

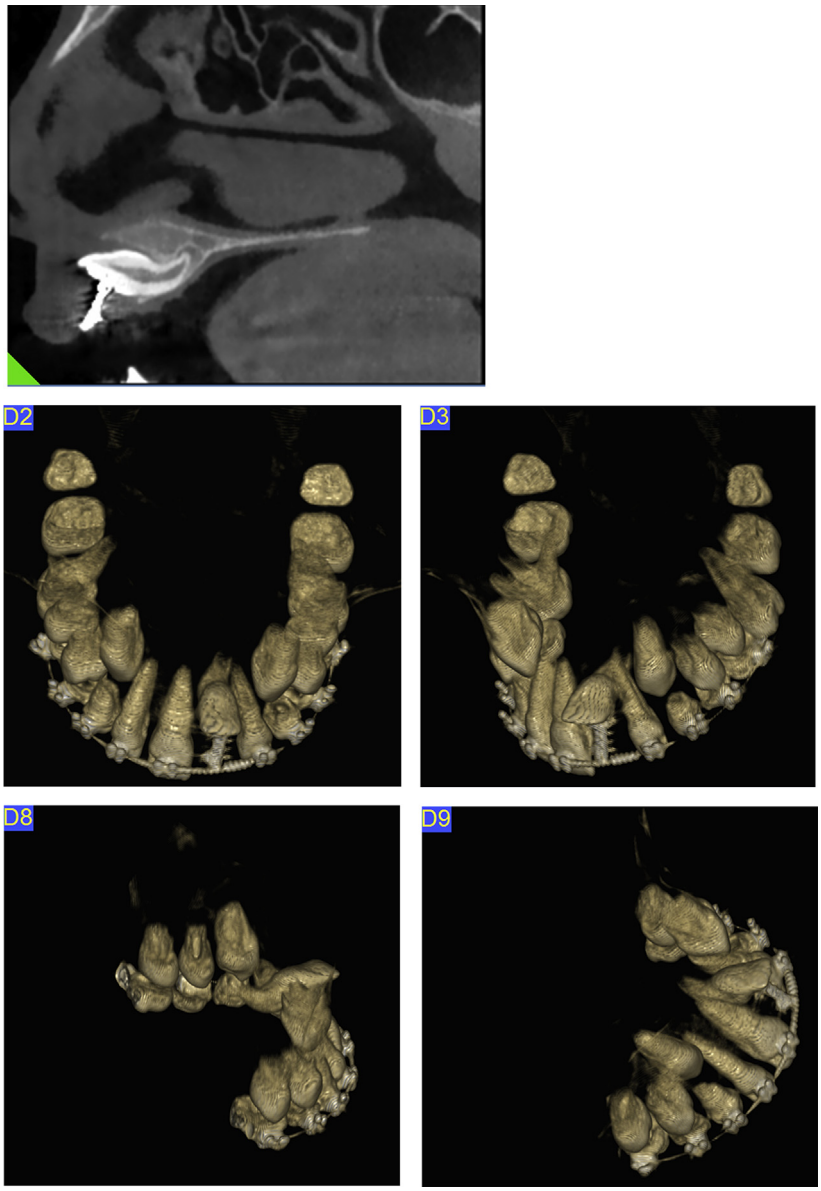

Fig 3. A, CBCT showing the short root of the impacted incisor. **B** and **C,** The apical third of the root was curved upwards in proximity to the palatal cortical bone (100° crown-root angle). **D** and **E,** Note the contact between the impacted incisor and the maxillary left lateral incisor.

conventional radiographs fail to provide sufficient information for treatment planning. It has been reported that more than 25% of treatment plans for impacted teeth were changed after obtaining CBCT images.[15] In patients with dilaceration, CBCT is used to ascertain the position of the impacted tooth, the relationships with the adjacent teeth, the degree of root development, the curvature and direction of the dilacerated root, and whether or not the cortical labial plate has been perforated.[15]

In this case, CBCT was done at the beginning of the traction of the dilacerated incisor because there was some concern about the unfavorable tooth rotation that might inhibit vertical traction. Precautions should be taken to avoid any traction that might damage the already compromised root of a dilacerated and rotated tooth. In our case, the direction of traction was changed and shifted distally on the basis of information provided by CBCT. At the end of the forced eruption, we decided to avoid unnecessary radiation exposure from CBCT

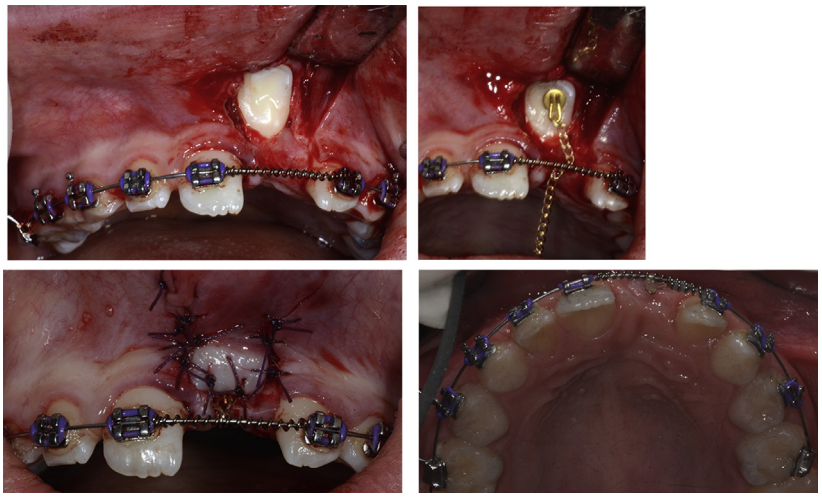

Fig 4. **A,** surgical exposure with a closed-eruption technique; **B,** lingual button; **C,** after repositioning and suturing; **D,** the chain was attached to the initial arch.

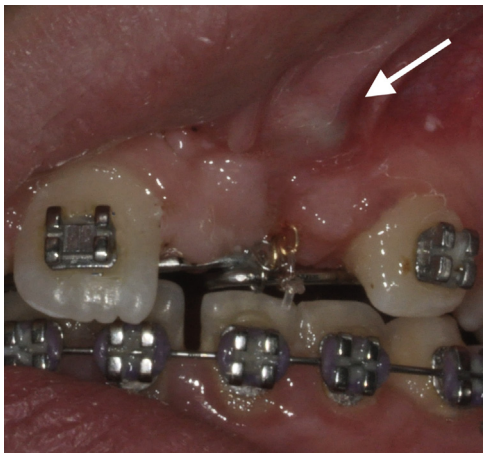

Fig 5. Incisal edge of the dilacerated tooth extruded under the alveolar mucosa before erupting.

imaging for documentation purposes because no sign or symptom indicated the need for further radiation.[16]

Chaushu et al[4] found that the distance of the impacted tooth from the occlusal plan (height) was the factor that significantly affected the length of the treatment because of the greater distance required for the impacted tooth to be in a correct position. It is known that age plays a major role in determining the treatment duration of impacted teeth. A strong correlation between traction duration and age had already been found when evaluating the treatment durations of impacted maxillary canines.[17,18]

Bhikoo et al[19] analyzed the impact of 9 variables (age, incisor length, crown-root angle, crown height and depth, angle of inversion, rotation to axial plane, distance, and angle to the midline) on treatment duration. Their findings showed that age, initial crown height, crown-root angle, and incisor length extended the duration of the treatment.[19]

The assessment of age, crown height, root dilaceration, and incisor length can help the orthodontist to predict treatment duration better. Hu et al[7] noted that in a sample of 12 patients, the growth of the inversely impacted maxillary central incisors was similar to the mature contralateral incisor in the 24-month follow-up period. The roots increased in length and changed the direction of the apex, without remarkable changes in the surrounding alveolar bone. Therefore, early treatment is recommended to create more space for root formation and to facilitate future treatment.

A dilacerated tooth is said to be more resistant to extrusion than a tooth with a normal root, making the apical area more prone to resorption because of the duration of force required for movement.[4]

Chaushu et al[4] reported an eruption failure in 5 of 27 dilacerated incisors with an almost 18% failure rate.

The first archwire applied after the RME on the deciduous teeth allowed the space for the dilacerated tooth to open and was used to secure the chain during the first surgery. The information provided by CBCT was used to prepare a palatal arch and redirect the elastic traction that had been applied to the initial archwire for only 3 weeks (Fig 4). Subsequently, the patient lost the deciduous molars, and the palatal arch was used to continue the forced eruption while avoiding intrusive mechanics on the other incisors.

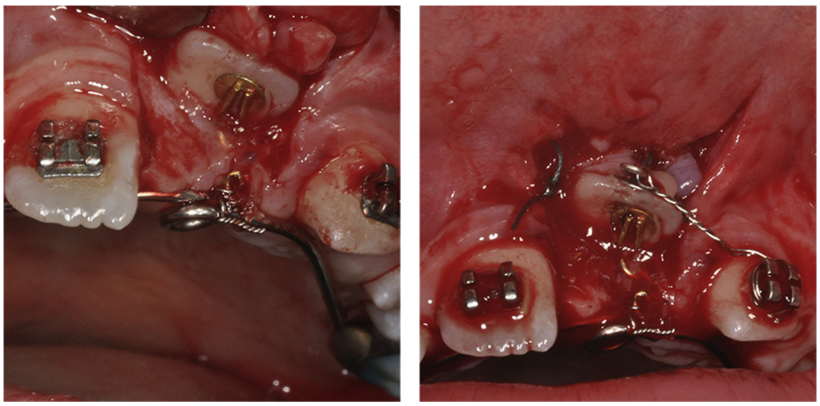

Fig 6. A, Apically positioned flap permitted the preservation of the gingival tissues. **B,** Buttonhole was bonded to the labial surface of the dilacerated incisor.

Fig 7. Ligature secured to the palatal arch. Forced eruption continued during exfoliation of the deciduous teeth.

Pressure sores on the palate, molar extrusion, and tipping of molars are possible side effects of the palatal arch, requiring continuous monitoring. Molar tipping and the Class II malocclusion can be corrected after the permanent tooth eruption. The palatal arch made it possible to continue the traction of the dilacerated tooth without apparent adverse effects.

The phase of surgical-orthodontic traction of the labial inversely impacted maxillary incisors required approximately 1 year. Chaushu et al[4] reported that the traction time was 8.0 ± 4.5 months, which was similar to the findings of Ho and Liao.[20]

Treatment of the Class II malocclusion started earlier than usual, as soon as the permanent teeth erupted. When the fixed appliances were removed, a removable functional appliance was provided as a retainer.[21]

At the end of the forced traction, the dilacerated root apex perforated the labial cortical plate and was palpable in the alveolar mucosa. The apicopalatal torque was increased to move the root palatally, then the thickness of alveolar mucosa increased, and the root was no longer palpable. The tooth was aligned, and apicoectomy was avoided; the tooth was still vital at the 2-year follow-up. This occurrence has already been described by Chang et al.[6]

In previous studies, root resorption of the dilacerated tooth and the adjacent teeth has been noted after the extrusion of the dilacerated central incisor.[12,13] Intrusive and torquing forces delivered to the adjacent incisors for a long period might significantly increase the percentage of resorbed root area.[22,23]

The tooth was brought to its place in the arch by light extrusive traction maintained by the elastic ligature. The 15-day interval also permitted the delivery of a light, continuous force, close monitoring of the force direction, tooth movement, and soft-tissue status.[22,23] Hu et al[7] used an auxiliary extrusive spring soldered to the palatal arch instead of elastics and delivered efficient long-acting force. In any case, close monitoring of the forces is necessary.

Anchorage reinforcement by miniscrews instead of the modified palatal arch was also considered in this young patient. There is evidence that midpalatal implants are an acceptable alternative to conventional techniques for reinforcing anchorage.[24-26] Midpalatal miniscrews with a connecting wire system and a spring for extrusion is a versatile method for controlling the maxillary dentition, avoiding adjacent developing teeth and roots, while having a low failure rate.[24] Nevertheless, data on patient acceptance or patient discomfort have not been currently reported in the orthodontic literature.[25,26] The patient's parents asked to avoid surgery for preventing anchorage loss as 2 unavoidable periodontal surgical procedures had already been scheduled.

Fig 8. Posttreatment intraoral photographs show that the teeth are properly aligned, the gingiva harmonious, and the texture matches the neighboring teeth.

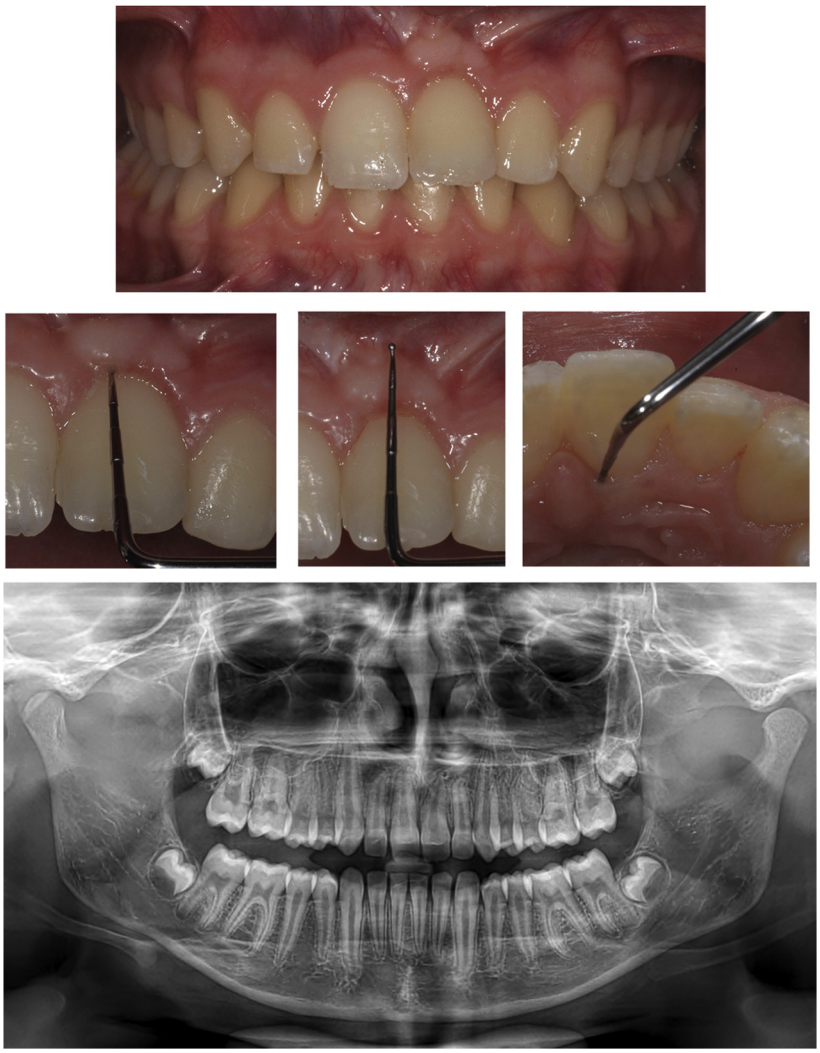

Fig 9. Two-year follow-up. **A,** keratinized gingival width (3 mm); **B-D,** clinical probing depth from 1 to 2 mm. **E,** final panoramic radiograph shows the root of the dilacerated tooth increased in length, and no incisor root resorption is evident.

The last panoramic x-ray did not show any damage or shortening of the roots of the adjacent incisors. This positive outcome can be attributed to the light, continuous force and reinforced anchorage because the permanent incisors were not used as anchorage for the forced eruption.[7,27]

Long-term follow-up of the dilacerated tooth and adjacent teeth has rarely been reported in the literature.[4] In a sample of 10 patients treated with the apically repositioned flap technique or closed eruption, the periodontal parameters (ie, clinical attachment level, probing depth, and soft-tissue recession were the same as in natural teeth at the 5-year follow-ups).[28]

The closed eruption was chosen as the first surgical approach to preserve the patient's healthy gingiva.[29-31]

A second interceptive mucogingival surgery was performed as the tooth approached its location to the arch, and the incisal edge of the dilacerated tooth was visible through the extremely thin alveolar mucosa (Fig 5). An apically positioned flap made it possible to move the attached gingiva labially and offer a good profile of the mucogingival junction in the area.[32,33]

Two surgical exposures are typically required in patients with a dilaceration.[4] The first surgery only permits exposure. The second is necessary to prevent the incisal edge from breaking through the alveolar mucosa while obtaining an appropriate amount of attached gingiva on the labial side of the exposed tooth.

The complete absence of keratinized gingiva on the labial surface of a tooth can make the area more susceptible to gingival recession and is quite unaesthetic. The apically positioned flap technique is an effective procedure for increasing the dimensions of attached gingiva.[33]

Because the effects on the pulp may not become evident for months or even years, periodic checks of vitality are necessary.

CONCLUSIONS

In the management of an ectopic and dilacerated central incisor, the treatment began in the mixed dentition. A modified palatal arch was attached to the molars as anchorage for the forced eruption of the dilacerated tooth to avoid excessive force and the intrusion of the adjacent teeth after a short initial phase (3 weeks) in which anchorage had been provided by the archwire. The roots of the dilacerated tooth and the adjacent teeth did not show any sign of resorption at the end of the forced eruption.

The first surgical session allowed for the closed eruption, and the second contributed to an optimal periodontal outcome.

In this case, the tooth was vital at the end of the treatment, and the apex was covered by alveolar mucosa. The periodontium was healthy and esthetically acceptable at the 2-year follow-up.

Long-term monitoring of the stability and periodontal health of the dilacerated incisor is required after forced orthodontic eruption. Further research is needed to assess the advantages of this combined surgical-orthodontic treatment.

ACKNOWLEDGMENTS

The authors thank Carlo Clauser, the oral surgeon who performed the surgical treatment.

REFERENCES

1. Andreasen JO. The impacted incisor. In: Andreasen JO, Petersen JK, Laskin DM, editors. Textbook and color atlas of tooth impactions: diagnosis, treatment, prevention. Munksgaard: Copenhagen; 1997. p. 113-24.
2. Grover PS, Lorton L. The incidence of unerupted permanent teeth and related clinical cases. Oral Surg Oral Med Oral Pathol 1985;59:420-5.
3. Vermette ME, Kokich VG, Kennedy DB. Uncovering labially impacted teeth: apically positioned flap and closed-eruption techniques. Angle Orthod 1995;65:23-32: discussion 33.
4. Chaushu S, Becker T, Becker A. Impacted central incisors: factors affecting prognosis and treatment duration. Am J Orthod Dentofacial Orthop 2015;147:355-62.
5. McNamara T, Woolfe SN, McNamara CM. Orthodontic management of a dilacerated maxillary central incisor with an unusual sequela. J Clin Orthod 1998;32:293-7.
6. Chang NY, Park JH, Kim SC, Kang KH, Cho JH, Cho JW, et al. Forced eruption of impacted maxillary central incisors with severely dilacerated roots. Am J Orthod Dentofacial Orthop 2016;150:692-702.
7. Hu H, Hu R, Jiang H, Cao Z, Sun H, Jin C, et al. Survival of labial inversely impacted maxillary central incisors: a retrospective cone-beam computed tomography 2-year follow-up. Am J Orthod Dentofacial Orthop 2017;151:860-8.
8. Sun H, Wang Y, Sun C, Ye Q, Dai W, Wang X, et al. Root morphology and development of labial inversely impacted maxillary central incisors in the mixed dentition: a retrospective cone-beam computed tomography study. Am J Orthod Dentofacial Orthop 2014;146:709-16.
9. Uematsu S, Uematsu T, Furusawa K, Deguchi T, Kurihara S. Orthodontic treatment of an impacted dilacerated maxillary central incisor combined with surgical exposure and apicoectomy. Angle Orthod 2004;74:132-6.
10. Wei YJ, Lin YC, Kaung SS, Yang SF, Lee SY, Lai YL. Esthetic periodontal surgery for impacted dilacerated maxillary central incisors. Am J Orthod Dentofacial Orthop 2012;142:546-51.
11. Becker A, Chaushu G, Chaushu S. Analysis of failure in the treatment of impacted maxillary canines. Am J Orthod Dentofacial Orthop 2010;137:743-54.
12. Cao L. Treatment of impacted dilacerated maxillary central incisors. Am J Orthod Dentofacial Orthop 2013;143:4-5.
13. Chandhoke TK, Agarwal S, Feldman J, Shah RA, Upadhyay M, Nanda R. An efficient biomechanical approach for the

management of an impacted maxillary central incisor. Am J Orthod Dentofacial Orthop 2014;146:249-54.
14. Stewart DJ. Dilacerate unerupted maxillary central incisors. Br Dent J 1978;145:229-33.
15. De Grauwe A, Ayaz I, Shujaat S, Dimitrov S, Gbadegbegnon L, Vannet BV, et al. CBCT in orthodontics: a systematic review on justification of CBCT in a paediatric population prior to orthodontic treatment. Eur J Orthod 2019;41:381-9.
16. The SEDENTEXCT Project. Radiation protection no 172: cone beam CT for dental and maxillofacial radiology. Luxembourg: European Commission; 2012.
17. Becker A, Chaushu S. Success rate and duration of orthodontic treatment for adult patients with palatally impacted maxillary canines. Am J Orthod Dentofacial Orthop 2003;124:509-14.
18. Zuccati G, Ghobadlu J, Nieri M, Clauser C. Factors associated with the duration of forced eruption of impacted maxillary canines: a retrospective study. Am J Orthod Dentofacial Orthop 2006;130:349-56.
19. Bhikoo C, Xu J, Sun H, Jin C, Jiang H, Hu R. Factors affecting treatment duration of labial inversely impacted maxillary central incisors. Am J Orthod Dentofacial Orthop 2018;153:708-15.
20. Ho KH, Liao YF. Predictors of surgical-orthodontic treatment duration of unilateral impacted maxillary central incisors. Orthod Craniofac Res 2011;14:175-80.
21. Nucera R, Lo Giudice A, Rustico L, Matarese G, Papadopoulos MA, Cordasco G. Effectiveness of orthodontic treatment with functional appliances on maxillary growth in the short term: a systematic review and meta-analysis. Am J Orthod Dentofacial Orthop 2016;149:600-11.e3.
22. Han G, Huang S, Von den Hoff JW, Zeng X, Kuijpers-Jagtman AM. Root resorption after orthodontic intrusion and extrusion: an intraindividual study. Angle Orthod 2005;75:912-8.
23. Weltman B, Vig KWL, Fields HW, Shanker S, Kaizar EE. Root resorption associated with orthodontic tooth movement: a systematic review. Am J Orthod Dentofacial Orthop 2010;137:462-76: discussion 12A.
24. Kang YG, Kim JY, Nam JH. Control of maxillary dentition with 2 midpalatal orthodontic miniscrews. Am J Orthod Dentofacial Orthop 2011;140:879-85.
25. Skeggs RM, Benson PE, Dyer F. Reinforcement of anchorage during orthodontic brace treatment with implants or other surgical methods. Cochrane Database Syst Rev 2007;CD005098.
26. Benson PE, Tinsley D, O'Dwyer JJ, Majumdar A, Doyle P, Sandler PJ. Midpalatal implants vs headgear for orthodontic anchorage–a randomized clinical trial: cephalometric results. Am J Orthod Dentofacial Orthop 2007;132:606-15.
27. Arriola-Guillén LE, Ruíz-Mora GA, Rodríguez-Cárdenas YA, Aliaga-Del Castillo A, Dias-Da Silveira HL. Root resorption of maxillary incisors after traction of unilateral vs bilateral impacted canines with reinforced anchorage. Am J Orthod Dentofacial Orthop 2018;154:645-56.
28. Farronato G, Giannini L, Galbiati G, Maspero CA. A 5-year longitudinal study of survival rate and periodontal parameter changes at sites of dilacerated maxillary central incisors. Prog Orthod 2014;15:3-8.
29. Crescini A, Clauser C, Giorgetti R, Cortellini P, Pini Prato GP. Tunnel traction of infraosseous impacted maxillary canines. A three-year periodontal follow-up. Am J Orthod Dentofacial Orthop 1994;105:61-72.
30. Becker A, Brin I, Ben-Bassat Y, Zilberman Y, Chaushu S. Closed-eruption surgical technique for impacted maxillary incisors: a postorthodontic periodontal evaluation. Am J Orthod Dentofacial Orthop 2002;122:9-14.
31. Kajiyama K, Kai H. Esthetic management of an unerupted maxillary central incisor with a closed eruption technique. Am J Orthod Dentofacial Orthop 2000;118:224-8.
32. Giorgetti R, Pini Prato GP, Fuso A, Nieri S, Cortellini P, Clauser C. Patologia pulpare dei molari decidui ed eruzione dei premolari. Studio longitudinale. Ortognatodonzia Italiana 1993;2:329-33.
33. Pini-Prato G, Mancini EA, Papini O, Crescini A. Mucogingival approaches in young orthodontic patients: combined strategies for success. Semin Orthod 2014;20:150-69.