Atypical extraction treatment for failing replanted maxillary and mandibular incisors with space closure of 2 mandibular incisors in the same quadrant

Ute Schneider[a,b] and Lorenz Moser[a,b]
Bolzano and Ferrara, Italy

We report the successful orthodontic treatment of a 13-year-old girl who had been involved in an accident with avulsion of her maxillary right central incisor and both mandibular left incisors. Fifteen months after replantation of the teeth, all showed severe root resorption with apical inflammation and had to be extracted. After compensatory removal of the maxillary left central incisor, all 4 extraction sites were closed within 20 months of active orthodontic treatment to avoid implant-prosthodontic replacement. By sequential extraction of the 2 hopeless replanted equilateral mandibular left incisors and common-sense management of straightwire mechanics, it was possible to move the right central incisor across the mandibular midline and close the large space completely. To our knowledge, no case report about orthodontic closure of 2 adjacent extraction spaces in the same quadrant has been published. (Am J Orthod Dentofacial Orthop 2020;157:117-27)

Dental trauma comprises 5% of all injuries for which people seek treatment, affecting 1 out of 4 schoolchildren and 1 out of 3 adults, mostly before the age of 20 years.[1,2]

Predisposing factors are an increased overjet as a result of protrusive maxillary incisors and lip incompetence. Tooth avulsions occur in 0.5%-16% of all dental injuries, mainly in the maxillary incisor area, and the prognosis depends mainly on the actions taken at the site of the accident and immediately after the avulsion.[1,3] Root maturation and the vitality of the periodontal ligament are the 2 key factors for long-term success after tooth replantation, but the recommended clinical guidelines are merely based on available information from case series and expert opinions.[4-7]

Although tooth survival rates of 83.3% after a median follow-up period of 2.8 years, and of 70% after a mean observation time of 5.1 years, are reported, periodontal healing occurs only in 50% and 24%, respectively, without external root resorption.[8,9] Even if the replanted teeth can be preserved for several years, ankylosis after replacement-related resorption is a common long-term sequela, leading to infraocclusion and, finally, to the loss of the affected tooth.[10-13] Apart from an unesthetic dental appearance of infraocclusion, a deficient bony implant site after surgical removal of the ankylosed tooth can be a serious problem, particularly in the esthetic zone, which requires subsequent complex and expensive interdisciplinary treatment with relatively unpredictable outcomes.[14-17] A viable treatment option for patients with tooth avulsions or with failing replanted incisors is to close the spaces orthodontically to avoid the looming sequelae of replacement-related resorption and ankylosis with infraocclusion over time.

This case report presents a patient with 3 failing replanted avulsed incisors and atypical orthodontic treatment with space closure.

DIAGNOSIS AND ETIOLOGY

A 13-year-old healthy adolescent girl presented to the authors' orthodontic office with the chief complaint of an unesthetic dental appearance and the fear of losing her previously traumatized maxillary and mandibular incisors. During a severe sledge accident that had occurred 15 months ago, she had fractured her left condyle and

[a]Department of Orthodontics, University of Ferrara, Ferrara, Italy.
[b]Private practice, Bolzano, Italy.
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Address correspondence to: Ute Schneider, City Center, Via Alto Adige 40, Bolzano 39100, Italy; e-mail, ute.moser@brennercom.net or info@perfect-smile.it.
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her mandible twice, with concomitant complete luxation of her maxillary right central incisor and both mandibular left incisors. She had received surgical treatment of the osseous fragments with a fixation splint and wire osteosynthesis, and the 3 avulsed teeth had been replanted without any endodontic treatment and stabilized with bonded lingual retainers. After 2 months, the fixation splint was discontinued and, after a total of 12 months, the osteosynthesis material was also removed. Since the accident, the patient had noted a mandibular deviation to the left side where she had fractured the condyle, and a limitation of her maximum bite opening, but without any other functional impairment or pain.

Within a year, the replanted teeth developed recurrent severe root resorptions and apical infections. The patient visited several dental specialists, who advised to postpone any therapy until end of the growth period without touching the affected teeth, and to then surgically remove and substitute them with subsequent implant-borne crowns. Most specialists had pointed out that the final esthetic treatment outcome was unpredictable owing to the unforeseeable amount of bony defect after surgical extraction of the ankylosed teeth. Two specialists had advised the parents to consult an orthodontist for evaluation of an alternative treatment plan.

Clinically, the patient's profile was convex, and the frontal view showed a slight facial asymmetry with vertical maxillary excess and minor lip incompetency. The functional examination revealed reduced maximum mouth opening with a 6-mm deviation to the left, but without any joint noises or reported pain. A bilateral Class I occlusion with moderate crowding, bimaxillary protrusion, an increased overjet of 5 mm, and an open bite of −1 mm was present (Fig 1). Furthermore, analysis of the dental casts revealed accentuated curves of Spee and accentuated maxillary curve of Wilson (Fig 2).

A maxillary lingual 2-2 retainer had been bonded after dental trauma for stabilization of the traumatized maxillary incisors. Apical fistulae with pus were observed in the vestibulum of the maxillary right and the mandibular left central incisor (Fig 3). A vitality test of the maxillary left central incisor was negative. Periapical radiographs showed, in more detail, the severe ongoing internal and external root resorptions of the 3 replanted incisors (Fig 4). The panoramic radiograph revealed ongoing severe root resorptions with apical infections of the avulsed and replanted maxillary right central incisor and of both mandibular left incisors. The left condyle had undergone almost complete resorption and deformation as a result of the previous fracture. The cephalometric analysis assessed a skeletal Class II malocclusion (ANB = 8°) with hyperdivergent vertical features (MP/SN = 47°), mandibular retrusion (SNB = 72°), and short mandibular length of 47 mm, with decreased chin projection (Pg-NA perp = −14°). The maxillary and mandibular incisors were severely proclined (U1-APg = 11°, L1-APg = 6.5°, and L1-OP = 56°), with a reduced interincisal angle of 107° (Fig 5).

TREATMENT OBJECTIVES

The patient was diagnosed with hyperdivergent Class II malocclusion with bimaxillary protrusion and crowding, and 3 hopeless ankylosed incisors with ongoing root resorptions. The treatment objectives were to (1) extract the hopeless teeth and close the spaces to avoid implant-borne crowns, (2) correct the bimaxillary protrusion and the arch length discrepancy, with normalization of the overjet and overbite, and (3) improve lip competence and smile esthetics.

TREATMENT ALTERNATIVES

Several procedures were explored to achieve an acceptable occlusion and an improvement of dental and facial esthetics. Because the patient presented a hyperdivergent facial pattern combined with bimaxillary protrusion and crowding, a 4 first premolar extraction treatment would have been the first treatment choice. Alternatively, a 4 first molar extraction therapy because of the deep restorations could have been another option. Nevertheless, none of these conventional extraction approaches would have eliminated the need for either implant-borne crowns or fixed bridgework as substitutions of the 3 hopeless incisors. As the 13-year-old patient was still in puberty, she would have required temporary substitutions (eg resin–bonded bridges) during the entire growth period before insertion of any implant would have been possible. Owing to the precarious condition of the maxillary right central incisor, the mandibular left central and lateral incisors, and the loss of sensitivity of the maxillary left central incisor, it seemed more appropriate to extract these hopeless teeth with subsequent orthodontic closure of the spaces. Although it would have been possible to treat the nonvital maxillary left central incisor endodontically and to extract the maxillary left first premolar instead, the long-term prognosis of the incisor would have remained uncertain.

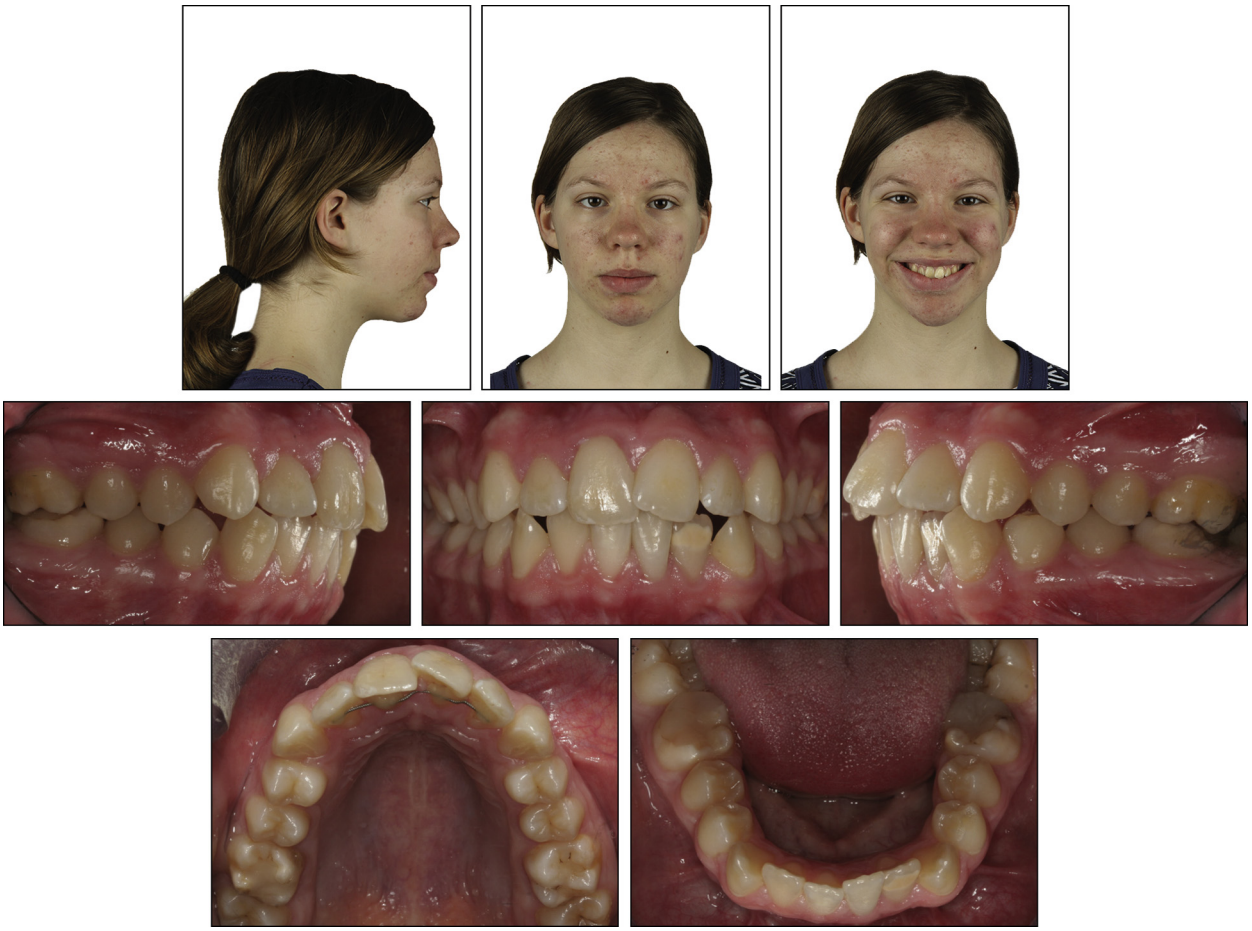

Fig 1. Pretreatment facial and intraoral photographs.

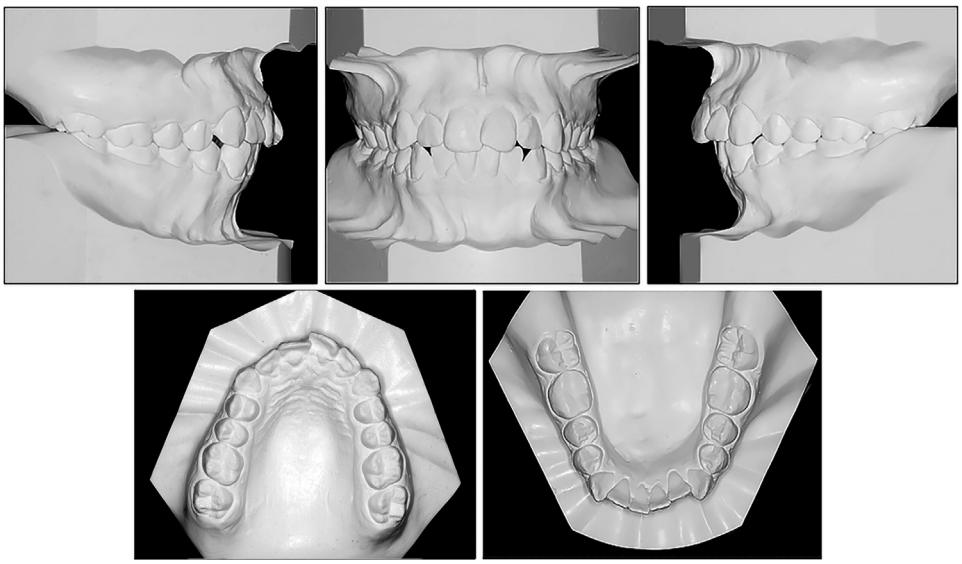

Fig 2. Initial dental casts.

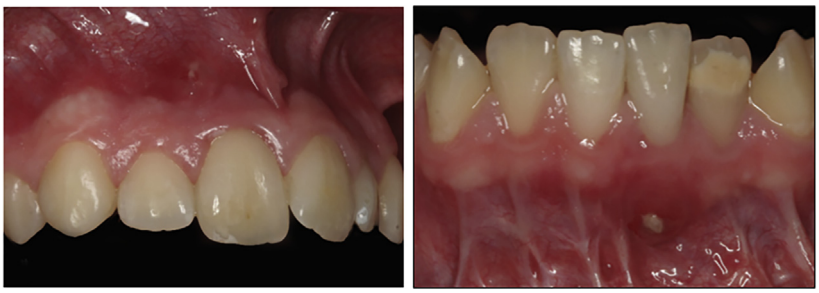

Fig 3. Apical fistulae of the maxillary right and mandibular left central incisor.

Fig 4. Severe ongoing root resorptions of the maxillary right central incisor and both mandibular left incisors.

The most challenging issue of this treatment approach was to extract 2 teeth in the same quadrant (both mandibular left incisors) and to move the mandibular right central incisor across the mandibular midline to the left, so that the new mandibular midline would be between the right central and the right lateral incisor. A digital setup was performed for a previsualization of the intended treatment outcome using ClinCheck Software (Align Technology, Santa Clara, Calif) (Fig 6). To our knowledge, no case report with space closure after extraction of 2 teeth in the same quadrant has been published in the orthodontic literature to date.

The patient and her parents were informed that this treatment plan included at least reshaping and bleaching of all 4 canines, a gingivectomy of the mesialized maxillary first premolars and the lateral incisors, and composite restorations of the maxillary lateral incisors to achieve a stable and functional result and to enhance dental esthetics. A more sophisticated prosthodontic approach with 6 ceramic laminates could further improve the esthetic outcome in the long term.

By mesializing the maxillary and mandibular dentition, adequate space for eruption of the third molars could be gained, so that the patient would finally end up with 28 permanent teeth.

TREATMENT PROGRESS

The mandibular first molars received conservative treatment and the mandibular left lateral incisor was treated endodontically, as this tooth would only be extracted after complete closure of the lower left central incisor extraction site. Both maxillary central incisors and the mandibular left central incisor were extracted on the day before full bonding of maxillary and mandibular 0.018-inch straightwire appliances (Roth). The extracted maxillary central incisors were temporarily substituted by denture teeth inserted in the fixed appliance. Sequential leveling, aligning, and space closure with 0.014-, 0.016-, 0.016 × 0.022-inch nickel-

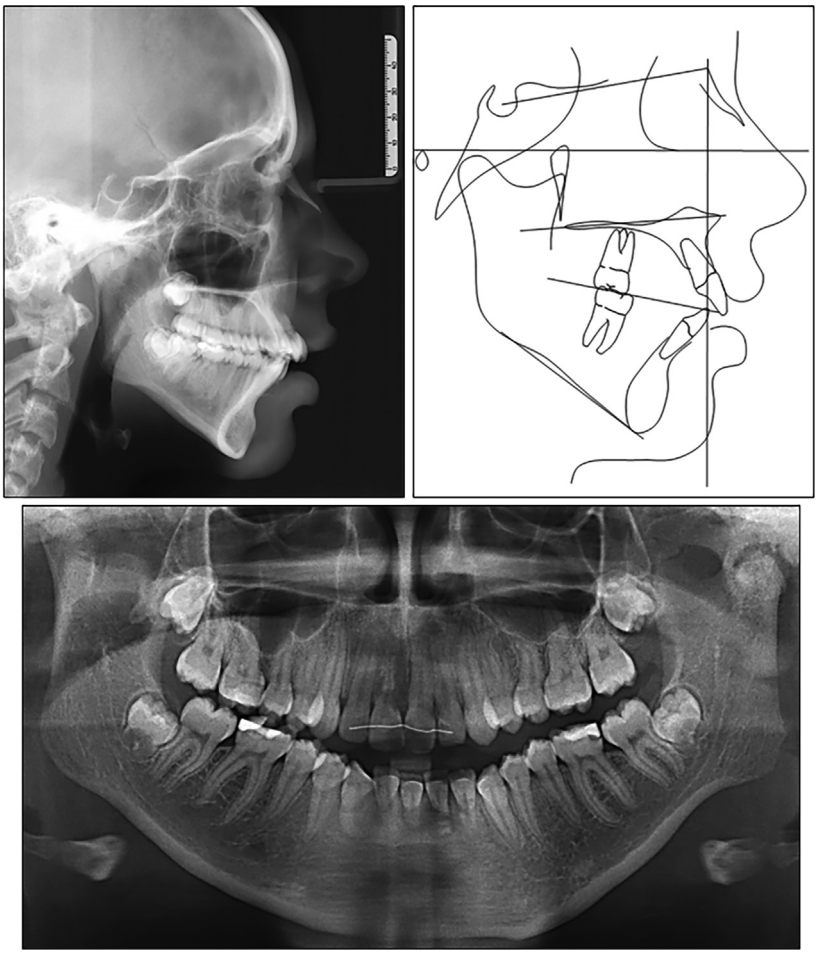

Fig 5. Initial panoramic radiograph, lateral cephalometric radiograph, and tracing.

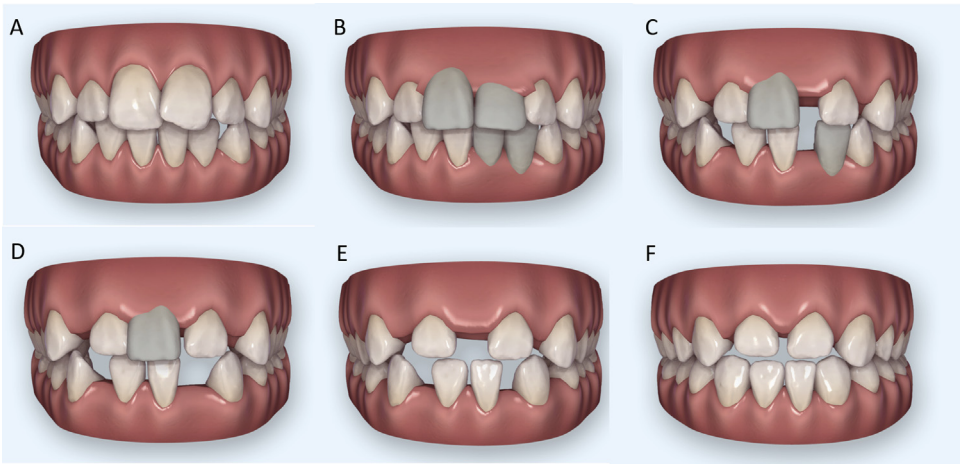

Fig 6. Digital setup for previsualization of the intended treatment result.

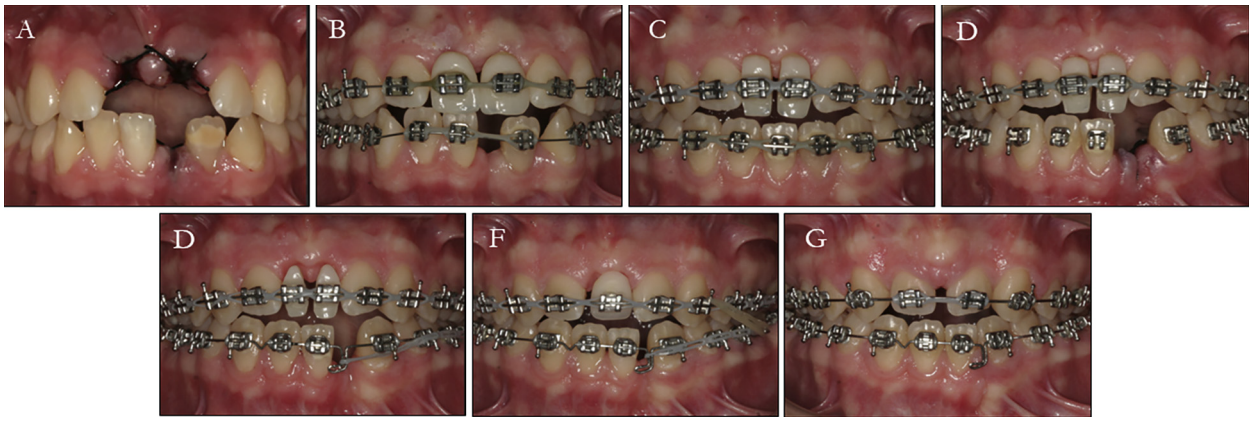

Fig 7. Sequential intraoral photographs illustrating progressive space closure.

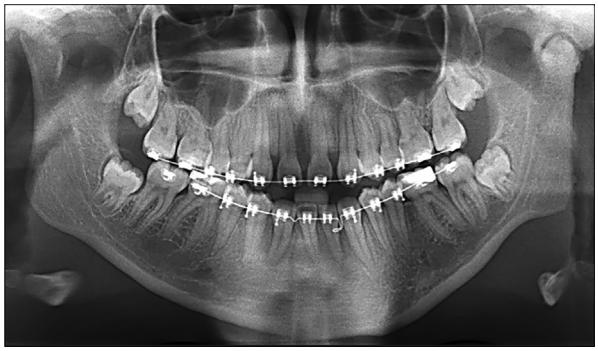

Fig 8. Panoramic radiograph for control of root parallelism during the finishing stage.

Fig 9. Deliberate intrusion of the mesialized lateral incisors and space distribution for subsequent composite restorations.

Fig 10. Gingivectomy of the maxillary first premolars and lateral incisors.

titanium archwires and 0.016 × 0.022-inch stainless steel archwires and intramaxillary elastic traction took 7 months until the mandibular space was completely closed. Only then was the mandibular left lateral incisor removed and a custom-made 0.016 × 0.022-inch stainless steel closing-loop archwire tied in. Furthermore, a Class II elastic on the left side to slip anchorage was necessary for space closure of the secondarily extracted mandibular left lateral incisor (Fig 7). Toward the end of active treatment, a panoramic radiograph was taken to check for satisfactory root parallelism, and several brackets were rebonded (Fig 8). Finishing procedures were performed with 0.016-inch nickel-titanium archwires and open coil springs between the maxillary lateral incisors and the canines to achieve a better distribution of the spaces, and sequential tooth reshaping of all 4 canines was performed (Fig 9). After a total treatment time of 20 months, the appliances were removed, a mild gingivectomy of the mesialized maxillary first premolars and lateral incisors was carried out, and composite restorations were performed (Fig 10). Lingual 3-3 retainers were bonded in both arches, and the patient received 2 Hawley retainers for nighttime wear.

TREATMENT RESULTS

The posttreatment extraoral photographs show that lip competence and chin projection was considerably

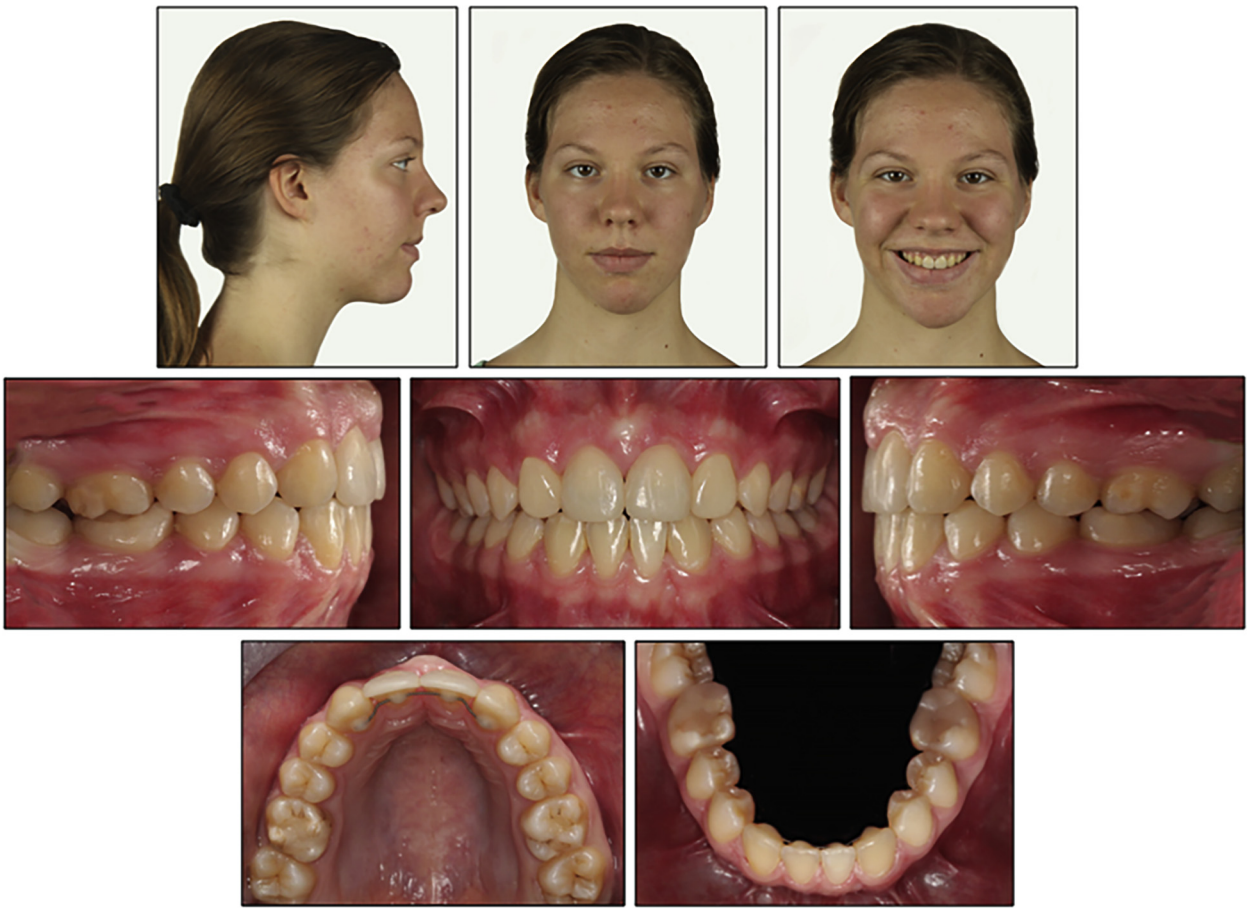

Fig 11. Posttreatment facial and intraoral photographs.

improved. However, the nasolabial angle became more obtuse because of the retraction of the maxillary incisors. A slight facial asymmetry is still present, but the smile arc is consonant and the smile line is harmonious.

The pre-existing limited mouth opening of 35 mm could not be improved by treatment because of the persistence of the traumatic condylar remodeling, but the patient does not report any subjective impairment.

A solid bilateral Class I occlusion has been achieved with normal overjet and overbite. A slight 0.5-mm mandibular dental midline deviation to the left is noticeable. The maxillary first premolars have not been transformed into canines because the parents refused to grind the palatal cusps. The dental arches are well aligned and leveled, with complete closure of all extraction sites. After extraction of both mandibular left incisiors, the spaces were totally closed while maintaining the intercanine and inter–first premolar width. No archform asymmetry can be assessed, although 2 homolateral incisors were extracted. The previously observed steep curves of Spee have been completely leveled, and the maxillary curve of Wilson has been flattened (Figs 11 and 12).

In the panoramic radiograph, all extractions sites have been closed without any major root resorptions while achieving good parallelism of the adjacent teeth, except for the lower right lateral incisor, which seems to be insufficiently made upright. In fact, this is as a result of an abnormal crown-root angulation. The third molars have enough space for eruption but require long-term monitoring. No particular change took place at the left condyle during treatment (Fig 13).

The posttreatment cephalometric evaluation showed a mild improvement of the ANB angle (8°-6°) because of retraction of the maxillary incisors and remodeling of the A-point. The vertical dimension did not increase with treatment. Considerable retraction of the maxillary and mandibular incisors occurred (114°-101° and 97°-89°, respectively), which helped to improve lip competence and chin projection, but has inevitably increased the nasolabial angle (108°-118°) (Fig 14; Table).

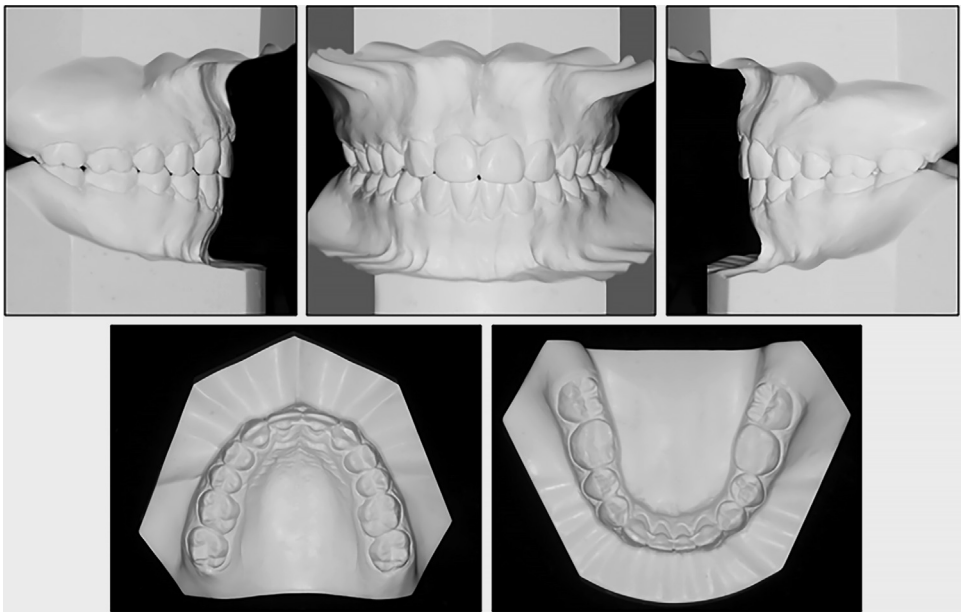

Fig 12. Posttreatment dental casts.

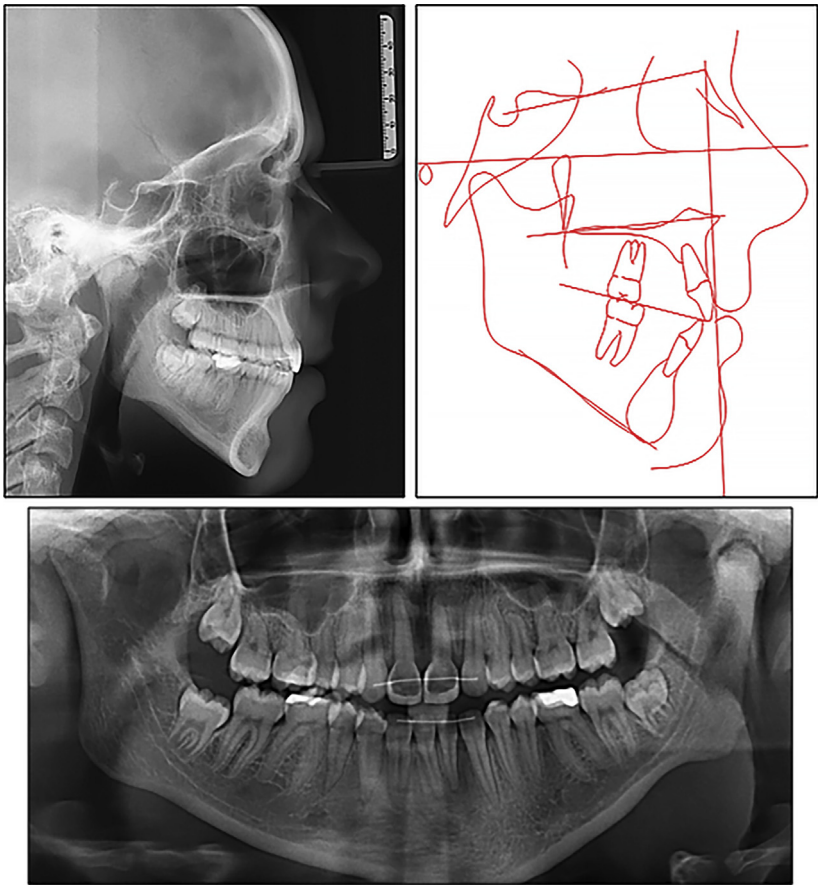

Fig 13. Posttreatment lateral radiograph with cephalometric tracing and panoramic radiograph.

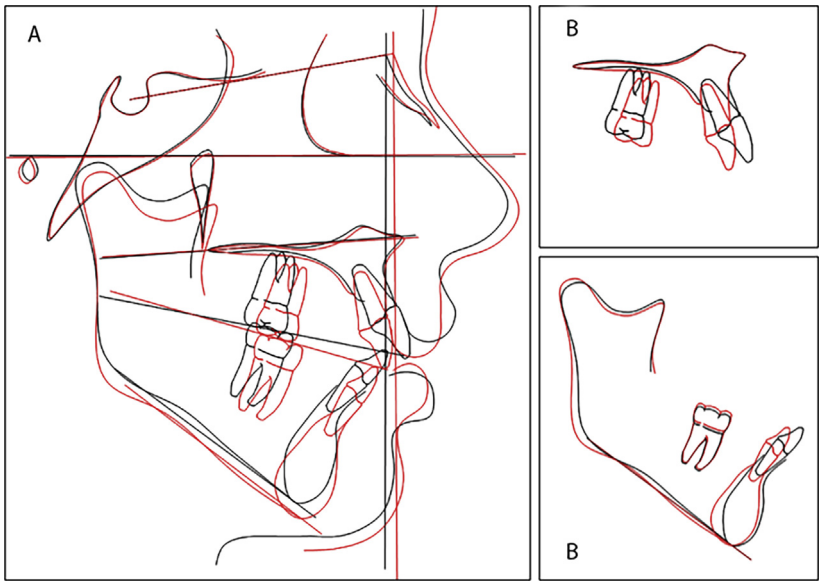

Fig 14. Superimposition tracing before (*black line*) and after treatment (*red line*): **A,** cranial base superimposition; **B,** maxillary superimposition; and **C,** mandibular superimposition.

Table. Cephalometric summary

Variable	*Mean ± SD*	*Preteatment*	*Posttretament*
SNA (°)	82 ± 3.5	80	78
SNB (°)	81 ± 3.5	72	72
SN-Pg (°)	80 ± 3.5	73	73
ANB (°)	2 ± 2.5	8	6
±	−1 ± 1	4.5	0
NA-APg convexity (°)	4 ± 2	14	11.5
Pg-NB (mm)	3 ± 1.5	2	5
S-N/Go-Gn (°)	33 ± 6.0	42	40
SN/OP (°)	14.5 ± 2.5	22	26
ANS-PNS/Go-Gn (°)	25 ± 6	36	34
U1/SN (°)	102 ± 5	108	97
U1/NA (°)	23 ± 6	29	17
U1/NA (mm)	4.5 ± 3	6	1
L1/NB (°)	25 ± 6.0	37	28
L1/NB (mm)	4 ± 2	10	7
IMPA (°)	95 ± 5	98	89
L1/A-Pg (mm)	1 ± 2	6	3
Overjet (mm)	2.5 ± 2.5	5.5	2
Overbite (mm)	2.5 ± 2.5	1	1
Interincisal angle (°)	130 ± 6	107	127
ST-convexity (°)	12 ± 2	18	16
LL-E-plane (mm)	−2 ± 2	1.5	−3
UL-E-plane (mm)	−5 ± 2	−2	−6

DISCUSSION

The present atypical treatment approach, with extraction of the failing avulsed and replanted maxillary right central incisor and both mandibular left incisors after compensatory extraction of the maxillary left central incisor and space closure of all extraction sites, can be considered a success. Excellent arch symmetry has been achieved with this very unorthodox extraction protocol. All hopeless teeth were eliminated so that the patient benefits from a natural dentition with a very favorable long-term prognosis now, avoiding the necessity for future bridgework or implant-borne crowns in the sensitive esthetic zone. Moreover, a solid bilateral Class I occlusion (with the maxillary and mandibular premolars functioning as canines) was established.

The ad hoc composite restorations of the mesialized maxillary lateral incisors were intended to be only a temporary solution, and we recommended to substitute them with feldspathic or disilicate ceramic veneers. However, neither the patient nor her parents were interested in any further prosthodontic enhancement of the achieved result.

We are aware that treatment was aimed only at resolving the patient's severe dental problem and that no effort has been made to correct the skeletal discrepancies. A combined orthodontic-orthognathic treatment approach was not considered a viable treatment option by the patient and her parents.

Retention records taken almost 7 years after the end of orthodontic treatment reveal excellent stability of the achieved result with a solid bilateral Class I occlusion and normal overjet and overbite (Fig 15). Mouth opening is still limited to 35 mm with a 5-mm mandibular deviation to the left side, but it is asymptomatic.

Fig 15. Facial and intraoral photographs at the 7-year follow-up.

All third molars have fully erupted so that the patient can benefit from a full 28-tooth dentition in the future. The gingival conditions appear healthy, but a surgical crown-lengthening procedure coupled with indirect ceramic veneers could improve both the crown-root anatomy and the gingival contour in the future.[18,19]

CONCLUSIONS

Orthodontic space closure after incisor trauma with avulsion, or after extraction of failing replanted incisors, is a valid treatment option to tooth substitution with implant-borne crowns, especially considering long-term problems such as infraocclusion or resorption of peri-implant hard and soft tissues.[20-24]

The present case report should also serve as an exemplary illustration of the fact that even a very challenging asymmetrical space closure protocol can by managed by using simple treatment mechanics (straightwire appliances with intra- and intermaxillary elastics), without the need for temporary anchorage devices or accelerated orthodontics. Common-sense diagnosis, individual treatment planning, and correct appliance management should prevail in our quest for excellence, especially as sound scientific evidence for the overall reduction of treatment time using these devices is still lacking.[25-28]

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