Case Report

Unilaterally impacted maxillary central incisor and canine with ipsilateral transposed canine-lateral incisor

Po-Sung Fu[a]; Jen-Chyan Wang[b]; Yi-Min Wu[b]; Ta-Ko Huang[c]; Wen-Cheng Chen[d]; Yu-Chuan Tseng[c]; Chin-Huang Tseng[e]; Chun-Cheng Hung[f]

ABSTRACT

Concurrent impaction and transposition of maxillary anterior teeth is uncommon and poses a challenge for dentists. Early diagnosis and management of eruption disturbances benefits esthetic and functional outcomes. This article describes the treatment of a teenager who had impactions of the left maxillary central incisor and canine as well as ipsilateral canine-lateral incisor transposition. Treatment alternatives and effective orthodontic techniques are delineated. To optimize the treatment results, the impacted maxillary canine was surgically exposed and orthodontically distalized with an innovative cantilever. Subsequently, the deeply impacted maxillary central incisor was uncovered and orthodontically mesialized into the arch. Finally, the displaced maxillary lateral incisor was brought into its normal position. The combined surgical-orthodontic approach resolved a difficult clinical issue and avoided additional restorations. An esthetic, functional outcome was achieved and satisfied the patient. (*Angle Orthod.* 2013;83:920–926.)

KEY WORDS: Impaction; Transposition; Orthodontic; Cantilever

INTRODUCTION

Impaction is defined as failure of a tooth to appropriately emerge into the dental arch after the normal age of eruption.[1] Second to third molar impaction, maxillary canine impaction, exhibits the highest 1% to 3% incidence, with a 2:1 female to male ratio.[2] However, maxillary central incisor impaction is uncommon, with a prevalence rate of 0.06% to 0.2%.[3] Potential causes related to impaction are divided into systemic and local factors. Crowding, the presence of eruption obstacles, the abnormal position of the tooth bud, prolonged retention or early loss of a deciduous tooth, dental trauma, and ankylosis are proposed as local factors for tooth impaction.[4–6] Among the systemic factors, cleidocranial dysplasia is the most common syndrome for tooth impaction.[7] Recently, mutation in parathyroid hormone receptor 1 has also been identified as an etiologic factor.[8]

Tooth transposition is defined as the positional interchange of two adjacent teeth within the same quadrant.[9,10] It is a rare condition with a prevalence of 0.09% to 1.4%, and a maxillary canine is the most commonly involved tooth.[10–12] Unilateral canine transposition occurs more frequently, and the left side is more commonly affected. Bilateral transposition has been reported in only 5% of the cases.[13,14] The most frequent type of transposition (55%–70%) is that of a maxillary canine and a first premolar. Maxillary canine-lateral incisor transposition is the second most common type (20%–42%), while maxillary canine-central incisor transposition is the unusual form (2%).[13–15]

Although the cause of transposition remains unclear, some etiologic factors such as trauma, genetics, interchange in the position of the developing tooth buds, mechanical interferences, and early loss or prolonged retention of deciduous teeth have been related to tooth transposition.[10–15] Besides, hypodontia,

[a] Visiting staff, Department of Family Dentistry, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan, ROC.
[b] Associate Professor, School of Dentistry, College of Dental Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan, ROC.
[c] Assistant Professor, School of Dentistry, College of Dental Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan, ROC.
[d] Associate Professor, Department of Fiber and Composite Materials, Feng Chia University, Taichung, Taiwan, ROC.
[e] Private practice, Kaohsiung, Taiwan, ROC.
[f] Professor, School of Dentistry, College of Dental Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan, ROC.
Corresponding author: Dr Chun-Cheng Hung, Department of Prosthodontics, Kaohsiung Medica University Hospital, 100 Tzyou 1st Road, Kaohsiung, Taiwan 80756, ROC
(e-mail: yuchali@ms21.hinet.net)

Accepted: February 2013. Submitted: January 2013.
Published Online: April 5, 2013

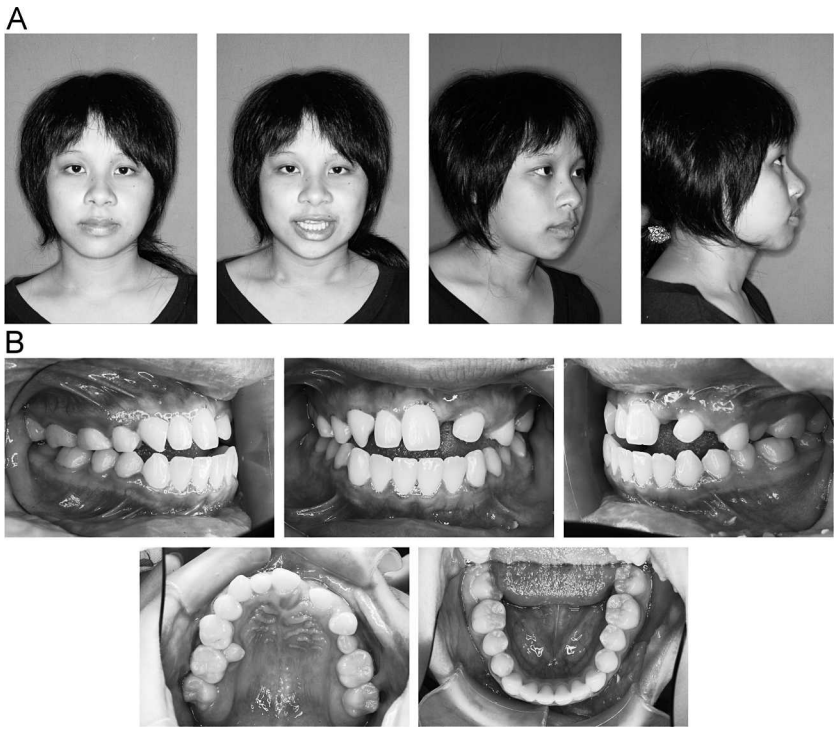

Figure 1. Pretreatment facial (A) and intraoral (B) photographs.

submerged deciduous teeth, supernumerary teeth, and third molar agenesis are considered as associated dental anomalies with transposition.[16]

There are different options about treating an impaction or a transposition. Tooth extraction, surgical reposition, surgical-orthodontic approach, and dental implant replacement all have been proposed.[1,5–7,13–15] The aim of this article was to present a case in which the combined surgical-orthodontic therapy had successfully guided the impacted left maxillary central incisor and canine to the dental arch. An innovative cantilever and mechanics simplified the reversion of the transposed canine-lateral incisor without periodontal complications. Besides, the anterior open bite and crossbite were corrected. This treatment modality had resolved a complicated malocclusion, avoided post-orthodontic restorations, and improved the esthetics as well as functions.

CASE REPORT

A 17-year-old girl, with delayed eruption of the left maxillary central incisor and canine (teeth 21 and 23) sought treatment for the impactions and malaligned teeth. She suffered dental trauma to the anterior maxilla at the age of 4 years, which resulted in the loss of the left maxillary deciduous central incisor (tooth 61). Review of the patient's medical and family histories revealed no significant findings. The patient presented a Class I malocclusion with an anterior open bite and crossbite. A slightly convex profile with mild chin asymmetry to the right side was noted. Her maxillary and mandibular dental midlines were displaced 2 mm to the left and 3 mm to the right of the facial midline, respectively. All of the permanent teeth had erupted except teeth 21 and 23 and the third molars. Prolonged retention of the right maxillary deciduous second molar (tooth 55) and anomalous maxillary second premolars (teeth 15 and 25) were also observed (Figure 1). Pretreatment panoramic and cephalometric radiographs revealed the overlapped impactions of teeth 21 and 23 as well as the transposition of teeth 23 and 22 (Figure 2). The root formation of the impacted teeth 21 and 23 had completed, while tooth 22 had a dilacerated root. Cephalometric analysis indicated a Class I skeletal pattern with a high mandibular plane angle. The L1 to MP angle of 102° reflected proclination of the mandibular incisors (Table 1). To better assess the positions of the impacted teeth 21 and 23 relative to the root of tooth 22, a cone-beam computed tomography (CBCT) scan was performed (Figure 3).

With regard to the impacted teeth 21 and 23 as well as the transposed teeth 23 and 22, the following treatment alternatives were considered: (1) staged surgical exposure of the impacted teeth 23 and 21 followed by orthodontic space opening, traction, and correction of the transposed teeth 23 and 22; (2) staged surgical exposure of the impacted teeth 23 and 21 followed by orthodontic space opening and traction,

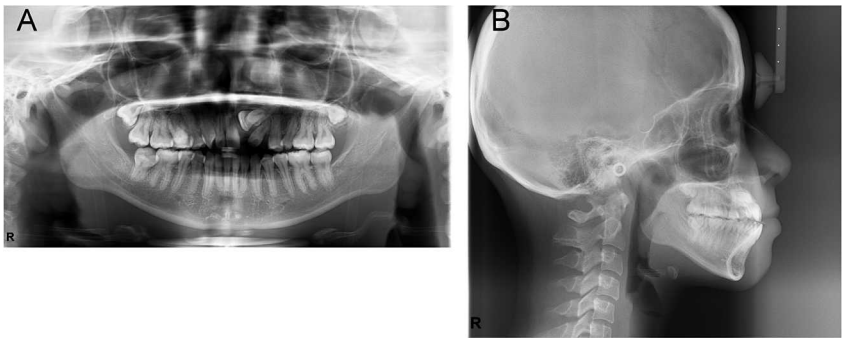

Figure 2. Pretreatment panoramic (A) and cephalometric (B) radiographs. Note the overlapped impactions of teeth 21 and 23 as well as the transposition of teeth 23 and 22.

and distalization of tooth 22 without resolution of the transposition followed by periodontal plastic surgery, postorthodontic restorations, and occlusal adjustments; (3) surgically removing impacted tooth 23, uncovering and orthodontic traction of tooth 21, normalization of tooth 22, and a future implant at the canine site; (4) surgically repositioning the impacted teeth 21 and 23 after orthodontic space redistribution; and (5) surgically removing the impacted teeth 21 and 23, performing ridge preservation, and orthodontic space redistribution for future implants at teeth 21 and 23.

Potential benefits and risks of the various treatment plans were explained to the patient and her parents. They wished to avoid postorthodontic restorations if possible and understood the likelihood of modifications during treatment. The decided treatment plan included orthodontic reposition of the impacted teeth 23 and 21 following staged exposure and traction. Reversion of the transposed teeth 23 and 22 into their normal order of the arch was planned. We also expected to replace the anomalous tooth 15 with the relatively stable tooth 55. Correction of the anterior open bite and crossbite was also planned. An informed consent was obtained before the treatment.

The impacted tooth 23 was surgically exposed and bonded with a button for traction. Through activation of a nickel-titanium (Ni-Ti) open coil spring for 4 months, the proper space for the impacted teeth 21 and 23 was created. An innovative cantilever attached to a miniscrew was used to pull the impacted tooth 23 buccally and distally toward its normal position (Figure 4). The key procedures to correct this transposition were eliminating tooth 22 from engaging with the archwire and keeping tooth 23 in as high a position as possible during its distalization.

Three months later, the impacted tooth 21 was surgically uncovered for orthodontic traction. Anterior vertical elastics from teeth 42 and 43 to tooth 21 were utilized to move the tooth 21 downward and mesially toward its normal position. Subsequently, a bracket and a lingual button were bonded on the tooth 21 for further alignment and correction of rotation. A 0.014-inch superelastic Copper Ni-Ti archwire (Damon, Ormco, Orange, Calif) was utilized to level the distorted upper arch. Through activation of the power chains, teeth 21 and 23 were pulled away from the palatally drifted tooth 22 (Figure 5). To avoid root interferences, tooth 22 was not engaged with the archwire until safe distances were created among teeth 21, 22, and 23. After 5 months, tooth 22 was engaged with 0.014-inch superelastic Copper Ni-Ti archwire for buccal movement and leveling. Furthermore, a 0.016 × 0.025-inch superelastic Copper Ni-Ti archwire (Figure 6) followed by a 0.018 × 0.025-inch

Table 1. Cephalometric Measurements

	Norm[a] (Female)			
Measurements	Mean	SD	Pretreatment	Posttreatment
SNA, degrees	82.9	3.4	78	80
SNB, degrees	80	3.1	76	77
ANB, degrees	2.8	1.9	2	3
Wits appraisal, mm	0	3	−3	−1
N perpendicular to A, mm	−1.1	3	1	3
N perpendicular to Pog, mm	−7	8	−4.5	−1
SN-GoGn, degrees	32.5	4.8	39	40
U1-SN, degrees	107.2	6	106	111
L1-MP, degrees	96	5.5	102	89.5
Interincisal angle, degrees	121.6	8.7	113	119

[a] For Taiwanese normative mean.

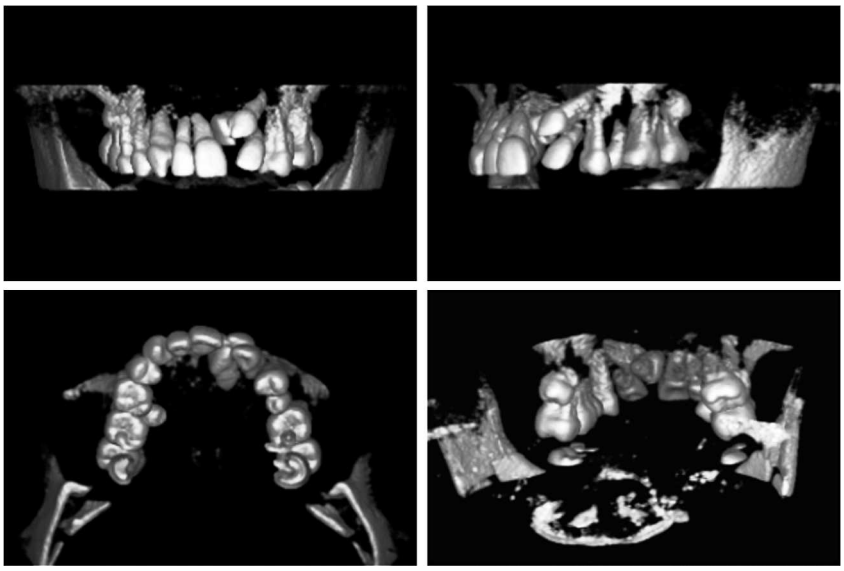

Figure 3. Pretreatment CBCT images showing the deeply impacted tooth 21 and buccally impacted tooth 23. The crown of the transposed tooth 23 situated buccally to the root of tooth 22 but palatally to the crown of tooth 22.

superelastic Copper Ni-Ti archwire and a 0.019 × 0.025-inch stainless-steel archwire were used to align and detail the arches. Anterior short Class III elastics were required for correction of the anterior open bite and crossbite. Myofunctional therapy such as training the tongue posture and the swallowing pattern reduced the relapse of the open bite.

Before extraction of the anomalous tooth 15, tooth 55 was reevaluated for statuses of periodontium, tooth mobility, root resorption, and prognosis. Neither root resorption nor periodontal destruction of the tooth 55 was seen, the anomalous tooth 15 was scheduled to be extracted without hindering the integrity of the upper arch. In the subsequent 14 months, root parallelism and occlusion detailing were attained. The orthodontic treatment required 29 months to complete, and good occlusion was achieved. A pleasant and harmonious smile was fulfilled. Posttreatment intraoral photographs demonstrated the corrections of the impacted teeth 21 and 23, the transposed teeth 23 and 22, the anterior open bite and crossbite, and the maxillary and mandibular dental midlines (Figure 7). Proper interdigitation, healthy periodontium, and harmonious gingival architecture were also realized.

The panoramic and cephalometric radiographs showed the corrected inclination of the impacted teeth 21 and 23 and reversion of the transposed teeth 23 and 22, with proper root parallelism (Figure 8). Cephalometric evaluation revealed that the U1 to SN angle was increased by 5°, the L1 to MP angle was decreased by 12.5°, and the interincisal angle was increased by 6°. The SN-GoGn angle was increased from 39° to 40° (Table 1). The movement of the maxillary incisors benefited the smile display, while the retroclination of the mandibular incisors aided the correction of the anterior crossbite and open bite (Figure 9). Palatal/lingual fixed retainers were placed in both arches. A circumferential retainer was also given for retention of the maxillary arch.

DISCUSSION

Simultaneous impaction of maxillary anterior teeth with teeth transposition is a rare clinical situation with diverse therapeutic approaches. In this case, making an appropriate treatment plan for the impacted teeth, the transposed teeth, and the anomalous teeth was challenging. Accurate assessment of the relative

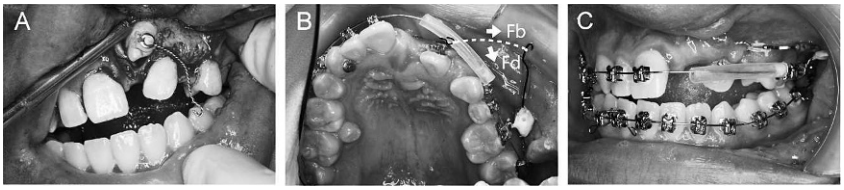

Figure 4. The guided eruption of the impacted tooth 23. (A) Surgical exposure of tooth 23. (B) The innovative cantilever before activation. Fb and Fd represent the designed buccal and distal forces acting on the impacted canine, respectively. (C) The activated cantilever induced buccal and distal movement of tooth 23.

Figure 5. The guided eruption of the impacted tooth 21. (A) Surgical uncovering of tooth 21. (B) The 0.014-inch superelastic archwire for further leveling. (C) The activated power chains pulled teeth 21 and 23 away from tooth 22.

positions of the affected teeth was fundamental to the treatment planning. The panoramic and cephalometric films in this case could not supply the exactly relative positions of the impacted teeth and transposed teeth. They also could not provide an accurate assessment of whether the central and lateral incisors suffered root resorption as the canine erupted ectopically. The CBCT scan provided three-dimensional images for accurate localization and evaluation of the affected teeth, thereby facilitating precise surgical and orthodontic management.[15,17,18]

In this case, no significant root resorption was found on teeth 21 and 22 when analyzing the initial CBCT images. The treatment plan including complete correction of the impactions and the transposition was regarded as the ideal solution. Guided eruption of the impacted teeth 21 and 23 eliminated the postorthodontic restorations, while reversion of the transposed teeth 23 and 22 contributed to esthetics and occlusion. However, the ideal treatment might subject the impacted and transposed teeth to mechanics with risks of root resorption and periodontal destruction. Another disadvantage of resolving a transposition is the possibility of a protracted treatment time.[9,15] Although proper surgical design and orthodontic mechanics were planned to treat all of the affected teeth, potential risks and alternative options must be clearly explained to the patient and her family before treatment.

One of the treatment alternatives was to keep the transposition of teeth 23 and 22. The advantages were the reduced risk of root interferences during alignment and less chance of buccal bony loss of tooth 23 during distalization. However, resolving a transposition benefits esthetics and function. On the contrary, an unsolved transposition usually needs periodontal plastic surgery for harmonious gingival architecture, postorthodontic restorations for normal crown morphology, and occlusal adjustments for ideal function.

Extracting the impacted tooth 23 and orthodontically repositioning teeth 21 and 22 could reduce the risk of root interferences during alignment. Another advantage was a relatively short treatment time. However, such therapy for this patient might negatively affect the deviated maxillary dental midline and anterior crossbite. Besides, the canine space must be preserved for a future implant-supported crown.

Surgically repositioning the impacted teeth 21 and 23 after orthodontic space redistribution was an unfavorable choice. In this clinical situation, surgically repositioning teeth 21 and 23 was technique-sensitive with possible damage to the periodontium and tooth structures. Moreover, the postoperative endodontic treatment of the repositioned teeth and potential tooth discoloration might complicate the treatment. Once this approach fails, the teeth have to be extracted, leaving an unpleasant treatment outcome.

The most aggressive method for treating the impacted teeth 21 and 23 was surgical extraction. In this case, the extraction requires delicate technique and cautious management to minimize the risk of injury to the adjacent teeth. Based on the patient's young age and the potential growth of the facial skeleton, the patient would have presented with edentulous sites in her left maxilla until the proper timing of dental implant placement.[19,20] The future cost of bone grafting and implant-supported crowns as well as a prolonged treatment period must be carefully considered before performing such invasive therapy.

Staged surgical approaches and orthodontic traction of teeth 23 and 21 might minimize the surgical trauma

Figure 6. Tooth 22 was leveled with a 0.016 × 0.025-inch superelastic archwire.

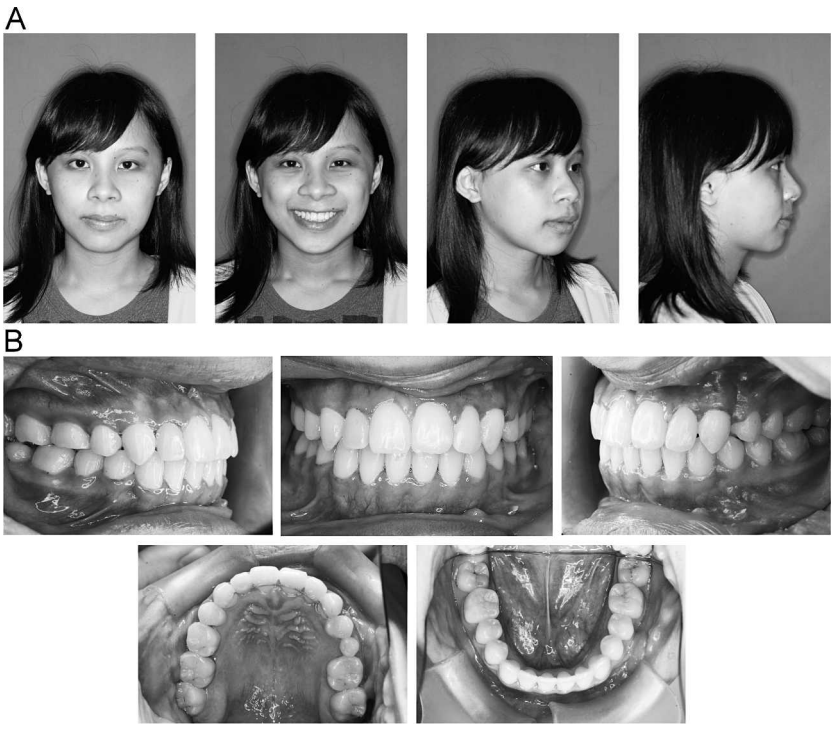

Figure 7. Posttreatment facial (A) and intraoral (B) photographs.

and root interferences. After tooth 23 was exposed and orthodontically distalized, tooth 21 could be simply uncovered and bonded an attachment for orthodontic traction.

To avoid adverse effects on the maxillary arch during reversion of the transposition, an innovative lever arm and a miniscrew were set to supply favorable forces and stationary anchorage, respectively. Activation of the lever arm was accomplished by creating a mesial toe-out bending and a tip-back bending. The distal end of the lever arm was fixed with glass ionomer cement to avoid it sliding out of position and to minimize tissue irritation of the miniscrew. Through hooking to the ligature wire attached to the impacted tooth 23, the wire bending produced buccal and distal pulling forces on tooth 23. The lever arm was easily reactivated in the mouth by a reinforced tip-back bending.

Another orthodontic design for minimal root interferences was the elimination of archwire engagement on tooth 22 during correction of the transposition. Without the archwire binding, tooth 22 could be a free object as tooth 23 being pulled over it. Clinically, tooth 22 had drifted spontaneously to the palatal side during the canine distalization.

To achieve a proper Bolton ratio and better intercuspation of the teeth, the anomalous tooth 15 was expected to be replaced by tooth 55. Preservation of tooth 55, furthermore, was beneficial for the correction of the anterior crossbite because the mesiodistal width of this tooth was greater than that of tooth 15. On the contrary, extraction of tooth 55

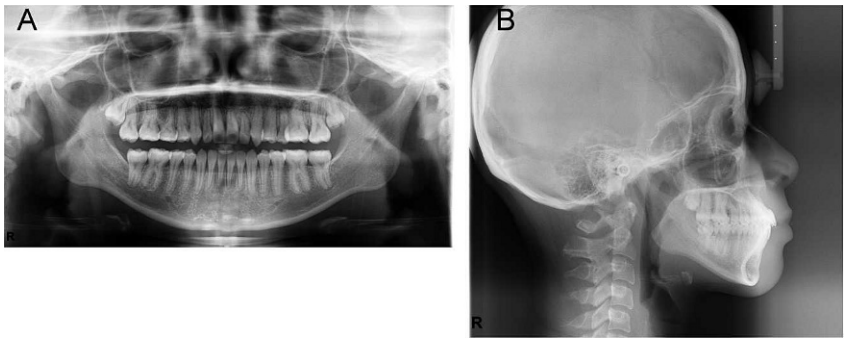

Figure 8. Posttreatment panoramic (A) and cephalometric (B) radiographs revealing corrected positions of the impacted teeth 21 and 23. The transposed teeth 23 and 22 were reversed to their natural order in the arch. Proper root parallelism and healthy periodontium were attained.

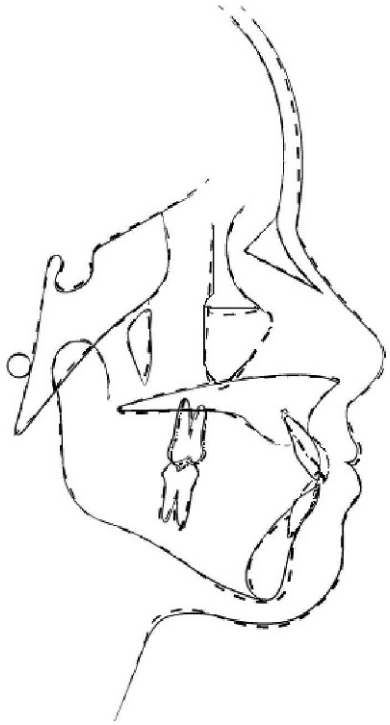

Figure 9. The superimposed cephalometric tracing. Initial, the solid line; final, the dotted line.

might result in future restorative work on tooth 15, which was against the patient's intention to avoid postorthodontic restorations.

Anterior short Class III elastics were required for correction of the anterior open bite and crossbite. To achieve the solid intercuspation and to reduce the possibility of relapse, the maxillary anterior teeth were extruded and the mandibular incisors were retroclined for adequate overbite and overjet. Moreover, the myofunctional therapy including lips seal, nasal respiration, and tongue training might contribute to the stability of the treatment outcomes.

The treatment of impacted and transposed teeth accompanying dental anomalies poses challenges for clinicians. Early diagnosis and treatment of eruption disturbances may reduce the formation of root dilaceration, adjacent tooth root resorption, and periodontal destruction. Accurate assessment of the affected teeth is crucial for developing a comprehensive plan that will minimize the adverse effects. In this case, the well-planned surgical exposure in conjunction with sequentially orthodontic correction of the impacted and transposed teeth contributed to optimal treatment outcomes.

REFERENCES

1. Kokich VG, Mathews DP. Surgical and orthodontic management of impacted teeth. *Dent Clin North Am*. 1993;37:181–204.
2. Walker L, Enciso R, Mah J. Three-dimensional localization of maxillary canines with cone-beam computed tomography. *Am J Orthod Dentofacial Orthop*. 2005;128:418–423.
3. Grover PS, Lorton L. The incidence of unerupted permanent teeth and related clinical cases. *Oral Surg Oral Med Oral Pathol*. 1985;59:420–425.
4. Bishara SE. Impacted maxillary canines: a review. *Am J Orthod Dentofacial Orthop*. 1992;101:159–171.
5. Nagaraj K, Upadhyay M, Yadav S. Impacted maxillary central incisor, canine, and second molar with 2 supernumerary teeth and an odontoma. *Am J Orthod Dentofacial Orthop*. 2009;135:390–399.
6. Pinho T. Impaction of both maxillary central incisors and a canine. *Am J Orthod Dentofacial Orthop*. 2012;142:374–383.
7. Kuroda S, Yanagita T, Kyung HM, Takano-Yamamoto T. Titanium screw anchorage for traction of many impacted teeth in a patient with cleidocranial dysplasia. *Am J Orthod Dentofacial Orthop*. 2007;131:666–669.
8. Frazier-Bowers SA, Simmons D, Wright JT, Proffit WR, Ackerman JL. Primary failure of eruption and PTH1R: the importance of a genetic diagnosis for orthodontic treatment planning. *Am J Orthod Dentofacial Orthop*. 2010;137:160.e1–e7.
9. Shapira Y, Kuftinec MM. Tooth transpositions—a review of the literature and treatment considerations. *Angle Orthod*. 1989;59:271–276.
10. Peck S, Peck L. Classification of maxillary tooth transpositions. *Am J Orthod Dentofacial Orthop*. 1995;107:505–517.
11. Chattopadhyay A, Srinivas K. Transposition of teeth and genetic etiology. *Angle Orthod*. 1996;66:147–152.
12. Papadopoulos MA, Chatzoudi M, Kaklamanos EG. Prevalence of tooth transposition. A meta-analysis. *Angle Orthod*. 2010;80:275–285.
13. Maia FA. Orthodontic correction of a transposed maxillary canine and lateral incisor. *Angle Orthod*. 2000;70:339–348.
14. Shapira Y, Kuftinec MM. Maxillary tooth transpositions: characteristic features and accompanying dental anomalies. *Am J Orthod Dentofacial Orthop*. 2001;119:127–134.
15. Pair J. Transposition of a maxillary canine and a lateral incisor and use of cone-beam computed tomography for treatment planning. *Am J Orthod Dentofacial Orthop*. 2011;139:834–844.
16. Peck S, Peck L, Kataja M. Concomitant occurrence of canine malposition and tooth agenesis: evidence of orofacial genetic fields. *Am J Orthod Dentofacial Orthop*. 2002;122:657–660.
17. Oberoi S, Knueppel S. Three-dimensional assessment of impacted canines and root resorption using cone beam computed tomography. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2012;113:260–267.
18. Yan B, Sun Z, Fields H, Wang L. Maxillary canine impaction increases root resorption risk of adjacent teeth. *Am J Orthod Dentofacial Orthop*. 2012;142:750–757.
19. Heij DG, Opdebeeck H, van Steenberghe D, Kokich VG, Belser U, Quirynen M. Facial development, continuous tooth eruption, and mesial drift as compromising factors for implant placement. *Int J Oral Maxillofac Implants*. 2006;21:867–878.
20. Fudalej P, Kokich VG, Leroux B. Determining the cessation of vertical growth of the craniofacial structures to facilitate placement of single-tooth implants. *Am J Orthod Dentofacial Orthop*. 2007;131:59–67.