

Surgical and orthodontic management of maxillary canine-lateral incisor transpositions

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Transposition of the maxillary canine and the lateral incisor is a complex dental anomaly to treat. The difficulty increases if the treatment aims to correct the transposition. These case reports describe 2 patients with transposition of the maxillary lateral incisor and canine. The first case involves bilateral incomplete transpositions, and the second is a complete transposition. The radiographic appearance of the canine was similar in the 2 patients. However, the treatments were distinct because of the 3-dimensional positions of the teeth. The first case involved palatally placed lateral incisor roots. To prevent resorption of the lateral incisors, the canines were moved into position buccally. In the second case, the lateral incisor root had a buccal position, and the canine crown was tractioned palatally. The position of the lateral incisor root was critical when electing the correct treatment and mechanics for each patient. (*Am J Orthod Dentofacial Orthop* 2016;150:876-85)

Tooth transposition is the positional interchange of 2 adjacent teeth or the development or eruption of a tooth in a position occupied normally by a nonadjacent tooth.¹ Although evidence has been found of transpositions in prehistoric skulls, the cause of a transposition is still unknown.² Genetic inheritance, previous trauma, alteration in the position of the dental lamina, or retention of the deciduous canine are current etiologic theories.^{1,3,4} The incidence of transpositions in the population is low (0.2%–0.38%).^{5–7} Most transpositions occur in the maxilla (76%), of which 88% are unilateral.⁸ The canine is involved in 90% of transpositions, most commonly with the first premolar (71%) or the maxillary lateral incisor (20%).⁶ Transpositions are classified as complete when both teeth have been entirely transposed or incomplete when only the crowns or the roots have interchanged positions.^{4,6}

Current diagnosis relies on clinical and radiographic observations. Two-dimensional radiography allows

predictions about the position and amount of resorption; however, cone-beam computer tomography (CBCT) improves visualization of the transposition, resorption, and associated risks.⁹

Because of low prevalence rates, robust trials regarding the most effective treatment and timing of treatment are not available. The following treatment options remain: (1) no treatment, (2) interception involving extraction of the deciduous canines, (3) extraction of 1 transposed tooth if extraction is required for correction of the malocclusion, (4) alignment of the teeth in the transposed position and subsequent restorative treatment for camouflage, and (5) orthodontic correction of the transposed teeth.^{10,11}

The 2 cases presented involve canine and lateral incisor transpositions in the maxilla: one was bilateral and incomplete, and the second was a complete transposition as classified in the literature.⁶ The differing tooth anatomies of the canine and the lateral incisor make this type of transposition more complex because of esthetic and functional considerations. The treatment option chosen for both patients was orthodontic correction. Although these cases involved the same teeth and both patients opted for the same treatment, the sequences of mechanics were different because of the position of the lateral incisor root in relation to the canine crown. The patients were informed of the associated risks and treatment alternatives.

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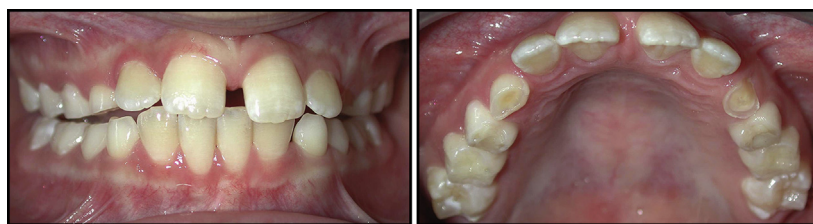


Fig 1. Patient 1: pretreatment intraoral photographs.

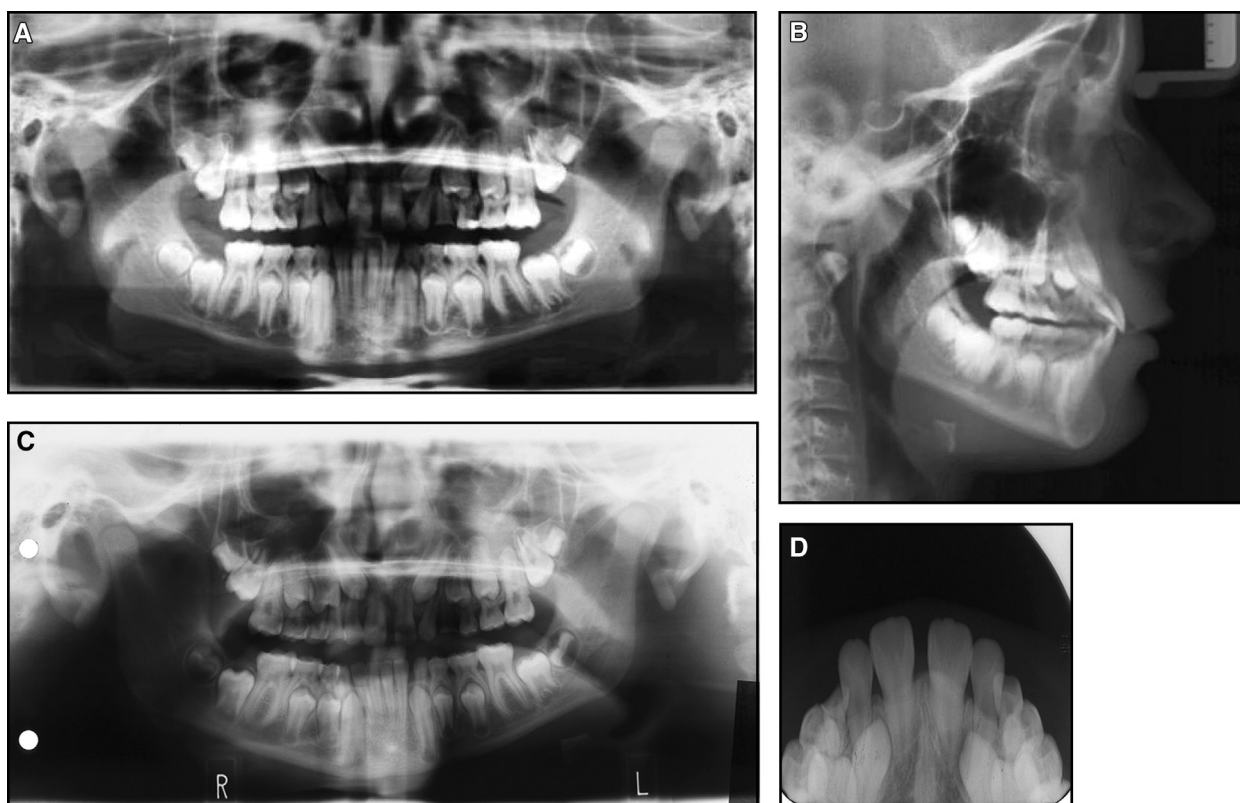


Fig 2. Patient 1: **A**, pretreatment panoramic radiograph; **B**, pretreatment lateral cephalometric radiograph; **C**, previous panoramic radiograph forwarded from transfer clinic confirming the change in canine position; **D**, maxillary anterior occlusal image from the transfer clinic allowing diagnosis of position.

PATIENT 1

Diagnosis and etiology

A 12-year-old boy came for an initial orthodontic assessment. It was noted on palpation that the maxillary left and right canines were buccally positioned between the respective central incisor and lateral incisor. A complete set of orthodontic records was taken. There was no relevant medical history.

Intraoral photos showed a Class I mixed dentition, with delayed exfoliation of posterior deciduous teeth including

the maxillary canines. The maxillary arch was spaced with a midline diastema associated with a low frenal attachment and proclination of the maxillary incisors. The photographs were taken in centric relation, but in occlusion there was a unilateral crossbite caused by a functional shift (Fig 1). The panoramic radiograph confirmed the presence of all teeth but demonstrated generalized delayed eruption of the permanent dentition. The crowns of the canines were transposed with the roots of the lateral incisors. The right side was an incomplete transposition, and the left side was nearing a complete transposition but with

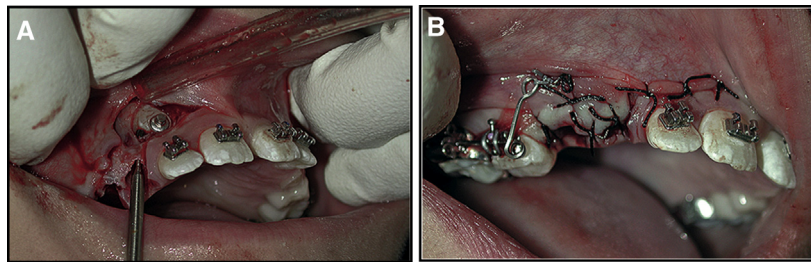


Fig 3. Patient 1: surgical exposure of the upper right canine; **A**, soft tissues reflected and button bonded to the canine; **B**, immediate activation of the maxillary right canine using a buccal arm.



Fig 4. Patient 1: progress intraoral photographs; **A**, vertical traction of the maxillary right canine; **B**, distal traction of the maxillary left canine with a buccal spring arm; **C**, canines aligned and lateral incisors included in the archwire.

favorable distal angulations and apex positions for correction. The lateral incisor roots had evidence of resorption. The lateral cephalometric radiograph also confirmed that the canine crowns were positioned buccal to the lateral incisor roots (Fig 2, A and B). Radiographs forwarded from the previous clinic (Fig 2, C and D) confirmed the buccal position of the canines with the parallax technique. Comparison of the panoramic radiographs confirmed that the bilateral transposition was progressing toward a complete transposition, and resorption on the roots of the lateral incisors was active.

Treatment objectives

The patient was treated in 2 phases. The objective of the first phase of treatment was to correct the bilateral transpositions with closed exposure of the canines and fixed orthodontics in the maxillary arch only. The objectives of the second phase of treatment were to (1) correct the crossbite, (2) level and align the arches while maintaining correct overjet and overbite, (3) correct the center line, and (4) achieve Class I molar and canine relationships. The overall objective was to provide the patient with improved esthetics and a functioning occlusion.

Treatment alternatives

Other alternatives were also considered, including extraction of 1 transposed tooth. This was deemed not

ideal because the malocclusion did not require extraction. Extracting a transposed tooth and later replacing it with an implant was not an option because of the esthetics, function, and financial cost to the patient. Another alternative was alignment of the teeth in the transposed position and subsequent camouflage. This was also rejected because correction gives better final esthetic and functional results with less long-term maintenance. No treatment was also considered. The risk of damage to the roots of the lateral incisors or the central incisors meant that interception was required. The need for treatment was increased because the transpositions were bilateral.

Treatment progress

In the first phase, fixed appliances (Roth 0.022 × 0.028-in slot) were placed in the maxillary arch with a quad-helix for crossbite correction. The surgical procedure was bilateral closed exposure under local anesthesia, performed by an author (P.L.). The maxillary right deciduous canine was extracted at the start of the procedure. The buccal mucoperiosteal flap was designed to cause minimal damage to the papillae. Three incisions were made to raise the flap. The first incision was along the alveolar ridge, the second was mesial to the deciduous second molar perpendicular to the alveolar ridge and approximately 12 mm in height, and the third incision was distal to the lateral incisor perpendicular to the



Fig 5. Patient 1: posttreatment intraoral photographs.



Fig 6. Patient 1: posttreatment panoramic radiograph.

alveolar ridge and 5 mm in height. The flap was raised to uncover the canine crown. Bone removal allowed exposure of the canine's buccal surface to facilitate bonding of a button (Fig 3, A). A metallic ligature wire (0.012-in stainless steel) with eyelets to facilitate traction was attached to the button. The mucoperiosteal flap was sutured into position. A buccal arm (0.019 × 0.025-in rectangular stainless steel wire) extended from the accessory buccal tube with an L-shaped spring (Fig 3, B). Activation took place every 2 to 3 weeks with elastic thread. To minimize further resorption of the lateral incisor roots, the canine crowns were tractioned from the buccal aspect with a distoapical vector, allowing the canine crown to move past the root of the incisor to the widest part of the dentoalveolar process in a controlled manner. Once the correct sequence of the teeth in the first quadrant had been achieved, a second buccal arm tractioned the canine vertical to its correct position in the arch (Fig 4, A). In the second quadrant, swapping the positions of the teeth was facilitated by moving the lateral incisor palatally to allow distal movement of the canine with an L-shaped buccal spring arm (Fig 4, B). Once the canines were uprighted and clear of the lateral incisor roots, the lateral incisors were fully incorporated into the archwire (Fig 4, C). Toward the end of treatment, increased labial-palatal torque was

placed on the lateral incisors using a Warren anterior torquing spring followed by final settling.

Treatment results

After 25 months of active treatment, the patient was debonded. The treatment was extremely complex but gave him excellent esthetic and functional results with a good long-term prognosis. Intraoral posttreatment records show that the canines were successfully aligned and the transposition corrected. The gingival levels of both canines were anatomically correct with no recession, buccally or palatally. The final torque and color of the canines were clinically pleasing. Class I molar and canine relationships were achieved bilaterally with ideal overjet and overbite (Fig 5). The radiographic assessment shows successful correction of the transpositions with good parallelism of the roots. The lateral incisors' root lengths were similar when compared with the pretreatment radiographs, and minimal resorption occurred during the treatment (Fig 6).

PATIENT 2

Diagnosis and etiology

A 15-year-old girl was referred for evaluation of an unerupted permanent canine in the maxillary left



Fig 7. Patient 2: pretreatment intraoral photographs.

quadrant. When the dentoalveolar process was palpated buccally, a transposition was suspected. There was nothing of note in the medical or social history.

Full orthodontic records were taken. In the intraoral photographs, a molar Class I relationship was evident bilaterally. Spacing was present in the maxillary arch with a median diastema. The buccal position of the lateral incisor root was confirmed from clinical palpation and the inclination of its crown (Fig 7). The panoramic radiograph showed that all teeth were present except the maxillary left third molar. The transposition was evident in the second quadrant. The position of the maxillary lateral incisor root was buccal and distally angulated. The transposed canine was palpable buccally, although because of the lack of a bulge, it was almost in the line of the arch, as shown in Figure 8.

Treatment objectives

The treatment objectives for this patient were to (1) correct the unilateral transposition with closed exposure of the canine and fixed orthodontics, (2) level and align the arches while maintaining correct overjet and overbite, (3) correct the center line, (4) achieve Class I molar and canine relationships, and (5) give the patient an improved esthetic result and a functional occlusion.

Treatment alternatives

The treatment alternatives were the same as discussed for patient 1.

Treatment progress

Because of the patient's age and the presence of all permanent teeth, the treatment was completed in 1 phase by an orthodontist (P.L.). This consisted of maxillary and mandibular fixed appliances (Roth 0.022 × 0.028-in slot), transpalatal bar, and closed exposure of the canine in the second quadrant. Because of the position of the lateral incisor root, there was insufficient bone to apply buccal traction to the canine. To correct the transposition, the canine needed to be

tractioned palatally between the roots of the lateral and central incisors to finally be repositioned between the lateral incisor and the premolar. Surgical exposure of the canine involved 2 mucoperiosteal flaps: one buccal and the other palatal. Palatal access to the canine crown was deemed to be difficult. It would have involved excessive bone removal to access the palatal surface, and subsequent bonding of the button in the ideal position would have been compromised. The risk of causing iatrogenic damage to the adjacent roots was also increased. In contrast, buccal access to the crown involved minimal bone removal, improved access, and isolation for bonding. To enable palatal traction, a tunnel 2 mm in diameter was prepared; this reduced the risk of iatrogenic trauma and improved the prognosis for bone repair. The buccal flap was semilunar in the unattached gingiva at the height of the canine crown, high enough to allow good access and subsequent bonding of the button. Once the canine cusp was identified, a guide hole was made to mark the level of the tunnel, providing access to the palatal side (Fig 9, A and B). The palatal mucoperiosteal flap extended from the mesial aspect of the first premolar to the central incisor of the contralateral quadrant. The tunnel access was created using a surgical drill from below the canine cusp to the palate. The exit hole could be visualized directly because of the raised palatal flap and ensured correct orientation of the burr (Fig 9, C). Bone was removed buccally to expose the canine and bond a button. A metal wire attached to the surgical button was passed through the tunnel from the buccal aspect to the exit on the palatal side (Fig 9, D). The wire was prepared with eyelets to allow future elastic traction. The palatal flap was repositioned and sutured in place, and a small incision in the palatal mucosa allowed the metal wire to exit (Fig 9, E). The transpalatal bar was placed with a traction arm (0.019 × 0.025-in stainless steel) welded to the bar. Traction of the canine was carried out on the same day as surgery and activated every 2 weeks with elastic thread. The canine was pulled palatally away from the central and lateral incisors' roots. The lateral incisor was not involved in the archwire to minimize

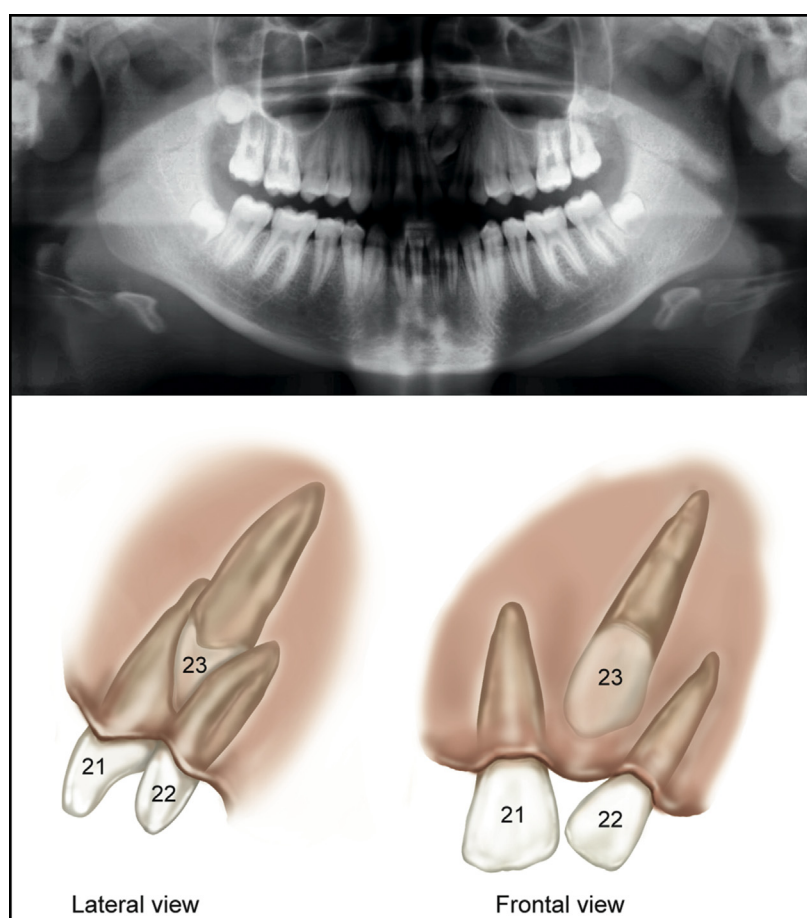


Fig 8. Patient 2: pretreatment panoramic and lateral cephalometric radiographs with a diagrammatic representation of the transposition.

the risk of root resorption (Fig 10, A). When the canine crown was no longer a risk, the lateral incisor was included in the archwire (Fig 10, B). The lateral incisor crown was moved mesially with a push coil until it was in contact with the central incisor, with the aim to open space for the canine. When there was sufficient space for the canine, the traction arm was changed to the accessory tube on the molar, and the canine was tractioned buccally (Fig 10, C). Once the canine erupted in the line of the arch, a permanent canine bracket was bonded, followed by routine leveling and aligning, with final space closure coordination of the arches and settling (Fig 10, D and E).

Treatment results

After 30 months of active treatment, the patient was debonded. In the intraoral photographs, a Class I occlusion can be seen with positive overbite and overjet (Fig 11). After the transposition correction, the

periodontal tissues were healthy. No periodontal pocketing or recession was evident on clinical examination. The maxillary lateral incisor showed some resorption of the root; however, there were no symptoms or mobility (Fig 12). The treatment was complex and aimed to solve the transposition with the least iatrogenic damage possible. The treatment plan was personalized to the patient's specific needs, giving her excellent esthetic and functional results with a good long-term prognosis.

DISCUSSION

The range of etiologic factors attributed to transpositions means that identifying patients predisposed to transpositions can be difficult. The genetic inheritance component of certain dental anomalies could result in future diagnosis being available via gene profiling.¹² This would allow the clinician to be aware of the risk before the transposition has occurred, enabling the ultimate personalized treatment. Until this is possible, we

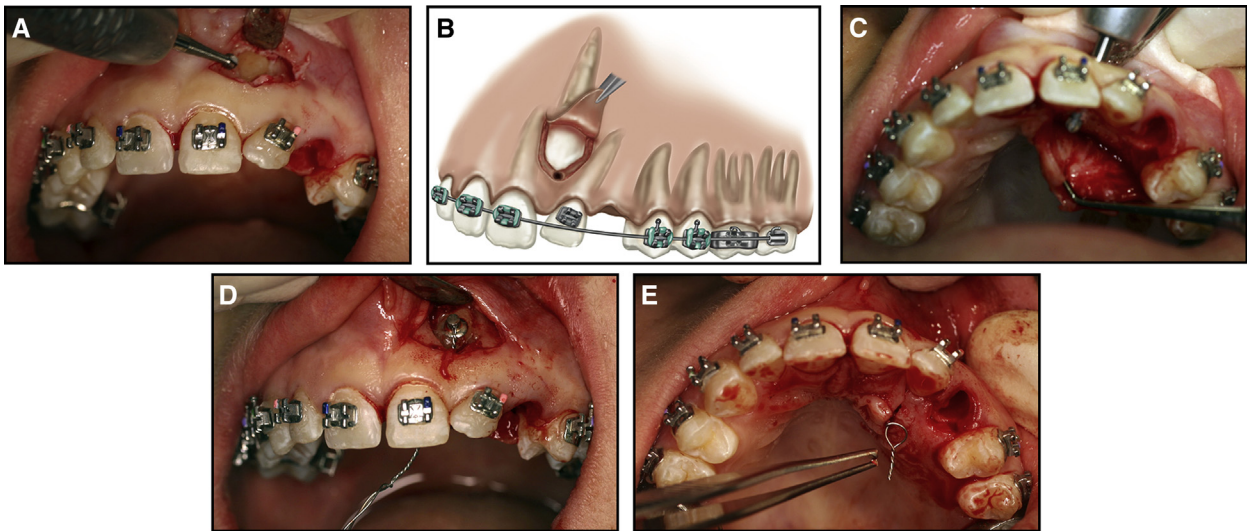


Fig 9. Patient 2: surgical exposure of the canine; **A**, buccal soft tissue reflection and bone removal to access the maxillary canine; **B**, representation of surgical buccopalatal tunnel access; **C**, surgical creation of a tunnel to allow traction; **D**, button bonded with a metal ligature passing through the tunnel to exit palatally; **E**, metal ligature exiting from the mucosa palatally.

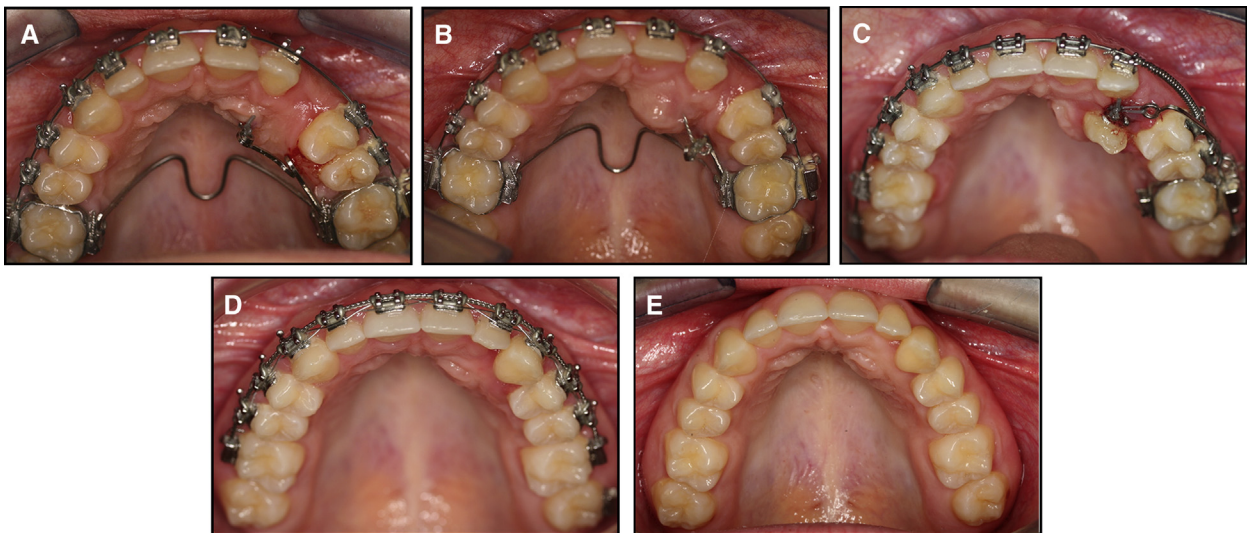


Fig 10. Patient 2: progress intraoral photographs; **A**, second activation of the canine, without the lateral incisor involved in the archwire to allow movement; **B**, canine bulge evident in the palate with the lateral incisor included in the archwire; **C**, eruption of the canine, with the palatal arm removed and traction beginning with a buccal arm; **D**, the canine is in the line of the arch, and final settling is taking place; **E**, postdebond alignment of the maxillary arch.

rely on family history, close clinical monitoring, and radiographic diagnosis to allow tailoring of the treatment to the characteristics and preferences of each patient.¹³

Once it is identified, correcting a transposition can be one of the most complicated treatments in orthodontics. The lack of information regarding maxillary

canine-lateral incisor transpositions and the difficulty of the treatment has led other authors to advise correcting only pseudotranspositions or incomplete transpositions. If a transposition is well established, the most frequently recommended treatment is to maintain it with subsequent camouflaging of the teeth or



Fig 11. Patient 2: posttreatment intraoral photographs.



Fig 12. Patient 2: posttreatment panoramic radiograph.

extraction of 1 tooth.^{11,14} Early diagnosis limits the amount the teeth have migrated into their transposed positions, increasing the opportunity to correct the transposition and improve the prognosis. Therefore, correction is possible in many cases if they are diagnosed in time.¹⁰ Comparing the radiographs which formed part of the orthodontic referral for the first patient with those taken at the orthodontic assessment; the progression from an incomplete transposition toward a complete transposition was evident. Active resorption was occurring on the lateral incisor roots and if left untreated may have compromised the long-term prognosis of the lateral incisor and placed the central incisors at risk of resorption. The second patient had a complete transposition, but the canine had not descended fully, thus improving the option of correction.

With CBCT, it is possible to more accurately locate the exact position of the teeth involved in 3 dimensions, aiding predictions of difficulty and the mechanics required.¹⁵ The introduction and growth of use of CBCT has moved faster than the availability of definitive or evidence-based clinical guidelines for many areas of dentistry, including diagnosis of ectopic canines.¹⁶

CBCT scanning was unavailable at the time of treatment. The treatments of both patients were successful; however, CBCT ultimately gives the clinician more information at the diagnosis stage, and the patient has more detailed information for an informed decision. Our current protocol is to request a CBCT scan if the exact position of the canine or lateral root, the extent of resorption, or any other pathology is in doubt.

If the teeth involved in the transposition are the canine and the lateral incisor, the functional and esthetic considerations are even more complex. Successful correction can give the patient improved esthetics and require less long-term maintenance. Factors that influence which treatment is selected are (1) the arch involved, (2) the teeth involved, (3) the positions of the crowns and the roots in the dentoalveolar process in all 3 planes, (4) the degree of resorption of the teeth, (5) the malocclusion, (6) the experience of the professional, and (7) the motivation of the patient.¹¹ Two important factors to be considered in future studies are the vertical position of the involved teeth and the width of the dentoalveolar process. The less the canine has descended into its position, the

wider the dentoalveolar process will be; this allows the opportunity to move teeth within bone and decreases the risk of recession.

Different types of mechanics have been described in the literature to solve transpositions: eg, sectional arches, springs, and transpalatal arches.^{14,17,18} The severity of a transposition and the classifications mainly relate to the sagittal position, but less consideration is given to the positions of the lateral incisor root and canine in the buccolingual plane. Our cases had a similar radiographic appearance, but they highlight that the same method of correction is not possible in each transposition patient, primarily because of the position of the lateral incisor root in relation to the canine crown. The lateral incisor roots were palatal and buccal in these the first and second cases, respectively. Because of this, the path of correction of the canine was different in each patient; the first case involved bringing the canine buccally and distally using sectional buccal spring arms, and the mechanics of the second case involved bringing the canine farther into the palate and then distally. Both treatments aimed to protect the roots of the incisors.

The reasons given not to treat transpositions include posttreatment resorption, recessions, and difficult mechanics. Root resorption is often present before treatment in patients with impaction or transposition¹⁹ and is often more evident at the end of treatment, in part because of the longer treatment times required.²⁰ It appeared that there was resorption before and after treatment on the maxillary lateral incisors involved in these corrected transpositions. The treatment aimed to distance the canine from the lateral root to prevent any further resorption and to improve the prognosis for long-term retention of the lateral incisors.²¹ Techniques used to decrease the probability of further resorption caused by orthodontic treatment include (1) involving the lateral incisor in the archwire as late as possible in the orthodontic process, (2) using rectangular stainless steel wires for as little time as possible, and (3) using the torquing spring for less than 2 months. All teeth with pretreatment resorption remained vital. The final successful esthetic and functional results outweighed the minimal resorption that was evident.

CONCLUSIONS

This article describes 2 cases of maxillary transposition involving the lateral incisor and the canine. In both, the canine had not descended fully into the dental arch, allowing for the option of correction. In the first patient, the lateral incisor root was palatally positioned,

and the canine crown was tractioned buccally to the maxillary lateral incisor until it reached the correct position. In the second patient, the lateral incisor root was buccal; therefore, the canine crown was tractioned palatally to facilitate correction. The position of the lateral incisor root in relation to the canine crown dictated the direction of traction and the mechanics, which were personalized for each patient.

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