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# TOOTH TRANSPOSITION: A REVIEW AND CLINICAL CONSIDERATIONS FOR TREATMENT

*This article reviews the literature on tooth transposition. Several cases with various types and combinations of tooth transposition are presented and treatment management and options are discussed. Indications, advantages, and disadvantages of correcting versus maintaining tooth order are shown.* World J Orthod 2008;9:303–318.

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In 1817, Miel<sup>1</sup> reported a rare case of transposition of teeth in which he described in detail a maxillary bilateral canine-first premolar transposition, suggesting a genetic background. Harris<sup>2</sup> described transposition as an aberration in the position of the teeth: “It sometimes happens that a central incisor is situated between the lateral of the side to which it belongs and the cupidatus, or that a right central is situated in the place of the left and the left in the place of the right; or that a lateral incisor is situated between the cupidatus and first

bicuspid, and at other times a cupidatus is found between the first and second bicuspids.” Transposition of teeth is defined as an abnormality of tooth alignment in which 2 adjacent teeth have erupted in interchanged positions in the dental arch.<sup>3</sup> More comprehensively, Peck et al<sup>4</sup> defined transposition as a dental anomaly characterized by the exchange of position between 2 adjacent teeth, especially in relation to their roots, or the development and eruption of a tooth in a position normally occupied by a nonadjacent tooth. In the

orthodontic literature, the terms *ectopic teeth* and *transposition* have been used interchangeably. Authors have classified various degrees of ectopic eruption as pseudotranspositions or incomplete, partial, simple, and coronal transpositions.<sup>5–7</sup> Undoubtedly, ectopic eruption may well designate any anomaly concerning an abnormal eruption pathway of teeth. Tooth transposition is the extreme variant of ectopic eruption<sup>8</sup>; it may be classified as complete when both crowns and roots exchange position, whereas only tooth crowns are involved in incomplete transpositions. Complete transpositions offer a greater challenge to therapy that may necessitate the sacrifice of 1 affected tooth.<sup>8–10</sup>

Prevalence varies: A rate of 0.38% was reported in Turkey,<sup>11</sup> 0.13% in Saudi Arabia,<sup>12</sup> 0.43% in an Indian population,<sup>13</sup> and 0.14% in Nigeria.<sup>14</sup> These studies were conducted in samples of dental patients. Prevalence rates in European studies were 0.03% among Swedish school children,<sup>15</sup> 0.25% in a sample of Scottish orthodontic patients,<sup>16</sup> and 0.09% among Greek dental patients.<sup>10</sup> A study of composite African sample dental casts and a skeletal sample of Nubians found a prevalence rate of 0.51%.<sup>17</sup> The great diversity observed may be attributed to limitations inherent with epidemiological studies.

Tooth transposition has been reported in both males and females. Most studies show a female predilection with a male-to-female ratio of 27:48,<sup>18</sup> 20:34,<sup>19</sup> and 25:40.<sup>20</sup> Other studies found higher incidence among males<sup>21,22</sup> and even no definite gender distribution.<sup>11</sup>

Both arches can exhibit tooth transposition. However, maxillary teeth transpositions are more frequent than mandibular transpositions.<sup>11,13,18,22–25</sup> Simultaneous occurrence of tooth transposition in both arches is seldom observed.<sup>4,7,8</sup> The majority of the cases are unilateral; few are bilateral.<sup>4,7,10,26</sup> A unique case of bilateral asymmetric transposition of maxillary right canine/first premolar and mandibular left canine/lateral incisor has been reported.<sup>27</sup> Both canine/first premolar and canine/lateral incisor transpositions in the maxilla occur

predominantly in the left quadrant,<sup>5,18,19,21,25</sup> while more right canine/lateral incisor transpositions are reported in the mandible.<sup>14,18,21,26</sup>

Another impetus by Peck and Peck<sup>28</sup> is a review of case reports of tooth transposition in the maxillary arch. In order of decreasing frequency, the transpositions were canine/first premolar, canine/lateral incisor, canine in the first molar site, lateral incisor/central incisor, and canine in the central incisor site. Jahangiri et al<sup>29</sup> reported a case of maxillary canines bilaterally transposed into the position of the central incisors, both of which were missing. As far as the mandible is concerned, the most common transposition was between the canine and lateral incisor.<sup>18–20</sup> Generally speaking, transpositions not involving the canine are extremely rare.<sup>10</sup>

Tooth transposition can be a manifestation of some chromosomal disorders. In Down syndrome patients, a prevalence of 14.29% was reported.<sup>30</sup> A correlation with shorter total hand digital line length was also suggested.<sup>31</sup> In cleft lip and palate patients, an incidence of 4.1% was found with atypical forms of tooth transposition.<sup>32,33</sup> Dental anomalies such as peg-shaped maxillary lateral incisors, congenitally missing teeth, retained primary teeth, misalignment of teeth, supernumerary teeth, ectopic eruption, and root ankylosis often coexist with tooth transposition.<sup>4,5,7,22,28,34,35</sup>

Several postulates of the pathogenesis of tooth transposition have been proposed. The coexistence of root ankylosis and rotations of neighboring teeth with tooth transposition may suggest trauma to deciduous teeth as an etiological factor.<sup>28,36,37</sup> Due to the high incidence of retained deciduous canines in cases of permanent canine/first premolar transposition, some authors suspected that this might cause migration of developing tooth buds.<sup>34,38–40</sup> However, prolonged retention of deciduous teeth is considered a result, not the cause, of transposition.<sup>4,13</sup> Moreover, it was hypothesized that early loss of permanent maxillary first molars may trigger distal canine displacement.<sup>28</sup> Other postulates included crowding due to mesial movement of pos-

terior teeth,<sup>41</sup> lack of synchronization between tooth and jaw development (especially in the mandible),<sup>24</sup> intraosseous migration of the maxillary canine tooth bud distally<sup>38</sup> and the mandibular lateral incisor distally,<sup>7</sup> or countermigration of the mandibular canine tooth bud to a position between the central incisors.<sup>42</sup> Oral pathologists implicated intraosseous lesions such as tumors and cysts with tooth transposition.<sup>5,33,43-46</sup> Exchange of tooth germs during odontogenesis,<sup>7,47</sup> or even the early exchange of the cells of the dental lamina, were also considered by oral biologists.<sup>48</sup> However, present data strongly attribute this disturbance to genetic influences within a multifactorial inheritance model.<sup>8</sup> This theory has been validated year after year by research results, namely the variation in racial prevalence of tooth transposition,<sup>4,48</sup> the high coincidence of congenital anomalies of teeth, such as peg-shaped lateral incisors and hypodontia,<sup>4,27</sup> moderate rate of bilateral occurrence (frequently with the same type of transposition),<sup>4,27</sup> gender differences,<sup>4,27</sup> and the presence of a familial pattern.<sup>49-51</sup> The underlying mechanism of this genetic influence has been investigated. An aberrant function of the gene encoding for the transposed tooth was suggested.<sup>52</sup> Recent molecular genetic studies have associated familial tooth agenesis involving mandibular posterior teeth, particularly third molars and second premolars, with point mutations in transcription factors MSX1 and PAX9.<sup>53-55</sup> Reporting the high incidences of mandibular second premolar and third molar agenesis in cases of lateral incisor/canine transposition, Peck et al<sup>56</sup> suggested the coupling of tooth transposition with the specific expression of posterior region hypodontia. This assumption leads on from a hypothesis in a previous study<sup>57</sup> that presumes an anteroposterior site-specific shift of tooth agenesis, associated genetically or epigenetically with maxillary canine/first premolar transposition. Still searching for genetic associations, Camilleri<sup>58</sup> postulated an association of maxillary canine/first premolar transposition with the genes that control tooth eruption, which in turn are linked

with the gene or genes that cause incisor/premolar hypodontia.

Tooth transposition causes misalignment of teeth and esthetic and functional problems. Early diagnosis can be made between 6 and 8 years of age with a conventional panoramic radiograph. When the alteration is detected early, interceptive procedures including the extraction of deciduous teeth and placement of eruption guides for the permanent teeth may be performed, preventing complete development of the anomaly.<sup>8</sup> Transpositions detected later must be approached as part of a comprehensive treatment plan for the entire dentition.

## TREATMENT CONSIDERATIONS

### Case 1: Mandibular canine/lateral incisor transposition

A 12-year-old girl in early permanent dentition had a retained deciduous mandibular left canine. Intraorally, a canine bulge could clearly be seen between the central and lateral incisors (Fig 1). Clinically, it looked like a labial impaction that needed surgical exposure with an apically positioned flap, followed by orthodontic traction of the canine into place. However, looking at the position of the root apices is essential: On the panoramic radiograph, both the crown and root apex of the unerupted canine were in the lateral incisor site and vice versa (Fig 2). A space was created between the central and lateral incisor after extraction of the deciduous canine, allowing the canine to erupt spontaneously into its transposed position (Fig 3a). Soldered torquing springs were used on the transposed teeth to correct torque for an optimal gingival level and better stability (Fig 3b). The shape, size, and color of the 2 transposed teeth were very similar (Fig 4). Therefore, an attempt to correct this mandibular canine/lateral incisor transposition was not worth the effort. It would have meant surgical uncovering, longer treatment time with risk of gingival recession, and potential root resorption.



**Fig 1** Case 1: Pretreatment intraoral photographs of a mandibular canine/lateral incisor transposition.



**Fig 2** Case 1: Pretreatment panoramic radiograph.

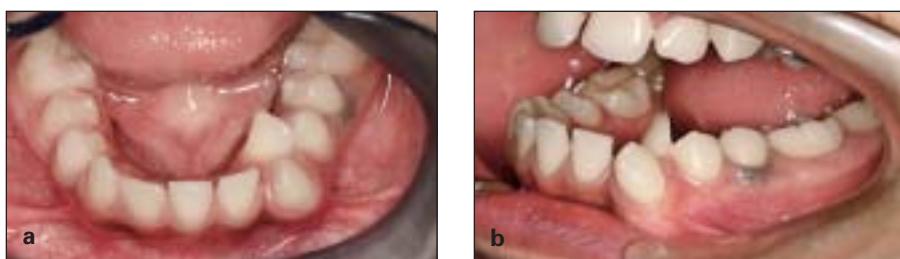


**Fig 3** Case 1: Midtreatment intraoral photographs.



**Fig 4** Case 1: Posttreatment intraoral photographs showing maintenance of the transposed tooth order.

**Fig 5** Case 2: Pretreatment intraoral photographs of a mandibular canine/lateral incisor transposition.



**Fig 6** Case 2: Pretreatment panoramic radiograph, incomplete transposition.



**Fig 7** Case 2: Midtreatment intraoral photographs.



**Fig 8** Case 2: Posttreatment intraoral photographs of the corrected crown transposition.

### Case 2: Mandibular canine/lateral incisor incomplete transposition

In this 13-year-old boy, the mandibular canine and lateral incisor erupted in a transposed position (Fig 5). However, the transposed crowns had their root apices in their relative normal position, which is indicative of an incomplete transposition (Fig 6). Crowding was not due to an arch-length deficiency of genetic origin but

was environmental as a result of the transposition. Space was therefore regained with an open coil (Fig 7a), and the crown transposition was corrected using chain elastics (Fig 7b) and an overlay wire (Fig 7c). Tooth order was reestablished as part of a comprehensive orthodontic treatment with an optimal esthetic outcome within the average treatment time frame (Fig 8).



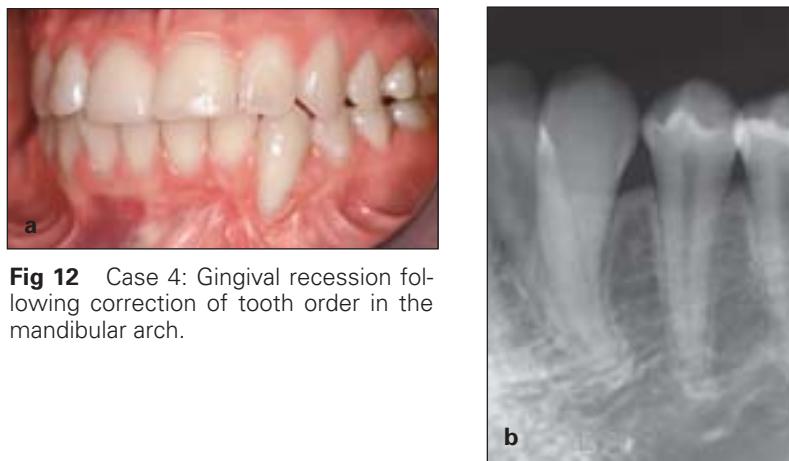
**Fig 9** Case 3: Pretreatment intraoral photograph and radiographs of a bilateral ectopic eruption of transposed mandibular lateral incisors.



**Fig 10** Case 3: Midtreatment intraoral photographs.



**Fig 11** Case 3: Posttreatment intraoral photographs, unilateral correction of transposition.



**Fig 12** Case 4: Gingival recession following correction of tooth order in the mandibular arch.

### Case 3: Bilateral mandibular canine/lateral incisor transposition

A girl 10 years 6 months of age in the mixed-dentition stage had a bilateral symmetrical ectopic eruption of the mandibular lateral incisors at the site of the first premolars with retained deciduous lateral incisors and canines (Fig 9a). The deciduous first molars exfoliated with the ectopic eruption of the lateral incisors. The root apices of the ectopic lateral incisors appeared near to their normal position with the left lateral incisor apex (Figs 9c and 9d) in a more favorable (mesial) position than the apex of the right lateral incisor (Figs 9b and 9d). First-phase orthodontic treatment was initiated in the mixed dentition after extraction of the deciduous canines. A lingual arch was inserted to avoid lingual tipping of the incisors, and chain elastics were used to mesially drive the lateral incisor crowns toward their normal position (Fig 10a). This allowed eruption of the first premolars (Fig 10b). The deciduous lateral incisors were then extracted to allow more mesialisation of the ectopic lateral incisors. The canines were the final teeth to erupt in the mandibular arch; the right canine was in a transposed position (Fig 10c). During the second phase treatment, the right canine and lateral incisor were maintained in their transposed position, with the lateral incisor in a slight labial position to mimic the eminence and offset of the canine it replaced (Fig 11).

### Case 4: Unsuccessful correction of a mandibular canine/lateral incisor transposition

This gingival recession and loss of buccal attachment on the canine is due to an unnecessary attempt to correct tooth order in the mandibular arch (Fig 12). Because of tooth resemblance, limited labiolingual dimension of the alveolar process, and bone density in this area, mandibular canine/lateral incisor complete transpositions are better maintained in their transposed position.

### Case 5: Maxillary first premolar/canine transposition

This is by far the most commonly reported transposition (71% of cases), and because of the resemblance between the maxillary canine and first premolar, teeth can be maintained in their transposed position. This 12-year-old girl had a complete transposition (Fig 13). The first premolar crown was moved mesially following deciduous canine extraction, and the teeth were aligned in their transposed positions. The size, shape, and gingival level of the first premolar were very similar to the canine it replaced (Fig 14). Early extraction of the retained deciduous canine could have favored spontaneous alignment in the transposed position, facilitating fixed appliance treatment.



**Fig 13** Case 5: Pretreatment panoramic radiograph and intraoperative photograph of a maxillary first premolar/canine transposition.



**Fig 14** Case 5: Posttreatment intraoperative photographs, exhibiting maintenance of transposed order.

#### Case 6: Bilateral maxillary first premolar/canine transposition with cleft lip and palate

This female patient with a cleft lip and palate had a bilateral transposition seen on a panoramic radiograph as early as 8 years 6 months of age (Fig 15a). A follow-up radiograph in the early permanent dentition confirmed complete left first premolar/canine transposition and ectopic migration of the right canine toward the first molar (Figs 15b and 15c). The left central and lateral incisors on the cleft side had to be extracted because of their atypical shape and lack of bone support. Orthognathic surgery with a 2-piece LeFort I osteotomy to expand and advance the maxilla was indicated. The ectopic maxillary right canine was extracted, and teeth were aligned in their transposed position on the left side with the first premolar replacing the missing lateral incisor (Figs 16 and 17a). A retainer with an acrylic tooth was delivered until a single-tooth implant could replace the missing central incisor (Fig 17b).

#### Case 7: Unsuccessful correction of a bilateral maxillary first premolar/canine transposition

This patient had completely blocked out maxillary canines between the first and second premolars (Fig 18a). The apices of the canines were at the site of the first premolars and vice versa, confirming a complete bilateral transposition of these teeth (Fig 18b). A hazardous nonextraction treatment was attempted to correct tooth order, resulting in severe gingival recession with loss of periodontal support on both maxillary canines (Fig 19). This bilateral transposition would have been resolved spontaneously with maxillary first premolar extraction. An arch-length deficiency of 15 mm was a clear indication for extraction.



**Fig 15** Case 6: Pretreatment panoramic radiographs and intraoral photograph of a bilateral maxillary first premolar/canine transposition in a cleft lip and palate patient.



**Fig 16** Case 6: Presurgical intraoperative photographs.



**Fig 17** Case 6: Posttreatment intraoperative photographs.



**Fig 18** Case 7: Pretreatment study cast and panoramic radiograph of a bilateral maxillary first premolar/canine transposition.



**Fig 19** Case 7: Severe gingival recession following hazardous correction of tooth order.



**Fig 20** Case 8: Pretreatment panoramic radiograph of a maxillary first premolar/canine transposition.



**Fig 21** Case 8: Transposition eliminated after maxillary first premolar extraction.

#### Case 8: Maxillary first premolar/canine transposition in an extraction case

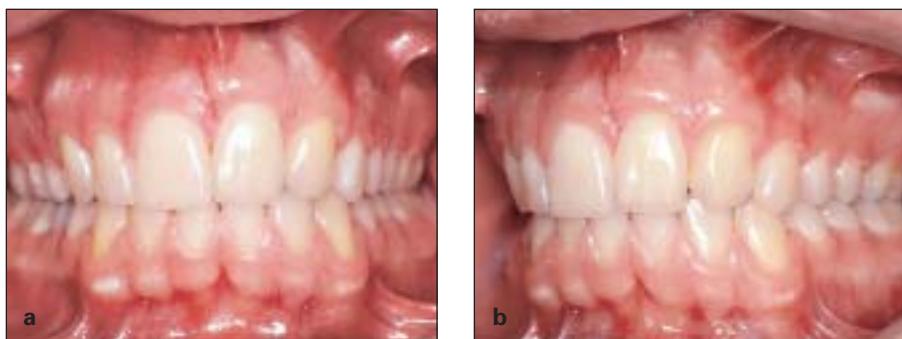
This female patient, seen in the mixed dentition stage, had an arch-length deficiency with a maxillary left first premolar/canine transposition and a right impacted canine (Figs 20 and 21a).

Unlike case 7, the transposition was spontaneously eliminated with maxillary first premolar extraction. A Nance holding arch was used as a space maintainer until full eruption of the permanent teeth (Fig 21b). The impacted canine erupted, and optimal alignment was achieved following fixed-appliance therapy (Fig 21c).



**Fig 22** Case 9: Pretreatment periapical radiographs and intraoperative photograph of a maxillary canine/lateral incisor transposition.

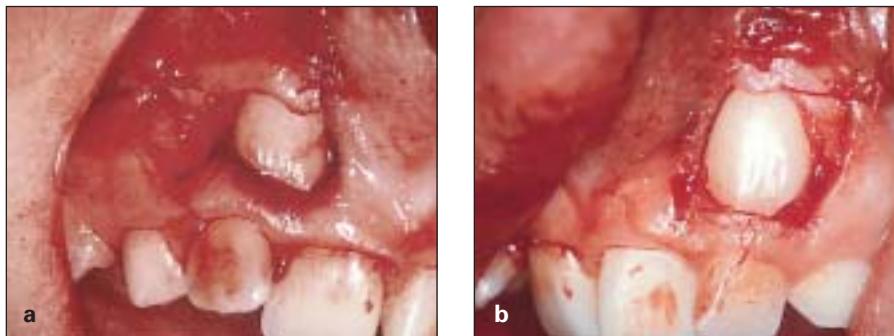
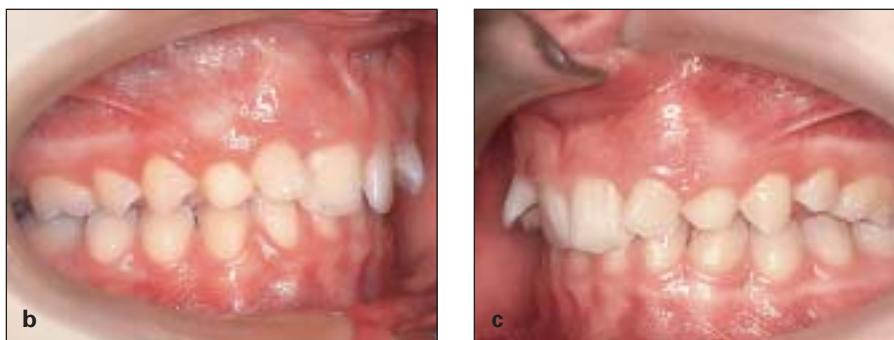
**Fig 23** Case 9: Posttreatment intraoperative photographs, maintenance of transposed order.



### Case 9: Maxillary canine/lateral incisor complete transposition

Maxillary canine/lateral incisor transposition is best seen on 2 periapical radiographs (anterior and posterior) taken with the parallel technique (Figs 22a and 22b). Clinically, one would be tempted to recuperate what appears to be a labially impacted canine (Fig 22c). However, because of the position of the root apices,

treatment in the transposed position was more appropriate for this young boy: A good esthetic outcome was achieved with only minor coronoplasty on the transposed teeth (Fig 23). When the maxillary canine and lateral incisor are kept in their transposed position, the esthetic drawback due to the lack of resemblance between the 2 teeth can be improved with proper tooth positioning and various restorative dentistry techniques.



**Fig 24** Case 10: Pretreatment panoramic radiograph and intraoral photographs of a maxillary canine/lateral incisor incomplete transposition.

**Fig 25** Case 10: Surgical exposure.

### Case 10: Bilateral maxillary canine/lateral incisor incomplete transposition

This 11-year-old girl in the mixed-dentition stage had labially impacted maxillary canines. The crowns were impacted between the central and lateral incisors, and the root apices were near their normal position (Fig 24a). A labially tipped lateral incisor crown is a sign of labial canine impaction (Figs 24b and 24c). At 13 years 6 months of age, the transposed canine crowns were surgically

uncovered via apically positioned flaps after full eruption of the permanent teeth (Fig 25). The canines were bonded and moved distally and labially with elastics on a removable appliance to avoid root interferences or resorption of the lateral incisors and transfer anchorage demands to the palatal vault and alveolar ridge (Figs 26a and 26b). As soon as the canines were in a more favorable mesiodistal position, fixed-appliance therapy was initiated (Fig 26c) and optimal esthetics were achieved following the correction of crown transpositions (Fig 27).



**Fig 26** Case 10: Midtreatment intraoral photographs.



**Fig 27** Case 10: Posttreatment intraoral photographs, correction of crown transpositions.

### Case 11: Maxillary canine/lateral incisor transposition

This 11-year-old girl in the mixed-dentition stage presented with early eruption of the maxillary canines (Fig 28). The left canine was erupting mesially between the lateral and central incisor (Fig 28b). A nearly complete transposition can be seen on radiographs (Fig 29). Because of

its intermediate location labial and parallel to the lateral incisor, the canine was repositioned after adequate space opening (Figs 30a and 30b). Root parallelism was achieved with a Storner box (Fig 30c) and a Beta-titanium alloy (TMA) wire. Optimal correction of this maxillary canine/lateral incisor transposition was possible (Fig 31).



**Fig 28** Case 11: Pretreatment intraoral photographs of maxillary canine/lateral incisor transposition.



**Fig 29** Case 11: Pretreatment panoramic and periapical radiographs.



**Fig 30** Case 11: Midtreatment intraoperative photographs.



**Fig 31** Case 11: Posttreatment intraoperative photographs, correction of transposition.

## CONCLUSION

Transposition is an interchange of position between 2 adjacent teeth. Most transpositions involve canines in the maxillary arch. The maxillary first premolar/canine transposition is the most common, followed by maxillary canine/lateral incisor transposition. Mandibular transpositions are between only the lateral incisor and canine. Unilateral transpositions have been reported more often than bilateral transpositions. Dental anomalies such as peg-shaped laterals, retained deciduous teeth and crowding can often coexist with tooth transpositions. The etiology of tooth transposition is unclear and several postulates and hypotheses have been proposed in the literature. No definite gender distribution has been found.

Attempts to correct tooth order may lead to gingival recession with loss of periodontal attachment, prolonged treatment time, and root resorption. Because of bone density and limited labiolingual dimension of the alveolar process in the mandible, teeth are better kept in their transposed position in the mandibular arch. The possibility of correcting tooth order in the maxillary arch is greater. However, maintaining tooth order is recommended with maxillary first premolar/canine complete transpositions because of tooth resemblance. Maintaining maxillary canine/lateral incisor transpositions may result in an esthetic compromise that can be improved with the recent innovative techniques in restorative dentistry. Conversely, incomplete transpositions, when root apices are close to their normal position, can be easily corrected within the average time frame and can lead to a better esthetic outcome. Transpositions should be managed as part of a comprehensive treatment plan. Early recognition and interceptive measures such as deciduous teeth extraction and tooth guidance could facilitate further treatment. The position of the root apices is essential and should not be overlooked.

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