Canine Transposition – Prevalence, Distribution and Treatment Considerations among Orthodontic Patients

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Tooth transposition is a relatively rare dental anomaly of interchange in position of two adjacent teeth. ***Aim****: To determine the prevalence and distribution of canine transposition in a sample of orthodontic patients and present treatment alternatives and outcome.* ***Study design:*** *The records of 3000 consecutively treated orthodontic patients from a university clinic were surveyed to detect canine transposition in both dental arches. The data was recorded according to gender, age, number and location.* ***Results:*** *Canine transpositions were detected in 15 subjects, 3 (20%) males and 12 (80%) females presenting a prevalence of 0.5%. Of them, 6 were between the maxillary canine and first premolar, 7 between the maxillary canine and lateral incisor, 2 transpositions were between the mandibular canine and the lateral incisor. A female to male ratio of 4:1 with left side predominance was found. Treatment options include extracting the transposed teeth, maintaining them in their transposed position, or repositioning them in their normal place within the dental arch.* ***Conclusion :****The prevalence of canine transposition in the present sample was found to be 0.5% with a greater frequency in the maxilla. Treatment options include extraction of one of the transposed teeth, alignment of the teeth in their transposed position or correction of the anomaly. The latter gives the best esthetic outcome.*

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INTRODUCTION

Harris[1], in his first edition of "A Dictionary of Dental Sciences, Biography, Bibliography and Medical Terminology", in 1894, first described tooth transposition as an aberration in the position of teeth. Transposition occurs when "a central incisor is situated between the lateral of the side to which it belongs and the cuspidatus, or that a lateral incisor is situated between the cuspidatus and first bicuspid, and a cuspidatus that is found between the first and second bicuspids". More recently, tooth transposition has been defined as an interchange in position of two adjacent permanent teeth in the same quadrant of the dental arch.[2] This was later extended to include "the eruption of a tooth in a place normally occupied by another non-adjacent tooth"[3,4]. Transposition is a type of ectopic eruption with exchange in tooth position and results in an abnormal sequence of the permanent teeth in the dental arch. All transpositions are types of ectopic eruption, but not every ectopic eruption is a transposition.[5]

A classification of five types of maxillary tooth transposition has been suggested by Peck[4] (Fig. 1): maxillary canine – first premolar (Mx.C.Pm1), maxillary canine-lateral incisor (Mx.C.I2), maxillary lateral incisor-central incisor (Mx.I2.I1), maxillary canine to central incisor site (Mx.C.to I1), maxillary canine to first molar site (Mx.C.to M1), and additional type in the mandible: mandibular canine-lateral incisor (Mn.C.I2). However, it has been proposed that the Mx.C.to I1 and Mx.C.to M1 patterns should not be defined as transpositions, rather be termed as extreme ectopic eruption,[6] or extreme canine migration.[7]

Transposition may present as complete, where the entire crowns and root structures of the involved teeth are in their transposed malposition, or incomplete (also described as "pseudo" or "partial") where only the crowns are transposed but the root apices remain in their normally occurring positions.[2] Transposition has been reported to be most frequently between the maxillary permanent canine and first premolar and occasionally involving the maxillary canine and lateral incisor or the mandibular canine and lateral incisor.[8,9] This anomaly has been reported to be more frequently found unilaterally than bilaterally, with left side predominance and more often in females than in males.[2,8] These predispositions have been attributed to heredity involving incomplete penetrance as well as other genetic tendencies.[2,5]

The etiology of canine transposition, similar to that of canine impaction, has not been elucidated. The presence of an obstacle such as a supernumerary tooth or an odontoma could be a factor causing the deflection and migration of a tooth. Several theories have been suggested as etiological factors such as interchange in location between the developing tooth buds,[10] trauma to the primary dentition,[11] genetics and heredity factors especially when reported bilaterally in siblings, [3,5,12,13] prolonged retention of the primary tooth,[14] crowding and inadequate arch length.[15] In the majority of canine transpositions or impactions retention of the primary canines was also reported.[8,10] Thus, overly retained primary canines have been suggested as the chief cause for the displacement of the permanent tooth. However, it is not entirely clear whether the retained primary tooth is the cause or the result of the displacement and ectopic eruption of its successor. In addition, canine transposition has been reported to be associated with other dental anomalies such as missing teeth, peg-shape maxillary lateral incisors, retained primary canines, rotations and malposition of adjacent teeth [6,16,17].

The purpose of the present study was to conduct a descriptive retrospective wide survey to determine the prevalence and distribution of transposed permanent canines in a sample of orthodontic patients and present some clinical treatment alternatives and outcome.

MATERIALS AND METHOD

The present study was conducted using direct clinical examination, as well as the pre-treatment facial and intraoral photographs, panoramic and periapical radiographs and dental casts of 3,000 consecutively treated orthodontic patients from the department of orthodontics at Tel Aviv University. The present study sample was comprised of 1780 (59%) females and 1220 (41%) males ranging in age from 10-40 years (mean age 17.3±9.3 years), and these were examined to detect canine transpositions in either dental arch. Data points were cataloged according to gender, age, location and number of transpositions in each jaw. Subjects were either referred by their general dentist upon detection of the dental malocclusion and/or mal-alignment, or presented under their own volition due to perceived dental appearance.

Inclusion criteria were complete patient records with good quality photographs and radiographs. Exclusion criteria were any trauma to primary teeth or extraction of teeth, orthodontic or surgical treatment and congenital craniofacial malformation or syndromes. Informed consent was obtained prior to initiation of orthodontic therapy as part of a standard procedure for all patients submitting for treatment in the university clinic permitting including use of their clinical information as part of teaching and/or research material. The study was approved by the Ethics Committee of Tel Aviv University.

RESULTS

In the present study sample, 15 subjects, 3 males (20%) and 12 females (80%) females, presented with canine transposition. This translates to a prevalence of 0.5%. Within this subset, 6 were between the maxillary canine and first premolar (1 male and 5 females), 7 were between the maxillary canine and lateral incisor (2 males and 5 females), 2 females had transposition between the mandibular canine and the lateral incisor (Table 1). Transposition was found to occur 4 times more in females than in males (*i.e.* 12 and 3 subjects, respectively).

Table 1 – Frequency of canine transposition according to Gender and location.

Gender	Max. Canine-Lateral Incisor	Max. Canine-First Premolar	Mand. Canine-Lateral Incisor	Total
Male	2	1	0	3 (20%)
Female	5	5	2	12 (80%)
Total	7 (47%)	6 (40%)	2 (13%)	15 (100%)

In the maxilla the distribution between canine-first premolar and canine-lateral incisor transposition was essentially equivalent (*i.e.* 6 and 7 subjects, respectively). In the mandible transpositions were

discovered between the canine and lateral incisors only. All transpositions were unilateral with left side predominance, except for one case of bilateral transpositions between the mandibular canine and lateral incisor. No subject was found to display transpositions in both arches. In addition, retained primary canines were detected in nearly all subjects with transpositions (3 males and 10 females) (Table 2). Each of the subjects with a transposition presented also with a Class I malocclusion. Of these 7 subjects (2 males, 5 females), also displayed mild anterior crowding of less than 3 mm, and in the remaining 8 subjects (1 male, 7 females) 3-5 mm was found (Table 2).

Table 2 – Type of malocclusion with canine transposition.

Classification	Crowding		Retained Primary Canine	Gender Total
	<3mm	3-5 mm		
Class I	2 M	1 M	3 M	3 M (20%)
Class I	5 F	7 F	10 F	12 F (80%)
Total	7 (47%)	8 (53%)	13 (87%)	15 (100%)

M- Male, F – Female

Table 3 presents the treatment modalities of maxillary canine-lateral incisor transposition in two of the subjects incorporated maintaining the transposed positon of the involved teeth. Placement of these teeth in their normally occurring positions was performed in 5 subjects. This treatment choice achieved the more pleasing esthetic outcomes. Treatment of maxillary canine-first premolar transposition in 4 subjects was achieved by maintaining them in their transposed position. In two subjects this was done by replacing them in their normal positions in the dental arch. The two subjects presenting mandibular canine-lateral incisor transposition were treated in a manner that retained these teeth in their transposed position.

Table 3 – Treatment Modalities of canine transposition.

Alignment in	Max. Canine-Lateral Incisor	Max. Canine-First Premolar	Mand. Canine-Lateral Incisor	Total
Transposed position	2	4	2	8 (53%)
Normal position	5	2	0	7 (47%)
Total	7 (47%)	6 (40%)	2 (13%)	15 (100%)

Max.- Maxilla, Mand.–Mandible

DISCUSSION

Canine transposition is a relatively rare dental anomaly of unknown etiology. Its reported prevalence varies according to ethnicity and/or country of origin. For example, in a Turkish population this was reported as being 0.38%,[17] 0.43% in India,[5] 0.55% in the Arab Israeli population[18] and 1.4% in Nigeria.[19] In the present study, the prevalence of transposition among Israeli orthodontic patients (0.5%) was similar to that reported for the Arab Israeli population.[18]

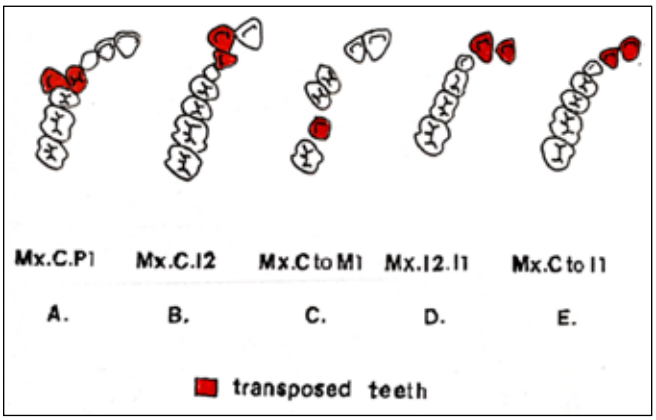
Dental anomalies may cause esthetic, functional and psychological disturbances for subjects in which they occur. The findings of the present study are based on a distribution where 59% of the participating subjects were females. Our findings detected a female predominance in occurrence of this anomaly, and it has also been previously reported that the majority of orthodontic patients are females.[20,21] The correlation of these findings might be related to a higher motivation of female subjects with regard to esthetic sensitivity. These findings are in agreement with other reports showing transposition more frequently in females [16,18] although Chattopadhyay and Srinivas reported the opposite.[5]

A possible explanation of the above may be structural, in that the female skull and jaws are smaller than that of males, and the concomitant lack of arch length may be a contributing factor for transposition. Furthermore, other dental anomalies, such as missing maxillary lateral incisors, impacted canines and cleft lip and palate have been reported to present with a higher prevalence in females and with left side predominance.[14-17,19] As with our findings, these previous studies yielded epidemiological information without causative conclusions. Meaning, that transpositions, like other dental anomalies, may present with a sexually dimorphic distribution, however, the reason for female and left side predominance is still obscure.

The tooth most frequently involved in transposition is the maxillary canine. It may, due to an unexplained mechanism, alter its path of eruption and migrate mesially to become transposed with the lateral incisor, or distally with the first premolar. In the mandible this most commonly occurs with the permanent lateral incisor is displaced distally causing it to become transposed with the canine.[22] In the maxilla the displaced canine is the cause for transposition while in the mandible it is the displaced lateral incisor.

The limitations of this study are directly related to the rareness in occurrence of dental transpositions, and the nature of the subjects comprising our study sample. The former limitation is reflected in the relatively small number of data points discovered, and the latter may be inherent when subjects are derived from a patient rather than the general population. This might introduce a selection bias and may be more significant than the former. However, the findings of this study highlight an esthetic clinical presentation frequently detected in young children by pediatric dentists.

Fig. 1–Classifications of maxillary transpositions.
[According to Peck L and Peck L: *AJO-DO* 1995;107(5):507-517].



Developing transpositions in the mandible can be detected as early as the age of 6-8. Specifically, when a mandibular permanent lateral incisor has fully erupted on one side while its antimere has failed to do so and primary lateral incisor is still present, a panoramic radiograph is mandatory. This will provide the clinician the proper tool to diagnose the disparity.

An ectopically erupting lateral incisor often causes premature loss of the primary first molar due to the severity of its divergence. This will result in transposition with the erupting permanent canine (Fig. 2 A & B – black dotted arrow shows the permanent lateral incisor ectopically erupted and rotated 90 degrees). Interceptive treatment should be initiated early to extract the retained primary lateral incisor and canine (Fig.2 A & B – white arrows), following by orthodontic correction of the ectopic lateral incisor to its normal position to prevent the developing transposition with the erupting permanent canine. Various techniques for such treatment have been previously described,[22] including arch length (space) maintenance. Furthermore, this condition should be managed as part of a comprehensive orthodontic treatment plan including resolution of the malocclusion, elimination of arch length deficiency/excess, correction of the location of root apices of the transposed teeth, esthetics and function. These need to be framed within a context that includes the duration of treatment.

The occurrence of this anomaly in the mandible presents added clinical challenges imposed by anatomical limitations related to the density of the cortical bone and the narrow labio-lingual dimension of the alveolar process. Any attempt to move the teeth in the labio-lingual plane to correct the transposed teeth to their normal position is difficult and may result in varying loss of periodontal support, gingival recession and root resorption.[22] Therefore, it is recommended that transposed teeth in the mandible be aligned but left in their transposed position as described earlier.[22,23]

Transpositions more commonly occur in the maxilla. The canine-first premolar transposition is easiest to resolve by aligning these teeth in their transposed position because of tooth resemblance. However, alignment of canine-lateral incisor transposition in this manner may result in an un-esthetic appearance (tooth shape, size and color). Therefore, orthodontic correction of these tooth positions is usually the option of choice. Such treatment requires proper planning, including the precise application of biomechanical principles, anchorage control and moment-to-force ratios. The degree of difficulty associated with this, commonly entails a longer than average treatment duration. However, a superior esthetic result can be anticipated as opposed to maintaining the transposition.[9]

The following cases illustrate the treatment alternatives to clinically resolve canine transpositions.

One option to consider is extraction of one of the transposed teeth and alignment of the rest of the teeth in the arch. This is presented in the mandibular arch of an 11 years old boy with the canine erupting between the central and lateral incisor (Fig. 3 A, arrow) presenting transposition of a mandibular canine and lateral incisor which is 90 degrees rotated. The lateral incisor was extracted, and the first premolar erupted so that there was no need for orthodontic treatment to produce both a functional as well as esthetic outcome. (Fig. 3 B).

Another treatment alternative is to align the teeth in their transposed position and reshape the incisal/cuspal surfaces to create a resemblance between the transposed tooth and its involved neighbor. This is depicted in a patient where the permanent maxillary canine is erupting between the first premolar and second primary molar (Figs. 4 A-D, arrow). The right primary canine and second primary molar were removed allowing space for orthodontic alignment of the teeth in their transposed position using edgewise .018'x.025' orthodontic appliance, followed by bonding of a fixed retainer (Fig. 4 E-H).

Finally, the more complex, prolonged and challenging procedure of moving the transposed teeth to their correct position in the arch which requires special management as described above.[9] This approach is most appropriate for treatment of maxillary canine-lateral incisor transposition to achieve significantly improved facial esthetic and functional outcomes.[9] Figure 5 illustrates a case of a 12 years old girl with a Class I malocclusion with mild maxillary anterior crowding and retained primary canine. Her maxillary permanent canine has erupted into a transposition between the central

Fig. 2 –Displacement of the mandibular right lateral incisor.

Radiograph (a part of a panoramic radiograph) showing the displaced right permanent lateral incisor (Black dotted arrow), under the right primary first molar.

Notice the retained primary canine and the retained primary lateral incisor (white arrows).

B. Intraoral occlusal view of the mandibular arch showing the ectopically erupted right permanent lateral incisor in 90 degrees rotation (Black dotted arrow) following early exfoliation of the primary first molar.

Notice the retained primary canine and the retained primary lateral incisor (white arrows).

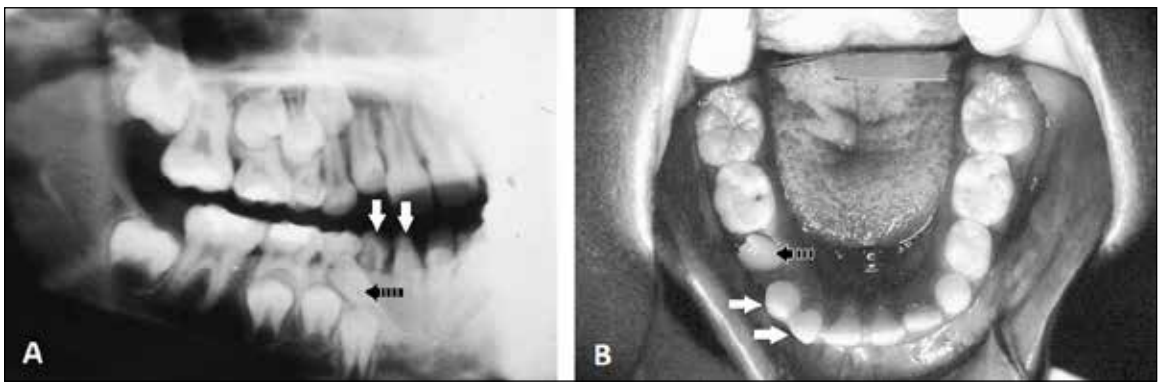


Fig. 3 – Mandibular canine-lateral incisor transposition.

A. Pre-treatment occlusal view showing the erupted canine between the central and lateral incisors (arrow). Note the 90 degrees rotation of the lateral incisor distal to the canine, and the buccally erupting first premolar.

B. Post-treatment occlusal view after extraction of the lateral incisor and self-alignment of the first premolar into the arch.

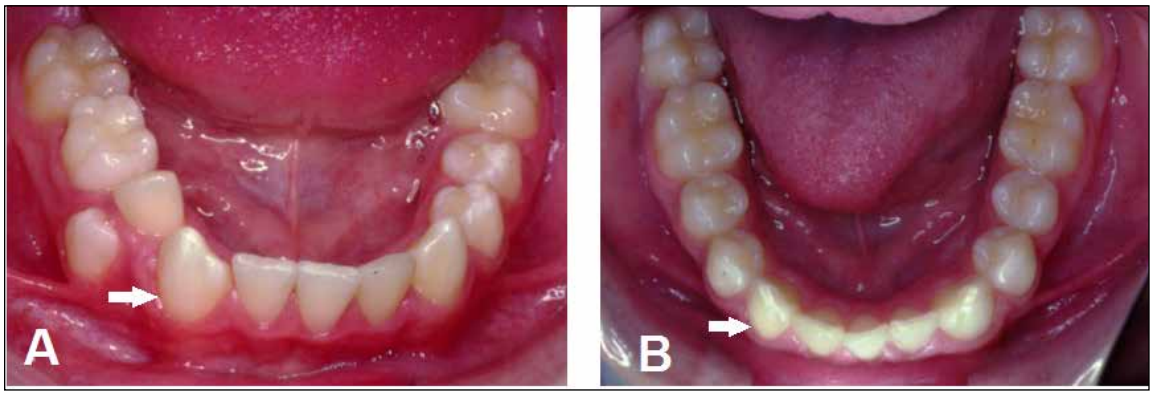


Fig. 4 – Maxillary canine-first premolar transposition.

A. Pre-treatment panoramic radiograph showing complete transposition of the right canine (arrow) with the first premolar, prior to removal of the primary canine.

B–D Pre-treatment front (B), right side (C) and occlusal (D) views showing the erupting canine between the first premolar and second primary molar (arrow), after removal of the primary canine.

E. Post-treatment panoramic radiograph showing the canine (arrow) aligned in transposed position with the first premolar.

F–H Post-treatment front (F), right side (G) and occlusal (H) views showing the canine (arrow) aligned in a transposed position with the first premolar.

and lateral incisors resulting in crowding (Figs. 5 A,B arrow). The retained primary canine was extracted and an edgewise fixed appliance together with appropriate mechanics, utilizing a sectional (rectangular) spring to temporarily position the lateral incisor palatally (Figs. 5 C,D). This provided a corridor for moving the permanent canine distally within the alveolar bone to its normal place in the arch (Figs. 5 E, F arrow). Once this has been achieved, the lateral incisor was moved back labially into its normal place in the arch, and its root was torqued and uprighted. The clinical result eliminated all influences of the presenting malocclusion and resulted in a highly esthetic outcome (Figs. 5 G, H).[9]

CONCLUSIONS

Based on the results of the present study, the following conclusions can be made:

1. The overall prevalence of canine transposition was found to be 0.5% in a sample of orthodontically treated patients in an Israeli population.
2. A greater frequency of canine transposition was found in the maxilla than in the mandible.
3. A 4:1 female and lefty side predilection was detected.
4. Treatment options include extracting one of the transposed teeth, maintaining them in their transposed position, or repositioning them in their normal place within the dental arch.

Fig. 5 – Maxillary canine-lateral incisor transposition.

A–B. Pre-treatment :

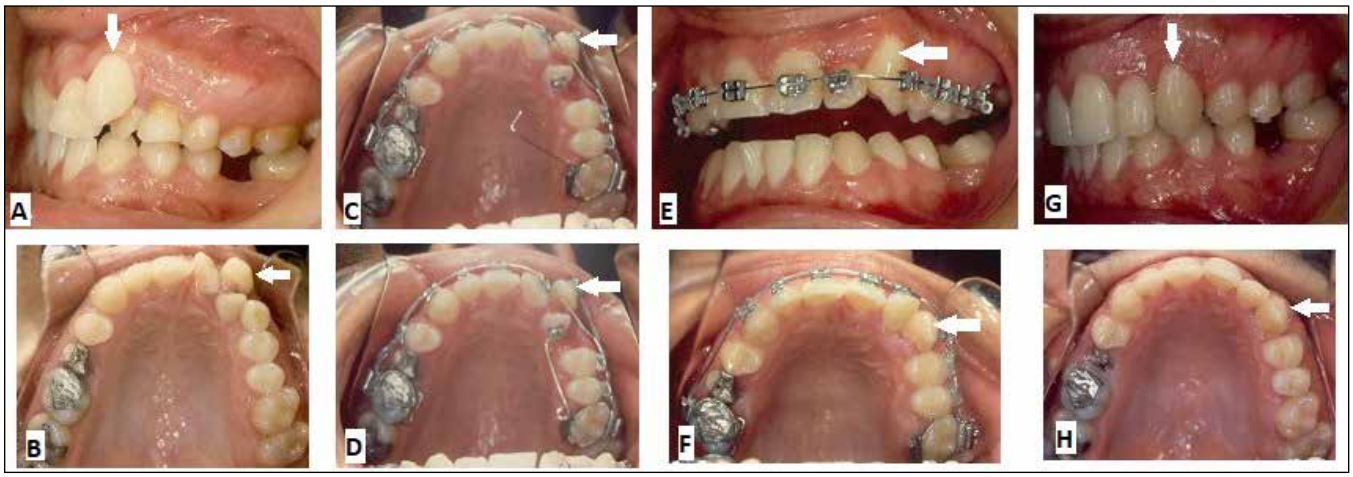
Left side (A) and occlusal (B) views showing the erupting permanent canine (arrow) in transposition between the central and lateral incisors.
Note the retained primary canine and the crowding in the region.

C–D. Occlusal views during treatment showing the palatal sectional spring (.016'x.022' stainless) passive (C) and active (D) used to move the lateral incisor palatally to free the way for canine (arrow) distalization .

E – F. Front view (E) and Occlusal view (F) during treatment with edgwise (.018'x.022') appliance.The canine is in its normal place in the arch (arrow).

G – H. Post-treatment :

Left side (G) and occlusal (H) views showing the final result with the canine (arrow) and latral incisor in their normal position in the dental arch.



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