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A Study of Transposed Canines in a Sample of Orthodontic Patients

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Abstract. *Tooth transposition is a positional interchange of two adjacent teeth. The most commonly transposed tooth is the permanent canine with either the first premolar or lateral incisor.*

The records of 54 subjects with transposed canines, both maxillary and mandibular, were collected. Pretreatment study models of these subjects were matched with a similar number of models from unaffected individuals. Bucco-lingual and mesio-distal tooth widths, arch depth and arch width were measured on each model.

Thirty-four subjects (63 per cent) were female. Thirty-seven (68·5 per cent) of the cases involved the maxillary arch and thirty-three (89·2 per cent) of these upper arch transpositions were of the canine and first premolar. In cases involving the lower arch the canine was invariably transposed with the lateral incisor. Peg-shaped lateral incisors, supernumerary and/or congenitally absent teeth occurred in 19 subjects. There were some small, but significant differences in the dimensions of some teeth, however there were no statistically significant differences in arch depths, arch widths and most tooth dimensions in subjects with and without transposed canines. These factors do not appear to be related to the development of canine transposition.

Index words: Canine Eruption, Tooth Abnormalities, Tooth Eruption (Ectopic), Transposition.

Introduction

Tooth transposition is defined as 'the positional interchange of two adjacent teeth—particularly of the roots—or the development or eruption of a tooth in a position occupied normally by a non-adjacent tooth' (Peck *et al*., 1993). The majority of published reports of tooth transposition describe individual cases. Only four studies are based on sample sizes greater than ten (Joshi and Bhatt, 1971; Shapira, 1980; Peck *et al*., 1993; Chattopadhyay and Srinivas, 1996). Approximately two-thirds of these examples of transposition were on the left side of the dental arch. Peck and Peck (1995) reviewed 201 previously published cases and found more than 90 per cent of these involved transposition of the canine with either a first premolar or a lateral incisor. Bilateral occurrence has also been reported (Payne, 1969; Shapira, 1978; Gholston and Williams, 1984).

The rate of occurrence of some dental anomalies (such as peg-shaped lateral incisors and congenitally absent teeth) is greater in subjects with transposed teeth than in the general population (Peck *et al*., 1993). These authors concluded that the aetiology of canine transposition was therefore partly genetic. To support this suggestion they reported examples of bilateral occurrence, familial patterns and gender bias. No other significant factors have been identified in the development of canine transposition. Analysis of canine impaction shows similar familial tendencies (Zilberman *et al*., 1990), gender bias (Dachi and Howell, 1961) and an increased rate of occurrence of dental anomalies (Becker *et al*., 1981). Crowding can also be involved in the development of palatally impacted canines (Thilander and Jakobsson, 1968).

To date, no published studies have assessed the role of tooth and arch size in the development of tooth transposition. The aim of this study was to determine the distribution of transposed permanent canine teeth, and to evaluate some of the possible aetiological factors, in a sample of orthodontic patients drawn from the School of Dentistry, University of Otago, and orthodontic practices in the South Island of New Zealand.

Methods and materials

Criteria for Patient Selection

From the records of the University of Otago School of Dentistry and specialist practices in Dunedin, Invercargill, Nelson and Christchurch, 54 subjects with transposed permanent canines were identified. Transposition was confirmed from pretreatment radiographs.

Pretreatment study models of four affected subjects were not available. The study models of the remaining 50 affected subjects were matched according to incisor classification (British Standards Institution, 1983), gender and dental development, with models of an untreated sample of consecutive subjects who had previously presented to the Department of Orthodontics, University

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of Otago. Using these criteria, a matched control group comprising the models of fifty individuals was selected. Cases was cleft lip and/or palate were excluded from the control group.

Data Collection

The subject's gender, race, age, malocclusion, and the presence of any other dental anomalies were recorded. A questionnaire was sent to all subjects to determine if a history of dental trauma or any familial history of dental anomalies was known. The dominant hand of the patient, as favoured in writing and sporting activities, was also recorded.

The records of all subjects were examined and checked for the presence of one or more of the following anomalies: supernumerary teeth, peg-shaped lateral incisors, and congenital absence of other permanent teeth (not including third molars). In two subjects, the presence or absence of such anomalies could not be ascertained from the records. A peg-shaped lateral incisor was recorded if there was a conical crown-size reduction, 'reducing in diameter from the cervix to the incisal edge' (Le Bot and Salmon, 1977).

From the 50 available pretreatment study models and their matched controls, the largest mesio-distal (M–D) width and bucco-lingual (B–L) width of all erupted permanent teeth in the affected arch were measured with calipers (Mitutoyo Corp., Japan). Each measurement was made three times to $\pm 0{\cdot}05$ mm. The means of these three measurements were used in all subsequent calculations. Arch width measurements were taken from the mid-points between the mesial and distal contact points of the first permanent molars, which approximates, or coincides with, the centroid of the tooth as described by Moyers *et al*. (1976). Arch depth was measured as the perpendicular distance from the midpoint of the most labial points of the central incisors to the midpoint of the line joining the mesial contact points of the first permanent molars (Moyers *et al*., 1976). The same measurements were made on the control models in the corresponding arch. Unerupted or partially erupted teeth, and teeth that could not be accurately measured, were excluded from the analysis.

Statistical Analysis

Tooth widths, arch depths, and arch widths in subjects with transposed teeth were compared to corresponding measurements in the control subjects using paired Student's *t*-tests. Tooth widths were also compared between affected and non-affected sides of the models from subjects with unilateral transposed teeth. As there were no differences between affected and non-affected sides ($P > 0{\cdot}05$) in the transposed group, nor between sides in the control group, these figures were pooled to give B–L and M–D widths for each tooth (transposed group and control). Paired Student's *t*-tests were used to determine whether a significant difference in individual tooth dimensions existed between subjects with transposed teeth and control subjects.

Differences significant at the level of $P < 0{\cdot}05$, using the Bonferroni correction for multiple testing, are reported. The Bonferroni correction reduces the probability of a significant finding due to chance (type I error) and is equivalent, in this study, to $P < 0{\cdot}013$ (four Student *t*-tests per tooth) when adjusted for multiple testing. Actual *P*-values are, however, reported.

Results

Subject Data

Thirty-four of the total transposed group of 54 subjects were female (63 per cent). The majority of transpositions (36) were in the maxillary arch (68·5 per cent). Thirty-three of these maxillary transpositions (89·2 per cent) were of the canine and first premolar. Of the four subjects with maxillary canine-lateral incisor transposition, only one of these involved a peg-shaped lateral incisor. In the mandibular arch all transpositions were of the canine and lateral incisor. No subject had transpositions in both the maxillary and mandibular arches. Six subjects had bilateral transpositions (11·1 per cent), three involving transposed maxillary canines and first premolars, and three involving transposed mandibular canines and lateral incisors. In all cases of bilateral transposition the same teeth were affected on both sides of the dental arch. Of those subjects with unilateral transpositions, twenty-nine (60·4 per cent) were on the left hand side of the dental arch. The distribution of the transpositions by site and gender are shown in Fig. 1. In the female subjects, 20 out of the 30 unilateral transpositions were on the left (66·7 per cent), whereas transpositions in male subjects occurred in equal numbers on each side.

Of the 52 subjects where the presence or absence of developmental anomalies could be determined, nineteen (36·5) had congenitally absent teeth, peg-shaped lateral incisors, or supernumerary teeth.

Forty-six of the 54 subject questionnaires (85·2 per cent) were returned. Of the respondents, 42 (91·3 per cent) described themselves as being of European racial origin. Previous trauma to the transposed area was recalled by four subjects (9·7 per cent), and a family history of dental anomalies was reported in nine subjects (19·6 per cent). Seven of these subjects (15·2 per cent) identified themselves as left-handed. Subject details are summarized in Table 1.

Of those individuals with unilateral transpositions and in whom the dominant hand was known, five of the 24 subjects (20·8 per cent) with left-sided transpositions and two of the 16 subjects (12·5 per cent) with right-sided transpositions, were left-handed. All bilateral transposition cases (six) were in right-handed subjects. Statistical analysis, using the Chi-squared test, showed there was no significant difference ($P = 0{\cdot}497$) between the number of left-handed subjects with left-sided transposition and left-handed subjects with right-sided transposition. Similarly, the percentage of left-handed subjects with left-sided transposition in this sample was not significantly increased ($P = 0{\cdot}077$) from the percentage of left-handers in the general population (using a population prevalence of 10 per cent). All bilateral transposition cases were in right-handed subjects.

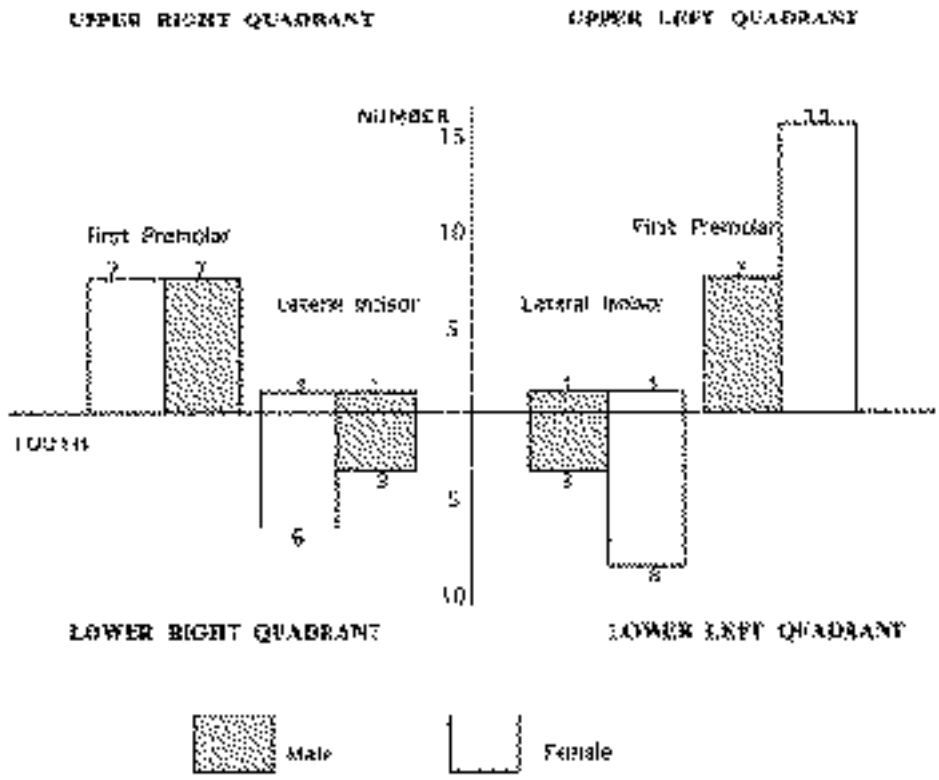

FIG. 1 Position and frequency of transposed canines, by gender.

Cast Analysis

The MD and BL widths of the upper lateral incisors were significantly smaller (both $P < 0{\cdot}001$) in the transposed group. There were eight cases with peg-shaped lateral incisors in the transposed group. When the measurements of the peg-shaped teeth were excluded from the data, the difference in MD ($P = 0{\cdot}001$) and BL ($P < 0{\cdot}001$) widths of the upper lateral incisors between the two groups remained significant. The MD ($P = 0{\cdot}002$) and BL ($P < 0{\cdot}001$) widths of upper central incisors and MD width ($P = 0{\cdot}003$) of the upper first premolars were also significantly smaller in the transposed group. The BL widths of the lower second premolars in the transposed group were significantly larger than the respective teeth in the control group ($P = 0{\cdot}009$). Mean MD and BL tooth dimensions are given in Table 2. No difference was found in arch widths and arch depths between the study models of subjects with transposed canines and those without.

Measurement Error

One case was randomly selected and all measurements were performed ten times. For the tooth width measurements the range was between $x \pm 0{\cdot}15$ mm and $x \pm 0{\cdot}40$ mm.. The range for arch width was $x \pm 0{\cdot}20$ mm and for the arch depth, $x \pm 0{\cdot}80$ mm.

Discussion

The 54 subjects in which transposed canines were reported provided an opportunity to examine the distribution of transposed canine teeth, and the association of other dental anomalies with this condition. This is the largest single group of canine transpositions described to date and, in agreement with previous studies, a male:female ratio of approximately 2:3 and a predominance of maxillary canine-first premolar transpositions were found. A left-sided bias affected only the female subjects, with transpositions in males equally distributed between left and right sides. Peck *et al.* (1993) also reported some differences in side distribution between sexes, but these observations are readily attributable to the small sample sizes.

The lack of significant differences in arch dimensions between the transposed and control groups suggested that arch constriction was not an aetiological factor in canine transposition in this sample. Indeed, it was observed that some transposed canines occurred in spaced arches.

Several tooth dimensions in the transposed sample were significantly different from their respective dimensions in the control group. For example, the bucco-lingual widths of the upper lateral incisors were smaller in the transposed subjects, even when peg-shaped lateral incisors were excluded from the analysis. The lateral incisor has been suggested to have a role in 'guiding' the eruptive path of the canine (Broadbent, 1941) and failure of this has been suggested as a mechanism for ectopic eruption of canines (Becker *et al.*, 1981). Only four of the maxillary transpositions (10·8 per cent) involved the canine and lateral incisor with the majority affecting the canine and first premolar. The transposed canines were, therefore, at least by the time of eruption, some distance from any local influence involving the size or presence of the upper lateral incisors in most of the cases in this study. The same is true

TABLE 1 *Subject data*

Number	Gender	Transposed teeth	Laterality	History	Anomalies Impactions
1	F	32–33	R	No	No
2	F	23–24	R	Familial	No
3	M	13–14	R	Trauma	No
4	F	13–14	R	No	12 Peg-shaped, 22 absent
5	F	23–24	R	Familial	22 Absent
6	F	13–14 23–24	R	Familial	No
7	F	23–24	L	No	No
8	F	23–24	R	No	No
9	F	32–33	Unknown	Unknown	23 Palatally impacted
10	M	32–33	R	No	No
11	M	32–33	R	No	No
12	M	23–24	L	No	22 Peg-shaped
13	F	13–14	L	No	12 + 22 Peg-shaped
14	F	32–33	R	No	No
15	M	23–24	R	Familial	15, 35 + 45 Absent
16	F	23–24	R	Familial	12 Absent
17	M	32–33 43–42	R	Trauma	No
18	F	23–24	Unknown	Unknown	No
19	M	42–43	Unknown	Trauma	No
20	F	23–24	Unknown	Unknown	22 Peg-shaped
21	F	23–24	Unknown	Unknown	12 + 22 Absent
22	M	13–14	R	No	No
23	F	23–24	R	Familial	No
24	F	23–24	L	Familial	15, 14, 25, 35, 45 Absent
25	F	32–33	Unknown	Unknown	12 + 22 Peg-shaped 23 Palatally impacted
26	F	13–14 23–24	R	No	No
27	F	32–33 43–42	R	No	No
28	F	32–33 43–42	R	No	Supernumerary 11 region
29	M	22–23	R	No	12 + 22 Peg-shaped
30	M	23–24	R	No	No
31	F	23–24	L	No	35 + 45 Absent
32	M	23–24	R	No	15 Palatally impacted
33	M	12–13	R	Trauma	No
34	M	13–14 23–24	R	No	No
35	F	32–33	R	No	No
36	F	23–24	R	No	No
37	M	42–43	L	No	No
38	F	42–43	R	No	35 + 45 Impacted
39	F	12–13	R	No	No
40	M	13–14	R	No	No
41	F	22–23	R	No	22 Peg-shaped
42	F	32–33	R	No	No
43	M	13–14	R	No	No
44	M	23–24	L	No	35 + 45 Absent 12 + 22 Peg-shaped
45	F	42–43	R	No	No
46	F	42–43	R	No	No
47	F	42–43	R	No	No
48	F	13–14	R	No	No
49	F	13–14	Unknown	Unknown	Unknown
50	F	23–24	R	Familial	12 + 22 Peg-shaped
51	M	13–14	R	No	No
52	F	13–14	Unknown	No	No
53	M	13–14	R	Familial	12 Absent 23 Palatally impacted
54	M	23–24	R	Unknown	Unknown

for any factors related to the size of the upper central incisors or lower second premolars. The statistically significant difference in mesio-distal widths of the upper first premolars may be relevant to the positioning of the canine, via disturbance of a similar guiding mechanism to that involving the upper lateral incisor. The actual difference however was small (see Table 2), and within measurement error in most cases. These are unlikely to be relevant to the development of canine transposition and may be chance findings.

There was a low incidence of oro-facial trauma recalled by the transposed subjects, indicating that this is unlikely to be a factor in the development of transposition.

Evaluation of the subjects' handedness was undertaken to establish whether a pattern existed between transposition side and the subject's dominant hand. Between 8 and 10 per cent of the general population are left-handed (Annett, 1978). Yorita and Melnick (1988) found the incidence of left-handedness was higher in patients with left-sided cleft lip (44·1 per cent) than in those with right sided clefts (8·9 per cent). A similar pattern with canine transposition was not found in the present study.

TABLE 2 *Mean (and standard deviation) of mesio-distal and bucco-lingual tooth dimensions*

		Mesio-distal (mm)				Bucco-lingual (mm)			
Tooth		Transposed	*n*	Control	*n*	Transposed	*n*	Control	*n*
Upper	1	8·36 ± 0·70	68	8·62 ± 0·48	70	6·86 ± 0·68	68	7·32 ± 0·72	70
	2	6·12 ± 0·89	64	6·81 ± 0·52	70	5·66 ± 0·66	60	6·55 ± 0·60	65
	3	7·60 ± 0·42	50	7·83 ± 0·36	49	7·68 ± 0·75	32	8·25 ± 0·63	30
	4	6·62 ± 0·54	60	6·90 ± 0·54	58	8·86 ± 0·65	56	9·12 ± 0·87	61
	5	6·46 ± 0·52	56	6·73 ± 0·50	47	9·21 ± 0·72	56	9·16 ± 1·93	48
	6	10·31 ± 0·65	69	10·48 ± 0·56	69	10·99 ± 0·72	68	11·21 ± 0·69	69
Lower	1	5·37 ± 1·01	29	5·35 ± 0·54	24	5·80 ± 0·68	29	5·86 ± 0·51	26
	2	5·65 ± 0·54	29	5·80 ± 0·53	30	5·98 ± 0·64	24	6·05 ± 0·60	27
	3	6·68 ± 0·45	15	6·75 ± 0·47	25	7·25 ± 0·83	10	7·14 ± 0·67	19
	4	6·98 ± 0·59	21	6·94 ± 0·35	23	8·04 ± 0·65	20	7·82 ± 0·56	20
	5	7,00 ± 0·55	14	6·95 ± 0·47	20	8·65 ± 0·47	15	8·27 ± 0·56	20
	6	10·38 ± 0·65	29	10·78 ± 0·59	30	10·35 ± 0·58	27	10·34 ± 0·51	30

There was a high incidence of congenitally absent teeth, peg-shaped lateral incisors and/or supernumerary teeth associated with these canine transpositions, with these occurring in 36·5 per cent of the transposed subjects. Congenital absence of teeth occurs in up to six percent of the general population (Muller *et al*., 1970), and peg-shaped lateral incisors in approximately one percent (Meskin and Gorlin, 1963). Although it appears that patients with transposed canines do have an increased prevalence of other dental anomalies and a gender bias exists, it is not possible to determine from the present study whether canine transposition has a genetic aetiology. It remains unclear whether transposition results from formation of the tooth germ in an ectopic position, or from displacement of the follicle and tooth germ after formation.

Conclusions

In this study of 54 cases of canine transposition:

1. There was a male:female ratio of approximately 2:3.
2. The majority of cases were in the maxilla (68·5 per cent) and most of these involved the canine and first premolar (89·2 per cent).
3. All mandibular transpositions were of the canine and lateral incisor.
4. The majority (88·9 per cent) were unilateral and 58·3 per cent affected the left side of the dental arches.
5. There was a high incidence of congenitally absent teeth, peg-shaped lateral incisors and/or supernumerary teeth.
6. Subject handedness was not related to the side of the transposition in unilateral cases.

Tooth dimensions, arch width and arch depth do not appear to be factors in the development of canine transposition.

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