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Original

A retrospective study on 69 cases of maxillary tooth transposition

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Abstract: The published literature on tooth transposition includes only a few studies that have involved more than 50 subjects. The aim of the present study was to investigate the prevalence of true maxillary tooth transposition and possible associated dental anomalies in a larger sample of children. The dental records and radiographs of children who had been diagnosed as having true maxillary tooth transposition at a School Dental Clinic in Hong Kong were studied retrospectively. Data were analyzed for sex and side distribution, as well as for associated dental anomalies. Trends of differences were analyzed statistically using the Fisher exact or chi-squared test. A total of 69 cases of true maxillary tooth transposition were identified and studied; its prevalence in Hong Kong Chinese children was 0.81%. More females than males were affected, and the difference between the sexes was statistically significant ($P < 0.05$). The prevalence of congenitally missing teeth, microdontia of the maxillary lateral incisors or dental impaction was higher in patients with maxillary tooth transposition than in the general population ($P < 0.05$, $P < 0.0005$, and $P < 0.0001$, respectively). The fact that patients with maxillary tooth transposition were more likely to have congenital absence or microdontia of the maxillary lateral incisors lent further support to the contention that a developmental field defect plays a role in the pathogenesis of maxillary tooth transposition. (J Oral Sci 54, 197-203, 2012)

Keywords: tooth abnormalities; tooth transposition; prevalence.

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Introduction

Tooth transposition is defined as the positional interchange of two adjacent teeth, especially their roots, or the development or eruption of a tooth in a position normally occupied by a non-adjacent tooth (1,2). Tooth transpositions occur more frequently in the maxilla than in the mandible (3). The prevalence of maxillary tooth transposition varies among samples, but has been under one per cent in most studies (4,5). Peck and Peck (2) have defined five clinical types of maxillary tooth transposition in the permanent dentition: Canine-first premolar (Mx.C.P1); Canine-lateral incisor (Mx.C.I2); Lateral incisor-central incisor (Mx.I2.I1); Canine-central incisor (Mx.C.I1); and Canine-first molar (Mx.C.M1). Canine-first premolar transposition has been the type encountered most commonly in study samples comprising mainly Caucasian subjects (3,6-8). In a few small-scale studies involving non-Caucasian patients, Mx.C.I2 has been found more frequently than Mx.C.P1 (4,9,10). Some authors have used terms such as incomplete, pseudo- or false transposition to denote cases in which only the crowns of the affected teeth showed positional interchange with the adjacent teeth yet the roots remained in their original positions (7,9,10). It is, however, controversial whether such cases should be counted as transposition (2).

Developmental dental anomalies are often found in association with maxillary tooth transposition. Those

reported most frequently have been microdontia of the maxillary lateral incisors, hypodontia, and retained primary canines (3,6,7,11). However, a recent literature review has suggested that the evidence pointing to those associations is weak, as most reports on tooth transposition have comprised mainly case series, case reports, or studies of small samples (12). In a meta-analysis of the existing evidence, Papadopoulos et al. (12) systematically reviewed the literature on tooth transposition and found only five studies that fulfilled their criteria. Four of those studies involved 21 or fewer subjects. Three of them involved patients seen at dental clinics or dental schools, one involved orthodontic patients, and one had not defined the study sample (12). Three of the studies included true cases exclusively, while the others recruited both true cases and cases of pseudotransposition. Those authors suggested that studies involving larger representative sample sizes would be needed. In fact, up to the time of writing, only a few studies of tooth transposition had involved more than 50 subjects. Plunkett et al. (6) reported 54 cases seen at an orthodontic department in New Zealand, 37 of which involved the maxillary arch. It was not specified whether pseudotransposition cases were included. Shapira and Kuftinec (7) studied 65 patients with maxillary tooth transposition. All of their cases involved orthodontic patients from New York or Israel, but they included both true and pseudotransposition cases. Ely et al. (3) reported 75 orthodontic patients in the U. K. with true tooth transpositions, 53 of which involved the maxilla. As all of these studies involved orthodontic patients, some selection bias may have been present, since these samples may not have been representative of the background populations (13). The aim of the present study was to investigate the prevalence of true maxillary tooth transposition, possible associated dental anomalies and characteristic features in a large sample of children from the general Chinese population residing in Hong Kong.

Materials and Methods

The study was carried out retrospectively at a regional School Dental Clinic responsible for the care of over 32,000 primary school children in Hong Kong. The clinical records and radiographs of children who attended the clinic in the period between January 2008 and December 2010, and had been diagnosed as having tooth transposition in the maxillary arch, were selected for review. Records were selected for study if the following criteria were met:

1. The children were ethnic Chinese;
2. No systemic syndromes were present;
3. True/complete transposition of one or more teeth had been diagnosed in the maxillary arch; To qualify as true/complete transposition, both the crown and the entire root structure of the involved tooth had to have been transposed (7).
4. Good-quality panoramic radiographs taken at the time of diagnosis had to be available. All panoramic radiographs were taken with CP-G Plus films (Agfa; Mortsel, Belgium) in an Orthopantomograph OP100 machine (Instrumentarium; Tuusula, Finland). The films were processed in an automatic processor (Dent-X Excel; NY, USA) using Dürr-Automat XR solutions (Dürr Dental; Bietigheim-Bissingen, Germany).

The selected dental records and radiographs were examined by the first author. Radiographs were viewed using a light viewing box in a darkened room. The following details were recorded for each subject:

1. Classification and location of transposition
2. Age at diagnosis, as at last birthday
3. Age on 31st December 2010 (for estimation of prevalence)
4. Gender
5. Presence of associated dental anomalies: hypodontia (third molars excluded), microdontia of the maxillary lateral incisors, dental impactions, retained primary canines, and supernumerary teeth.

All selected radiographs and records were reviewed by the same author one month after the original analysis, and the findings of the two examinations were compared for discrepancies. Data were pooled and analyzed for sex and side distribution. The prevalence of associated dental anomalies was compared with that found in the general Hong Kong Chinese population. Trends of differences were analyzed statistically using tests for categorical data (Fisher exact or chi-squared test) and were considered statistically significant at $P < 0.05$.

Results

A total of 71 cases of maxillary tooth transposition were diagnosed in the period 2008 to 2010. Two cases were excluded because of the presence of underlying systemic syndromes. Good-quality panoramic radiographs were available for all of the remaining 69 cases, and the diagnosis of true transposition was confirmed radiographically. Full details of the 69 investigated cases are listed in the Appendix. Fifty-five cases were diagnosed as canine-first premolar transposition (Mx.C.P1) (eight bilateral, 21 right unilateral and 26 left unilateral), and 12 cases belonged to the canine-lateral incisor type (Mx.C.I2) (six right unilateral and six left unilateral).

Table 1 Distribution of the transposed teeth in this study

Types of transposition*	Unilateral	Bilateral
Mx.C.P1	21 Right, 26 Left	8
Mx.C.I2	6 Right, 6 Left	0
Mx.C.I1	1 Right	0
Mx.C.M1	1 Right	0
Total	61	8

* Mx.C.P1: Maxillary canine-first premolar; Mx.C.I2: Maxillary canine-lateral incisor; Mx.C.I1: Maxillary canine-central incisor; Mx.C.M1: Maxillary canine-first molar.

Table 2 Frequency of associated dental anomalies found in the 69 studied cases

	Nos. of cases	Teeth affected
Hypodontia	11	Total 19 permanent teeth missing: Mandibular incisors: 7 Maxillary lateral incisors: 6 Premolars: 5 Maxillary canine: 1
Microdontia of the maxillary lateral incisor	10	Right lateral incisor: 3 cases Left lateral incisor: 4 cases Bilateral: 3 cases
Impaction	11	Total 15 permanent teeth impacted: Maxillary canines: 6 Mandibular second molars: 6 Premolars; 2 Mandibular canine: 1
Retained primary canines	52	Right canine: 21 cases Left canine: 23 cases Bilateral: 8 cases
Supernumerary teeth	2	1 mesiodens, 1 supplemental premolar

Table 3 Comparison of the two major types of maxillary tooth transposition in this study

	Mx.C.P1 Nos. (%)	Mx.C.I2 Nos. (%)	Fisher exact test
Male to female	22:33	3:9	Not significant
Left to right	26:21	1:1	Not significant
Hypodontia	8 (14.5%)	3 (25%)	Not significant
Microdontia of the maxillary lateral incisor	8 (14.5%)	2 (16.7%)	Not significant
Impaction	10 (18.2%)	1 (8.3%)	Not significant
Retained primary canines	44 (80%)	8 (67%)	Not significant

The remaining two cases involved canine-central incisor (Mx.C.I1) and canine-first molar (Mx.C.M1), respectively (Table 1). The age at diagnosis was 11.2 ± 0.9 (range 9-15) years. Most (37) of the patients were diagnosed at the age of 11 years, followed by those at age 12 years (19 cases). Twenty-six male and 43 female patients were affected, and the male to female ratio was 1:1.7. The most common associated dental anomalies seen in these patients were hypodontia, microdontia of the maxillary lateral incisor, impactions of teeth other than the transposed ones, and retention of the corresponding primary canine (Table 2). The teeth most commonly found to be congenitally missing were mandibular incisors, maxillary lateral incisors and premolars. Complete concordance was found between the two evaluations, conducted one month apart.

As most of the cases were either Mx.C.P1 or Mx.C.I2, these two groups were analyzed statistically with respect to sex ratio, side distribution and associated dental anomalies. No significant differences were found between the two groups (Fisher exact test), and therefore all the cases were treated as one single category (Table 3).

In 2010, a total of 324,953 children were seen at the School Dental Clinic, of whom 169,295 were boys and

Table 4 Prevalence of associated dental anomalies in this and previous studies involving Hong Kong Chinese children

	Present study Nos. (%)	Tsai & King (15) Nos. (%)	Davis (14) Nos. (%)	Fisher exact test
Total sample	69	725	1041	
Hypodontia	11 (15.9%)	53 (7.3%)		$P < 0.05$
Microdontia of the maxillary lateral incisor	10 (14.5%)	24 (3.3%)		$P < 0.0005$
Impaction	11 (15.9%)		35 (3.4%)	$P < 0.0001$
Supernumerary	2 (2.9%)	16 (2.2%)		Not significant

155,658 were girls. When compared with the male-to-female ratio of maxillary tooth transposition among the 69 cases included in the present study (26:43), the difference was statistically significant (chi-squared test with Yates correction $P < 0.05$). On the other hand, there was no significant difference in the left- or right-sided distribution in unilateral cases (Fisher exact test). With regard to the prevalence of associated anomalies in the affected children, the data were compared with previous figures for children in the general Hong Kong Chinese population (14,15) (Table 4). The risk of having congenitally missing teeth, microdontia of the maxillary lateral incisors, or dental impaction was higher in patients with maxillary tooth transposition than in the general population.

To estimate the prevalence of true maxillary tooth transposition in the population, the 12-year-old group was used. This was the average age of Primary six school children in Hong Kong, and most of the present cases of transposition (81%) were diagnosed at or before this age. The number of children who had attended the School Dental Clinic and were aged 12 as of December 2010 was 3,476. The number of 12-year-old children in the same year who were diagnosed as having transposition of one or more maxillary teeth was 28, giving a prevalence of 0.81%.

Discussion

The present study sample comprised primary school students registered at a regional School Dental Clinic, which served all children in the northern part of Hong Kong. In this region, there are a total of 46 primary schools (excluding international schools and schools for those with special needs), and all of them are included in the School Dental Care Service. The School Dental Clinic provides dental services to all of the students in these schools, and the children are followed up from Primary 1 to Primary 6. Bias due to sample selection was minimal, and therefore the present study sample was regarded as fairly representative of children in the general Hong Kong Chinese population.

Only maxillary cases were investigated in this study, as it has previously been shown that the genetic causes and associated dental anomalies of patients with maxillary and mandibular transpositions differ (11). Moreover, only cases diagnosed as true transposition were included. Some authors have used terms such as incomplete, pseudo- or false transposition to denote cases in which only the crowns of the affected teeth show positional interchange with adjacent teeth, while the roots remain in their original positions (7,9,10). Peck and Peck (2) considered that such cases should not be counted as transposition, as they share the same clinical features as ectopic eruption. Among previous studies of exclusively true cases, only two have involved samples larger than 40. Peck and Peck (2) presented 43 cases of Mx.C.P1 transposition, and Ely et al. (3) presented 75, of which 53 cases involved the maxillary canines. Both studies, however, recruited only orthodontic patients, which might have induced selection bias. The present study involved 69 patients taken from the general population in Hong Kong. At the time of writing, this study appeared to represent the largest sample of true maxillary tooth transposition reported in the English literature.

Previous studies of maxillary tooth transposition have found that females were more commonly affected than males (1,3,7,10,16). However, most of those studies comprised patients from orthodontic clinics, and the apparent female predilection may have been due to the fact that more female than male patients seek treatment for this condition (1). On the other hand, Chattopadhyay and Srinivas (4) studied 20 patients with maxillary tooth transposition in India and found that more male than female patients were affected. Papadopoulos et al. (12,13) performed a meta-analysis of data from the literature and found no significant difference in predilection between the sexes. However, only a few studies were included in that meta-analysis, and the authors conceded that hetero-

geneity of the original samples precluded any definitive conclusions (12). The present study involving children from a representative sample of the general population found that females were affected more commonly than males, and that the difference was statistically significant.

Most previous studies of maxillary canine transposition have found a left-sided predominance, but statistical analysis was not performed due to the small number of cases examined (1,4,6,7,9,10,16,17). In the present study, no significant difference between the two sides was found in unilateral cases. Fifty-five (80%) of the 69 cases in this study exhibited Mx.C.P1 transposition. Ely et al. (3) studied 85 cases of true dental transposition in 75 patients in the U. K., 53 of which involved the maxillary canines and 81% were Mx.C.P1, a result very similar to that of the present study. Taguchi et al. (18) studied eight cases of true maxillary canine transposition in Japanese children, and found that six of them were also Mx.C.P1. On the other hand, Chattopadhyay and Srinivas (4) studied 20 cases of true maxillary transposition in India, and reported that only six of them (30%) were Mx.C.P1 cases. It is not known whether racial differences may account at least partly for such differences in clinical presentation. Further large-scale studies of other Asian populations would provide more information.

In this study, 61 of the 69 cases (88%) were unilateral, concurring with the findings of previous studies in which the prevalence of unilaterality has been within the range 80-88% (3,4,6,7). Various dental anomalies have been found to be associated with tooth transposition, including hypodontia (1,3,4,6,7,16), microdontia of the maxillary lateral incisors (1,3,4,6,7), dental impaction (10,16), and sella turcica bridging (8). In their meta-analysis of data from the literature, Papadopoulos et al. (12) found no association between tooth transposition and other anomalies. However, they were unable to draw any definitive conclusions as their analysis included only five heterogenic studies, four of which involved 21 or fewer subjects, and they suggested the need for studies involving larger sample sizes representing the general population. In addition, the validity of using meta-analysis for this purpose has been challenged, as the original purpose of such analysis was to provide stronger evidence by considering a number of randomized controlled clinical trials together (12). The present study, which involved 69 cases of true maxillary tooth transposition, provided stronger evidence for possible associations between maxillary transposition and hypodontia, microdontia of the maxillary lateral incisors, and dental impaction, respectively. This might be clinically important, as such anomalies could be the first diagnostic signs of maxillary canine transposition.

In this study, 52 of the 69 cases (75%) showed retained primary canines in the corresponding areas. This concurred with the findings of previous studies (3,4,7). Two theories have been proposed to explain this association. According to the first, delayed resorption of the primary predecessor is a cause of tooth transposition because the dental crypt of the permanent successor cannot take its proper position (12). On the other hand, the second theory suggests that retention of the primary tooth is the result rather than the cause of tooth transposition, because there is no successor in the proper place to absorb the root of the primary predecessor (1). The present authors support the latter possibility, as in some of the cases we examined, the affected canines were seen to be developing in the transposed position at a very early stage of development.

Here we found that the prevalence of true maxillary tooth transposition in 12-year-old Chinese children was about 0.81%. This might have been an under-estimation, as panoramic radiographs are not routinely taken during examinations conducted by the School Dental Care Service in Hong Kong, and therefore some children with late dental development would be diagnosed at a later stage. However, the prevalence was higher than those found in previous studies involving Caucasian (16) (0.43%), Turkish (9) (0.24%) or Indian (4) (0.41%) populations.

It has been suggested that genetic factors may play an important role in the etiology of tooth transposition, based on the following facts (1,3,4,8,16,19,20):

1. Racial differences in prevalence;
2. Increased frequency of associated dental anomalies;
3. Symmetrical presentations in bilateral cases;
4. Female predilection;
5. Familial occurrence;
6. Increased frequency of sella turcica bridging in those affected; and
7. Increased prevalence in patients with chromosomal disorders.

In the present study, as well as an increased frequency of associated dental anomalies, symmetrical presentations in bilateral cases and female predilection, the pattern of hypodontia in those affected was also of interest. Previous studies of Chinese children have shown that the permanent teeth most commonly found to be missing congenitally are mandibular incisors (15,21). In the present study, 19 permanent teeth were found to be missing congenitally among the 69 cases, and six of them were maxillary lateral incisors (32%); mandibular incisors accounted for only 37% of the missing teeth.

This observed pattern of hypodontia in patients with maxillary canine transposition differed markedly from that seen in the general population, where about 60% of missing teeth were mandibular incisors, followed by second premolars (18%) and maxillary lateral incisors (8%) (21). The fact that patients with maxillary tooth transpositions were more prone to congenital absence or microdontia of the maxillary lateral incisors lent further support to the contention that maxillary canine transposition might represent a developmental field defect in the maxilla under strong genetic influence (11).

In conclusion, the prevalence of true maxillary tooth transposition in Hong Kong Chinese children has been shown to be 0.81%. The higher prevalence of congenital absence or microdontia of the maxillary lateral incisors in those affected provides further support for the contention that a developmental field defect plays a role in the pathogenesis of maxillary canine transposition.

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Appendix: Details of the 69 studied subjects

Case no.	Sex	Transposed Teeth	Age at diagnosis	Age as at 31 Dec. 2010	Type*	Congenital missing	Retained primary teeth	Microdontia	Impaction	Supernumerary
1	F	13	10	12	A	23	53,63			
2	F	13	11	13	A	35,45	53			
3	F	13	11	13	A		53		43	
4	F	13	11	13	A		53		47	
5	F	13	11	12	A		53			
6	F	13	11	12	A		53			
7	F	13	11	12	A		53			
8	F	13	10	11	A		53	12,22		
9	F	13	11	11	A					
10	F	13	11	12	A		53			
11	F	13	12	12	A		53			
12	F	13	10	11	A		53			
13	F	13	12	12	A		53		15,37,47	
14	F	13	11	12	A					
15	M	13	12	15	A		53			
16	M	13	12	14	A		53		47	
17	M	13	11	12	A		53			
18	M	13	11	12	A					
19	M	13	12	13	A		53			
20	M	13	12	12	A	12	53,52			
21	M	13	11	11	A	32,42	53			
22	F	23	11	13	A		63			
23	F	23	13	15	A	22	62,63	12	13,15	
24	F	23	11	14	A		63			
25	F	23	13	15	A			22		
26	F	23	11	14	A			22		
27	F	23	10	12	A		63		13	
28	F	23	11	13	A		63			
29	F	23	12	13	A		63			
30	F	23	12	13	A		63			
31	F	23	11	12	A		53,63		13	
32	F	23	12	12	A		63			
33	F	23	12	12	A		63			
34	F	23	12	12	A		63	12,22		
35	F	23	11	12	A		63			
36	F	23	12	12	A		63		13	
37	F	23	12	12	A		63			
38	M	23	11	13	A					
39	M	23	15	17	A		63	22	37	
40	M	23	9	11	A		63			15
41	M	23	12	14	A		63	22		
42	M	23	12	13	A		63			
43	M	23	11	12	A					
44	M	23	10	10	A		53,63	12,22	13	
45	M	23	12	12	A		63			
46	M	23	11	11	A	32,42	63			mesiodens
47	M	23	11	11	A					
48	F	13 23	10	11	A		53,63			
49	F	13 23	11	11	A					
50	F	13 23	11	11	A		53,63			
51	M	13 23	11	14	A					
52	M	13 23	11	13	A	12,22	52,62,53,63			
53	M	13 23	12	12	A		53,63			
54	M	13 23	11	12	A					
55	M	13 23	9	10	A	12,22,42	52,53,62,63			
56	F	13	11	14	B		53			
57	F	13	11	13	B		53			
58	F	13	11	13	B	32				
59	F	13	11	12	B		53	12		
60	M	13	12	14	B		53			
61	M	13	11	13	B					
62	F	23	11	13	B					
63	F	23	11	12	B					
64	F	23	11	12	B	32	63			
65	F	23	11	12	B		63		13	
66	F	23	12	12	B	15,35,45	63	12		
67	M	23	9	10	B		63			
68	F	13	11	13	C					
69	M	13	10	11	D				37	

* Type A: Maxillary canine-first premolar, Type B: Maxillary canine-lateral incisor, Type C: Maxillary canine-central incisor, Type D: Maxillary canine-first molar.