PEDIATRIC DENTAL JOURNAL 19(1): 136–144, 2009

Case Report

Classification of maxillary canine transpositions in Japanese children: A report of 10 cases

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Abstract The aim of the present study was to examine the prevalence rate and treatment outcome of maxillary canine transposition in Japanese children according to the conventional standard and our new additional consideration of the classification. From 140 cases with ectopic canines diagnosed in the Pediatric Dental Clinic of Niigata University Medical and Dental Hospital, we selected 10 transposition cases as the present subjects. Out of 10 cases, 4 were males and 6 females. Six were classified into type A: the mesio-distal positional interchange of the canine and the first premolar, 2 cases into type B: the mesio-distal transposition of the canine and the lateral incisor, and the other 2 cases into type C: the present new classification that showed the vertical transposition of the canine and the first premolar within the developmental bone. The prevalence rate of types A and B resembled the previous papers regarding the ratio of sex and bilateral occurrence. Although 3 cases in type A, one case in type B and one case in type C could finally be aligned in the normal tooth order, every one of the types A and B cases were aligned in the reverse order. For every one case in types A and C, the transposed canines were extracted. It is recommended that pediatric dentists take an orthopantomogram during early mixed dentition as a routine practice in order to detect anomalies of tooth eruption, such as tooth transposition, as early as possible.

Key words
Ectopic eruption,
Eruption disturbance,
Maxillary canine,
Tooth transposition

Introduction

Tooth transposition is defined as a unique and extreme form of ectopic eruption in which a permanent tooth develops and erupts in the position normally occupied by another permanent tooth[1,2]. Although the term ectopic eruption is often used in a wide sense to refer to any aberrant and abnormal eruption path taken by a tooth[3,4], the term of transposition is confined to refer to an interchange in the position of two adjacent teeth within the same quadrant of the dental arch[1,2,5,6]. It has been reported that transposition of maxillary teeth occurs approximately in one of 300 orthodontic patients and that transposition between the canine and the first premolar appears most often (70%) in maxillary dentition, followed by the one between the canine and lateral incisor (20%)[1]. In Japanese children, however, the prevalence rate or the treatment course of canine transposition has not been documented.

Many previous articles on tooth transposition[1,2,5–10] have described the horizontal (mesio-distal) tooth relationship, but have not mentioned the vertical interchange of two adjacent teeth buds during pre-eruptive dental development. In order to examine the development or the eruptive movement of the permanent tooth germ, the pediatric dentist usually takes x-ray photographs during mixed dentition. On these x-ray photographs, we can sometimes discover the positional anomaly that can be called vertical tooth transposition.

Received on September 19, 2008
Accepted on December 3, 2008

Table 1 Distribution of patients with maxillary canine transposition

Case No.	Gender	Age at detection	Affected side	Dental age (Hellman)	Type of transposition
1	M	8y 3m	R	IIIA	A
2	F	11y 1m	L	IIIB	A
3	F	11y10m	R	IIIB	A
4	M	12y 9m	L	IIIB	A
5	M	10y 4m	R	IIIC	A
6	F	12y 2m	R+L	IIIC	A
7	F	11y 9m	L	IIIB	B
8	F	10y10m	L	IIIB	B
9	M	6y 8m	L	IIIA	C
10	F	9y 3m	L	IIIA	C

A: Type A transposition defined as mesio-distal interchange between the canine and the first premolar, B: Type B transposition defined as mesio-distal transposition between the canine and the lateral incisor, C: Type C transposition defined as vertical transposition between the canine and the first premolar.

The aim of the present study was to examine the prevalence rate and treatment outcome of maxillary canine transposition in Japanese children according to the conventional standard and our new additional consideration of classification.

Materials and Methods

The present retrospective observational study analyzed child patient records collected from the outpatients, at the Hellman dental age of IIIA to IVA, who visited the Pediatric Dental Clinic of Niigata University Medical and Dental Hospital between 1979 and 2002. The total number of patients with ectopically erupting maxillary canines was 140 (54 males and 86 females), in which 20 bilateral cases (6 males and 14 females) were included. The diagnosis of an aberrant eruptive path of maxillary canine was based on x-ray photographs of the patients taken during routine assessments of oral health, according to the criteria provided in the previous reports[11,12]. The ages of the child patients were distributed between 7 years 9 months and 17 years 1 month at detection of canine anomaly, and the average age was 10 years 0 months.

From the above ectopic canines, we were able to select 10 transposition cases as the present subjects (Table 1). The maxillary canine transposition was divided into two types according to the conventional standard (mesio-distal transposition) and to one more type depending on the vertical interchange between the canine and the first premolar buds during pre-eruptive dental development (Fig. 1). Type A was defined as mesio-distal interchange between the

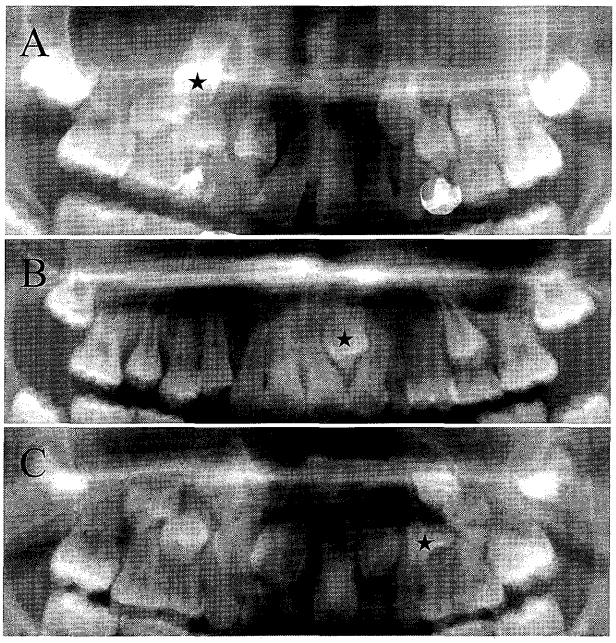

Fig. 1 Classification of maxillary canine transposition in orthopantomograms

A: Type A was defined as mesio-distal interchange between the canine and the first premolar, B: Type B was defined as mesio-distal transposition between the canine and the lateral incisor, C: Type C was defined as vertical transposition between the canine and the first premolar. Each asterisk marks the transposed canine.

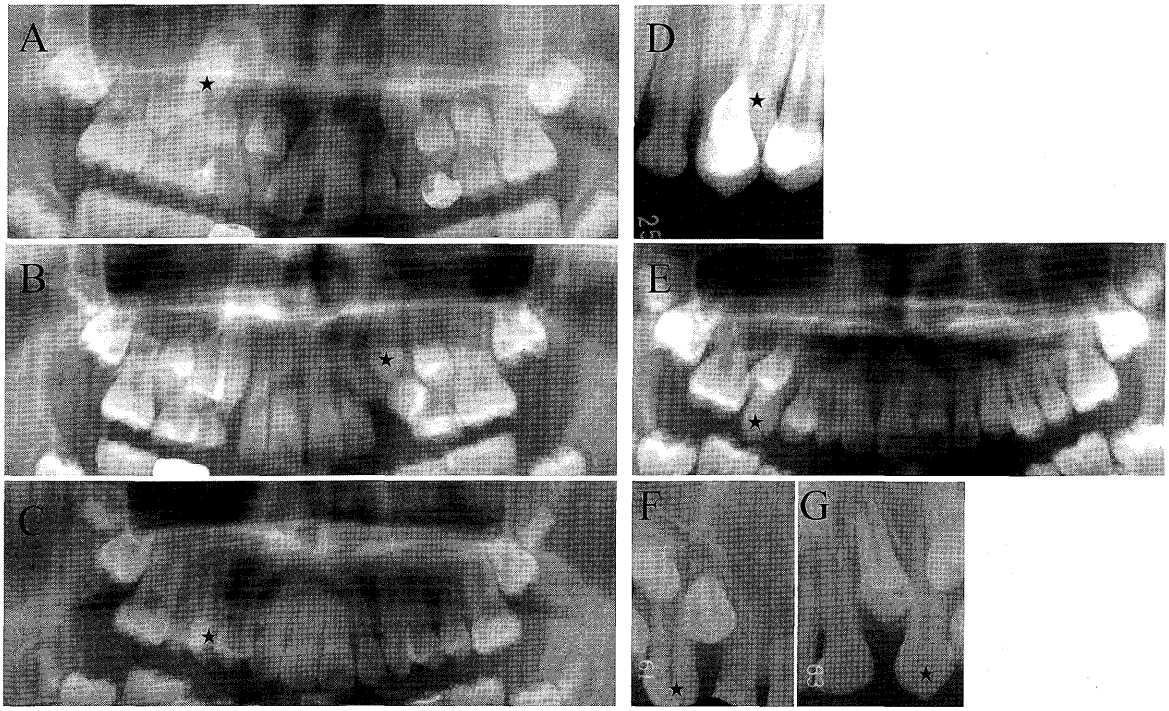

Fig. 2 The initial x-ray photographs in Cases 1 to 6 of type A

Alphabetical number (A to E) corresponds to each case number (1 to 5) in Tables 1 and 2. F and G correspond to the right side and the left side in Case 6, respectively. Each asterisk marks the transposed canine.

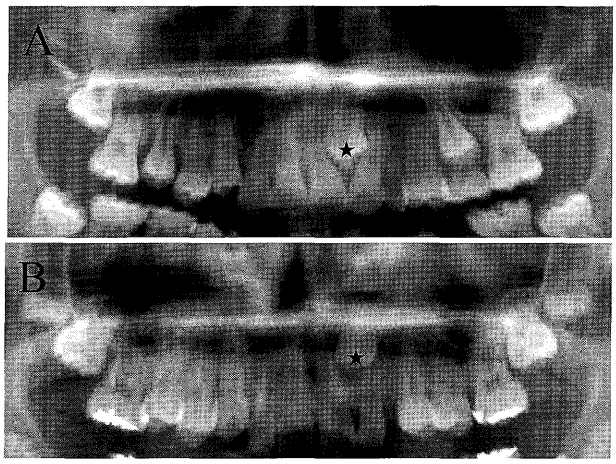

Fig. 3 The initial orthopantomograms in Cases 7 and 8 of types B

A: Case 7, B: Case 8. Each asterisk marks the transposed canine.

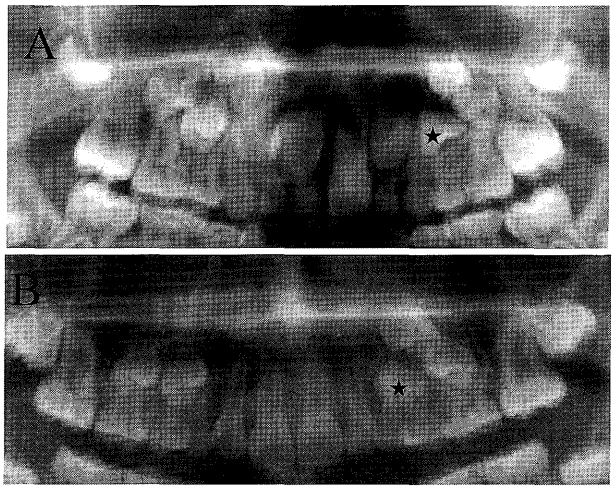

Fig. 4 The initial orthopantomograms in Cases 9 and 10 of types C

A: Case 9, B: Case 10. Each asterisk marks the transposed canine.

canine and the first premolar, type B was defined as mesio-distal transposition between the canine and the lateral incisor, and type C was defined as vertical transposition between the canine and the first premolar. On the orthopantomograms around 10 years old, it is well known that the normal maxillary canine germ locates in a higher position than the first premolar germ[3]. In type C, the canine located near the occlusal line and the first premolar was situated in a high position.

Table 2 Treatment sequences in each case

Type of transposition	Case No.	Start age of treatment	Treatment course				Final tooth alignment
			Extraction of		Fenestration (FN), traction (TR) and/or occlusal guidance (OG)	Period of treatment	
			primary tooth	permanent tooth			
A	1	8y 3m	52, 53, 54	—	OG	3y 2m	normal order
	2	11y 2m	65	—	TR+OG	2y 6m	normal order
	3	11y10m	—	—	OG	2y 9m	normal order
	4	12y 9m	63	—	OG	1y 1m	24, 23, 25
	5	10y 4m	—	13	—	—	12, 14, 15
	6	14y 7m	—	14, 24	—	—	—
B	7	11y 9m	63	—	FN+OG	11m	23, 22, 24
	8	10y10m	—	24	TR+OG	1y 3m	normal order
C	9	9y 1m	63, 64, 65	—	OG	3y11m	normal order
	10	10y 5m	63, 64, 65	23	TR+OG	2y11m	22, 24, 25

Results

Of the 10 present cases, 4 were males and 6 females, and their ages on detection ranged from 6 years and 8 months to 12 years and 9 months (Table 1). Six cases were classified into type A (Fig. 2), 2 cases into type B (Fig. 3), and the other 2 cases into type C (Fig. 4).

The treatment sequences in each case are listed in Table 2. The treatment for types A and B was started soon after discovery of canine transposition, except for Case 6, which was a bilateral case and was referred to the orthodontic clinic. In Case 6, we were thus offered to extract the bilateral first premolar at the age of 14 years and 7 months. The start of treatment in both cases in type C were postponed until the affected canine initiated its root formation.

In type A, although 3 cases (Cases 1, 2 and 3) were aligned in the normal tooth order, the canine in Case 4 was arranged in the transposed position and the canine in Case 5 was extracted.

In Case 1, the predecessors of the affected side (the primary canine and the first primary molar) were extracted, and the right primary lateral incisor was also extracted because the successor exhibited eruption disturbance (Fig. 5A). Two months after extraction of three primary teeth, the lateral incisor began to erupt. On the orthopantomogram, 6 months after extraction, the transposition in the affected side was improved within the bone since the first premolar moved toward eruption and the canine changed the eruptive movement toward the mesial direction (Fig. 5B). The affected first premolar and canine erupted in the normal tooth order, 4 months and 1 year later, respectively. Thereafter, occlusal guidance was needed for good alignment and the total period of treatment was 3 years and 2 months until the finish of retention after extraction of the primary teeth.

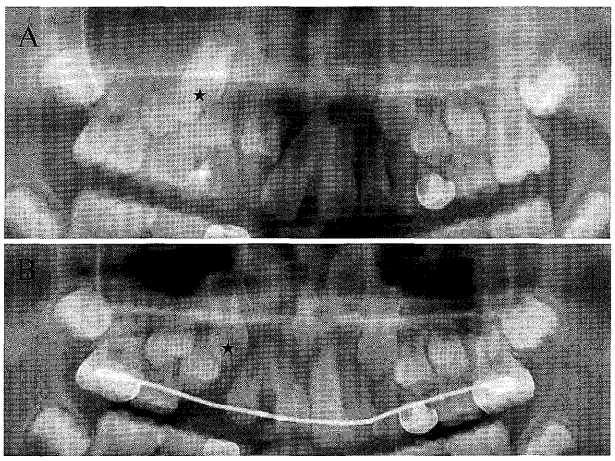

Fig. 5 The orthopantomograms of treatment course in Case 1
A: At extraction of the right primary lateral incisor, the primary canine and the first primary molar and setting of the lingual arch for space maintenance, B: 6 months after extraction of the primary teeth. Each asterisk marks the transposed canine.

In Case 2, the left second primary molar was extracted in order to facilitate the eruption of the left first premolar tilted severely to the distal direction

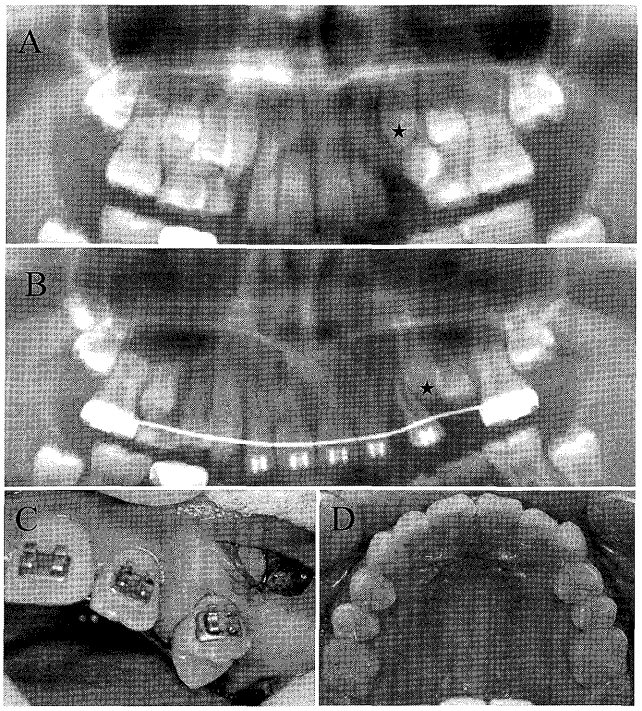

Fig. 6 The orthopantomograms and intraoral photographs of treatment course in Case 2
A: At extraction of the left primary second molar, B, C: The start of traction of the left canine by the sectional arch wire technique at 11 months after extraction of the primary molar, D: Alignment of the transposed canine 2 years and 6 months later. Each asterisk marks the transposed canine.

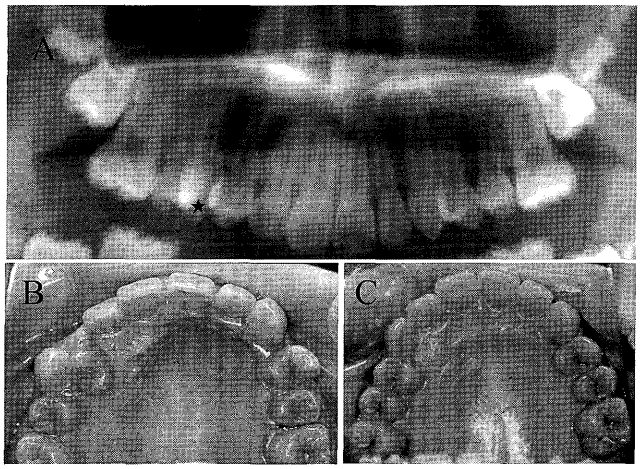

Fig. 7 The orthopantomograms and intraoral photographs of treatment course in Case 3
A, B: The start of exchange of the right canine and the first premolar, C: Alignment of the transposed canine 2 years and 9 months later. The asterisk marks the transposed canine.

(Fig. 6A). Eleven months after extraction, since the first premolar was kept upright by occlusal guidance (Fig. 6B), traction of the unerupted canine placed in the buccal position was started toward the mesial direction (Fig. 6C), and the alignment in the normal tooth order was finished after 2.5 years (Fig. 6D).

In Case 3, the affected right canine already erupted in the first premolar site and the right first premolar erupted palatally, coming close to the lateral incisor (Fig. 7A, B). Occlusal guidance for the

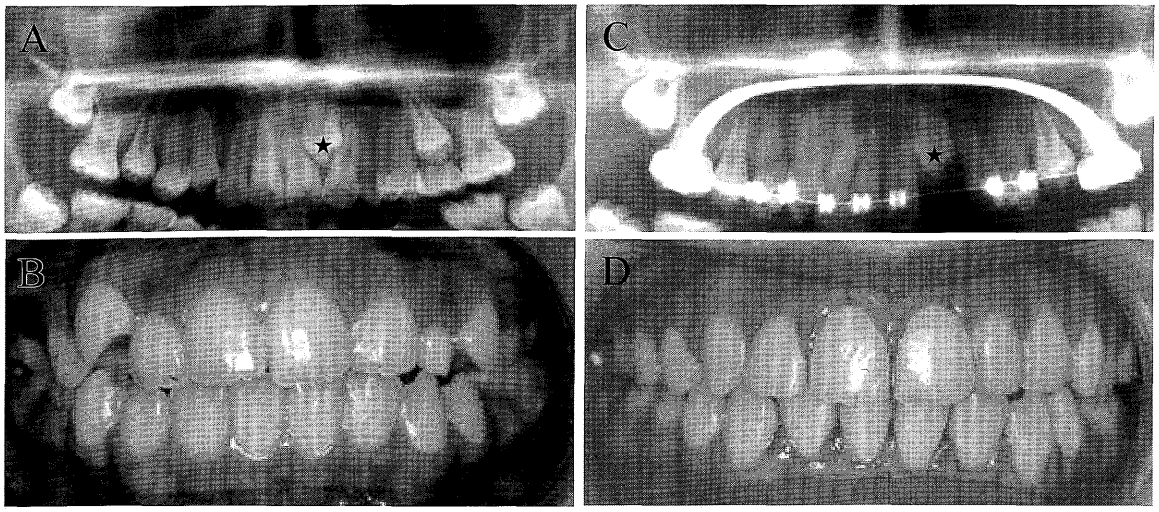

Fig. 8 The orthopantomograms and intraoral photographs of treatment course in Case 7

A, B: The start of traction of the left lateral incisor toward distal direction by the multi brackets technique with the palatal bur after extraction of the left primary canine, C: Just before fenestration of the left canine at 3 months later, D: Alignment of the transposed canine 11 months later. Each asterisk marks the transposed canine.

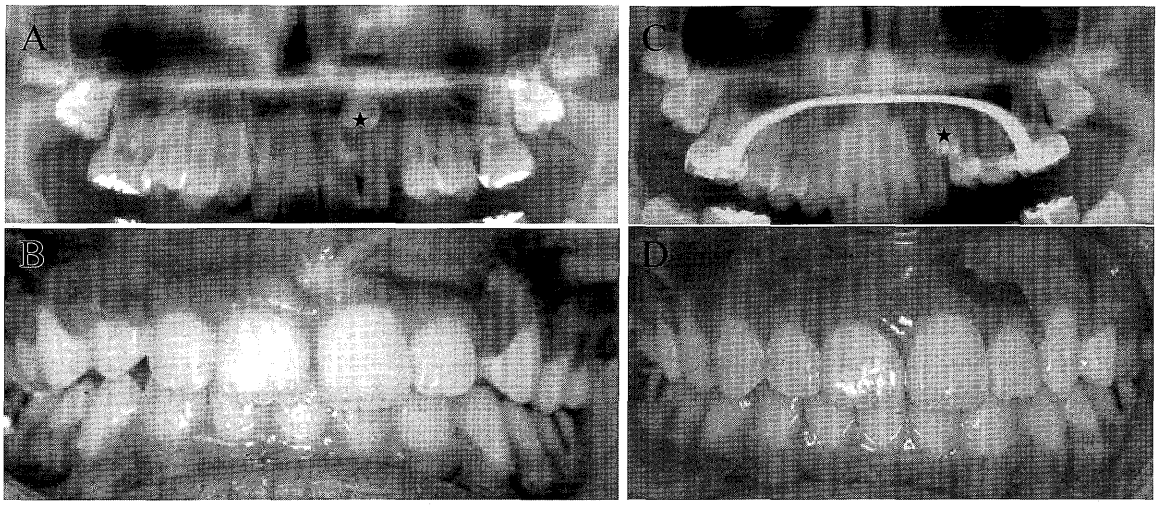

Fig. 9 The orthopantomograms and intraoral photographs of treatment course in Case 8

A, B: The start of fenestration and traction of the left transposed canine toward distal direction by the sectional arch wire technique with the palatal bur, C: 6 months later, D: Alignment of the transposed canine 15 months later. Each asterisk marks the transposed canine.

exchange of both teeth and retention were finished 2 years and 9 months later (Fig. 7C).

In Case 4, who had slight mental retardation, we abandoned the exchange of the left first premolar and canine because the patient could not tolerate the long-term and complex occlusal guidance, and aligned the affected teeth in the reverse order. In Case 5, the right canine erupting in the second premolar site was extracted because the parents refused to let their child have any more treatment, such as canine transplantation to the extracted site of the left primary canine.

In both canines of type B, one could be aligned in the normal site but the other had be aligned in the site of the lateral incisor. In Case 7, the left canine impacted near the alveolar ridge and situated in the middle of the alveolar bone labio-palatally (Fig. 8). The lateral incisor was moved to the distal direction

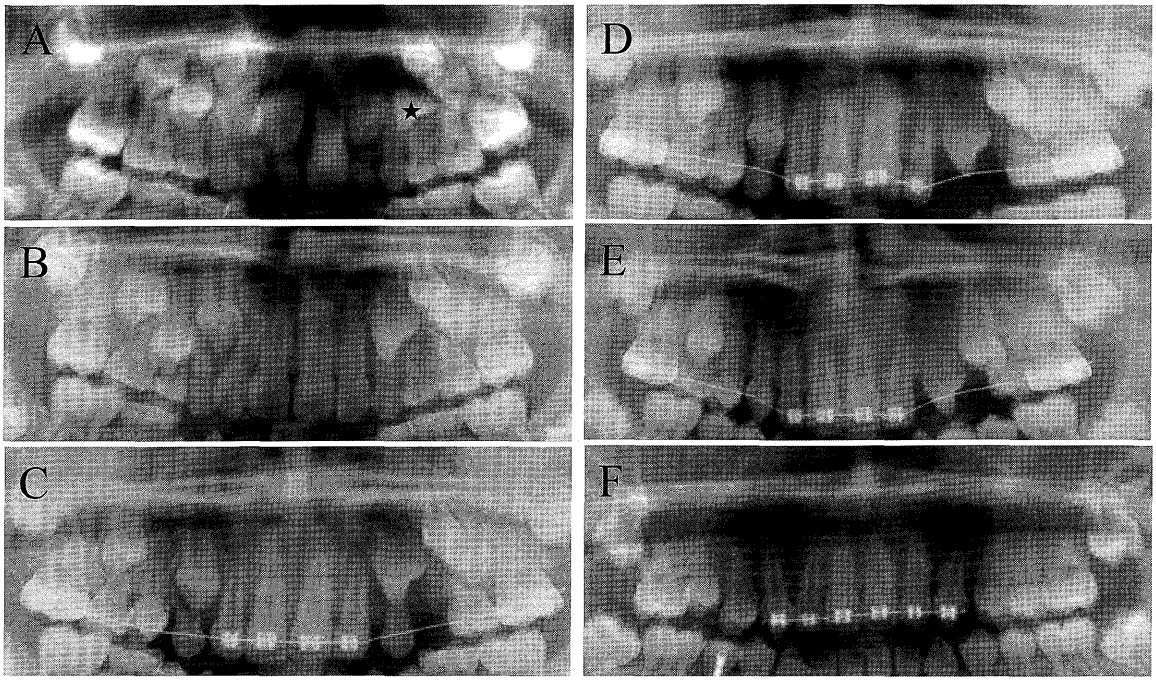

Fig. 10 The orthopantomograms of treatment course in Case 9

A: At the age of 6 years and 8 months, B: Just before extraction of the left primary first molar at the age of 9 years and 1 month, C: 3 months later and then extraction of the left primary canine, D: 11 months later and thereafter extraction of the left primary second molar, E: At the age of 10 years and 6 months, F: Alignment of the transposed canine at the age of 11 years and 11 months. Alignment of the transposed canine was performed by the multi brackets technique (C-F). The asterisk marks the transposed canine.

after extraction of the left primary canine, and the canine was aligned in the lateral incisor site after fenestration for eruption. In Case 8, the left canine impacted far from the alveolar ridge and in the labial position (Fig. 9). The affected canine was moved toward the site of extraction of the left first premolar by traction.

In both canines of type C, one could be aligned in the normal site but the other had to be extracted. In Case 9, whose impaction of the maxillary right central incisor was suspected at the age of 6 years, the vertical transposition of the canine and first premolar germs in the left quadrant was unexpectedly found on the orthopantomogram (Fig. 10A). At the age of 9 years, the right canine and first premolar moved toward eruption, and the vertical position became almost the same between the bilateral canines, although the affected left premolar was still situated high (Fig. 10B). Thereafter, the first primary molar was first extracted, and the extraction of the primary canine and the second primary molar was performed 3 months and 11 months later respectively, to facilitate the eruptive movement of the left first premolar (Fig. 10C, D). The position of the first premolar was improved (Fig. 10E) and erupted at the age of 11 years. Active movement for alignment was done for 11 months (Fig. 10F) and then retention for 14 months.

In Case 10, on the orthopantomogram to estimate the dental development at the age of 9 years, the congenital absence of the maxillary right canine and the vertical interchange of the maxillary left canine and first premolar germs were detected. Like the treatment course in Case 9, the primary canine and the first primary molar were first extracted at the same time of the age of 10 years 5 months and then the second primary molar was extracted one year later, in order to facilitate the eruptive movement of the left first premolar. Although the affected first premolar moved toward eruption, it caused the root resorption of the canine, which had already erupted in the normal position. Traction of the impacted first premolar could not succeed to separate it from the resorption site of the canine, and therefore extraction of the canine was performed because of severe root resorption in the apical to middle third. The final maxillary dentition was aligned without bilateral canines in this patient.

Discussion

It has been reported that tooth transposition most commonly involves the maxillary canine and first premolar, followed by the maxillary canine and lateral incisor[1,2]. In the general population, a prevalence of 0.1% to 0.5% has been roughly estimated for maxillary canine-first premolar transposition[7–9]. Among all transpositions of the maxillary teeth, the prevalence of 55% to 71% has been documented for the canine-first premolar transposition and that of 20% to 42% for the canine-lateral incisor transposition. Although the present study focused only on the canine transposition, the canine-first premolar transposition was found more frequently than the canine-lateral incisor transposition in Japanese children. According to the conventional standard of transposition excluding type C, the canine transposition was detected in 8 (5.7%) out of 140 cases with the ectopic maxillary canine, and the prevalence rate of the canine-first premolar was 75% of these cases.

Shapira *et al.*[2] demonstrated a moderate female (60%) and left side dominance (58%), as well as indicating that more transpositions were unilateral (88%). The present study also showed that the canine transposition appeared somewhat frequently in females and on the left side, and that there was only one bilateral case. As to the etiology of tooth transposition, it has been considered from the above findings that unknown local factors related to genetic origin may play a major role in the occurrence[1,2,5,6].

Most of the present transpositions in types A and B were detected at IIIB or IIIC of the Hellman dental age, except for Case 1. In Case 1, the transposition was improved spontaneously only by extraction of the related primary teeth. In Cases 2 and 3, whose anomalies were detected at IIIB, their treatments to exchange the affected teeth were fairly complicated. In Cases 5 and 6 detected at IIIC, extraction of the transposed canine or the first premolars could not be avoided. Moreover, comparing Case 7 with Case 8, the dental development in Case 8 was a little late, but the affected canine positioned high within the bone. If the anomaly in Case 7 could have been detected earlier, as it was in Case 8, the transposed canine might have situated in a higher position and have been moved to the normal site. Due the above consideration, we feel it is essential for pediatric dentists to take an orthopantomogram during the early mixed dentition as a routine practice in order to detect anomalies of tooth eruption, such as tooth transposition, as early as possible. As to early detection of eruption disturbance of maxillary canine, Ericson *et al.*[11] indicated the importance of the clinical signs noticed by radiographic assessment in children around the age of 10 years. They reported that about 90% of the ectopic canines improved its position and inclination within one year after extraction of the predecessor when the cusp tip of the affected canine overlapped the mesial part of the adjacent lateral incisors on the orthopantomograms.

During IIIA of the Hellman dental age, it is well known that the normal maxillary canine germ develops in a higher position than the first premolar germ[3]. Then, the canine moves toward eruption through the longest way within the alveolar bone and appears into the oral cavity around 10 years old. The present both cases in type C, the canines located near the occlusal line and the first premolars were situated in a high position, in spite of IIIA. The new classification (type C transposition) advocated in the present study has not been reported in any previous articles. Although this vertical type of transposition will be rare, there were 2 cases among the present cases, which was the same prevalence as the canine-lateral incisor transposition (type B). We concluded that careful consideration of when to start the treatment is needed, although we postponed the treatment until both affected canines initiated their root formation after early discovery because a tooth moves toward eruption after root formation proceeds. Moreover, since the ectopic canines sometimes cause root resorption of the lateral or central incisor[13–15], it should be emphasized canine root resorption is also a possibility, and may occur by the movement toward eruption of the first premolar, such as in Case 10.

Acknowledgments

This research was supported by KAKENHI (20592395), a Grant-in-Aid for Scientific Research (C).

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