Dental age in maxillary canine ectopia

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An etiologic connection between palatally ectopic canines and small and missing teeth is well established in the literature. Additionally, it has been observed that patients with palatally ectopic canines have a delayed dental development. The present study was designed to examine the validity of this latter observation. We radiographically assessed the subjects' dental ages using criteria of tooth calcification, rather than tooth eruption pattern. A similar determination was made in relation to subjects in whom buccally ectopic canines were present. The experimental group consisted of panoramic radiographs of 55 consecutively treated patients with palatally displaced maxillary canines and of 47 consecutively treated patients with buccally displaced canines. They were compared with a control group of 57 consecutively treated patients with normally placed canines. Approximately half the subjects with palatal displacement exhibited a late-developing dentition, whereas the timing of dentition in the remaining subjects appeared to be normal. Buccal displacement was not associated with a retarded dental development, and the ranges of the dental age values were similar to those seen in the control group. The results support the idea that there are different etiologies for the occurrence of buccal versus palatal ectopia in maxillary canines. They also suggest that dentitions with a palatal canine appear to be of 2 distinct varieties, with different dental characteristics and, perhaps, different etiologies. (Am J Orthod Dentofacial Orthop 2000;117:657-62)

As early as 1959, Newcomb[1] reported that experience had taught him that ". . . with few exceptions . . . potential impaction of permanent teeth is seen in patients exhibiting moderate to severe retardation of dental maturation . . . a slow rate of permanent teeth formation." He also believed that ". . . it would be useful . . . to correlate dental and bone ages" among these patients. Despite this astute clinical observation, the past 40 years has seen only a minimum number of references to the phenomenon of delayed dental development in patients with palatally displaced maxillary canines.

An association has been illustrated between palatally displaced canines and small teeth, missing teeth, and late-developing teeth.[2] The by-product of a subsequent study of familial trends among patients with palatally displaced canines and other related phenomena indicated delay in dental development.[3] However, in all these studies, the dental age assessment was made on the basis of tooth eruption, rather than on the more accurate criterion of tooth calcification.

Many of these linked phenomena have been confirmed in a more recent study.[4] However, in a subsequent exchange of letters to the editor, pursuant to the publication of this last paper, the coauthor questioned the existence of different etiologies for buccal and palatal ectopic canine eruption.[5,6]

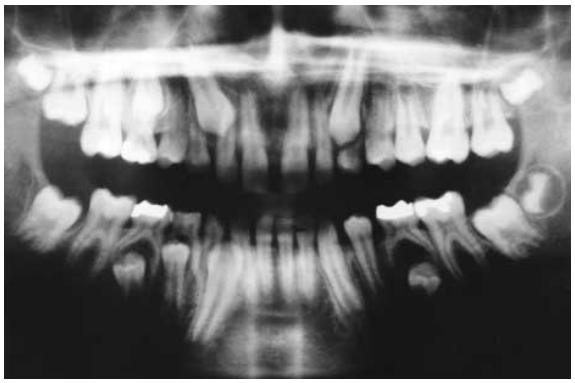

Fig 1. Twelve-year-old patient with root development defining dental age as 11 years. Note late-developing mandibular second premolars.

The present study was undertaken in an attempt to shed some light on the validity of these clinical observations. The intention here was to examine

1. Whether Newcomb's original clinical impression, that the incidence of palatally displaced maxillary canines is closely related to a retarded overall development of the permanent dentition, could be confirmed; and
2. Whether there is a similar tendency for delayed

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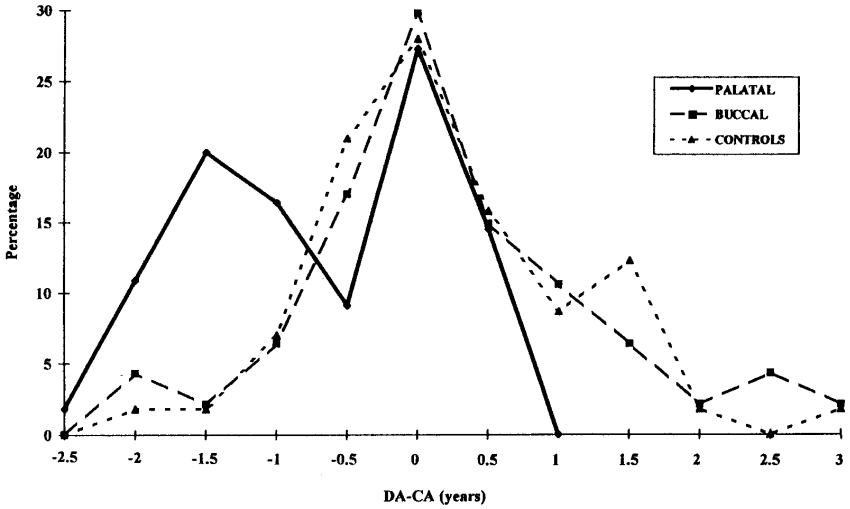

Fig 2. Distribution graph showing percentage of subjects with delayed, normal, or advanced dental age in different groups of canines. *DA-CA,* Difference between dental age and chronologic age (negative means delayed dental age; positive means advanced dental age).

development of the dentition when buccally ectopic canines are present.

In the interests of accuracy in the determination of dental age, it was considered of prime importance to examine the extent of root development of the permanent teeth on the radiographic records of the patients, rather than to rely on the results of a clinical inspection of the erupted dentition.

SUBJECTS AND METHODS

Three groups of patients were assembled from the records of 3 private orthodontic practices in Jerusalem and Tel Aviv. The groups were defined as follows:

- Experimental group 1: 55 consecutively treated patients with unilateral or bilateral palatally displaced maxillary permanent canines
- Experimental group 2: 47 consecutively treated patients with unilateral or bilateral buccally ectopic maxillary permanent canines
- Control group: 57 consecutively treated patients with bilaterally erupted maxillary permanent canines in the line of the arch or unerupted, but undisplaced, as confirmed by reference to the models and radiographs

Good quality panoramic radiographs and periapical views of the incisor regions were available for each patient.

The films were then studied, and dental age was evaluated for each of the permanent teeth, erupted and unerupted. The assessments were made to an accuracy tolerance of 0.5 years, on the principles established in the classic published works in the field,[7-13] and according to the practical system advocated by Becker.[14] A reasonable degree of accuracy may be achieved, using the easily recognizable stages of tooth formation. The earliest signs of calcification may be distinguished shortly after initiation. The completion of the crown and the advancing stages of root formation are assessed, through to closure of the root apex and the disappearance of the root-forming dental papilla. This last stage is the most accurate to diagnose and can be used as a baseline from which to begin the evaluation of a patient's dental age. When the patient is aged 6 years, the mandibular central incisors erupt, closely followed by the first permanent molars. In common with virtually all the other teeth, the roots of these teeth close fully 2.5 to 3 years later.[8] When the radiographs are viewed and completed apices of these teeth are discernible, it may be assumed that the patient has reached the dental age baseline of 9 years. The observer now follows a simple line of investigation in search of fully closed root apices in the next teeth to erupt, namely, the mandibular lateral incisor and the maxillary central incisor. Approximately 3 years is added to the normal eruption ages for these teeth to indicate the increasing dental age: 10 years for the maxillary central incisor, 11 years for the maxillary lateral incisor, 12 to 13 years for the mandibular canines and first premolars, and so on, until 15 years for the second permanent molars. A tentative dental age is then determined on the basis of the last tooth of the series to exhibit a closed apex. At this point, the expected devel-

opmental stages of the remaining teeth, for that dental age, are assessed by referring to the charts of ideal tooth development and are compared with the actual root lengths seen on the radiographs of the patient.[7-10] Care should be taken when discrepancies occur with regard to late-developing maxillary lateral incisors and mandibular second premolars, which are known to be variable teeth (Fig 1). With the use of this line of investigation, it should now be relatively straightforward to calculate from the panoramic radiograph in Fig 1 that the dental age of this patient is 11 years.

The chronologic age of the patients at the time the radiographs were taken was calculated by subtracting the patients' birth dates, as recorded in their record cards, from the dates recorded on the radiographs to the nearest half-year. This part of the study was not recorded until all the dental age assessments had been completed, to avoid bias. The discrepancy between the dental age and the chronologic age was assessed for each case. A comparative statistical analysis of the data was performed with a 2-tailed, unpaired Student *t* test.

RESULTS

Table I lists the patients with palatally displaced canines and compares their dental and chronologic ages. It can be seen that approximately half the patients exhibited retarded dental development to a greater or lesser extent, whereas the remaining half showed a dental age that corresponded to the chronologic age. There were no cases of accelerated dental development.

For patients with buccally ectopic canines, almost two thirds showed no dental age discrepancy, with a small number of patients on both the early and late side of the norm, as would be expected in a normal distribution curve (Table II). The control group of orthodontically treated patients, whose canines were not displaced at the beginning of treatment, had approximately the same results as the patients with buccally ectopic canines (Table III).

The graph (Fig 2) illustrates that the values from the control and buccal canine groups conform to a normal distribution curve and to each other. The palatal canine group produces a curve markedly skewed to the side of retarded dental development.

The difference between the dental age values for the palatal and buccal canine groups was found to be highly statistically significant ($P < .001$), and the same statistical significance was found when comparing the palatal canine group with the control group. With an emphasis on the similarity between the dental ages in the buccal canine and control groups, differences between these 2 groups did not reach statistical significance ($P = .89$).

Table I. Comparison of dental and chronologic ages of subjects with palatally displaced canines*

Patient	*Chronologic age*	*Dental age*	*Difference*
1	13.0	10.5	–2.5
2	12.5	10.5	–2.0
3	14.0	12.0	–2.0
4	12.0	10.0	–2.0
5	14.0	12.0	–2.0
6	12.5	10.5	–2.0
7	14.0	12.0	–2.0
8	11.5	10.0	–1.5
9	12.5	11.5	–1.5
10	12.0	10.5	–1.5
11	16.0	14.5	–1.5
12	11.5	10.0	–1.5
13	14.0	12.5	–1.5
14	11.5	10.0	–1.5
15	11.0	9.5	–1.5
16	10.5	9.0	–1.5
17	11.0	9.5	–1.5
18	16.0	14.5	–1.5
19	13.0	12.0	–1.0
20	16.0	15.0	–1.0
21	12.0	11.0	–1.0
22	12.5	11.5	–1.0
23	16.0	15.0	–1.0
24	12.5	11.5	–1.0
25	14.0	13.0	–1.0
26	12.5	11.5	–1.0
27	13.0	12.0	–1.0
28	11.0	10.5	–0.5
29	14.0	13.5	–0.5
30	14.0	13.5	–0.5
31	12.0	11.5	–0.5
32	14.0	13.5	–0.5
33	13.5	13.5	0
34	14.0	14.0	0
35	14.0	14.0	0
36	12.0	12.0	0
37	12.5	12.5	0
38	15.0	15.0	0
39	14.0	14.0	0
40	14.0	14.0	0
41	14.0	14.0	0
42	15.0	15.0	0
43	10.0	10.0	0
44	15.0	15.0	0
45	11.0	11.0	0
46	11.5	11.5	0
47	13.0	13.0	0
48	13.5	14.0	0.5
49	10.5	11.0	0.5
50	13.5	14.0	0.5
51	11.5	12.0	0.5
52	14.0	14.5	0.5
53	11.0	11.5	0.5
54	11.0	11.5	0.5
55	13.5	14.0	0.5

*The ages are recorded in years to an accuracy tolerance of 0.5 years.

Table II. Comparison of dental and chronologic ages of subjects with buccally displaced canines*

Patient	*Chronologic age*	*Dental age*	*Difference*
1	14.0	12.0	–2.0
2	13.5	11.5	–2.0
3	12.0	10.5	–1.5
4	12.0	11.0	–1.0
5	11.0	10.0	–1.0
6	12.0	11.0	–1.0
7	11.0	10.5	–0.5
8	12.5	12.0	–0.5
9	12.5	12.0	–0.5
10	11.0	10.5	–0.5
11	10.5	10.0	–0.5
12	10.0	9.5	–0.5
13	14.5	14.0	–0.5
14	12.5	12.0	–0.5
15	9.0	9.0	0
16	11.0	11.0	0
17	13.5	13.5	0
18	14.0	14.0	0
19	10.5	10.5	0
20	12.5	12.5	0
21	15.0	15.0	0
22	15.0	15.0	0
23	13.0	13.0	0
24	10.0	10.0	0
25	15.0	15.0	0
26	12.0	12.0	0
27	11.5	11.5	0
28	12.5	12.5	0
29	12.0	12.5	0.5
30	13.0	13.5	0.5
31	14.5	15.0	0.5
32	10.0	10.5	0.5
33	12.0	12.5	0.5
34	13.5	14.0	0.5
35	13.5	14.0	0.5
36	10.0	11.0	1.0
37	14.0	15.0	1.0
38	11.5	12.5	1.0
39	13.5	14.5	1.0
40	13.5	14.5	1.0
41	11.5	13.0	1.5
42	12.0	13.5	1.5
43	13.0	14.5	1.5
44	13.0	15.0	2.0
45	11.0	13.5	2.5
46	12.0	14.5	2.5
47	12.0	15.0	3.0

*The ages are recorded in years to an accuracy tolerance of 0.5 years

DISCUSSION

A word of caution is pertinent regarding the difference between the control group used in this study and a random sample control group. This study was performed on existing radiographs of patients in orthodontic treatment. It would be unethical to take radi-

Table III. Comparison of dental and chronologic ages of subjects with normally placed canines

Patient	*Chronologic age*	*Dental age*	*Difference*
1	13.0	11.0	–2.0
2	12.5	11.0	–1.5
3	12.0	11.0	–1.0
4	12.0	11.0	–1.0
5	10.5	11.5	–1.0
6	13.5	12.5	–1.0
7	13.5	13.0	–0.5
8	12.0	11.5	–0.5
9	12.5	12.0	–0.5
10	11.0	10.5	–0.5
11	11.5	11.0	–0.5
12	10.0	9.5	–0.5
13	11.0	10.5	–0.5
14	11.0	10.5	–0.5
15	12.5	12.0	–0.5
16	11.5	11.0	–0.5
17	11.5	11.0	–0.5
18	11.0	10.5	–0.5
19	9.75	9.5	0
20	13.5	13.5	0
21	14.0	14.0	0
22	10.0	10.0	0
23	12.5	12.5	0
24	13.0	13.0	0
25	12.0	12.0	0
26	10.5	10.5	0
27	12.5	12.5	0
28	15.0	15.0	0
29	10.5	10.5	0
30	14.5	14.5	0
31	13.0	13.0	0
32	10.5	10.5	0
33	14.0	14.0	0
34	11.5	11.5	0
35	12.0	12.5	0.5
36	12.5	13.0	0.5
37	14.0	14.5	0.5
38	9.0	9.5	0.5
39	11.0	11.5	0.5
40	9.5	9.0	0.5
41	11.0	11.5	0.5
42	14.0	14.5	0.5
43	10.0	10.5	0.5
44	13.0	14.0	1.0
45	13.0	14.0	1.0
46	11.0	12.0	1.0
47	13.5	14.5	1.0
48	13.5	14.5	1.0
49	13.0	14.5	1.5
50	12.5	14.0	1.5
51	12.0	13.5	1.5
52	13.0	14.5	1.5
53	13.0	14.5	1.5
54	10.5	12.0	1.5
55	10.5	12.0	1.5
56	12.5	14.5	2.0
57	11.0	14.0	3.0

*The ages are recorded in years to an accuracy tolerance of 0.5 years.

ographs of a random sample of patients who are not considering treatment or who are unaware of the need for such treatment. It therefore becomes impossible to obtain a truly random control sample. However, patients undergoing orthodontic treatment are overwhelmingly healthy, normal individuals, and it was considered justifiable to assemble a control group in the manner described here and to use it as the standard against which to compare the 2 ectopic canine groups.

From the tables, it may be clearly seen that the occurrence and range of dental age values in the buccal canine group are closely similar to those of the control group. It may be concluded, with a high degree of statistical significance ($P = .89$), that patients with buccally ectopic maxillary canine teeth have a normal rate of dental development and/or maturation, similar to that seen in any other healthy child who is seen for orthodontic treatment for other unrelated problems.

However, the patient with a palatally displaced canine does not experience a normal rate of development. With a high degree of statistical significance ($P < .001$), the patients in the palatal canine group showed a distinct tendency for delayed dental development. The results seen in this group show a phenomenon not seen in previous studies. The graph shown in Fig 1 illustrates that both the buccally ectopic group and the control group have a normal distribution of timely, early, and late development of the dentition. However, the curve for the group with palatally displaced canines shows a double-peaking phenomenon: the left peak represents a subgroup of approximately half the patients whose dental age was delayed by a mean of 1.5 years, and the right peak represents the other half of the patients who have a normal dental age. This could perhaps lead us to speculate on the existence of 2 separate and distinct etiologic factors for the palatal displacement of the canine. One etiologic factor accounting for half the cases appears to be linked to several hereditary phenomena, such as small teeth, late dentitions, anomalous lateral incisors, missing teeth, impacted maxillary first molars, and infraoccluded deciduous teeth. The palatal displacement of the canine occurs either as a similar hereditary trait or as the result of the lack of guidance of the lateral incisors.[15,18-22] Earlier studies have revealed anomalous (ie, small, peg-shaped, or missing) lateral incisors in approximately half of the patients with palatally displaced canines.[15-17] Furthermore, missing or small teeth are known to be associated with a tendency for delayed development.[11]

The second factor (or group of factors) is unrelated to these hereditary, parallel phenomena. It points to the existence of possible alternative causative agents or other phenomena.[14]

Ethnic differences in the relative frequency of prevalence of palatal versus buccal ectopia have been shown to exist between whites and Asians.[23,24] This could account for the differing results that have been reported in other studies. In this study, the ratio of palatal canines adjacent to anomalous lateral incisors versus normal lateral incisors was 50:50. Although the Welsh population examined by Brenchley and Oliver[25] was small, the ratio was markedly in favor of the normal lateral incisor group. A similar ethnic difference may also account for the views on etiology expressed by Kurol.[6]

These findings have further implications regarding treatment and future studies on palatally displaced canines. The timing of certain recommended procedures, such as extraction of a deciduous canine aimed at promoting the spontaneous eruption of a potentially impacting permanent canine, should be decided on the basis of dental age.[26,27] Studies in tooth agenesis should use a “critical dental age” rather than chronologic or eruption age.[28]

CONCLUSIONS

From this radiographic study, it has been shown that

1. among the patients with palatally displaced maxillary canines, approximately half have significantly delayed dental development;
2. buccal displacement is not associated with retarded dental age, which appears not to be different from other normal healthy patients;
3. there are seemingly different etiologies for the occurrence of buccal versus palatal ectopia in maxillary canines.

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