Morphology of Anterior Teeth Associated with Displaced Canines

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Abstract. *This clinical study compared tooth dimensions of maxillary central and lateral incisors on the same side as a palatally impacted maxillary canine with those of the contralateral side with a normally erupted canine, in a group of 33 consecutively referred patients. The dimensions recorded were the mesio-distal width, labio-palatal depth, obtained from models of the four upper anterior teeth and total tooth length obtained from an orthopantomographic radiograph. The results showed that there was no statistically significant evidence to support the view that palatally impacted maxillary canines are associated with diminutive maxillary lateral incisors.*

Index words: Impaction, Maxillary Canines, Maxillary Lateral Incisors.

Refereed Paper

Introduction

The maxillary permanent canine is second only to the third molar in frequency of impaction, with a reported prevalence ranging from 0.92 per cent (Dachi and Howell, 1961) to 8 per cent (Shah *et al.*, 1978). Most reports, however, put the figures between 1 and 2 per cent (Bass, 1967; Thilander and Jakobsson, 1968; Brin *et al.*, 1986; Ericson and Kurol, 1986). It is predominantly (85 per cent) misplaced palatally (Ericson and Kurol, 1987) and there is no convincing evidence for a sex predilection. Broadway and Gosney (1987) found that impacted canines accounted for just over half the referrals to the oral surgery department and, in common with Galloway and Stirrups (1989), reported that there was late recognition and referral of the problem. Complications of canine impaction include the serious problem of resorption of the root of the adjacent tooth, which is reported to occur in 12 per cent of ectopic canines (Ericson and Kurol, 1987). There seems to be a consensus that resorption is more likely to occur in girls than boys (Ericson and Kurol, 1988; Howard, 1971; Newman, 1975; Sasakura *et al.*, 1984).

The aetiology of ectopic canines is obscure, however, it has been suggested that it is more frequently associated with peg shaped or small lateral incisors (Becker *et al.*, 1981, 1984; Brin *et al.*, 1986). This could not be substantiated by Oliver *et al.* (1989).

If the morphology of the maxillary lateral incisor is a predictor of palatal canine impaction, then it could serve as an easily recognized early warning sign for the monitoring of the canine position and prompt early referral in appropriate cases.

The aim of this study was to measure the mesio-distal, labio-palatal and occluso-gingival crown dimensions of the maxillary lateral and central incisors adjacent to a palatally impacted canine, and to compare these measurements to those of the central and lateral incisor on the contra-lateral side where the canine had erupted into a normal position. Furthermore, the radiographic tooth length of the incisors was measured on orthopantomograms, corrected for local magnification factors, and compared between the impacted and non-impacted sides.

Materials and Methods

The sample consisted of 33 consecutive patients referred to the Orthodontic Department of the Cardiff Dental Hospital. The patients were admitted to the study on the basis that they were willing to participate and satisfied the following criteria:

1. Unilateral palatally impacted maxillary canine.
2. The contra-lateral canine was present and at least partially erupted in the line of the arch.
3. Both maxillary lateral incisors were present and erupted.
4. The anterior tooth morphology had not been altered by trauma, caries or conservation.
5. Informed, written consent was obtained from the patients prior to the study.

By using patients with unilateral canine impaction, the teeth on the contralateral side of the maxilla could act as a control group for the dimensions of the anterior teeth.

At the initial visit a history and examination was undertaken, together with alginate impressions for study models, and all appropriate radiographs apart from an orthopantomograph. At the second visit, a secondary impression of the six maxillary anterior teeth was taken in a special tray using a medium viscosity polyvinylsiloxane impression material (Extrude®). This impression was cast in a hard stone material used for construction of

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crowns etc. (Vel-Mix®). On a duplicate of the initial study model a 0·5-mm thick Drufolit® vacuum moulded splint covering the incisor teeth was constructed into which were incorporated straight lengths of 0·4-mm stainless steel wire (Fig. 1). Two lengths of wire were arranged on the labial surface of each incisor tooth, one horizontal, parallel to the incisal edge, and one vertical, parallel to the long axis of the tooth. Each length of wire was pre-measured using a Vernier gauge. The splint was fitted to the incisors immediately prior to the taking of the orthopantomograph (Fig. 2).

At the second visit the patient was seen by a consultant for treatment planning and further referral as appropriate.

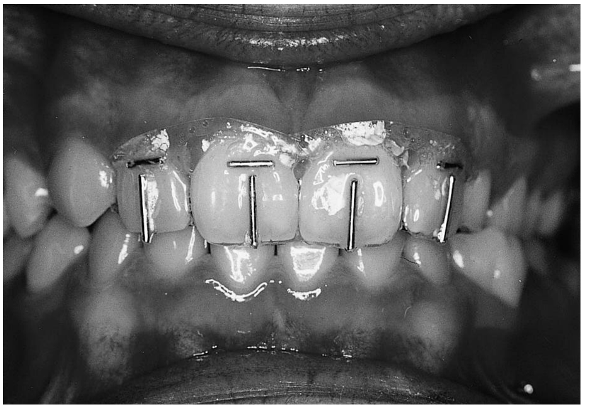

FIG. 1. Photograph of the upper anterior teeth with the splint holding the stainless steel markers.

Model measurements

The four incisors on each study cast obtained from the secondary impression were measured using a Reflex Microscope. The points were identified and premarked on the models using a sharp pencil prior to digitization.

The following dimensions from each tooth were recorded (Fig. 3):

1. Crown width:
   (i) the distance between the interproximal mesial gingival margin and the interproximal distal gingival margin;
   (ii) the distance between the most mesial occlusal point and the most distal occlusal point.
2. Crown depth:
   (i) the distance between the midpoint of the labial surface at the gingival margin to the mid-point of the palatal surface at the gingival margin;
   (ii) the distance between the mid-point of the palatal surface to the midpoint of the labial surface, 1 mm apical to the incisal edge.

In an attempt to more fully describe the shape of the teeth, the following calculations were performed:

1. The mesio-distal taper of each tooth was calculated by subtracting the mesio-distal width at the incisal edge from the mesio-distal width at the gingival margin.
2. The labio-palatal taper of each tooth was calculated by subtracting the labio-palatal thickness at the incisal edge from the labio-palatal thickness at the gingival margin.

FIG. 2. Orthopantomograph showing stainless steel markers superimposed on the shadows of the upper incisors.

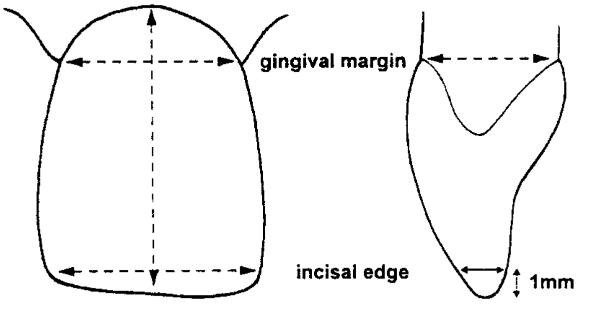

FIG. 3. Diagram of an incisor indicating the location of the distances measured.

Radiographic measurements

The following dimensions on the orthopantomographic radiographs were obtained:

1. Total radiographic tooth length from the apex of the root to the mid-point of the occlusal surface of the crown for each of the incisors.
2. The length of the vertical wire in the splint for each of the incisors.

The points were digitized using a dedicated radiographic measuring package (Dentofacial Planner®).

For the purposes of this part of the project, the horizontal wires in the incisal splint were ignored. The actual total length of the tooth was found by calculating the magnification of the vertical wire in the incisal splint and applying this correction to the radiographic length of the tooth.

The ratio of the actual tooth length of the lateral incisor to the central incisor for the control and experimental sides was calculated.

For both the study cast and the radiograph, each dimension on each tooth was measured in a predetermined order three times, and the mean of the three readings taken.

Statistical analysis

The mean, standard deviation, 95 per cent confidence interval, minimum and maximum dimensions of the central and lateral incisor derived from the study models and radiographs on the side of the impacted canine (experimental side) and the contralateral (control) side were calculated, and the mean difference, standard deviation of difference, 95 per cent confidence interval of difference and statistical significance using the unpaired *t*-test of the control versus experimental side were calculated.

Results

The mean age of the sample was 14 years 6 months, the youngest subject was 11 years 4 months and the eldest 26 years 3 months. Thirty-nine per cent of impacted canines were on the left side (a non-significant difference between the sides).

The incisor classification of subjects in this study compared with a larger group of randomly selected patients referred to the same hospital examined in a previous unrelated study (Patel, 1989) revealed statistically significant differences in the proportion of incisor classifications. There were more Class II Division 2 and Class III malocclusions in the experimental group (chi square = 10·69, df = 3, $P < 0{\cdot}05$).

Model measurements

Table 1 gives the summary statistics for the Tooth Width at the Gingival Margin obtained from the study models, and the unpaired *t*-tests for control versus experimental sides. No statistically significant differences could be demonstrated. However, inspection of the 95 per cent confidence intervals for the difference between the dimensions of the control and experimental lateral incisors shows that there is a trend towards a difference for this dimension and the Mesio-Distal Crown Taper (Table 2). The lateral incisor on the side of the impacted canine demonstrates a greater tooth width at its gingival margin than that on the unaffected side. The lateral incisor on the affected side shows a greater taper in width towards the incisal edge than that on the control side.

There were no statistically differences between the labio-palatal thickness, or labio-palatal taper of experimental and control lateral or central incisors, and the 95 per cent confidence intervals for the difference between control and experimental sides revealed no clear trends.

Radiographic measurements

Table 3 shows that for measurements direct from the radiograph, the experimental lateral incisor is almost half a millimetre shorter than the control. However, when the radiographic measurements are corrected for magnification, the lateral incisor on the affected side appears to be slightly longer than the control side, whereas the experimental central remains shorter than the control side. Whilst these differences escape statistical significance, the 95 per cent confidence interval clearly shows a trend for a difference on the central incisors, but not for the lateral incisors.

The ratio of lateral incisor to central incisor actual tooth length for control versus experimental side just reaches a statistically significant difference (Table 4). The ratio for the control side is 0·97, whereas that for the experimental side is 1·04, reflecting the fact that the experimental lateral incisor displays a longer root length than its adjacent central incisor.

TABLE 1 *Tooth dimension from study model*
Tooth width: mesial gingival margin to distal gingival margin (mm)

	Control lateral	Experimental lateral	Control central	Experimental central
Mean	6·49	6·76	8·83	8·88
Standard deviation	0·65	0·64	0·56	0·54
95% Confidence interval	6·26–6·72	6·54–6·99	8·63–9·03	8·69–9·07
Minimum	5·1	5·43	7·85	7·99
Maximum	7·9	8·07	10·35	9·86

Difference (control–experimental)

	Mean	95% Confidence interval	*t* Value	Significance
Lateral	−0·27	−0·59–0·05	−1·7	N.S.
Central	−0·05	−0·33–0·22	−0·41	N.S.

TABLE 2 *Tooth dimension from study model*
Mesio-distal crown taper (mesio-distal width at the gingival margin–mesio-distal width at the incisal edge)

	Control lateral	Experimental lateral	Control central	Experimental central
Mean	1·33	1·6	1·28	1·23
Standard deviation	0·66	0·6	0·64	0·57
95% Confidence interval	1·1–1·57	1·38–1·81	1·05–1·51	1·03–1·43
Minimum	−0·87	0·58	−0·16	−0·27
Maximum	2·33	2·84	2·9	2·68

Difference (control–experimental)

	Mean	95% Confidence interval	*t* Value	Significance
Lateral	−0·27	−0·57–0·05	−1·68	N.S.
Central	−0·05	−0·25–0·35	0·33	N.S.

Discussion

Only one of the lateral incisors in the 33 subjects in the trial appeared macroscopically to be peg-shaped or diminutive, and this was, in fact, one of the control lateral incisors. This subject was not excluded from the trial, and the reduced dimensions of this control tooth will have dragged down the mean values for the dimensions of the control group. To discover if this phenomenon had affected the results, the values were re-calculated excluding this individual. This procedure made only minor differences to the values given in the tables, however, the statistically significant difference found in Table 4 was lost on the recalculation.

Based on the evidence collected, the results suggest that, if anything, the lateral incisor adjacent to an ectopic canine is slightly larger than the contralateral incisor. This supports the previous paper by Oliver *et al.* (1989) which was carried out on a similar number, but totally different group of individuals and used much cruder measurement techniques. Both reports contradict the findings of Becker *et al.* (1981, 1984) and Brin *et al.* (1986). They used the mandibular lateral incisor as a guide to the reduction in size of the maxillary lateral incisor, and accepted bilaterally impacted canines into their study group. Using a sample of patients from an orthodontic practice and an orthodontic department of a teaching hospital, they found that just over 50 per cent of lateral incisors adjacent to palatally displaced canines were of normal morphology, 25 per cent were small, 17 per cent peg shaped, and 5 per cent absent (Becker *et al.*, 1981). These figures were broadly confirmed in a later epidemiological study of almost two-and-a-half thousand adolescents (Brin *et al.*, 1986).

In their study of radiographic tooth length, the lateral incisors adjacent to an impacted canine were found to be just over 2 mm shorter than their control group. However, they used a mixture of orthopantomographic and peri-apical radiographs for their measurements, and claimed validity of measurements by using the ratio of tooth length of lateral incisor to adjacent central incisor (Becker *et al.*, 1984). In the present study, an accurate estimation of the actual tooth length was used, and no statistically significant difference between the control and lateral incisor tooth lengths could be found. However, by applying the same method as Becker *et al.* (1984), using the ratio of lateral incisor to central incisor tooth length to our data, the difference between control and experimental sides just reaches statistical significance, but in an opposite direction to Becker *et al.* (1984) and this significance is lost when the individual with the control peg lateral is excluded. Their ratio for the normal (control) side was 0·96, which is similar to our 0·97; however, on the experimental side, their ratio is 0·91 compared with our 1·04.

The difference between their study and this study arises because they have an experimental group which contains 12 per cent small or peg-shaped lateral incisors which would have a shorter root length. Our study contained no diminutive lateral incisors in the experimental group. In addition, using the algebraic method to calculate the actual tooth length must be more reliable than that of Becker *et al.* (1984). The displaced canine is, in our experience, frequently associated with a labiopalatal displacement of the adjacent lateral incisor. Our study group shows a high proportion of Class II Division 2 malocclusions, compared with a representative sample of cases being treated in the department, and does not compare with the figures quoted by Brin *et al.* (1986) where they found 73 per cent Class I, 20 per cent Class II, and 7 per cent Class III. This variation in labiopalatal position will have a profound influence on the degree of radiographic distortion, which will not necessarily be shared by the adjacent central incisor.

If similar aetiological factors for canine impaction were operating in South Wales, then we would expect to find approximately 15 of our group to display abnormal lateral incisor morphology. It is likely that the different ethnic backgrounds present different predisposing factors for the palatal displacement of maxillary canines.

TABLE 3 *Tooth length*
Radiographic tooth length (mm)

	Control lateral	Experimental lateral	Control central	Experimental central
Mean	26·73	25·8	28·84	28·13
Standard deviation	2·43	2·41	2·8	2·8
95% Confidence interval	25·87–27·59	24·95–26·65	27·85–29·84	27·14–29·12
Minimum	20·95	21·45	22·9	22·45
Maximum	31·5	30·85	34·35	34·35

Estimated actual tooth length (mm)

Control	Control lateral	Experimental lateral	Control central	Experimental central
Mean	24·46	24·92	25·38	24·04
Standard deviation	3·77	4·11	3·94	3·67
95% Confidence interval	23·12–25·8	23·46–26·38	23·99–26·78	22·74–25·34
Minimum	16·62	14·22	18·52	18·55
Maximum	34·74	37·77	37·79	35·87

Difference (control–experimental) estimated actual tooth length

	Mean	95% Confidence interval	*t* Value	Significance
Lateral	−0·46	−2·4–1·48	−0·47	N.S.
Central	1·34	−0·53–3·22	1·44	N.S.

TABLE 4 *Ratio of lateral incisor to central incisor tooth length*
Estimated actual tooth length

	Mean	Standard deviation	95% Confidence interval	Maximum	Minimum
Control	0·97	0·13	0·92–1·02	1·39	0·67
Experimental	1·04	0·16	0·99–1·1	1·46	0·76

Difference (control–experimental)

Mean	95% Confidence interval	*t* Value	Significance
−0·07	−0·14–0·00	−2·01	<0·05

Conclusions

This study of South Wales patients has failed to support the work performed earlier by Israeli workers which suggested that peg shaped or small maxillary lateral incisors are associated with palatal displacement of the adjacent canine. This may be due to ethnic differences.

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