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Tooth size discrepancies in female patients with palatally impacted canines

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Background: Small upper lateral incisors in patients with palatally impacted canines may contribute to inter-arch tooth size discrepancies.
Aim: To compare the Bolton ratios in female patients with and without unilateral palatally impacted canines.
Methods: The pretreatment dental casts of 30 female patients with unilateral palatally impacted canines (Impaction group) and 30 female patients without palatally impacted canines (Control group) were used. The latter were matched for age and incisor malocclusion with the Impaction group. The anterior and overall Bolton ratios were calculated for each group.
Results: Although the total width of the upper anterior teeth in the Impaction group was significantly smaller than the total width of the upper anterior teeth in the Control group ($p = 0.029$), there was no significant difference between the mesio-distal widths of the lower anterior teeth in the two groups. Furthermore, there were no significant group differences in either the mean anterior Bolton ratio ($p = 0.156$) or the overall Bolton ratio ($p = 0.652$).
Conclusion: Females patients with palatally impacted canines may not have more inter-arch tooth size discrepancies than female patients without palatally impacted canines.
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Introduction

Inter-arch tooth size discrepancies can make it difficult to obtain a good occlusion at the end of treatment, especially if the discrepancies are greater than 1.5 mm.[1,2] The mesio-distal widths of the upper lateral incisors are very variable and, as a result, this tooth is usually responsible for discrepancies between the widths of the upper and lower anterior teeth. There have been several reports that the mesio-distal widths of the upper incisors, particularly the upper lateral incisors, are significantly less in patients with palatally impacted canines.[3–8] This view is by no means universal, as Brenchley and Oliver reported that palatally displaced canines were not associated with diminutive upper lateral incisors.[9] We also found that there were no differences in the widths of the upper lateral incisors in male and female subjects with and without palatally impacted canines.[10] Obviously, an inter-arch tooth size discrepancy is only likely to occur if the widths of the lower anterior teeth do not compensate for upper lateral incisors with reduced crown widths.

The purpose of this study is to compare the anterior and overall Bolton ratios in female patients with and without unilateral palatally impacted canines.

Material and methods

The material for this study consisted of the dental casts of 30 female orthodontic patients with unilateral palatally impacted maxillary canines (Impaction group). This group comprised female patients treated at the Dental Hospital, Jordan University of Science and Technology in the period between 2000 and 2005. The inclusion criteria were:

1. Unilateral palatal canine impaction, determined radiographically with the parallax technique.

2. The impacted canines had fully formed root apices and had not erupted into the oral cavity.

Table I. Distribution of incisor malocclusions in female subjects with unilateral palatally impacted canines.

Incisor classification	Number of cases
Class I	17
Class II division 1	3
Class II division 2	7
Class III	3

Table II. Anterior and overall Bolton ratios in the Impaction and Control groups.

	Impaction group Mean (SD)	Control group Mean (SD)	Difference	*p*
Sum of upper anterior teeth (mm)	44.7 (2.4)	46.3 (3.1)	-1.7	**0.029**
Sum of lower anterior teeth (mm)	35.2 (1.7)	36.0 (2.1)	-0.8	0.138
Anterior Bolton ratio (%)	78.8 (3.1)	77.7 (2.6)	1.1	0.156
Sum of all upper teeth (mm)	92.2 (5.0)	94.5 (5.6)	-2.3	0.101
Sum of all lower teeth (mm)	85.0 (5.3)	87.0 (4.7)	-2.0	0.124
Overall Bolton ratio (%)	92.2 (1.3)	92.0 (1.4)	0.2	0.686

Significant value in bold

3. All permanent teeth from first molar to first molar had erupted.

4. There were no crown or bridge restorations.

5. The upper lateral incisors were not peg-shaped.

6. Pre- and post-treatment dental study casts.

This group ranged in age from 13 to 41 years (Mean age: 18.9 years; SD: 4.8 years). Each subject was then age-matched to within one year with a female patient without an impacted upper canine attending the same institution and with a similar incisor classification (Control group).[11] The distribution of incisor malocclusion is given in Table I.

The mesiodistal width of each tooth (first molar to first molar) was measured from the mesial anatomical contact point to the distal anatomical contact point. The teeth were measured at least twice using a sharpened Boley gauge by the same examiner (IA). If the difference between the two measurements was more than 0.2 mm a third reading was made and the aberrant reading discarded. The mean of two measurements was used in the calculations. The mesio-distal width of the impacted canine was measured on the post-treatment upper cast. The inter-arch tooth size ratios, or anterior and overall Bolton ratios, were calculated.[1] The measurement error was calculated according to Dahlberg's double determination method.[12] The measurement error for the mesio-distal widths of all teeth was 0.24 mm.

Statistical analysis

Means and standard deviations for the anterior and overall Bolton ratios were calculated using SPSS (Chicago, Ill, USA). The anterior and overall Bolton ratios in the two groups were compared with Student's *t*-test. The significance level was set at $p \leq 0.05$.

Results

The mean anterior Bolton ratio for the Impaction group was 78.8 per cent (3.1) and for the Control group it was 77.7 per cent (2.6) (Table II). This difference was not statistically significant ($p = 0.156$). The overall Bolton ratios in the Impacted and Control groups were similar: 92.2 per cent and 92 per cent, respectively ($p = 0.686$). The total mesio-distal width of the upper anterior teeth was significantly smaller in the Impaction group as compared with the Control group ($p = 0.029$).

Comparing the mesio-distal width of each tooth in the Impaction group with its counterpart in the

Table III. Mesio-distal widths of the teeth in the Impaction and Control groups, in millimetres.

Tooth	Side	Impaction group	Control group	Difference	*p*
Upper central incisor	A	8.5 (0.68)	8.6 (0.64)	-0.1	0.547
	N-A	8.5 (0.59)	8.7 (0.67)	-0.2	0.259
Upper lateral incisor	A	6.3 (0.96)	6.9 (0.60)	-0.6	**0.007**
	N-A	6.3 (0.99)	6.7 (0.55)	-0.4	0.058
Upper canine	A	7.5 (0.57)	7.8 (0.46)	-0.3	**0.038**
	N-A	7.5 (0.85)	7.7 (0.62)	-0.2	0.370
Upper first premolar	A	6.8 (0.91)	6.9 (0.55)	-0.1	0.697
	N-A	6.8 (0.49)	6.9 (0.55)	-0.1	0.475
Upper second premolar	A	6.5 (0.35)	6.6 (0.43)	-0.1	0.146
	N-A	6.5 (0.52)	6.7 (0.52)	-0.2	0.121
Upper first molar	A	10.5 (0.68)	10.6 (0.65)	-0.1	0.571
	N-A	10.5 (0.54)	10.5 (0.48)	0.0	0.913
Lower central incisor	A	5.2 (0.66)	5.3 (0.51)	-0.1	0.294
	N-A	5.2 (0.54)	5.3 (0.40)	-0.1	0.238
Lower lateral incisor	A	5.8 (0.52)	6.0 (0.52)	-0.2	0.100
	N-A	5.7 (0.96)	6.0 (0.55)	-0.3	0.062
Lower canine	A	6.7 (0.54)	6.8 (0.48)	-0.1	0.434
	N-A	6.7 (0.53)	6.8 (0.41)	-0.1	0.231
Lower first premolar	A	7.0 (0.38)	7.2 (0.46)	-0.2	**0.032**
	N-A	7.0 (0.53)	7.2 (0.47)	-0.2	0.062
Lower second premolar	A	7.0 (0.59)	7.2 (0.61)	-0.2	0.149
	N-A	7.0 (0.59)	7.3 (0.52)	-0.3	**0.031**
Lower first molar	A	11.0 (0.67)	11.0 (0.72)	0.0	0.918
	N-A	11.0 (0.54)	11.1 (0.56)	-0.1	0.790

A, affected side; N-A, non-affected side
Significant values in bold

Control group (Table III), all teeth in the Impaction group had smaller mesio-distal widths. In the upper arch, however, only the impacted canine and the adjacent lateral incisor were significantly different (p = 0.038 and p = 0.007, respectively). In the lower arch, the first premolar on the affected side and the second premolar on the non-affected side showed a statistically significant difference (p = 0.032 and p = 0.031, respectively).

Tables IV and V show the anterior and total Bolton ratios in each malocclusion type. There was no significant difference in the anterior or total Bolton ratios between the Impaction and Control groups in any type of malocclusion.

Discussion

The purpose of this investigation was to investigate the Bolton ratios in female subjects with palatally impacted canines. Canine impactions occur frequently in Class II division 2 malocclusions,[13] a malocclusion that has been reported to be associated with smaller teeth than other forms of malocclusion.[14,15] Moreover, the Bolton ratio was reported to vary in different forms of malocclusion.[16] For this reason the Impaction and Control groups were matched for the type of malocclusion. Attrition is another factor that may influence mesio-distal crown widths, especially in the older population, therefore we also age-matched the two groups.

Sex differences in tooth dimensions have been reported in the literature: males generally have larger teeth than females.[17,18] However, there is a lack of agreement regarding sex differences in relation to inter-arch tooth sizes.[19–22] We used female subjects only because canine impaction is more commonly found in females, and by using a single sex sample we

Table IV. Anterior Bolton ratios in the malocclusion groups, in percentages.

Incisor classification	Impaction group Mean % (SD)	Control group Mean % (SD)	Difference	*p*
Class I	78.6 (3.8)	78.1 (3.6)	0.5	0.739
Class II/1	78.1 (3.2)	75.6 (1.2)	2.5	0.279
Class II/2	79.3 (1.5)	78.3 (2.2)	1.0	0.330
Class III	79.8 (5.1)	75.3 (4.9)	4.5	0.332

Table V. Total Bolton ratios in the malocclusion groups, in percentages.

Incisor classification	Impaction group Mean % (SD)	Control group Mean % (SD)	Difference	*p*
Class I	92.0 (1.5)	92.2 (1.6)	0.2	0.796
Class II/1	92.3 (0.5)	92.0 (0.2)	0.3	0.400
Class II/2	92.3 (0.2)	91.8 (1.4)	0.5	0.372
Class III	93.1 (1.1)	91.6 (0.4)	1.5	0.101

avoided the confounding effects of gender differences in tooth size on the Bolton ratios.[10]

The mean anterior Bolton ratio in the Control group was 77.7 per cent with a standard deviation of 2.6. In Chinese subjects this ratio was 77.5 ± 1.8,[22] 78.1 ± 2.78 in Dominican Americans,[23] 79.6 in Caucasians, 79.3 in Black Americans and 80.5 in Spanish Americans.[20] There were high percentages of subjects with Class II division 2 malocclusions (23.3%) in both groups, and it has been reported that subjects with this malocclusion have smaller anterior Bolton ratios.[3,7]

We attribute the significant difference between the total mesio-distal widths of the upper anterior teeth in the Impaction and Control groups to the narrower upper lateral incisors adjacent to the impacted canines in the Impaction group. In agreement with previous studies we found that this tooth, although well-formed clinically, was significantly smaller mesio-distally than its counterpart in the Control group.[3–7] However, it is interesting to note that the upper lateral incisors were of similar widths on the affected and non-affected sides in the Impaction group.

Although we found a small, but statistically significant, difference between the total mesio-distal widths of the upper anterior teeth in the Impaction and Control groups, the anterior Bolton ratios were not significantly different. The lesser widths of the upper anterior teeth in the Impaction group were accompanied by slightly narrower lower anterior teeth. Although the Impaction group – Control group difference was less than 1 mm it appears to have been sufficient to compensate for the narrower upper anterior teeth.[7]

The overall Bolton ratio was very similar in both groups. The presence of comparable overall Bolton ratios in the two groups is explained by the fact that the difference in the anterior Bolton ratio was compensated by smaller mesio-distal widths of the lower premolars in the Impaction group (Table III). However, it should be noted that the differences in the mesio-distal widths of the lower premolars are of no clinical significance as they did not exceed 0.3 mm with a measurement error of 0.24 mm.

Conclusions

There were no differences between the anterior and overall Bolton ratios in female subjects with unilateral palatally impacted canines and female subjects of the same age without palatally impacted canines and with similar malocclusions.

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