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An investigation of tooth size in Northern Irish people with bimaxillary dental protrusion

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SUMMARY This study examined tooth size in a sample of thirty Northern Irish people with bimaxillary dental protrusion. The mesiodistal diameters of all permanent teeth (excluding second and third molars) were measured. The tooth sizes were compared with a control group who did not have bimaxillary dental protrusion. The results revealed that, on average, tooth size for the overall maxillary and mandibular dentition was 5.7 per cent larger in the bimaxillary sample than in the control sample.

Introduction

Bimaxillary dental protrusion implies a particular occlusal pattern where the upper and lower incisors are proclined.

The molar relationship is usually normal and as such this occlusal pattern is often considered to be a sub-set of Class I malocclusion (Gianelly and Goldman, 1971; Graber, 1972; Posen, 1972). Bimaxillary dental protrusion is predominant among black people but is also found among whites (Keating, 1985). Cephalometric studies of the skeletal and soft tissue relationships of white people with bimaxillary dental protrusion have revealed similarities with those of other ethnic groups exhibiting the same dentofacial morphology (Keating, 1985).

The high frequency of this occlusal pattern among black people has led to speculation that tooth size may contribute to the bimaxillary dental protrusion (Carter and Slattery, 1988). The average mesiodistal crown diameter has been shown to be greater in black people than among whites (Lavelle, 1972). Keene (1979) reported that tooth size for the overall maxillary and mandibular dentition among black people was on average 8.4 per cent larger than for whites.

In both racial groups the mesiodistal diameter of the teeth has been found to be greater in males than in females (Lavelle, 1972; Beresford, 1969; Garn *et al.*, 1964; Moorrees, 1959; Sanin and Savara, 1971).

The relationship between tooth size and different types of malocclusion such as crowding and Angle's classification has been extensively studied. Some workers have concluded that mesiodistal tooth size is larger in white subjects with crowded dentitions (Lundström, 1969; Fastlicht, 1970; Norderval *et al.*, 1975; Doris *et al.*, 1981; Smith *et al.*, 1982; Gilmore and Little, 1984) while others could find no significant difference in mesiodistal tooth diameters between crowded and uncrowded dentitions (Mills, 1964; McKeown, 1981; Howe *et al.*, 1983; Richardson, 1967; Glenn *et al.*, 1987; Puneky *et al.*, 1984). In the latter studies arch size was found to be a more significant factor, with crowding more common in subjects with smaller arch dimensions. The most recent study to examine the relationship between crowding, tooth size, and arch size, also reported that arch size was a more important factor in dental crowding than tooth size, although these two factors were considered to be interrelated (Radnzic, 1988). These reports have added weight to the argument that small jaws rather than large teeth underlie tooth/arch discrepancy (Corruccini, 1990).

Early studies which reported a relationship between tooth size and Angle's classification overlooked the influence of gender (Beresford, 1969; Lavelle, 1972). Later studies which controlled for this factor found no relationship

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between tooth size and occlusal category (Arya *et al.*, 1974).

Although no clear association has been found between malocclusion and tooth size, previous studies have concentrated on broad categories such as crowded or uncrowded dentitions or Angle's class. No studies have been carried out on smaller sub-groups such as bimaxillary dental protrusion. This investigation aimed to determine if tooth size plays a role in the aetiology of this occlusal pattern among white people.

Materials and method

Plaster dental casts were obtained from 30 white subjects (14 male and 16 female) diagnosed as having an Angle's class I bimaxillary dental protrusion. A control group of 30 white subjects (14 male and 16 female) exhibiting a variety of malocclusions but without bimaxillary protrusion were randomly selected from the orthodontic department's patient records. The mean age of the bimaxillary protrusion group was 12.75 years (range 9–21 years), and the mean age of the control group was 14.3 years (range 9–28 years).

The selection criteria were:

1. All permanent teeth present in each arch (excluding second and third molars) and sufficiently erupted to allow measurement of the mesiodistal crown dimension.
2. The dental casts were examined to ensure that all the teeth were morphologically sound. Dental casts revealing loss of tooth substance due to caries, attrition, or restorations affecting the mesiodistal crown diameter were rejected.
3. No congenital craniofacial anomalies or previous history of orthodontic treatment.
4. The availability of a lateral cephalometric radiograph taken prior to any orthodontic treatment.

Cephalometric analysis was used to confirm the clinical diagnosis of bimaxillary dental protrusion using the criteria developed by Keating (1985). Using these criteria bimaxillary dental protrusion is considered to be present if the interincisal angle is less than 125 degrees, the maxillary incisors are proclined beyond 115 degrees to the maxillary plane, and the mandibular incisors are proclined beyond 99 degrees to the mandibular plane.

The cephalometric radiographs of subjects included in the control group were analysed to confirm that the interincisal angle was greater than 125 degrees and the incisor proclination was less than 115 degrees in the maxilla, and less than 99 degrees in the mandible.

Measurement technique

Measurements were made directly on the unsoaped dental casts by a single operator using a Baker Vernier microscope (C Baker, London, England). The greatest mesiodistal measurement between the anatomic mesial contact point and the anatomic distal contact point of each tooth was taken to the nearest 0.1 mm.

The reproducibility of the dental cast measurements were determined from duplicate measurements of 10 sets of dental casts randomly selected from the total sample. The differences between the first and second measurements were computed and the occurrence of a systematic difference was determined by a paired *t*-test of the mean difference. The method error was calculated using the formula:

$$SE = \sqrt{d^2/2N}$$

where d is the difference between the two measurements and N is the number of duplicate measurements (Houston, 1983).

The significance of the differences detected between the bimaxillary group and the control group were tested using the *t*-test for independent samples.

Results

The reproducibility of the measurements made on dental casts was found to be good. No significant differences between duplicate recordings were identified. The method error was found to be 0.2 mm. It is likely that in only 1 in 20 occasions would repeat measurements from a randomly selected patient differ by more than 0.56 mm (Bland, 1987).

The average individual tooth sizes for the bimaxillary and control groups are shown in Table 1. For every tooth the mean mesiodistal diameter was larger in the subjects with bimaxillary dental protrusion.

The sum of tooth sizes for males and females in each jaw as well as the differences between

Table 1 Individual tooth sizes for the bimaxillary and control groups.

Tooth	Control group ($n=30$) mean (mm)	SD	Bimaxillary group ($n=30$) mean (mm)	SD	Difference Bimax-control(mm)
Maxilla					
I^1left	8.62	0.90	9.23	0.83	0.61
I^1right	8.60	0.88	9.27	0.79	0.67
I^2left	6.76	0.62	7.31	0.65	0.55
I^2right	6.78	0.67	7.21	0.63	0.43
C left	7.44	0.58	8.02	0.56	0.58
C right	7.55	0.49	8.07	0.52	0.52
P^1left	6.83	0.37	7.20	0.51	0.37
P^1right	6.78	0.49	7.08	0.52	0.30
P^2left	6.58	0.55	7.01	0.51	0.43
P^2right	6.63	0.50	7.00	0.54	0.37
M^1left	10.14	0.61	10.59	0.54	0.45
M^1right	10.08	0.71	10.69	0.68	0.61
Mandible					
I_1left	5.62	0.54	5.75	0.46	0.13
I_1right	5.64	0.56	5.72	0.41	0.08
I_2left	6.01	0.48	6.18	0.35	0.17
I_2right	6.02	0.38	6.38	0.57	0.36
C left	6.57	0.46	7.11	0.40	0.54
C right	6.68	0.57	7.19	0.40	0.51
P_1left	6.97	0.57	7.23	0.56	0.26
P_1right	6.95	0.41	7.28	0.51	0.33
P_2left	6.98	0.51	7.49	0.65	0.51
P_2right	7.02	0.48	7.35	0.40	0.33
M_1left	10.70	0.64	11.19	0.61	0.49
M_1right	10.70	0.59	11.13	0.60	0.43

Table 2 Sum of mesiodistal tooth size and differences between the control and bimaxillary groups.

	Control group n	mean (mm)	SD	Bimaxillary group n	mean (mm)	SD	Difference Bimax-control (mm)	P
Maxilla								
Sum of mesiodistal tooth size								
male	14	94.64	3.55	14	101.25	3.36	6.61 (3.91, 9.28)	<0.001
female	16	91.45	3.83	16	96.46	3.91	5.01 (2.21, 7.80)	0.001
Mandible								
Sum of mesiodistal tooth size								
male	14	86.85	4.38	14	92.78	3.16	5.93 (2.96, 8.90)	<0.001
female	16	84.69	3.90	16	87.75	3.22	3.06 (0.48, 5.65)	<0.001

the bimaxillary group and the control group are shown in Table 2. For both males and females the sum of tooth sizes were significantly greater for the bimaxillary group than for the control group. The total tooth size for males with bimaxillary dental protrusion was on average 6.61 mm greater in the maxilla, and 5.93 mm greater in the mandible. Similarly, in females the bimaxillary group were on average 5.01 mm larger in the maxilla, and 3.06 mm larger in the mandible. On average tooth size for the overall maxillary and mandibular dentition was 5.7 per cent larger in the bimaxillary sample than in the control sample.

Within both the bimaxillary and control groups the average sum of tooth sizes was greater for males than for females.

Discussion

The classification of a malocclusion as a Class I bimaxillary dental protrusion is usually made clinically. In this study the cephalometric criteria developed by Keating (1985) were also

used to confirm that the bimaxillary sample was composed of subjects with proclined maxillary and mandibular incisors and a reduced interincisal angle. Although these cephalometric criteria are arbitrarily selected, similar defining criteria were used by Lamberton *et al.* (1980) in a study of Thai people with bimaxillary dental protrusion. In the latter study bimaxillary dental protrusion was considered to be present if the interincisal angle was below 124 degrees.

Many patients with bimaxillary dental protrusion are concerned about their facial and dental appearance especially their protruding teeth and everted lips (Lamberton *et al.*, 1980; Keating, 1986). Treatment usually involves extraction of premolar teeth followed by orthodontic therapy to upright the incisors and increase the interincisal angle. This allows the lips to move posteriorly and reduces the convexity of the profile. In both black and white people there is a shortage of longitudinal data on the effects of this form of treatment and concerns have been expressed about the long-term stability of this approach (Carter and Slattery, 1988). These concerns focus on the retraction of lower incisors from a position of soft tissue equilibrium between the tongue and lower lip. The light but long-lasting pressures from tongue, lips and cheeks are considered to be a major influence on the equilibrium of the teeth (Proffit, 1986). Nonetheless, clinically significant and permanent increases in the interincisal angle of Caucasians with bimaxillary protrusion (treated by extraction of four first premolars) have been reported (Keating, 1986).

The aetiology of bimaxillary dental protrusion is considered to be multifactorial in origin involving environmental factors, as well as soft tissue and skeletal factors (Lavelle, 1972; Lamberton *et al.*, 1980). The complex nature of this malocclusion means that care should be exercised when extrapolating causal relationships. However, the results of the present study indicate that tooth size may also play a part in the aetiology of bimaxillary proclination. The Northern Irish people with bimaxillary dental protrusion examined in this study had on average larger teeth than the control group. This increase in tooth size affected all the teeth examined and was not isolated to specific teeth or groups of teeth. Although the adjacent soft tissues are likely to play a dominant role in the aetiology of bimaxillary dental protrusion, it is conceivable that the larger teeth found in these patients also contribute to the proclination of their incisors. It is also interesting to speculate whether this means that a greater amount of stable lower incisor retraction is possible in patients with bimaxillary proclination following extraction of premolars.

Further longitudinal research into the stability of orthodontic treatment of bimaxillary dental protrusion is required to confirm this hypothesis. This will also help to establish the amount of stable lower incisor retraction which can be achieved in these cases.

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