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Variations in tooth size and arch dimensions in Malay schoolchildren

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Aims: To compare the mesio-distal tooth sizes and dental arch dimensions in Malay boys and girls with Class I, Class II and Class III malocclusions.

Methods: The dental casts of 150 subjects (78 boys, 72 girls), between 12 and 16 years of age, with Class I, Class II and Class III malocclusions were used. Each group consisted of 50 subjects. An electronic digital caliper was used to measure the mesio-distal tooth sizes of the upper and lower permanent teeth (first molar to first molar), the intercanine and intermolar widths. The arch lengths and arch perimeters were measured with AutoCAD software (Autodesk Inc., San Rafael, CA, USA).

Results: The mesio-distal dimensions of the upper lateral incisors and canines in the Class I malocclusion group were significantly smaller than the corresponding teeth in the Class III and Class II groups, respectively. The lower canines and first molars were significantly smaller in the Class I group than the corresponding teeth in the Class II group. The lower intercanine width was significantly smaller in the Class II group as compared with the Class I group, and the upper intermolar width was significantly larger in Class III group as compared with the Class II group. There were no significant differences in the arch perimeters or arch lengths. The boys had significantly wider teeth than the girls, except for the left lower second premolar. The boys also had larger upper and lower intermolar widths and lower intercanine width than the girls.

Conclusion: Small, but statistically significant, differences in tooth sizes are not necessarily accompanied by significant arch width, arch length or arch perimeter differences. Generally, boys have wider teeth, larger lower intercanine width and upper and lower intermolar widths than girls.

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Introduction

Determinations of tooth size are an important step in the diagnostic process, particularly in management of complex cases.[1] Disproportions in intra- and inter-arch tooth sizes may contribute to crowding or spacing in the dental arches. Failure to compensate for these discrepancies during treatment generally results in unsatisfactory alignment and occlusion of the teeth at the end of orthodontic treatment. Large teeth relative to the size of the jaws are associated with crowded dental arches and small teeth with spaced dental arches: both conditions can be localised to a few teeth or affect all teeth.[2]

Before we can know if a tooth is under- or oversize it is necessary to have data on tooth sizes for the relevant ethnic, gender and malocclusion group.[3–5] These data are important for orthodontic clinical diagnosis and treatment planning and may be useful in forensic dentistry[6] and as records marking technological advances, environmental variations and dietary improvements affecting tooth size.[4] The accumulated evidence indicates that tooth size reflects a complex interaction between a variety of genetic and environmental factors.[4]

The objectives of the present study were to compare the mesio-distal tooth sizes and dental arch

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Table I. Comparisons of the mesio-distal tooth widths (mm) in the malocclusion groups.

Arch	Tooth	Class I Mean ± SD	Class II Mean ± SD	Class III Mean ± SD	*p*
Upper	1 R	8.36 ± 0.50	8.48 ± 0.44	8.57 ± 0.64	NS
	L	8.36 ± 0.50	8.48 ± 0.41	8.57 ± 0.66	NS
	2 R	6.68 ± 0.60 **a**	6.87 ± 0.47	7.03 ± 0.65 **a**	**0.01**
	L	6.70 ± 0.45 **a**	6.84 ± 0.48	6.97 ± 0.63 **a**	**0.03**
	3 R	7.83 ± 0.42 **a**	8.06 ± 0.46 **a**	8.05 ± 0.51	**0.05**
	L	7.81 ± 0.45 **a**	8.04 ± 0.46 **a**	7.98 ± 0.50	**0.05**
	4 R	7.42 ± 0.38	7.39 ± 0.39	7.52 ± 0.42	NS
	L	7.39 ± 0.38	7.43 ± 0.39	7.51 ± 0.43	NS
	5 R	6.92 ± 0.39	7.03 ± 0.44	7.16 ± 0.48	NS
	L	6.49 ± 0.47	7.07 ± 0.51	6.94 ± 0.38	NS
	6 R	10.21 ± 0.53	10.36 ± 0.51	10.19 ± 0.65	NS
	L	10.20 ± 0.53	10.40 ± 0.52	10.20 ± 0.72	NS
Lower	1 R	5.41 ± 0.36	5.45 ± 0.27	5.56 ± 0.45	NS
	L	5.40 ± 0.29	5.45 ± 0.27	5.34 ± 0.43	NS
	2 R	6.02 ± 0.36	6.12 ± 0.32	6.10 ± 0.43	NS
	L	6.00 ± 0.36	6.14 ± 0.29	6.14 ± 0.41	NS
	3 R	6.77 ± 0.43 **a**	7.00 ± 0.36 **a**	6.95 ± 0.52	**0.02**
	L	6.75 ± 0.43 **a**	7.00 ± 0.32 **a**	6.89 ± 0.70	**0.04**
	4 R	7.29 ± 0.45	7.29 ± 0.44	7.31 ± 0.43	NS
	L	7.29 ± 0.45	7.33 ± 0.36	7.35 ± 0.46	NS
	5 R	7.11 ± 0.46	7.28 ± 0.42	7.16 ± 0.48	NS
	L	7.17 ± 0.48	7.28 ± 0.41	7.12 ± 0.47	NS
	6 R	11.16 ± 0.51 **a**	11.48 ± 0.61 **a**	11.34 ± 0.63	**0.02**
	L	11.16 ± 0.53 **a**	11.46 ± 0.68 **a**	11.40 ± 0.63	**0.04**

The letters indicate groups significantly different from each other (Scheffe test)
Significant values in bold; NS, $p > 0.05$

dimensions in Malay schoolchildren with Class I, Class II and Class III malocclusions, and to determine if gender differences in tooth sizes and arch dimensions are present in Malay schoolchildren.

Materials and methods

In this cross-sectional study, mesio-distal tooth sizes, intercanine and intermolar widths, arch lengths and arch perimeters were measured on the dental casts of 150 Malay schoolchildren (78 boys, 72 girls) from the Kota Bharu District, Kelantan. The children who were between 12 and 16 years of age had Class I (N = 50), Class II (N = 50) and Class III (N = 50) malocclusions. The mesio-distal tooth sizes, intercanine and intermolar widths were measured on the dental casts with calipers and the upper and lower arch perimeters and arch lengths were measured with AutoCAD software (Autodesk Inc., San Rafael, CA, USA). The study was carried out at Universiti Sains Malaysia.

Subjects were included if all permanent teeth, except the third molars, were present and there was no history of previous orthodontic treatment. Subjects were excluded if a dental cast had an impression and/or casting artefact affecting the crowns of the teeth, conical and/or peg-shaped incisors or hypoplastic teeth.

The following measurements were recorded: the largest mesio-distal widths of the permanent teeth except the second molars in each arch, the intercanine and intermolar widths, arch length and arch perimeter. The mesio-distal widths of the teeth were measured between the anatomical contact points and perpendicular to the long axes of the teeth on orthodontic models by the same examiner with an

Table II. Comparisons of arch length, arch width and arch perimeter in different malocclusion groups.

Arch	Variable	Class I Mean ± SD	Class II Mean ± SD	Class III Mean ± SD	*p*
Upper	Intercanine	35.10 ± 1.31	34.99 ± 1.18	5.74 ± 5.78	NS
	Intermolar	47.87 ± 2.03	46.71 ± 2.83 **a**	48.42 ± 2.81 **a**	**0.00**
	Arch length	39.51 ± 2.09	39.48 ± 2.45	39.87 ± 2.48	NS
	Arch perimeter	102.00 ± 4.66	103.22 ± 4.64	103.53 ± 5.09	NS
Lower	Intercanine	27.03 ± 1.46 **a**	26.02 ± 1.08 **a**	27.49 ± 1.79	**0.00**
	Intermolar	41.77 ± 2.18	41.97 ± 2.98	42.28 ± 2.75	NS
	Arch length	35.01 ± 2.05	39.48 ± 2.45	34.57 ± 2.31	NS
	Arch perimeter	91.26 ± 4.97	91.19 ± 3.59	90.05 ± 4.81	NS

The letters indicate groups significantly different from each other (Scheffe test)
Significant values in bold; NS, $p > 0.05$

Table III. Gender comparisons of the mesio-distal widths (mm).

	Tooth	Male Mean ± SD	Female Mean ± SD	*p*	Tooth	Male Mean ± SD	Female Mean ± SD	*p*
Upper	11	8.62 ± 0.55	8.30 ± 0.47	**0.00**	21	8.61 ± 0.55	8.33 ± 0.48	**0.00**
	12	6.97 ± 0.55	6.75 ± 0.62	**0.02**	22	6.93 ± 0.51	6.74 ± 0.54	**0.03**
	13	8.15 ± 0.45	7.80 ± 0.43	**0.00**	23	8.14 ± 7.72	7.72 ± 0.44	**0.00**
	14	7.52 ± 0.41	7.35 ± 0.36	**0.01**	24	7.53 ± 0.40	7.36 ± 0.39	**0.01**
	15	7.06 ± 0.46	6.90 ± 0.43	**0.03**	25	7.06 ± 0.46	6.90 ± 0.43	**0.03**
	16	10.39 ± 0.48	10.11 ± 0.56	**0.00**	26	10.46 ± 0.48	10.06 ± 0.65	**0.00**
Lower	41	5.53 ± 0.38	5.41 ± 0.35	**0.05**	31	5.53 ± 0.37	5.39 ± 0.29	**0.01**
	42	6.18 ± 0.39	5.96 ± 0.32	**0.00**	32	6.18 ± 0.39	6.00 ± 0.30	**0.00**
	43	7.07 ± 0.43	6.73 ± 0.40	**0.00**	33	7.01 ± 0.57	6.75 ± 0.42	**0.00**
	44	7.41 ± 0.43	7.17 ± 0.41	**0.00**	34	7.40 ± 0.42	7.24 ± 0.42	**0.02**
	45	7.30 ± 0.44	7.06 ± 0.45	**0.00**	35	7.23 ± 0.47	7.14 ± 0.44	0.20
	46	11.46 ± 0.55	11.18 ± 0.61	**0.00**	36	11.5 ± 0.60	11.16 ± 0.62	**0.00**

Significant values in bold

electronic digital caliper (ProMax, Fowler Company, Newton, MA, USA) to 0.01 mm.

The intercanine widths were the horizontal distances between the tips of the cusps of the upper and lower permanent canines, and the intermolar widths were the horizontal distances between the right and left central fossae of the upper and lower first permanent molars.[7] Arch length was the line drawn from midline between the central incisors perpendicular to the tangent touching the distal surfaces of the first permanent molars.[8] Arch perimeter was a smooth curve drawn from the distal surface of a first permanent molar around the arch over the contact points and incisal edges to the distal surface of the contralateral first permanent molar.[8] These measurements were performed on images of the occlusal surfaces taken with a Scan-jet 5550 (Hewlett-Packard Asia Pacific Ltd, Singapore). A piece of squared paper was included with the scanned images for the purposes of calibration and calculation of the magnification.[9] These images were downloaded into the AutoCAD 2008 software (Autodesk Inc., San Rafael, CA, USA) and the arch lengths and arch perimeters measured to within 0.1 mm.[8]

Statistical analysis

Twenty pairs of dental casts were randomly selected and remeasured one month after the initial measurements. There were no statistically significant differences between the two sets of measurements.

Table IV. Gender comparisons of the dental arch dimensions (mm).

	Variable	Male Mean ± SD	Female Mean ± SD	*t*-value	*p*
Upper	Canine	35.38 ± 3.04	35.16 ± 4.07	0.38	0.70
	Intermolar	48.25 ± 2.60	47.03 ± 2.60	2.87	**0.01**
	Arch perimeter	103.37 ± 5.02	102.42 ± 4.58	1.21	0.23
	Arch length	39.54 ± 2.37	39.70 ± 2.31	-0.42	0.67
Lower	Intercanine	27.12 ± 1.63	26.55 ± 1.50	2.23	**0.03**
	Intermolar	42.54 ± 2.61	41.43 ± 2.59	2.62	**0.01**
	Arch perimeter	90.83 ± 4.18	90.83 ± 4.86	-0.00	0.10
	Arch length	35.08 ± 1.89	34.92 ± 2.29	0.48	0.63

Significant values in bold

The data were analysed using SPSS version 12.0.1 for windows (SPSS Inc., 2003). An analysis of variance (ANOVA) was used to determine whether statistically significant differences existed between Class I, Class II and Class III groups and the post hoc Scheffe test was used to determine which groups were different from each other. Student's *t*-test was used to investigate gender differences in the samples. The significance level was set at $p \leq 0.05$ for all statistical tests.

Results

The results are given in Tables I to IV.

There were eight statistically significant mesio-distal width differences between the malocclusion groups: the upper lateral incisors in the Class III group were significantly larger than the lateral incisors in the Class I malocclusion group, both upper and lower canines were significantly larger in the Class II group than the corresponding canines in the Class I group; and the lower first molars in the Class II group were significantly larger than the lower first molars in the Class I group (Table I).

The upper intermolar width was significantly larger in the Class III group than the Class II group and the lower intercanine width in the Class II malocclusion group was significantly smaller than the intercanine width in the Class I malocclusion group (Table II). There were no statistically significant differences in arch perimeter or arch length.

To investigate the sexual dimorphism, the malocclusion groups were combined. The data from 78 boys were compared with the data from 72 girls (Table III). The mesio-distal sizes of all upper teeth were significantly larger in the boys than in the girls. In the lower arch the mesio-distal widths of all teeth except the lower left second premolar (tooth 35) were again significantly larger in the boys than in the girls.

The lower intercanine width and the upper and lower intermolar widths were statistically significantly larger in boys than in the girls (Table IV). There were no statistically significant gender differences in either the upper and lower arch lengths or the upper and lower arch perimeters.

Discussion

The importance of tooth size discrepancies in orthodontic diagnosis has been widely reported in the orthodontic literature because a discrepancy may affect the relationship between the upper and lower arches and the excellence of the treatment outcome. We compared the tooth sizes and arch dimensions in Malay schoolchildren with Class I, Class II and Class III malocclusions and in the boys and girls. We found that although the children in the Class III group had larger upper lateral incisors and tended to have larger upper teeth than the children in the Class I group, there were no statistically significant differences in arch length or arch perimeter.

The wider lower canines in the Class II group may have contributed to the narrower lower intercanine width in that group. A deep bite may inhibit development in width of the lower dentoalveolar segment in patients with Class II malocclusions, and it could

be argued that the slightly larger lower canines we found may have contributed to our finding that the lower intercanine width was reduced.[10] However, this hypothesis is not supported by Sayin and Türkkahraman[11] who reported that the lower intercanine width was significantly larger in Class II malocclusions than in Class I malocclusions. Differences in intercanine widths may be due also to the age of the samples and/or the severity of the maloclusions.[11] Because our subjects were between 12 and 16 years of age further changes in the arch widths were unlikely to occur.[7,8,11,12]

Our finding that the upper intermolar width in the Class III group was significantly larger than that the intermolar width in the Class II malocclusion group partially agrees with Al-Khateeb and Abu Alhaija's finding that the upper arch is narrower in Class II malocclusions compared with other malocclusions.[3] Our findings do not support Buschang et al.[13] and Lux et al.[14] who reported that the lower arch is wider in Class I malocclusiosn than Class II malocclusion. In agreement with Poosti and Jalali,[8] we found no differences in arch length or arch perimeter in the malocclusion groups.

Limited changes in arch width occur between 13 and 25 years of age.[15] Therefore, we assumed that the arch widths in our subjects were stable. The early permanent dentition provides the best time for tooth size measurements because there is generally less attrition and fewer teeth have been extracted.[16] It is also more convenient and accurate to measure the mesio-distal widths of teeth, arch length and arch perimeter on study casts than intra-orally.[7]

The boys in our study had larger teeth than girls, with the exception of the left lower second premolar. This gender difference is supported by previously published studies on the sizes of teeth in different populations.[3,6,17]

Conclusions

Malay girls have smaller permanent teeth than Malay boys.

The lower intercanine width was significantly smaller in Malay children with Class II malocclusions than children with Class I malocclusions. There were no differences in the upper intercanine width among the different malocclusion groups.

The upper intermolar width was larger in the group with Class III malocccclusions as compared with the group with Class II malocclusions.

There were no differences in either arch length or arch perimeter among the malocclusion groups.

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