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Tooth size and dental arch dimensions: a stereophotogrammetric study in Southeast Asian Malays

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Structured Abstract

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Objective – To investigate tooth size and dental arch dimensions in Malays using a stereophotogrammetric system.

Setting and Sample Population – The sample consisted of 252 subjects with ages ranged from 13 to 30 years.

Materials and Methods – Images of dental casts were captured by stereophotogrammetry and selected variables were measured using a three-dimensional (3D) imaging system. Sex differences and changes associated with age were assessed, and interrelationships between different variables were explored within the study group.

Results – Men had significantly larger mesio-distal crown widths and dental arch dimensions than women ($p < 0.05$). None of the dental arch dimensions or mesio-distal crown widths showed a significant change because of age except the widths of the upper canine, lower first molar and central incisor. Significant correlations of tooth size with dental arch dimensions were found, particularly with arch lengths and perimeters. A principal component analysis showed interrelationships between the majority of tooth size variables with inter-canine width, arch length and perimeter distances.

Conclusion – This study has established new reference data for tooth size and arch dimensions in Malays and demonstrated patterns of variation that are relevant to anthropologists interested in making comparisons within and between different populations and also to clinicians developing treatment plans for their patients. The study confirmed the accuracy of the 3D photogrammetric method for measuring dental casts.

Key words: dental arch; principal component analysis; stereophotogrammetry; tooth size

Introduction

Dental arch dimensions and tooth size display ethnic and gender differences (1–3). For example, Ling and Wong (4, 5) noted wider dental arch width in Chinese compared with Caucasians and Japanese. Differences in tooth size between Malays, Chinese, Indians and Malaysian

Aborigines have been reported previously (6). Tooth size was also found to be larger in men than in women for more than 75% of the dental variables, with sexual dimorphism being more marked in mandibular teeth (6). Mesio-distal crown size and dental arch dimensions were compared in a sample of 150 Malay school children aged between 12 and 16 years with Class I, Class II and Class III malocclusions (7). They found that upper lateral incisors, as well as upper and lower canines and first molars, were significantly smaller in children with Class I occlusions. Men had larger teeth and dental arch dimensions; however, no significant difference was observed in arch perimeter.

Previous studies have generally used direct measurement methods, for example hand-held callipers, to record dimensions on dental models, as this is a relatively simple and reproducible approach (4–7). However, advances in computer technology now allow dental casts to be viewed in three-dimensions (3D) (8, 9). These systems provide accurate and reliable tools for obtaining measurements and carrying out analyses (10, 11). Moreover, they have additional benefits, such as accessibility of the images produced, reduction in storage costs and the ability to analyse images using sophisticated software (10, 12).

There have been relatively few 3D studies of tooth size and dental arch dimensions (13), and, according to the authors' knowledge, there is limited information about the teeth and dental arches of many ethnic groups, including those of Malay origin. This information is of significance because the Malay population is a large community that shares many common facial characteristics with other Southeast Asian populations. Thus, the aim of this study was to employ a 3D imaging technique to measure mesio-distal crown widths and dental arch dimensions in Malays.

Materials and methods

Sample

The sample was randomly collected from different states within Malaysia. A total of 252 subjects (126 men and 126 women) were selected according to the following inclusion criteria: Malay ancestors for three generations, full set of permanent teeth from right first molar to left first molar, bilateral Class I molar and canine relationships, not more than 4 mm of dental crowding, no cross-bites or previous orthodontic treatment. To estimate the effects of age, participants were divided into three age categories: 13–14, 15–17 and 18–30 years for each gender.

The sample size was calculated using the single mean formula ($n = [z\ \sigma/\Delta]^2$). The resulted number was adjusted, and the final sample size in each group = n + (n × 0.2). In this study, n is considered as the number of subjects, $z = 1.96$ for 95% confidence, σ (standard deviation) = 0.61 mm (7) and (Δ) precision = 0.2 unit. According to this, the calculated sample size for each age group was approximately 42 subjects. The study was approved by the Human Ethics Research Committee at the Universiti Sains Malaysia [No.156.4 (5) 2008].

Dental impressions were obtained of both upper and lower dental arches. Alginate impression material was handled according to manufacturer's instructions (Kromopan, Firenze, Italy). To minimize distortion, impressions were cast as soon as possible with dental die stone (Calstone, Paris, France). Afterwards, each study cast was trimmed and prepared for subsequent imaging.

Image acquisition and processing

The imaging procedures were based on the methods of Majid et al. (14). The dental casts were placed in the middle of a photogrammetric frame board with 55 well-distributed retro-reflective targets. Images were captured by a pair of digital cameras (Sony Electronics, Tokyo, Japan) mounted on an adjustable holder and triggered simultaneously by a remote control synchronizing switch (Fig. 1). The camera-object distance

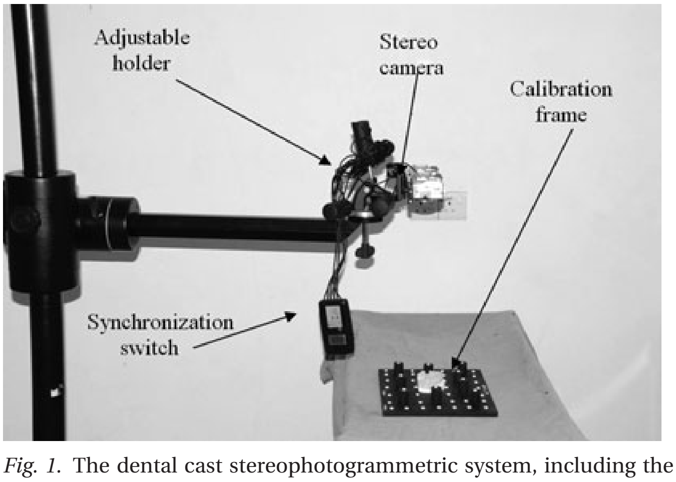

Fig. 1. The dental cast stereophotogrammetric system, including the stereo camera, synchronization switch, calibration frame and camera's adjustable holder.

was fixed at 450 mm, and the distance between the stereo cameras was 113 mm, which was calculated to be one quarter of the subject-to-camera distance (14, 15). The Australis software package was employed for image acquisition and data processing (16, 17).

Dental cast measurements

After image acquisition, the landmarks were digitized and measurements were made between specific landmarks. The dental cast measurements were calculated from *x*, *y* and *z* coordinates of landmarks and presented as numerical values in millimetre. Maximum mesio-distal crown width was measured from the occlusal surfaces, parallel to the occlusal plane. Measurements were obtained between points that represented the anatomical contact points with the neighbouring tooth.

The measurements of dental arch dimensions followed those of the previous studies (18, 19). They were defined as follows:

1. Inter-canine distance: distance between the cusp tips of the permanent canines;
2. Inter-premolar distance: distance between the buccal cusp tips of the right and left maxillary and mandibular first and second premolars;
3. Inter-molar distance: distance between the mesio-buccal cusp tips of the right and left maxillary and mandibular permanent first molars;
4. Arch length: diagonal line between the mesio-buccal cusp tip of the first molar and the mesial contact area of the central incisors;
5. Arch perimeter: sum of two bilateral arch length segments. The first segment was the distance between the distal measurement point of the first molar and the mesial contact point of the canine, while the second segment was the distance from the distal contact point of the lateral incisor to the mesial contact point of the central incisor (Fig. 2).

The imaging protocol was conducted, and all of the variables were measured on a computer screen by the same investigator (ARK).

Error of the method

In this study, accuracy is defined as the closeness of measured values to the true value, whereas precision refers to the closeness of repeated measurements of the same quantity (20). To evaluate the accuracy of measurements, 15 upper and lower casts were selected randomly and variables were measured directly using electronic digital callipers (Mituyoto, Tokyo, Japan) with accuracy up to 0.01 mm. Any differences above 0.5 mm were considered to be clinically significant (8). Furthermore, precision was estimated by processing and analysing the same 15 dental casts second time within a 15-day interval.

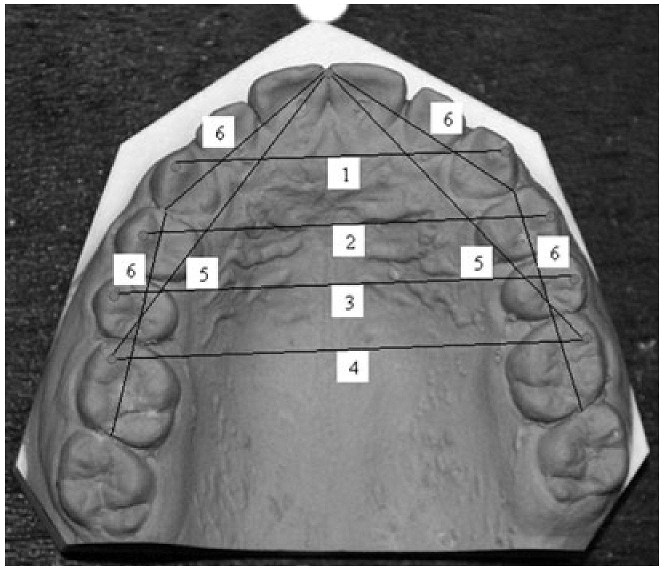

Fig. 2. Dental cast image showing measured dimensions: (1) inter-canine, (2) inter- first premolar, (3) inter-second premolar, (4) inter-molar, (5) arch length and (6) arch perimeter segments.

Statistics

One-sample *t*-tests and the intraclass correlation coefficients (ICC) were used to evaluate accuracy and precision respectively (20, 21). Contra-lateral differences were tested by paired *t*-tests. Sexual dimorphism was assessed using the independent-samples *t*-test, and the percentages of sexual dimorphism were calculated according to Garn et al. (22). The effect of age and sex on the study variables was assessed by a two-way analysis of variance (ANOVA). We also calculated Pearson's correlation coefficients and performed a principal component analysis (PCA) to investigate the relationships between dental crown and dental arch measurements for both maxillary and mandibular arches in each sex. To facilitate the interpretation of the relevant components, the first selection step was followed by a rotation of the retained components. Only components with eigenvalues above 1.0 were assessed.

The data were analysed using the SPSS 12.0.1 program (SPSS Inc., Chicago, USA), and statistical significance was set at $p < 0.05$.

Results

Accuracy and precision

Most of the mean differences between the calliper and system measurements were not statistically significant ($p > 0.05$). They ranged between 0.02 and 0.2 mm. The precision was generally high, with all ICC values being >0.80.

Right and left comparisons

The paired *t*-test revealed a few significant statistical differences between right and left variables, for example for lower lateral incisors and upper and lower arch length in men, as well as for lower first molars, canines, central incisors and lower arch length in women. However, the average differences were small, and, for this reason, summary statistics and statistical analyses are reported for the right side only.

Descriptive statistics including mean values, standard deviations and coefficients of variation were determined for each sex (Table 1). The most variable dimensions were the upper inter-canine distance, lower inter-canine distance and lower inter-first premolar distance in men and women. The most variable tooth size measurement in both sexes was the mesio-distal crown diameter of the upper lateral incisor, followed by the lower central incisor in men and the lower first premolar in women.

Sex and age comparisons

Most of the values for tooth size and arch dimensions in men exceeded those in women significantly (Table 1). However, the difference in some measurements, such as the crown width of upper and lower first premolars and lateral incisor, was not significantly different ($p > 0.05$), but men were still larger than women. The mesio-distal width of the canine and the upper inter-molar and inter-second premolar distances showed the highest percentage of sexual dimorphism.

The descriptive analyses of the study variables across age groups are presented in Tables 2 and 3 for men and women, respectively. The results showed minimal increase over time in the majority of dental arch dimensions in the study groups. Two-way analysis of variance showed that the upper canine, lower molar and central incisors had significant effect on age (Table 4). On the other hand, no interaction between the age and sex was evident.

Principal component analysis

In both men and women, the correlations in the upper arch between tooth size and arch dimension were significant, particularly with arch length and perimeter. PCA was conducted to summarize the interrelationships between mesio-distal crown widths and dental arch dimensions. As expected, the first PCA factors in both men and women reflected positive global size relationships between variables. The principal component analysis showed independent interrelationship of the dental arch width variables. On the other hand, the relations between crown widths and the arch perimeter and length were more predominant. This indicated that teeth with large mesio-distal crown widths may predispose to exhibit long rather than wide dental arch.

The first three principal components based on the male data explained 60.7% of the variance in the maxilla, and the first two components explained 58.9% in the mandible (Table 5). Principal component analysis in the upper arch of men showed that the first principal component (PC) was related to the inter-molar, inter-second premolar and inter-first premolar distances. However, the second PC was attributed to inter-canine distance, arch length and the crown size of the canine, lateral incisor and central incisors. The third component disclosed the relation between arch perimeter and the crown sizes of the first molar, first premolar and second premolar (Table 5).

In women, the first three components accounted for 62.3% of the total variation in the maxilla, and the first two components accounted for 60.9% of the total variation in the mandible (Table 5). In the upper arch, the first PC related to inter-molar, inter-first premolar and inter-second premolar distances. The second PC explained variation in the crown widths of posterior teeth, whereas the third component explained inter-canine distance, arch perimeter and crown width of central and lateral incisors (Table 5).

The expression of the PCA in the lower arch was nearly identical in both men and women as the mesio-

Table 1. **Mean values, standard deviations (SD), coefficients of variation (CV) and dimorphism per cent for dental arch dimensions and mesio-distal crown widths in men and women**

	Men (n = 126)			Women (n = 126)			
Variables (mm)	Mean	SD	CV	Mean	SD	CV	Dimorphism %
Upper dental arch							
Dental arch dimensions							
Inter-molar	54.4*	2.3	4.7	51.9	2.5	4.8	4.7
Inter-second premolar	49.4*	2.4	4.9	47.2	2.2	4.6	4.6
Inter-first premolar	43.3*	2.3	4.9	42.0	2.1	5.2	3.1
Inter-canine	35.3*	2.5	7.2	34.1	2.2	6.4	3.4
Arch length	39.4*	1.8	4.6	38.2	1.7	4.6	3.1
Arch perimeter	91.9*	4.4	4.8	89.6	4.3	4.8	2.5
Mesio-distal crown widths							
First molar	10.6*	0.5	5.3	10.2	0.5	4.9	3.3
Second premolar	6.8*	0.4	6.7	6.5	0.4	6.2	4.1
First premolar	7.0	0.4	6.3	6.9	0.5	7.1	1.4
Canine	8.0*	0.5	6.8	7.6	0.4	5.7	5.6
Lateral incisor	6.8*	0.5	8.1	6.7	0.5	8.4	1.9
Central incisor	8.5*	0.5	6.6	8.2	0.4	5.5	3.1
Lower dental arch							
Dental arch dimensions							
Inter-molar	45.5*	2.5	5.5	43.9	2.0	4.7	3.5
Inter-second premolar	40.3*	2.3	5.8	39.4	2.0	5.0	2.3
Inter-first premolar	34.9*	2.1	6.1	34.3	2.2	6.4	1.7
Inter-canine	26.4*	1.6	6.2	26.0	1.5	5.9	1.6
Arch length	33.8*	1.5	4.5	32.5	1.9	5.8	4.2
Arch perimeter	83.6*	3.3	4.0	81.0	3.4	4.1	3.1
Mesio-distal crown widths							
First molar	11.0	0.5	5.1	10.6	0.5	5.5	3.7
Second premolar	7.1*	0.4	6.0	6.9	0.4	6.3	2.4
First premolar	7.1*	0.4	5.7	7.0	0.5	7.6	1.4
Canine	6.9*	0.4	6.7	6.6	0.3	5.9	5.0
Lateral incisor	5.9	0.3	5.9	5.8	0.3	6.5	1.2
Central incisor	5.4*	0.4	8.1	5.2	0.3	6.3	3.8

*Significant at $p < 0.05$.

distal crown widths were gathered with inter-canine distance, arch length and perimeter in the first component, whereas the posterior dental arch dimensions were explained by the second component (Table 5).

Discussion

Computer technology is being applied in clinical dentistry to obtain 3D images of dental cast, but it is important that these new systems display very high levels of accuracy and precision if they are to be used for research purposes (9). In this study, accuracy was assessed by comparison of direct measurements, representing the gold standard, with those obtained from 3D images. The results showed minimal differences in measurements (0.02–0.2 mm) between values based on the callipers and those derived from the 3D system. Differences in this magnitude are expected because of slight variations in the manual positioning of callipers,

Table 2. **Mean values and standard deviations (SD) for dental arch dimensions and mesio-distal crown widths across the age groups in men**

	Age group 13–14 years		Age group 15–17 years		Age group 18–30 years	
Variables (mm)	Mean	SD	Mean	SD	Mean	SD
Upper dental arch						
Dental arch dimensions						
Inter-molar	54.1	2.7	54.8	2.0	54.3	2.1
Inter-second premolar	49.4	2.8	49.7	2.0	49.1	2.4
Inter-first premolar	42.9	2.8	43.4	2.3	43.6	1.9
Inter-canine	35.4	2.9	35.4	2.1	35.2	2.6
Arch length	39.6	1.8	39.5	1.6	39.2	2.0
Arch perimeter	92.2	4.3	92.5	3.8	91.2	5.1
Mesio-distal crown width						
First molar	10.7	0.6	10.6	0.5	10.5	0.5
Second premolar	6.9	0.5	6.8	0.4	6.6	0.4
First premolar	7.0	0.3	7.0	0.4	7.0	0.5
Canine	7.7	0.4	8.5	0.4	7.9	0.4
Lateral incisor	6.8	0.4	6.8	0.5	6.9	0.6
Central incisor	8.5	0.5	8.5	0.4	8.4	0.6
Lower dental arch						
Dental arch dimensions						
Inter-molar	45.8	2.6	45.1	2.4	45.6	2.4
Inter-second premolar	40.7	2.5	40.0	2.2	40.1	2.3
Inter-first premolar	34.6	2.0	34.8	1.8	35.2	2.4
Inter-canine	26.6	1.4	26.0	1.6	26.7	1.7
Arch length	34.0	1.5	33.8	1.3	33.8	1.7
Arch perimeter	83.8	3.5	83.7	3.0	83.3	3.5
Mesio-distal crown width						
First molar	11.0	0.5	10.8	0.5	11.2	0.5
Second premolar	7.1	0.3	7.0	0.4	7.1	0.4
First premolar	7.1	0.4	7.0	0.3	7.2	0.4
Canine	6.8	0.4	6.9	0.4	7.0	0.4
Lateral incisor	5.8	0.3	5.8	0.3	5.9	0.3
Central incisor	5.3	0.3	5.3	0.3	5.6	0.5

even when landmarks are clearly marked (11). The results of our test of accuracy are in agreement with those of a previous study (8). Goonewardene et al. (23) showed better accuracy than reported by Asquith et al. (24), who found that mean differences between image-based and direct measurements ranged between 0.05 and 4.78 mm. Additionally, assessment of intra-examiner precision yielded highly significant correlations, with most of the values of ICC being >0.8. Roberts and Richmond (25) have suggested that ICC values below 0.4 reflect poor reliability, values between 0.4 and 0.75 can be interpreted as fair to good and those above 0.75 are excellent. Although some of the variables have showed statistically significant differences, the actual differences between the calliper and 3D measurements were relatively small and unlikely to bias the results. So in the present study, intra-examiner precision using our 3D system was high.

Dental models were collected from the age of 13 years because this corresponds to the time when

Table 3. **Mean values and standard deviations (SD) for dental arch dimensions and mesio-distal crown widths across the age groups in women**

	Age group 13–14 years		Age group 15–17 years		Age group 18–30 years	
Variables (mm)	Mean	SD	Mean	SD	Mean	SD
Upper dental arch						
Dental arch dimensions						
Inter-molar	51.5	2.5	52.4	2.6	51.9	2.3
Inter-second premolar	47.0	2.1	47.6	2.4	47.1	2.1
Inter-first premolar	41.6	2.1	42.3	2.2	42.0	2.2
Inter-canine	34.1	2.6	34.3	2.1	34.1	1.7
Arch length	38.0	1.9	38.4	1.7	38.3	1.6
Arch perimeter	88.2	4.4	91.9	3.7	88.8	3.8
Mesio-distal crown width						
First molar	10.2	0.5	10.3	0.5	10.2	0.5
Second premolar	6.5	0.4	6.5	0.3	6.5	0.4
First premolar	6.9	0.4	6.9	0.5	6.9	0.5
Canine	7.6	0.4	7.6	0.4	7.6	0.4
Lateral incisor	6.6	0.6	6.7	0.5	6.8	0.5
Central incisor	8.2	0.5	8.2	0.3	8.2	0.4
Lower dental arch						
Dental arch dimensions						
Inter-molar	43.6	2.0	44.4	2.1	43.7	2.0
Inter-second premolar	39.1	1.9	39.7	2.2	39.3	1.8
Inter-first premolar	34.1	1.7	34.3	1.9	34.3	2.8
Inter-canine	25.9	1.4	26.0	1.5	26.0	1.7
Arch length	32.5	1.6	32.2	1.5	32.7	2.4
Arch perimeter	81.2	3.6	81.4	3.2	80.6	3.3
Mesio-distal crown width						
First molar	10.4	0.5	10.7	0.6	10.7	0.5
Second premolar	6.8	0.5	6.9	0.4	6.9	0.4
First premolar	6.9	0.7	7.0	0.4	7.0	0.4
Canine	6.5	0.4	6.6	0.3	6.6	0.4
Lateral incisor	5.8	0.3	5.8	0.3	5.8	0.4
Central incisor	5.2	0.2	5.2	0.3	5.2	0.3

conventional orthodontic therapy is often commenced (26). Because dental arch dimensions vary between the different types of malocclusions, (19, 27–29) we standardized our study by including only a normal occlusion sample.

We have established new measurements for selected mesio-distal crown widths and arch dimensions of the dental arches in Malays. Our findings differ from those reported in previous studies (6, 7), but the differences did not exceed 0.4 mm for most of the measurable values. The present investigation has shown that the crown dimensions of Malays are similar to Chinese but larger when compared with Caucasians, which is consistent with other findings (5, 29). In contrast, dental arch widths in Chinese (6) are larger when compared with this study. In addition, comparisons of the dental arch dimensions with other populations showed that Malays have smaller arches than African Americans

Table 4. **Two-way analysis of variance for dental arch dimensions and mesio-distal crown widths in upper and lower dental arches**

Variables (mm)	*F* statistics
Upper dental arch	
Dental arch dimensions	
Inter-molar	2.05
Inter-second premolar	1.19
Inter-first premolar	1.93
Inter-canine	0.14
Arch length	0.32
Arch perimeter	0.53
Mesio-distal crown widths	
First molar	1.09
Second premolar	0.83
First premolar	0.28
Canine†	16.30*
Lateral incisor	1.52
Central incisor	0.01
Lower dental arch	
Dental arch dimensions	
Inter-molar	0.05
Inter-second premolar	0.13
Inter-first premolar	0.90
Inter-canine	1.12
Arch length	0.50
Arch perimeter	0.71
Mesio-distal crown widths	
First molar	5.03*
Second premolar	0.52
First premolar	1.00
Canine	2.62
Lateral incisor	0.39
Central incisor†	5.07*

*Significant at $p < 0.05$.
†Significant interaction between age and gender.

(30). These variations presumably reflect genetic and environmental differences between various ethnic groups (31–33).

The contra-lateral measurements showed non-significant differences in both sexes except for the crown sizes of the upper lateral incisor, lower canine, central incisor and arch length, with the dominant side tending to be on the right. These results are in agreement with other studies where researchers recorded differences in size between tooth size and dental arch measurements on right and left sides (2, 27, 34). Townsend (35) recorded small mean differences in dental crown size of around 0.1 mm between the right and left sides in Aboriginal Australians and considered that these variations reflected both genetic and environmental factors. Furthermore, this asymmetry is considered to be result from the differences in genetic information between teeth in the two quadrants of the arch (36).

Statistically significant sex differences were recorded for most of the mesio-distal crown widths and dental arch dimensions. The greatest dimorphism was shown by the upper inter-molar distance and the crown size of canines, and the least sexual dimorphism was recorded for the crown size of the upper lateral incisor. These findings are in general agreement with those of a previous study in Malays (6). Sexual dimorphism in dental arch and tooth dimensions has been shown in different populations. Al-Khateeb and Abu Alhaija (2) noted that the main difference between men and women was in the crown size of canines and molars. Alvaran et al. (3) found that the difference was more pronounced in inter-molar than in inter-premolar or inter-canine arch widths.

Comparison of crown and dental arch dimensions between different age groups showed no significant differences except for the mesio-distal crown widths of the upper canine, lower molar and central incisor. This result is consistent with the previous findings that showed no significant differences in the inter-canine and inter-molar distances between the age of 13 and 26 years (18). In contrast, Harris (37) found that arch widths increased significantly from the age of 22 to 55 years, while arch length was reduced significantly. Furthermore, Ward et al. (38) reported a decrease in inter-molar and inter-canine widths over the period from 11 to 14 years, but these dimensions increased between the ages of 24 and 30 years. The difference in the results between this study and other previous investigations might be attributed to the sample sizes included and the measurement methods used.

Principal component analysis is a procedure used to reduce a large number of variables into a smaller number of principal components that account for most of the variance observed. PCA was performed on the data for the maxilla and mandible in men and women separately. The analysis suggests that the crown widths of the anterior and posterior teeth are independent of each other to some extent in the upper arch. In addi-

Table 5. **Rotated principal component analysis for the upper and lower dental arches in men and women**

	Component					
	Men			Women		
Variable	1	2	3	1	2	3
Upper dental arch						
Inter- molar	0.86			0.86		
Inter-second premolar	0.91			0.91		
Inter-first premolar	0.78			0.81		
Inter-canine		0.60				0.46
Arch length		0.56				0.56
Arch perimeter			0.50		0.53	
First molar			0.50		0.51	
Second premolar			0.84		0.83	
First premolar			0.76		0.71	
Canine		0.59			0.55	
Lateral incisor		0.79				0.80
Central incisor		0.69				0.79
Eigenvalue	4.58	1.61	1.08	4.79	1.59	1.09
Accumulative value	60.7%	62.3%				
Lower dental arch						
Inter- molar		0.86			0.87	
Inter-second premolar		0.91			0.90	
Inter-first premolar		0.81			0.77	
Inter-canine	0.48			0.55		
Arch length	0.63			0.58		
Arch perimeter	0.64			0.72		
First molar	0.63			0.57		
Second premolar	0.62			0.78		
First premolar	0.70			0.60		
Canine	0.69			0.74		
Lateral incisor	0.75			0.72		
Central incisor	0.77			0.70		
Eigenvalue	5.38	1.69		5.73	1.58	
Accumulative value	58.9%	60.9%				

tion, inter-canine distance, arch length and arch perimeter are more related to mesio-distal crown dimensions than to posterior dimensions. Previous studies (39, 40) have demonstrated that changes in dental arch dimensions mainly affect inter-canine distance and arch perimeter, whereas inter-molar widths tend to remain constant. This could explain the inter-relations we have observed between dental crown widths, inter-canine distance and arch perimeter as reflected in the first PC and the associations with other dimensions in the second PC.

Conclusions

The present 3D investigation has provided new values for mesio-distal crown widths and dental arch dimensions of Malays, with normal occlusion based on a 3D photogrammetric method that showed high accuracy and precision. Malays are characterized by relatively large crown widths and dental arch dimensions when compared with other populations. Significant sexual dimorphism also exists in most of the measured variables. The mesio-distal crown widths appeared to be more interrelated with dental arch length and perimeter than with arch width measurements.

Clinical relevance

Tooth size and dental arch analysis are one of the basic tools of diagnosis and treatment planning. Mesio-distal crown widths and arch dimensions have shown to be different among populations. 3D stereophotogrammetry could be a helpful tool in the assessment of tooth size and dental arch dimensions. This study obtained values for a sample of Malay population. Moreover, the new method for 3D analysis of the dental arch that was introduced in this study could be applicable to other components of the orthodontic diagnosis as well.

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