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Analysis of Malay Arch Width and Anthropometric Correlations

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ABSTRACT

The objectives of the study were to determine the normal dental arch width of Malays, their correlation with the facial framework and the ideal size of orthodontic impression trays that fit the dental arch. Eighteen adult Malays with normal Class I occlusion were evaluated. Arch width was measured on each subject's dental cast. Direct anthropometric measurements were taken for 8 facial landmarks. Orthodontic impression trays were tried on each subject's dental cast to determine the best fitting tray. Correlations analysis was made between the arch widths and the best fitting impression trays used and also with various craniofacial anthropometric measurements. The eight measurements from the craniofacial region were compared with the maxillary and mandibular intercanine, interpremolar and intermolar widths. In the maxillary arch, there were significant correlation between the face width and the interpremolar and intermolar widths respectively, while in the mandibular arch, significant correlations were noted between the mandible depth and the interpremolar and intermolar widths respectively. The most common fitting impression tray was size 6 for the upper jaw and size 5 for the lower jaw. There was a significant correlation between the maxillary intercanine width and the size of the impression trays. The significant correlation between upper and lower interpremolar and intermolar widths and the anthropometric measurements of this Malay population may assist in predicting arch expansion to achieve Class 1 occlusion during orthodontic or maxillofacial surgical treatment. The significant correlation between the upper intercanine width and the size of impression tray can be a useful parameter when determining the size of impression tray.

Keywords: Arch width, facial framework, orthodontic impression trays, anthropometric measurements

INTRODUCTION

Improvement of facial appearance is a common objective among dental clinicians and patients especially in the field of orthodontics, oral and maxillofacial surgery and prosthodontics. . Improvement in aesthetic post-orthodontic treatment has been related to satisfaction with psychosocial outcome (1). Studies have been conducted to understand the harmony and balance of facial and dental appearance and any correlations to these elements (2). Downs, as early as 1948 (3), investigated facial relationship and its significance in treatment and prognosis and they concluded that there is a facial pattern that represents mean or average form for individuals possessing excellent occlusions (4) suggested that there is an interrelationship between arch width, arch depth, and arch perimeter. Thu et al (5) found weak correlations between maxillary

arch width and bizygomatic width. Basically, study of dental arch width within a specific ethnic group has many contributions in the dental field especially in diagnosis and treatment planning in order to have ideal outcome for the particular population.

In Malaysia there are three major ethnic groups namely Malays, Chinese and Indians. Based on the existing studies, there remain questions yet to be answered. What is the mean value for dental arch width among these different ethnic groups? Does dental arch width have a relationship with the type and size of orthodontic impression tray selection? What is the ideal range of orthodontic tray sizes used for individuals with various dental arch widths? The answers to these questions can assist in the diagnosis and management of patients for orthodontic, orthognathic and cosmetic dentistry treatment.

The objectives of this study are to determine the mean dental arch width among the Malay ethnic group, to determine any correlations between arch width and facial anthropometric measurements and to investigate the ideal range of orthodontic tray sizes for Malaysian Malay population.

MATERIALS AND METHODS

Subject Selection criteria

The study was conducted at the General Dental Practice clinic of the Faculty of Dentistry, University of Malaya. The subjects consisted of a convenient sample of Malay dental students from the faculty. They were recruited on a voluntary basis. A total of eighteen students volunteered for the study from a total of 30 identified subjects.

The subjects were generally healthy and exhibited no craniofacial abnormalities either acquired through road traffic accidents or other forms of trauma, congenital or developmental discrepancies and had no history of plastic or reconstructive surgery. The inclusion criteria included subjects with healthy state of gingiva and periodontium, full complement of caries free teeth, from second molar to second molar in both arches, Class 1 incisor relationship (BSI Classification), normal molar and canine relationship (Angle Class I relationship), normal overjet (< 3 mm) and overbite (<4 mm), minimal rotations or attrition and no prior orthodontic treatment.

Subjects of mixed parentage were excluded from this study. Subjects with obvious diastema or crowding of teeth in the anterior segment (>3 mm), reverse curve of spee, presence of supernumerary teeth, peg-shaped laterals or other anomalies, abnormal buccal or lingual tipping of teeth and crossbite relationship were also excluded from the study.

Collection of data

Ethical approval (DF DP1002/0005[L]) for the study was obtained from the Medical Ethics Committee, Faculty of Dentistry of the University of Malaya. Written consent was obtained from all subjects who underwent examination and/or impression taking procedure. Direct craniofacial measurements were made on the subjects. Measurements were also prepared on the study cast of the subjects. All measurements were under taken by a single calibrated examiner.

a) Measurement of arch sizes

Dental impressions of the subjects' maxillary and mandibular arch were taken using alginate impression material (Kromopan, Lascod SPA, Italy) on a stock tray. The cast was prepared using hard dental stone. The maxillary and mandibular intercanine, interpremolar, and intermolar arch widths were obtained from the study cast made for each subject. The 3 arch widths (Figure 1) were measured directly based on the Foster criteria (6). An AOS Absolute Digimatic Caliper (Mitutoyo, USA http://ecatalog.mitutoyo.com/cmimages/003/319/2129-AOS-Calipers.pdf) with 0.01mm decimal points and a least count of 0.02mm was used for obtaining the measurements.

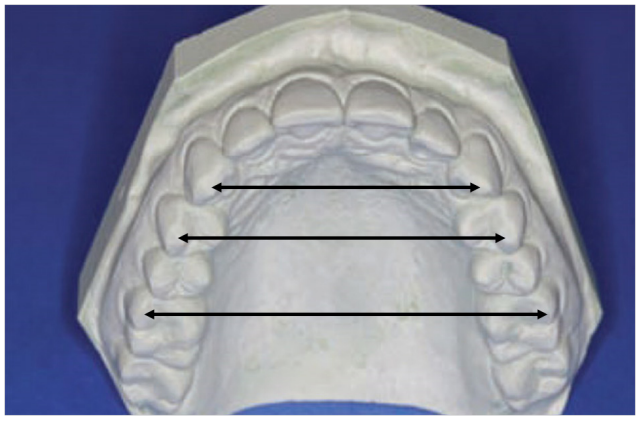

Figure 1: (a) Intercanine (right canine cusp tip to left canine cusp tip width), (b) interpremolar width (right first premolar buccal cusp tip to left first premolar buccal cusp tip), (c) intermolar width (right first molar mesiobuccal cusp tip to left first molar mesibuccal cusp tip)

b) Craniofacial anthropometric measurements

The subjects were seated upright. The examiner stood in front of the subject with the head of the examiner at the same level with the head of the subject. Readings were taken at rest position and standard positions of the head, according to the

requirements for each measurement. The rest position of the head was determined by the subject's own feeling of natural head balance.

A spreading calliper, which consists of two curved arms connected at their bases with a large pivoting screw and a sliding calliper were used to obtain the craniofacial measurements. The measurements of the face and the mouth were carried out according to standard methods of physical anthropometry (7). Eight measurements were taken from the craniofacial region (Figure 2 a-h).

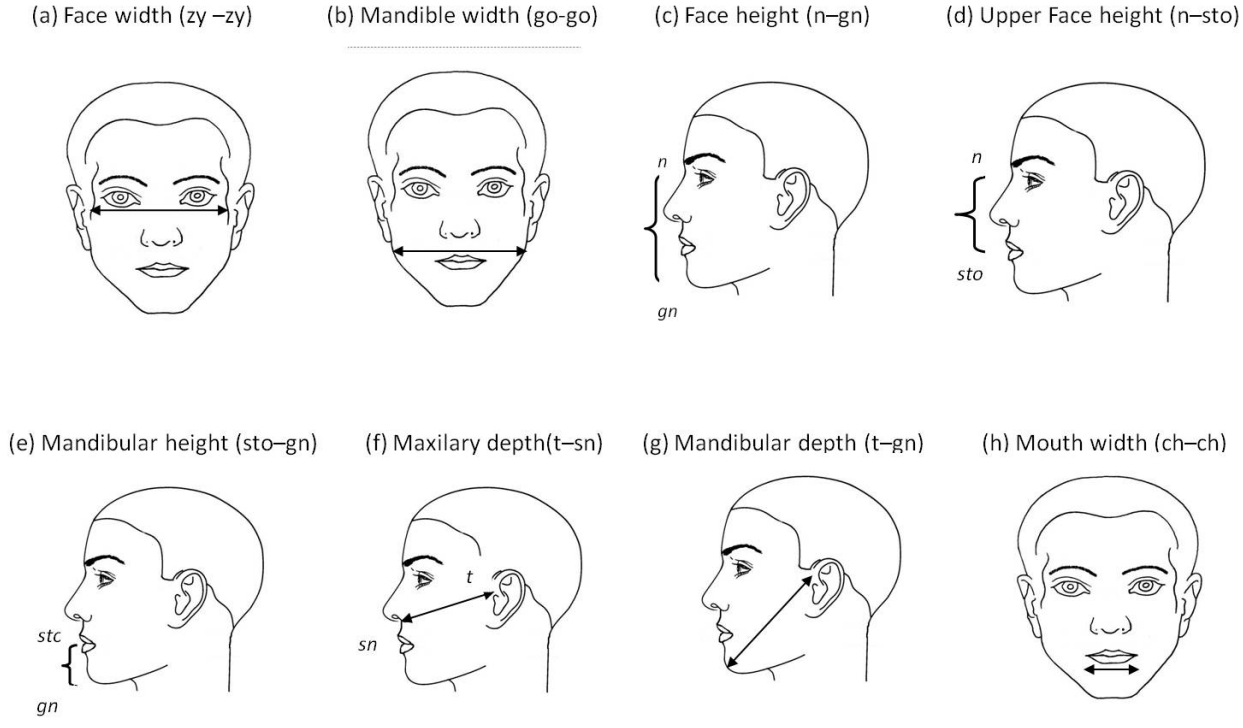

Figure 2 : Evaluation of indices of Craniofacial landmarks as adapted from Hajnis et al. *(Hajnis K, Farkas LG, Ngim RCK, Lee ST, Venkatadri G. Racial and ethnic morphometric differences in the craniofacial complex. In: Anthropometry of the head and face. 1994, Farkas LG (ed). New York: Raven Press: 201-18)*

c) Impression trays

Orthodontic impression trays (Extend-O perforated orthodontic impression tray, TP Orthodontic Inc, IN, USA), ranging between size 3 to 8 were used to determine the best fitting trays for each of the subjects' dental cast. Each tray was fit on to the dental cast to obtain the best fitting impression tray.

Reproducibility test

A test-retest exercise was undertaken to ensure that the data collected were consistent and accurate. Five sets of dental cast were selected randomly to be measured again to validate the measurement. The reproducibility of measurements was analysed using intraclass coefficient correlation (ICC).

Statistic Analysis

Data collected were entered into Statistical Package for Social Science statistical software (Version 12.0; SPSS Inc, Chicago, Illinois, USA). The arch widths and craniofacial anthropometric measurements were recorded for each subject to the nearest 0.01 and 0.1 mm respectively, and described in terms of average values and standard deviations. The significance value was set at 95% ($p<0.05$). Correlations analysis was made between the arch widths and the best fitting impression trays used and also with various craniofacial anthropometric measurements. The intra-observer reproducibility as derived from the Cronbach's alpha for all the parameters was good (ICC value more than 0.80) indicating very high reliability.

RESULTS

Eighteen (n=18) subjects fulfilled the criteria and were included in this study. They were 4 males and 14 females. Their average age was 21.6 ± 1.9 years old.

Analyse showed that the average respective maxillary intercanine, interpremolar and intermolar arch widths were 35.83 ± 1.84 mm, 44.25 ± 2.04 mm and 54.75 ± 3.65 mm respectively. Their corresponding mandibular intercanine, interpremolar and intermolar arch widths were 26.97 ± 2.24 mm, 35.72 ± 2.92 mm and 46.33 ± 3.71 mm respectively.

For the upper jaw, the most common fitting impression tray was size 6 (n=9), followed by size 5 (n=7), and size 4 and 7 (1 each). The most common impression tray size for the lower jaw was size 5 (n=8), followed by size 4 (n=4), 6 (n=3) and 7(n=3).

The correlation results between the arch widths and tray sizes are shown in Table 1. The overall mean craniofacial anthropometric measurements and its spearmen correlation with the maxillary and mandibular arch widths are as shown in Table 2. Generally, spearmen correlation analysis showed no significant correlation between the upper and lower arch widths and almost all craniofacial anthropometric measurements. However, significant correlations were noted between the upper intermolar width and interpremolar width to the face width and between the upper intermolar width and interpremolar width to the mandibular depth.

Table 1: Spearman correlation between dental arch widths and tray sizes

	Tray size	
	Spearman correlation (*r*)	Significance (*p*)
Upper intercanine width	0.813	**0.000***
Upper interpremolar width	0.406	0.133
Upper intermolar width	0.497	0.060
Lower intercanine width	0.406	0.133
Lower interpremolar width	0.024	0.933
Lower intermolar width	0.100	0.724

Table 2: Mean craniofacial anthropometric measurements and the spearman correlation between upper and lower dental arch widths with the various craniofacial anthropometric measurements

		Upper dental arch						Lower dental arch					
		intercanine width		interpremolar width		intermolar width		intercanine width		interpremolar width		intermolar width	
	Mean, mm (SD)	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
face width	107.4 + 6.7	0.260	0.297	0.573	0.013*	0.471	0.049*	0.139	0.583	0.204	0.416	0.346	0.160
face height	67.1 + 4.1	0.112	0.658	0.163	0.518	0.196	0.435	0.054	0.832	0.001	0.997	0.129	0.609
upper face height	42.3 + 4.4	0.023	0.927	0.003	0.992	0.312	0.208	0.088	0.730	0.024	0.925	0.223	0.373
mandible width	107.1 +7.6	0.105	0.677	0.281	0.258	0.165	0.512	0.740	0.770	0.019	0.240	0.112	0.658
mandible height	117.9 + 6.9	0.400	0.100	0.029	0.908	0.286	0.250	0.241	0.336	0.031	0.904	0.194	0.442
mandible depth	50.3 + 2.0	0.101	0.690	0.116	0.648	0.316	0.201	0.188	0.455	0.548	**0.019***	0.616	**0.006***
maxillary depth	129.3 + 11.9	0.012	0.962	0.103	0.685	0.332	0.179	0.057	0.822	0.035	0.889	0.178	0.480
mouth width	50.5 + 2.7	0.082	0.748	0.148	0.557	0.260	0.297	0.041	0.870	0.230	0.358	0.314	0.204

r = Spearman correlation ; *p*= Significance

DISCUSSION

Differences in the craniofacial dimensions and dental arch of different populations are genetically inherited and these inherited differences are useful for management of dental patient (8). Tooth morphology is known to be influenced by cultural, environmental and racial factors (9). As a result, tooth size has been reported to differ between the caucasoids, negroids and mongoloids (10). Because of this, the jaw widths may differ significantly as well.

Several similar studies have been conducted previously among different ethnic groups (9, 11-15). Most of them studied dental arch among specific ethnic group but not all used the same method as in

this present study. Therefore, only studies that use similar method are further compared. From a study done among a Malay population (5), it was reported that the mean of maxillary interpremolar width was 35.41 ± 3.57 mm and maxillary intermolar width was 46.50 ± 0.58mm. This showed slight difference from the results of the present study. This could be because their selection crieteria did not take into account the skeletal pattern of the subjects but only the dental relationship. It was found that the correlation coefficient between bizygomatic width and anterior-arch-width was 0.18 and was not significant among that population unlike in the present study where we found significant correlation.

Ling and Wong's study (16) among a Southern Chinese population reported that intercanine width was 35.09 ±3.52mm, interpremolar width was 42.83 ±4.19mm and intermolar width was 52.63 ±2.59mm. Their results were almost similar to that reported in this study. This may be explained by the fact that the Chinese population were of Mongoloid descend and have similar facial characteristic as the Malays. Uysal *et al* (17) also studied on dental arch width on a Turkish population and they reported maxillary intercanine width of 34.4 ± 2.1 mm and maxillary interpremolar width of 50.7 ± 3.7 mm. The results indicate that the Turkish population had almost similar arch width measurement with the Malay population in this study. The Turkish were originally considered Mongoloid although due to major population movement and the effect of migration and admixture with the Caucasians, due to their location between Europe and South Asia, they have undergone a genetic drift. However due to the genetic relatedness between Caucasians and Mongoloids, it is not rare to have similar arch width measurements.

Correlation between bizygomatic diameter (zy-zy) or face width and inter premolar width and intermolar width shows significant correlation (p = 0.05 and 0.036) respectively. This study showed consistency with that reported by Sergl (18) where they found a strong correlation between the bizygomatic arch and maxillary dental width. However, the analysis was based on data obtained from the model and anthropological measurements of 50 adult German subjects with fairly eugnatic dentition, and their dental arch widths showed a perfect correlation Pont's indices. Thus, clinicians may likely use the maxillary and mandibular interpremolar width and intermolar width as guidance in determining arch expansion in cosmetic management of patients.

We found significant correlation between upper intercanine width and size of the impression trays noted, suggesting the upper intercanine width may be a useful parameter to be considered when predicting the size of impression tray to be selected for the Malay population.

In this study, we focused on Malaysian Malay population as this is the largest ethnic population in the country. However, this study will be more clinically applicable if all the major ethnic groups can be included to determine if there is significant difference in the dental arch width among the various ethnic groups in Malaysia. Besides, our sample size was not large enough to accurately and reliably state the norm for the entire Malaysian Malay population. Majority of the male subjects screened for this study had Class III skeletal pattern and incisor relationship. Therefore, it was difficult to identify male subjects who fulfilled our inclusion criteria

For correlation with facial anthropometry in Class I skeletal pattern, face width have significant correlation with maxillary interpremolar width and intermolar width. It is said that dental arch width is associated with gender and facial vertical morphology (6). The correlation between mandibular depth and the inter premolar and intermolar width shows the jaw size is determined by the function of teeth and its position in the jaw. Further study can be done in subjects with Class II and Class III skeletal pattern, to determine if their skeletal pattern is within the norm range as we hypothesise that buccal expansion can be determined by using the bizygomatic measurements as guide.

CONCLUSIONS

The dental arch width of Malays with Class 1 occlusion was determined. The significant correlation between the upper and lower interpremolar and intermolar widths and the anthropometric measurements of this Malay population may assist in predicting arch expansion to achieve Class 1 occlusion during orthodontic or maxillofacial surgical treatment. Meanwhile, the significant correlation between the upper intercanine width and the size of impression tray suggests that this may be a useful parameter when determining the selection of impression tray.

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