Bimaxillary Protrusion in Malay Population: Cephalometric Analysis of Skeletal, Dental and Soft Tissue Components

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Abstract

This cross-sectional study aimed to analyze skeletal, dental and soft tissue components of bimaxillary protrusion in a sample of Malay population in Malaysia.

116 lateral cephalometric radiographs were traced and digitized using Dolphin Imaging software. Thirty radiographs were randomly selected for calibration of two weeks interval by 2 operators. Eight angular and eight linear parameters were measured to assess the cephalometric characteristics.

Intraclass correlation coefficient (ICC) and descriptive statistics were used to assess operator's calibration and cephalometric characteristics respectively. Inter-rater and intra-rater reliability showed excellent correlation at ICC 0.831 and ICC 0.99 respectively.

Significant biskeletal protrusion with SNA of 84.3° (SD 3.9) and SNB of 80.1° (SD 3.9) and bidental protrusion of incisors were also observed (UIA: 125.48°; LIA: 102.56°) with acute interincisal angle (102.73°).

A marked difference to Caucasian and Chinese standards were observed. They also have evident soft tissue protrusion. Bimaxillary protrusion is significant in Malay population with varying degree of protrusion in skeletal, dental and soft tissue. Thus, diagnosis and treatment plan should be made according to their characteristics.

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Introduction

Bimaxillary protrusion (*bimax*) entity is commonly seen among Asians, which is described by protrusive and proclined upper and lower incisors and an increased in procumbency of the upper and lower lips with or without incompetent lips[1–5] and values much higher than the Caucasian norm.[1,6–9] These ethnic groups portrayed profile convexities due to bidental protrusion when compared with a relatively straight profile of Caucasians.[10–12] Bimaxillary protrusion faces can variably display its anomaly in Class I, II and III skeletal patterns and most times do not conform to standard facial profile classification of true straight, convex or concave, but variations such as straight-convex, convex-concave and vice versa. Class I skeletal pattern was identified by ANB degree (Table 1) which represents the sagittal skeletal discrepancy between maxilla and mandible. Hence, ANB of 2 to 5 degrees is classified as Class I skeletal pattern, beyond 5 degrees is Class II skeletal pattern and less than 2 degrees is Class III skeletal pattern.[4,13]

Literatures shown that most patients preferred a straighter profile than what has been described as normal for their population.[14,15] The emergence of surgical option has made many patients seek further treatment to reduce this procumbency and improve their facial appearance.[3,8] Thus, proper diagnosis and treatment according to their distinctive norms is of prime importance.[8,16] Currently, there are no studies to determine bimaxillary protrusion characteristics among Malay Malaysians. Therefore, aim of this study is to analyze skeletal, dental and soft tissue components through cephalometric measurements. Also, to compare the results with established norms of Caucasian and Chinese to demonstrate the disparity in a *bimax* sample.

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Subjects and methods

This cross-sectional study included patients with bimaxillary protrusion who attended the Orthodontic clinic at Universiti Teknologi MARA (UiTM) from the year of 2013 until 2017. Ethical approval was obtained from the UiTM Research Ethics Committee (600-IRMI 5/1/16) in August 2016. Records of patients were taken from those who have consented. All the patients' records were kept confidential. Sample with *bimax* were identified through profile photos and lateral cephalometric radiographs were retrieved for evaluation with following inclusion criteria adopted:

I. Malay race and speaking Malay, with no interracial marriages in two generations predecessor[1,17]
II. Patients of 18 to 30 years old
III. Patient presented with either skeletal, dental, soft tissue protrusion or any combination
IV. Established occlusion with permanent teeth presents up to second molars
V. Class I, mild II or III skeletal pattern

Any subjects with craniofacial deformities, anomalies or any previous orthodontic treatment and extraction were excluded. Patients were identified as having dental, skeletal or soft tissue protrusion subjectively through clinical evaluation.[5,18]

By using one-sample mean formula[19], ensuring 95% confidence interval estimate of the standard deviation is within 1.54 unit[10] of the true SD, a sample size of 100 is needed. To accommodate 14% of incomplete cases, sample size of 116 was needed. Thus, the minimum selected sample size required for this study was 116 patients' records. There were 83 female subjects and 29 male subjects with a mean age of 22.6 ± 3.5 and 22.9 ± 4.7 years old respectively. The Malay *bimax* sample were compared with the established Eastman's standard of Caucasians,[20] Chinese[10] norm and Malay soft tissue norm[21] to observe the difference.

The lateral cephalograhs selected were taken on either 2 radiographic unit, Planmeca x-ray machine or Instrumementarium Orthoceph OC200D. The standard magnification set up was at 1.06 in the scale for both units, with cephalostat set at 85kv, 13 miliampere and 7.69 seconds. 116 lateral cephalometric radiographs were traced and digitized by single operator using Dolphin Imaging software. As a method of standardization, the radiographs were oriented to the Frankfort Horizontal (FH) plane,[22] which is a horizontal reference line constructed through porion to orbitale (Figure 1). All cephalometric landmarks were identified, systematically traced to Eastman analysis[20] from soft tissue to hard tissue parameters. Twenty-one hard tissues and 11 soft tissue cephalometric landmarks were digitized (Figure 1 and Figure 2). Four skeletal, 3 dental[20] and 9 soft tissue parameters[23–26] were measured, which consist of angular and linear measurements, as described in Table 1, Figure 1 and Figure 2. The soft tissue measurements represent the amount of lip protrusion in relation to the established soft tissue reference lines.[23–26]

No	Variables	Description
	Skeletal	
1	SNA	Sella-nasion to A Point angle
2	SNB	Sella-nasion to B Point angle
3	ANB	A point to Nasion to B point angle
4	MMPA	Maxillary plane to mandibular plane angle
	Dental	
5	UIA	Upper incisor to maxillary plane angle
6	LIA	Lower incisor to mandibular plane angle
7	IIA	Inter-incisal angle, angle between upper incisor and lower incisor
	Soft Tissue	
8	NLA	Nasolabial angle Angle formed by columella breakpoint, subnasale and labiale superius
9	Rickett's E line ULE LLE	Measure the distance of the lips to Rickett's E line Distance of upper lip to E line Distance of lower lip to E line
10	Burstone line ULB LLB	Vertical line from subnasale to soft tissue pogonion Distance of upper lip to Burstone line (B line) Distance of lower lip to Burstone line (B line)
11	Steiner's line ULS LLS	Vertical line from midway between tip of the nose and subnasale to soft tissue pogonion Distance of upper lip to Steiner's line (S line) Distance of lower lip to Steiner's line (S line)
12	Arnett's lip thickness ULT LLT	Thickness of the lips measured from outermost point to the innermost point of upper and lower lip Thickness of the upper lip measured from labiale superius to inner lip Thickness of the lower lip measured from labiale inferius to inner lip

Ricketts, 1968[23], Burstone, 1967[24], Steiner, 1960[25],Arnett et al., 1999[26]

Table 1. Cephalometric Measurements and Description.

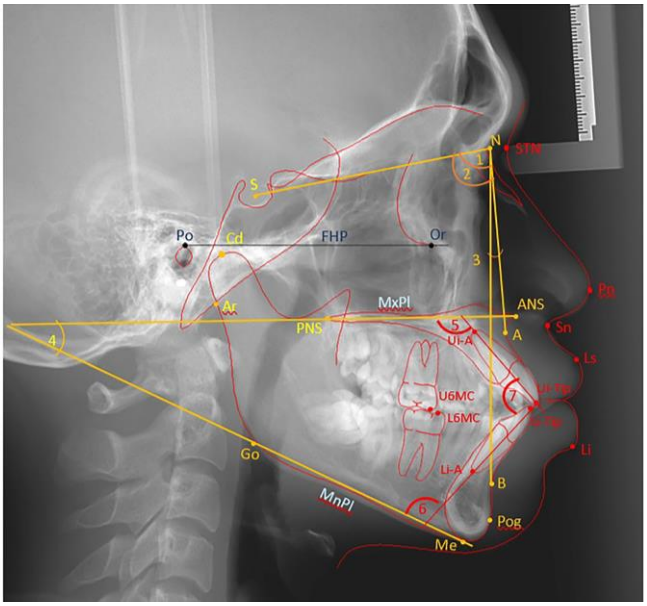

Figure 1. Cephalometric landmarks, planes and angles of skeletal and dental components.

S=Sella, N=Nasion, Po=Porion, Or=Orbitale, Ar= Articulare, C=Condylion, Go=Gonion, Me=menton, Pog=Pogonion, ANS=Anterior nasal spine, PNS= Posterior nasal spine, A=A point, B=B point, Ui-Tip=Upper incisor tip, Li-Tip=Lower incisor tip, Ui-A=Upper incisor root apex, Li-A=Lower incisor root apex, U6MC=Upper first molar mesial cusp, L6MC=Lower first molar mesial cusp, STN=Soft tissue nasion, Pn=Pronasale, Sn=Subnasale, Ls= Labiale superioris, Li =Labiale inferioris. 1=SNA, 2=SNB, 3=ANB, 4=MMPA, 5=UIA, 6=LIA, 7=IIA

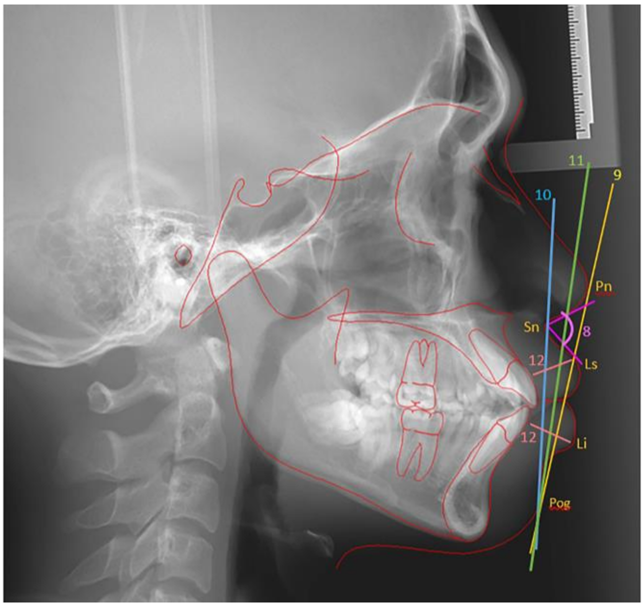

Figure 2. Cephalometric landmarks, lines and angles of soft tissue measurements with their relation to the soft tissue lips.

Pn=Pronasale, Sn=subnasale, Pog=pogonion, Ls=Labiale superioris, Li=Labiale inferioris.
8 (purple)=NLA, 9 (yellow)=Ricketts line, 10 (Blue)=Burstone line, 11 (green)=Steiner's line, 12 (pink)=Arnett's lip thickness

Error Measurement. Thirty radiographs were randomly selected, traced and digitized by the same operator and a second operator. Both operators were Orthodontic residents and all radiographs tracing were approved by an Orthodontic specialist. Tracings were then repeated within 2 weeks interval to assess measurement error. The reliability assessment for consistency of cephalometric measurements among two operators using intraclass correlation coefficient (ICC), shows excellent and good correlation for both intra-operator (0.990) and inter-operator (0.831) assessment. The ICC gives a measure of reliability of the measurement in terms of consistency, with values between 0.75 to 0.9 considered being good and more than 0.9 as excellent correlation.[27]

Statistical Analysis. The data were imported to the Statistical Package for Social Science software version 13.0 (SPSS Inc., USA) for analysis including means, standard deviation, mean difference and correlation coefficient. Descriptive statistics were used to assess the dentoskeletal characteristics and demographic data of patient. Whereas, comparison between Malay *bimax* sample and standards were measured using one sample *t*-test. Sexual dimorphism was evaluated by using independent *t*-test. The level of significance was set at *P*-value of less than 0.05 and *P*-value of less than 0.001 to be highly significant.

Results

Table 2 analyzes the presence of sexual dimorphism. The cephalometric measurements reveal no significant difference between males and females for all 16 variables (P > 0.05) except for MMPA, UIA and ULT (P < 0.05). Females were found to have higher vertical proportion, MMPA (P = 0.021) whereas males showed significant increase in upper incisal inclination (P = 0.010) and upper lip thickness (P = 0.010).

The cephalometric measurements for both genders of Malay *bimax* sample were pooled for further analyses. Table 3 shows that.

Variables	Sex	Mean (SD)	Mean diff	95% CI	*P* value

Skeletal	**SNA**	Male	85.27 (4.57)	-1.33	-2.94 to 0.28	0.104
		Female	83.94 (3.63)			
	SNB	Male	80.71 (4.57)	-0.81	-2.45 to 0.84	0.333
		Female	79.90 (3.76)			
	ANB	Male	4.33 (2.65)	-0.29	-1.30 to 0.73	0.579
		Female	4.04 (2.39)			
	MMPA	Male	27.17 (6.47)	2.81	0.43 to 5.18	0.021*
		Female	29.97 (5.48)			
Dental	**UIA**	Male	127.73 (6.32)	-3.16	-5.55 to -0.77	0.010*
		Female	124.57 (5.59)			
	LIA	Male	102.99 (6.35)	-0.59	-2.97 to 1.78	0.619
		Female	102.40 (5.54)			
	IIA	Male	102.10 (5.70)	0.88	-1.67 to 3.42	0.497
		Female	102.97 (6.35)			
Soft Tissue	**NLA**	Male	96.51 (11.73)	0.23	-4.04 to 4.50	0.915
		Female	96.74 (9.83)			
	ULE	Male	0.64 (2.05)	-0.27	-1.16 to 0.63	0.558
		Female	0.37 (2.23)			
	LLE	Male	3.27 (2.42)	0.16	-0.87 to 1.18	0.762
		Female	3.43 (2.51)			
	ULB	Male	7.25 (1.83)	-0.67	-1.38 to 0.05	0.070
		Female	6.58 (1.72)			
	LLB	Male	6.04 (2.41)	0.05	-1.02 to 1.13	0.923
		Female	6.09 (2.68)			
	ULS	Male	3.59 (1.85)	-0.51	-1.27 to 0.24	0.177
		Female	3.08 (1.81)			
	LLS	Male	4.52 (2.39)	0.19	-0.82 to 1.21	0.713
		Female	4.70 (2.50)			
	ULT	Male	11.84 (1.35)	-1.12	-1.80 to -0.44	0.001*
		Female	10.72 (2.26)			
	LLT	Male	12.08 (1.63)	-0.74	-1.56 to 0.08	0.078
		Female	11.34 (2.12)			

significance value at *P<0.05; **P<0.001, SD: standard deviation, CI: confidence interval

Table 2. Comparison of Skeletal and Dental Cephalometric Measurements among Malay *Bimax* Sample using Independent Sample *t*-test (n=116)

Variables	**Mean**	**Standard deviation (SD)**	**95% CI**	
			Lower	Upper
Skeletal				
SNA	84.25	3.94	73.70	94.20
SNB	80.13	3.99	70.20	91.10
ANB	4.12	2.46	-5.10	9.10
MMPA	29.19	5.88	10.20	44.10
Dental				
UIA	125.48	5.94	109.60	146.00
LIA	102.56	5.75	89.30	119.60
IIA	102.73	6.17	85.50	122.80
Soft tissue (Angular)				
NLA	96.68	10.33	68.90	121.60
Soft tissue (Linear)				
ULE	0.45	2.17	-6.00	6.50
LLE	3.39	2.47	-3.30	10.00
ULB	6.77	1.76	0.60	12.30
LLB	6.08	2.59	-2.90	14.30
ULS	3.22	1.83	-2.50	8.30
LLS	4.65	2.46	-1.50	12.00
ULT	11.03	2.10	1.00	16.70
LLT	11.55	2.02	1.00	16.60

CI: confidence interval

Table 3. Mean Variables of Skeletal and Dental Cephalometric Measurements of Malay *Bimax* Sample (n=116)

The mean of all skeletal measurements presents with narrow standard deviation except for MMPA and dental components presented with wider standard deviation range. Wide range of skeletal and dental protrusion was observed from the minimum to maximum values. The soft tissue measurements present the mean of lip protrusion which shows acute nasolabial angle (NLA) with wide standard deviation

Table 4 and Table 5 portrayed highly significant differences between Malay *bimax* sample and Caucasians in all cephalometric variables (P < 0.001). Table 4 also shows significant difference in comparison to the established Chinese norm[10] in all skeletal and dental variables except for SNA value. All values suggested protrusion in the *bimax* sample, apart from SNB which shows less protrusive in the *bimax* sample (80.1°) compared to the Chinese (82.3°). However, a wider standard deviation observed in the *bimax* sample may rectify the difference existed between the two groups. The result conveys significant difference in all soft tissue variables between Malay *bimax* sample and the Malay soft tissue norm[21] (Table 4) except for upper lip in relation to Ricketts E-line which shows about similar protrusion. Generally, the skeletal, dental and soft tissue measurements were significantly higher in the Malay *bimax* sample compared to the norms.

Variables	Sample Mean (SD)	Caucasian[1] Mean (SD)	Mean diff (CI)	*P* value	Chinese[2] Mean (SD)	Mean diff (CI)	*P* value
Skeletal							
SNA	84.3 (3.9)	81 (3)	3.31 (12.59 - 4.04)	< 0.001	84.6 (0.9)	-0.37 (-1.09 -(- 0.36))	0.317
SNB	80.1 (3.9)	78 (3)	2.13 (1.39 - 2.86)	< 0.001	82.3 (0.8)	-2.13 (-2.87 -(-1.39))	< 0.001
ANB	4.1 (2.4)	3 (2)	1.12 (0.67 - 1.57)	< 0.001	2.4 (1.13)	1.69 (1.25 - 2.15)	< 0.001
MMPA	29.2 (5.9)	27 (5)	2.19 (1.12 - 3.28)	< 0.001	24.9 (8.9)	4.26 (3.18 - 5.34)	< 0.001
Dental							
UIA	125.5 (5.9)	109 (6)	16.45 (15.35 - 17.54)	< 0.001	123.7 (1.1)	1.69 (0.59 - 2.78)	< 0.05
LIA	102.6 (5.8)	93 (6)	9.56 (8.50 - 10.62)	< 0.001	100.7 (1.3)	1.84 (0.78 - 2.90)	< 0.001
IIA	102.7 (6.2)	135 (10)	-32.27 (-33.40 -(-31.14))	< 0.001	114.5 (1.3)	-11.72 (-12.85 -(-10.59)	< 0.001

[1]Caucasian mean was adopted from values of Eastman standards[20]

[2]Chinese mean was adopted from values of Malaysian Chinese[10]

Table 4. Comparison of Skeletal and Dental Malay *Bimax* Sample Measurements with Caucasians and Chinese Norm using one-sample mean test

Variables		Sample Mean (SD)	Caucasian[1] Mean (SD)	Mean difference (CI)	P value	Malay[3] Mean (SD)	Mean difference (CI)	P value
Angular measurements								
NLA		96.68 (10.33)	100 (8)	-3.32 (-5.22-(-1.42))	<0.001	88.45 (11.13)	8.22 (6.32 - 10.12)	< 0.001
Linear measurements								
Ricketts	ULE	0.45 (2.23)	- 4 (2)	4.45 (4.04 - 4.84)	<0.001	0.38 (1.04)	-0.12 (-0.49 -(- 0.47)	0.962
	LLE	3.39 (2.51)	- 2 (2)	5.39 (4.93 - 584)	<0.001	1.38 (1.44)	2.05 (1.50 - 2.59)	<0.001
Burstone	ULB	6.77 (1.72)	3.5 (1.4)	3.27 (2.94 - 3.59)	<0.001	2.91 (0.92)	3.67 (3.29 - 4.05)	<0.001
	LLB	6.08 (2.68)	2.2 (1.6)	3.88 (3.40 - 4.36)	<0.001	3.02 (1.42)	3.07 (2.49 - 3.65)	<0.001
Steiner's	ULS	3.22 (1.81)	0	3.22 (2.88 - 3.55)	<0.001	1.58 (1.07)	1.49 (1.09 - 1.88)	<0.001
	LLS	4.65 (2.51)	0	4.65 (4.20 - 5.11)	<0.001	2.21 (1.52)	2.49 (1.96 - 3.04)	<0.001
Arnett's	ULT	11.03 (2.25)	12.6 (1.8)	-1.57(-1.96 -(-1.19))	<0.001	4.39 (0.79)	6.32 (5.83 - 6.81)	<0.001
	LLT	11.55 (2.12)	13.6 (1.4)	-2.05 (-2.42 -(-1.68))	<0.001	5.66 (0.79)	5.69 (5.22 - 6.14)	<0.001

[1]Caucasian mean was adopted from values of Eastman standards[20]

[3]Malaysian mean was adopted from normal Malaysian Malay lip morphology values[21]
Ballard, 1956[20], Ricketts, 1968[23], Burstone, 1967[24], Steiner, 1960[25],Arnett et al., 1999[26]

Table 5. Comparison of Soft Tissue Malay *Bimax* Sample Measurements with Caucasian and Malay Norm using one-sample mean test

Discussion

The presentation of bimaxillary protrusion may varies according to ethnic, gender and geography. The cultural background, influence of social media and patient's perception may render different impression on the *bimax* appearance. Thus, it is important to determine the presentation and characteristics of bimaxillary protrusion in a population. This will facilitate orthodontic diagnosis and treatment planning to conform to their population norm. This study could be the first to study *bimax* in a Malay sample describing its distinctive skeletal, dental and soft tissue features.

Since the Caucasian standard[20] was widely established and commonly practiced as our reference norm in diagnosis and treatment plan of our Malay population, this standard was selected to convey the differences. The Chinese norm was used as a normal population group because the Chinese and Malays were categorized in the same Mongoloid race and share some similarities in their features.[28–30] Currently, the available Malay norms are sourced from unpublished thesis,[31] limited usage of dental analysis[1] and small sample comparison study of normal and Thalasemia patients.[32] Due to these reasons our Malay sample was compared to the Caucasian[20] and Chinese[10] to illustrate the differences in a *bimax* sample. However, soft tissue Malay norm[21] was established and thus be used as comparison to the soft tissue measurements of our Malay *bimax* sample. The cephalometric measurements of our *bimax* sample show no gender difference except for 3 variables; MMPA, UIA and ULT. However, these differences were minimal which was about 2 to 3 degrees in angular measurements (MMPA, UIA) and 1mm difference in linear measurement (ULT). This is in agreement with previous cephalometric studies on Chinese that found minimal gender difference[10] and no sexual dimorphism detected in a Malay sample.[32] Therefore, measurements for both genders were pooled in this study.

The finding in this study is in concurrence with many other studies that found skeletal and dental protrusion especially among Asians that is far beyond the White. The South East Asian people are among the cluster that infamously inherit bimaxillary protrusion namely Vietnamese, Thai, Malays, Chinese and Filipinos.[1,8,10,12,33,34]

Skeletal Measurements. All skeletal variables shown wide distribution of measurements which confirm that the Malay *bimax* sample consist of a wide range of skeletal protrusion. The mean SNA and SNB of Malay *bimax* sample are greater than the Caucasian which indicate that the Malay maxilla and mandible are more prominent than the Caucasian (Table 4). This concurs with other cephalometric studies among Malaysians.[1,32] This results also demonstrated that the protruded mandible of Malaysian Malay is of that mainly distributed to the skeletal bimaxillary protrusion characteristics. This is in agreement with other studies that found prognathic mandible.[1,7,35] The sagittal relationship between maxilla and mandible was represented by the ANB angle. This study shows that the Malay sample presented with Class I skeletal pattern with ANB of 4.1°. Though, there was a slight tendency towards Class II skeletal pattern. Tendency of mandibular backward rotation may attributed to the increase in ANB angle.[36] Other studies of Malay[1,32] and geographically closed populations, Malay Indonesians and Malay Singaporean.[1] have Class I skeletal norm.

In *bimax* cases, the increased in MMPA could be due to either increased in anterior lower facial height or decreased in posterior facial height which give rise to backward growth rotation.[36,37] Consequent, development of high angle causes the other problems such as receding chin and marked ANB discrepancy. The increased in vertical relationship found in this study was consistent with skeletal presentation of bimaxillary protrusion in Caucasian, Sudan and Mosul.[36–38] However, in contrast to the horizontal growth pattern revealed in Zimbabweans and normal vertical growth in Indian and Saudis.[16,39]

In comparison with Chinese (Table 4), only the SNA value was insignificant, however only little difference was noted. Nonetheless, the differences between the cephalometric values of Malay *bimax* and Caucasians are more profound in comparison to the Chinese population. The Chinese are more protrusive than the Caucasian, whereas the Malay *bimax* are shown to be even more protrusive than the Chinese.

Dental Measurements. Bimaxillary proclination was a common term used interchangeably with bimaxillary protrusion because it describes merely the proclination of the teeth. Patients with this bidental protrusion displayed increased in upper and lower incisor proclination with resultant in an acute inter-incisal angle. Earlier studies have agreed that an inter-incisal angle of less than 120 degrees can be identified as a distinct measure for presence of bimaxillary protrusion.[8,38] Present studies still used this identification as a reference for their norm.[7,10,40] Despite that, the Malay sample exhibited a severe form of protrusion with IIA as acute as 85.5 degrees (Table 4). In contrast to the Caucasian norm, the dental protrusion (IIA) was higher, giving a significantly large mean difference of more than 30 degrees. The mean of upper incisors (UIA) are significantly more proclined than the Caucasian and almost similar to the Chinese. However, the *bimax* sample have a wide standard deviation giving significantly a wider range of protrusion. The range of dental protrusion seen in this study may be a contribution of dentoalveolar compensation for tendency of skeletal II or skeletal III discrepancy. The finding in this study that found both skeletal and dental protrusion in Malay *bimax*, was in contrary to other studies that found dentoalveolar protrusion on a normal skeletal base.[16,36]

Soft Tissue Measurements. Regarding soft tissue measurements, generally all bimaxillary protrusion sample are accompanied with some degree of soft tissue protrusion. It was shown that they have higher soft tissue protrusion when compared to the Malay norm[21] and Caucasian.[20,23–26] Several lines have been imported to evaluate the anteroposterior position of the lips and the aesthetic value of the profile. Multiple analysis chosen for this study to evaluate the soft tissues to strengthen the meaning of the values.[20,23–26] The findings in this study is in concurrence with other study that found acute nasolabial angle (NLA), which is widely used as a determinant factor of soft tissue procumbency.[35,41–43] The soft tissue procumbency also exaggerate our Malay condition because of flatter nose which is set behind the lips.[9,10,44] There is wide divergence in the cephalometric values for most of the variables indicating the variety and a range of protrusion exist seen among these population. Geographic disparity has been illustrated that there is different skeletal presentation and protrusion seen with different population. Sivakumar et al, 2014 also found that there is wide divergence in occurrence of protrusion and that they could have varying severity.[16] This support findings from this study that there is wide range of severity in bimaxillary protrusion especially dental protrusion.

One of the limitation is that, during the preliminary period of this study was conducted, majority of patients who came to the UiTM clinic was Malay, which limits our study sample to the Malay group. Nevertheless, in agreement with other findings, due to *bimax* protrusion features of Malays,[1,45] it is reasonable to evaluate norm of these population.

Besides that, we are lacking in Malay norm to compare with our Malay bimax sample. Due to this limitation, the Chinese norm was adopted because of its nearest lineaments to the Malays. The norm was used to compare with our Malay bimax sample to describe the differences of cephalometric pattern in a bimax sample.

The findings in this study have presented the significant differences between the Malay bimax sample and the standards. This strengthen the notion that any treatment should be outlined according to their respective population norm especially in a population with prevalent bimaxillary protrusion cases. Thus, the values resulted from this study could be a reference norm in comprehensive treatment planning.

Conclusions

Generally all the skeletal and dental cephalometric components showed higher values compared to the Caucasians and Chinese. Likewise, the soft tissue measurements showed significant higher values than the standards This association proves that the Malay *bimax* sample had more protrusive characteristics.

Declaration of Interest

The authors report no conflict of interest.

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