Original Article

Access this article online

Quick Response Code:

Website: www.jorthodsci.org

DOI: 10.4103/jos.jos_173_21

The relationship of maxillary arch dimension with vertical facial morphology in proto-malay race

Hilda Fitria Lubis, Mimi Marina Lubis and Christinawaty Sutan

Abstract

OBJECTIVE: To determine the relationship between the dimensions of the maxillary arch and vertical facial morphology within the Proto-Malay race.

DESIGN: A cross-sectional study.

SETTING: Orthodontics Department, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia.

PARTICIPANTS: Proto-Malay individuals aged ≥18 years without orthodontic treatment history (n = 104).

METHODS: Lateral cephalometric radiographs and maxillary study model were obtained from 104 subjects who had never received orthodontic treatment (45 males and 59 females), aged 18 years, belonging to the Proto-Malay race, with skeletal class I malocclusion, normal overjet and overbite, and complete dentition (except the third molar). The vertical facial morphology was obtained by measuring the Jarabak's ratio on lateral cephalometric radiographs by using CorelDRAW. The study model was used to measure the dimensions of the maxillary arch, which are intercanine width, intermolar width, arch length, and palatal height, by using the Korkhaus modification device.

RESULTS: The results showed a significant positive correlation between intercanine and intermolar width and a negative correlation between arch length and palate height with vertical facial morphology in the male and female groups within the Proto-Malay race.

CONCLUSION: There is a relationship between the maxillary arch dimension with vertical facial morphology in the male and female groups in the Proto-Malay race.

Keywords:

Class I malocclusion, maxillary arch dimensions, vertical facial morphology

Introduction

The triumph of orthodontic treatment relied on the clinical capability in determining the diagnosis, treatment plan, and technique utilized in a variety of malocclusion treatments.[1] Some assessments need to be done in determining orthodontic diagnoses, such as cephalometric radiography and dental cast examination. In cephalometric radiography examination, the skeletal pattern can be classified into vertical disproportions (hyperdivergent, normovergent, and hypodivergent) and anteroposterior disproportion (Class I, II, and III skeletal malocclusion).[2] Facial morphology is a unique characteristic for every patient and an important aspect in orthodontic diagnosis, treatment plan, and prognosis.[3-5] Facial morphology can be determined using some parameters, such as posterior and anterior facial height ratio (Jarabak's ratio), MP-SN angle, and gonial angle.[6]

The long-face pattern usually shows a high MP-SN and gonial angle, whereas the short-face pattern shows a low MP-SN and

Department of Orthodontic, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia

Address for correspondence:
Dr. Hilda Fitria Lubis, Department of Orthodontic, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia.
E-mail: hildadrgusu@gmail.com

Submitted: 10-Sep-2021
Revised: 14-Dec-2021
Accepted: 04-Feb-2022
Published: 04-May-2022

How to cite this article: Lubis HF, Lubis MM, Sutan C. The relationship of maxillary arch dimension with vertical facial morphology in proto-malay race. J Orthodont Sci 2022;11:17.

gonial angle.[6-8] Moreover, the long-face patterns have a smaller transverse arch dimension than the short-face pattern,[3,7,9,10] thus indicating that there is a significant correlation between MP-SN angle and arch width in Caucasoid sample in Philadelphia, and the short-faced group shows a wider arch width compared to the long-face group.

In dental cast examination, the arch dimension also plays an important role and must be considered within the orthodontic treatment plan and has to be maintained to achieve an aesthetic, stable, and prevent iatrogenic effect such as tooth movement over the bone.[3,7,9,11] Arch dimension can be determined with arch length, arch width, and palatal height measurement. Some factors affect arch dimensions, such as genetics, gender, bone growth and development, and environmental factors such as muscle pressure and stomatognathic system.[12,13]

Previous studies in 100 male and 100 female subjects showed that males have a significantly wider arch length and arch width compared to females ($P < 0.001$)[14,15] and showed that male subjects have a significantly larger palatal height compared to female subjects.

In general, there are four races in the world: Mongoloid, Negroid, Caucasoid, and other races. Mongoloid race is divided into Proto-Malay ad Deutro-Malay. The Proto-Malay race consists of Batak, Nias, Mentawai, Dayak, Sasak, Toraja, and Ambon race.[16]

Clinically, the archwire is a vital component in fixed orthodontic treatment. A well-planned arch shape or arch width is mandatory to prevent relapse of the arch dimension.[9,17] Preformed archwire was routinely used by orthodontists without facial morphology and gender consideration; thus, it is highly recommended to use individual archwire for each orthodontic patient.[6,7]

In this study, we investigated the relationship between the maxillary arch dimension and vertical facial morphology by using the modified Korkhaus device for arch dimension measurement.

Material and Methods

Ethical clearance

Ethical clearance was obtained from the Universitas Sumatera Utara ethical committee with order No: 330/KEP/USU/2021 based on the Nuremberg Code and Helsinki Declaration guidelines.

Sample selection

This study was conducted on 104 subjects (59 females and 45 males) aged ≥18 years. Lateral cephalometric radiographs and study models were obtained from the patients' records in the Orthodontics Department, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia.

The subjects were selected based on the inclusion criteria, that is, subjects belonging to Proto-Malay race, no history of previous or ongoing orthodontic treatment, class I skeletal malocclusion, normal overjet and overbite, and complete dentition (except the third molar). The exclusion criteria for the sample are crowding with arch length discrepancy >5 mm, anterior and/or posterior crossbite, dental anomaly (peg shape, enamel hypoplasia, etc.), and bad habits (such as mouth breathing, tongue thrusting, and thumb sucking).

Lateral cephalometric radiographs analysis

The lateral cephalometric radiographs were traced on acetate tracing sheets and analyzed using CorelDRAW software [Figure 1]. For each cephalogram, the distance from the posterior facial height (S-Go) and anterior facial height (N-Me) were measured and the ratio was determined using Jarabak's ratio.

Study model analysis

Study model measurements were determined using the Korkhaus modification device [Figures 2 and 3]. Maxillary arch dimensions were measured from

1. Intercanine width – from the canine cusp tip
2. Intermolar width – from the first permanent molar buccal cusp tip
3. Arch length – from the contact point between the permanent central incisors perpendicular to the line of intermolar width
4. Palatal height – the perpendicular distance from palatal width (central fossa of the first permanent molar) to the deepest point in the midline.

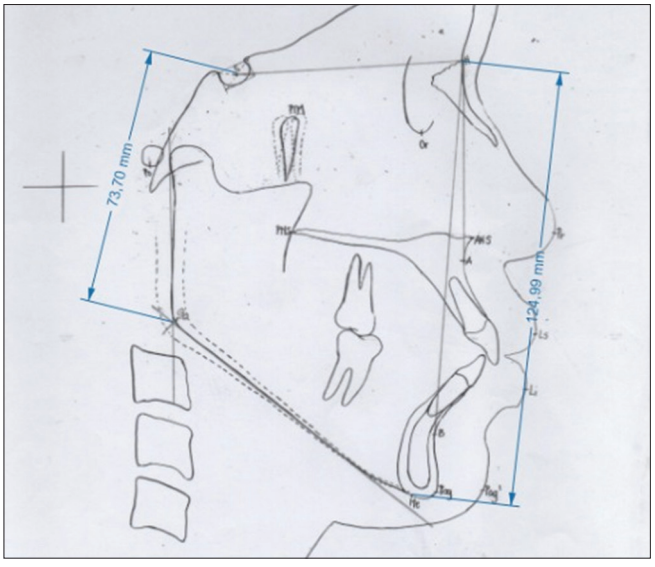

Figure 1: Lateral Cephalogram analyzed with CorelDRAW

Statistical analysis

Statistical analysis was performed to obtain the standard deviation and mean of the maxillary arch dimension (intercanine and intermolar width, arch length, and palatal height) in males and females. ANOVA and post hoc tests were used to determine the relationship between the maxillary arch dimension and vertical facial morphology in the Proto-Malay race. All statistical analysis was carried out using SPSS v26.0.

Results

A total of 104 subjects consisting of 59 females and 45 males were included in this study. The vertical facial morphology was divided into three subgroups, namely hypodivergent, normovergent, and hyperdivergent, based on the Jarabak's ratio. Table 1 presents the mean value and standard deviation of maxillary arch dimension, which showed a significantly larger intercanine and intermolar width, arch length, and palatal height in males with $P < 0.05$. Table 1 also shows that the hyperdivergent subjects had the largest arch length and palatal height both in males and females. This present study also showed that the hypodivergent subjects had the largest intermolar and intercanine width compared to normovergent and hyperdivergent subjects.

There was a significant positive correlation between intercanine and intermolar width with vertical facial morphology. The positive correlation showed a relationship between vertical facial morphology and arch width (intercanine and intermolar width) move in the same direction. Moreover, there is a negative correlation between arch length and palatal height with vertical facial morphology in hypodivergent, normovergent, and hyperdivergent subgroup both in male and female group The negative correlation showed that vertical facial morphology with arch length and palatal height move in opposite direction, which is the greater vertical facial morphology value, the smaller the arch length and palatal height value. [Tables 2 and 3].

Discussion

In this study, we found that males have a significantly larger arch dimension measurement than females.

Table 1: Comparison between the maxillary arch dimension in males and females based on vertical facial morphology (Independent *T*-Test)

Vertical Facial Morphology	Maxillary Arch Dimension	Male (*n*=45)	Female (*n*=59)	*P*
Hypodivergent (*n*=41)	Arch Length	31.98±1.30	30.04±1.87	0.000*
	Intercanine Width	36.32±1.74	34.99±2.32	0.035*
	Intermolar Width	51.32±3.07	48.69±2.99	0.005*
	Palatal Height	20.00±1.06	17.92±2.15	0.000*
Normovergent (*n*=30)	Arch Length	32.95±0.72	29.32±2.01	0.000*
	Intercanine Width	32.42±1.47	33.31±1.38	0.044*
	Intermolar Width	49.17±1.62	47.57±1.91	0.022*
	Palatal Height	20.45±0.98	19.22±1.91	0.043*
Hyperdivergent (*n*=33)	Arch Length	33.93±1.31	31.26±1.23	0.000*
	Intercanine Width	32.29±1.40	31.11±1.08	0.020*
	Intermolar Width	48.71±1.40	47.34±1.46	0.023*
	Palatal Height	21.03±0.99	19.82±1.36	0.018*

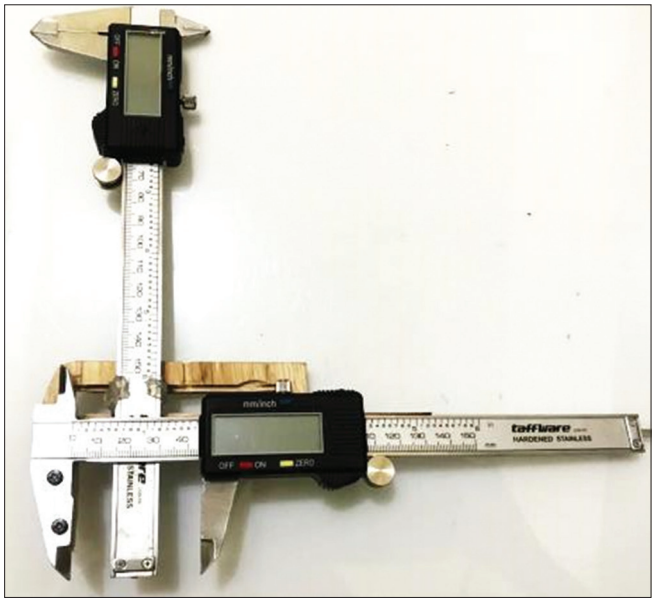

Figure 2: Korkhaus modification device

Figure 3: Intermolar measurement

Table 2: Pearson correlation between the maxillary arch dimension and vertical facial morphology in the female group

Vertical Facial Morphology	Maxillary Arch Dimension			
	Arch Length	Intercanine Width	Intermolar Width	Palatal Height
Hypodivergent				
Pearson correlation	−0.345*	0.463*	0.440*	−0.376
P	0.012	0.034	0.046	0.093
Normovergent				
Pearson correlation	−0.130	0.597*	0.570*	−0.630
P	0.673	0.031	0.042	0.210
Hyperdivergent				
Pearson correlation	−0.222*	0.609*	0.620*	−0.430
P	0.012	0.047	0.042	0.187

Table 3: Pearson correlation between the maxillary arch dimension and vertical facial morphology in the male group

Vertical Facial Morphology	Maxillary Arch Dimension			
	Arch Length	Intercanine Width	Intermolar Width	Palatal Height
Hypodivergent				
Pearson correlation	−0.161*	0.427*	0.399*	−0.068
P	0.043	0.030	0.043	0.742
Normovergent				
Pearson correlation	−0.116	0.486*	0.605*	−0.604
P	0.656	0.048	0.010	0.511
Hyperdivergent				
Pearson correlation	−0.446*	0.519*	0.511*	−0.438
P	0.038	0.039	0.043	0.090

This study was performed following some previous studies.[7,12,18,19] The difference between males' and females' arch dimensions is possibly caused by genetic, hormonal, and environments, such as nutrition and masticatory muscle strength.[4,15,20] Males usually have a higher testosterone level, which stimulates the anterior pituitary gland to produce growth hormone (GH). Testosterone, growth hormone, and insulin-like growth factor I are potent anabolic hormones in protein synthesis. Those hormones play a big role in bone and muscle growth and development, especially in males,[21,22] which causes the masticatory muscle in males to be stronger than in females, thus affecting the growth and development of the arch dimension.[4,15,20]

Tables 2 and 3 showed a moderately positive correlation between intercanine and intermolar with vertical facial morphology in both males and females groups. The positive correlation indicated that the relationship between vertical facial morphology with intercanine and intermolar width move in the same direction, which means that the higher the vertical facial morphology value, the bigger the intercanine and intermolar width. Studies done by[10,23] showed that there is a negative correlation between arch width (intercanine, interpremolar, and intermolar width) with MP-SN value, which indicated that the higher the MP-SN value, the wider the arch width. The difference in correlation sign with the present study is because of the fact the studies done by[10,23] used the MP-SN parameter to classify the vertical facial morphology, whereas in the present study, we used Jarabak's ratio. As we know, the higher the MP-SN value, the more vertical the facial morphology, whereas the higher the Jarabak's ratio, the more horizontal the facial morphology.

The present study also showed that there is a negative correlation between arch length and palatal height with vertical facial morphology, which means that those variables move in opposite directions.[24] Another study showed that hypodivergent patterns usually have a decreased arch length compared to hyperdivergent and normovergent patterns.[25] Hyperdivergent and normovergent patterns show more palatal height than the hypodivergent pattern. The relationship between palatal height and vertical facial morphology is because the hypodivergent pattern usually shows a low tongue position, causing the supra-eruption of upper teeth, narrow maxillary arch, and more palatal height than hypodivergent and normovergent patterns.

Conclusion

We conclude that there is a relationship between maxillary arch dimension with vertical facial morphology in the Proto-Malay race both in the male and female groups. The significant relationship between intercanine and intermolar width with vertical facial morphology showed that a proper diagnosis and treatment plan was mandatory, especially regarding the use of individual archwires for each patient.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Singh DP, Garg AK, Singh SP, Krishna Nayak US, Gupta M. Comparison of the dental arch changes in patients with different malocclusions. Indian J Dent Res 2014;25:623-9.
2. Chae J-M, Park JH, Tai K, Mizutani K, Uzuka S, Miyashita W, Seo HY. Evaluation of condyle-fossa relationships in adolescents with various skeletal patterns using cone-beam computed tomography. Angle Orthod 2019;90:224-32.
3. Nahidh M, ali Ahmed HM, Kadhum AS, Al-Attar AM. The association between the facial and dental arch forms. Int J Sci Res 2017;6:659-63.
4. Sadia S, *et al*. Correlation of Vertical Facial Morphology and Dental Srch Width in Untreated Pakistan Adults. Int J Dent Health Sci 2014; 1(6):890-899.

5. Ahmed HMA, Al-khawaja NFK, Nahidh M. Assessment of palatal dimensions in a sample of Iraqi adults with different facial forms Iraqi Orthod J 2014;10:8-11.
6. Farooq A, Mahmood A, Jabbar A. Correlation of inter canine width with vertical facial morphology in patients seeking orthodontic treatment. Pakistan Oral Dent J 2015;35:213-15.
7. Khera AK, Singh GK, Sharma VP, Singh A. Relationship between dental arch dimensions and vertical facial morphology in class I subjects. J Indian Orthod Soc 2012;46:316-24.
8. Prasad M, Kannampallil ST, Talapaneni AK, George SA, Shetty SK. Evaluation of arch width variations among different skeletal patterns in South Indian population. J Nat Sci Biol Med 2013;4:94-102.
9. Grippaudo C, Oliva B, Greco AL, Sferra S, Deli R. Relationship between vertical facial patterns and dental arch form in class II malocclusion. Prog Orthod 2013;14:43.
10. Forster CM, Sunga E, Chung CH. Relationship between dental arch width and vertical facial morphology in untreated adults. Eur J Orthod 2008;30:288-94.
11. Al Shammout RWK. The effect of various classes of malocclusions on the maxillary arch forms and dimensions in Jordanian population. Adv Dent Oral Heal 2016;2:22-5.
12. Saeed HK, Mageet AO. Dental arch dimensions and form in a Sudanese sample. J Contemp Dent Pract 2018;19:1235-41.
13. Adil M, Adil S, Syed K, Aziz T, Badshah A. Comparison of inter premolar, molar widths and arch depth among different malocclusions. Pakistan Oral Dent J 2016;36:2016.
14. Shubha C *et al*. Shubha C *et al* (2018) 'Arch Length and Arch Width: A Tool in Gender Determination', *International Journal of Current Advanced Research,* 07(8), pp. 14822-14824.
15. Al-Zubair NM. Determinant factors of Yemeni maxillary arch dimensions. Saudi Dent J 2015;27:50-4.
16. Saragih AS. Statistik Daerah Provinsi Sumatera Utara. Medan: Badan Pusat Statistik Provinsi Sumatera Utara; 2011.
17. Oliva B, Sferra S, Greco AL, Valente F, Grippaudo C. Three-dimensional analysis of dental arch forms in Italian population. Prog Orthod 2018;19:34.
18. Mankapure PK, Barpande SR, Bhavthankar JD. Evaluation of sexual dimorphism in arch depth and palatal depth in 500 young adults of Marathwada region, India. J Forensic Dent Sci 2017;9:153-6.
19. Zarringhalam M. Measuring palatal height in normal occlusion and malocclusions. J Dent Tehran Univ Med Sci 2004;1:39-42.
20. Widodo R, Muntasir A. Dentino: Jurnal kedokteran gigi. J Kedokt Gigi 2017;II: 12-5.
21. Sathyanarayana H, Premkumar S, Manjula W. Assessment of maximum voluntary bite force in adults with normal assessment of maximum voluntary bite force in adults with normal occlusion and different types of malocclusions. J Contemp Dent Pr 2012;13:534-8.
22. Peter H. An interview with Peter H. Buschang. Dental Press J Orthod 2010;19:26-36.
23. Sara Mariam *et al*., A Cross-Sectional Research to Assess the Association Vertical Facial Morphology and Inter Canine Width., Indo Am. J. P. Sci, 2019; 06(08).
24. Nakatsuka M, Iwai Y, Jue S-S, Oh S-H, Guo L, Tominaga Y, *et al*. A morphological study on the classification of maxillary dental arches. Okajimas Folia Anat Jpn 2004;81:5-13.
25. Huang X, Hu X, Zhao Y, Wang Y, Gu Y. Preliminary comparison of three-dimensional reconstructed palatal morphology in subjects with different sagittal and vertical patterns. BMC Oral Health 2020;20:55.