High Angle Cases in Different Types of Skeletal Pattern among Malay Orthodontic Patients

Afifah Syairah Abu Yazid[1], Amir Ashraf Muhammad Sukri[2], Syiral Mastura Abdullah[3]*, Aspalilah Alias[4]

1. Klinik Pergigian Benta, Pahang.
2. Klinik Pergigian Presint 9, Putrajaya.
3. Department of Paediatric Dentistry and Orthodontic, Faculty of Dentistry, Universiti Sains Islam Malaysia.
4. Department of Basic Science, Faculty of Dentistry, Universiti Sains Islam Malaysia.

Abstract

High angle case is a type of malocclusion where the value of maxillo-mandibular plane angle (MMPA) exceed normal value and orthodontist often faces problem in managing patient with this type of case.

This retrospective study was conducted to determine the prevalence and dentoalveolar features of high angle cases in Malay orthodontic patients treated in USIM specialist clinic. The sample comprised of 264 lateral cephalograms that were traced manually. The following values were assessed: ANB angle, MMPA, interincisal angle (IIA), upper molar angulation (UMA), lower molar angulation (LMA) based on 11 landmarks. Vertical skeletal pattern, anteroposterior skeletal pattern and dentoalveolar features based on interincisal angle and molar angulation were calculated. All data were analysed using descriptive statistic and chi square test. The prevalence of high angle cases were the highest in class II skeletal pattern. There was significant association between anteroposterior and vertical skeletal pattern. For dentoalveolar features, IIA and UMA revealed the most acute angle in class II skeletal pattern. In contrast for LMA, class I skeletal pattern had the most acute angle.

Most patients with class II skeletal pattern were found with high angle vertical dimension and acute interincisal angle and upper molar angulation which indicated high anchorage demand and long-term retention after orthodontic treatment.

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Introduction

Most people might have some degree of malocclusion. There are various etiologic factors that can contribute to malocclusion. Hereditary play a strong role as etiologic factor in both families and in racial group and ethnic.[1] Etiology of malocclusion can be due to deviation in dental, skeletal and soft tissue development of the person. Different individual might have one or more etiologic factors that can lead to malocclusion.[2] Both skeletal and dental play an important role in determining the diagnosis and treatment planning. Early detection of malocclusion can help in future effective treatment.[3]

It has always been a challenge in orthodontic field because of various clinical manifestation of different malocclusions and has their own influence on every individual. High angle case is one type of malocclusion where the value of Maxillary mandibular plane angle (MMPA) exceeds normal value. MMPA value exceed normal means that there is presence of excessive vertical growth where lower anterior facial height (LAFH) is greater than normal. The angle is traced and measured on lateral cephalogram and range of normal value is different depends on ethnicity. One of the challenges that orthodontic often experienced is management of the long face syndrome's patient. There are various terms that can be used for excessive vertical craniofacial growth for instance long face syndrome, skeletal open bite, high angle, hyperdivergent, dolichofacial and adenoid

Corresponding author:
Syiral Mastura Abdullah,
Department of Paediatric Dentistry and Orthodontic, Faculty of Dentistry, Universiti Sains Islam Malaysia.
Email: drsyiralmastura@usim.edu.my

face.[4] Long face syndrome or facial hyperdivergent is defined as a disproportion of facial features which give elongated face impression even if the dimension is normal.[5] The etiological factor of excessive vertical growth facial development is associated with both genetic and environmental factor. Enlarged adenoids, nasal allergies, weak masticatory muscles, oral habit and genetic factors are among the contributors that have been proposed in development of long face morphology.[6]

In orthodontic, cephalometric radiographs is an essential and valuable tool in diagnosis and treatment planning. Cephalometric radiography which is gold standard is referring to measurement of cranium and also orofacial complex with help of standardized skull radiographs by verifying certain planes, lines or angles between the anthropometric landmarks and points. The word *cephalo* means head and *metrics* mean measurement and three planes that commonly used in orthodontics are transverse, sagittal and vertical. This cephalometric technique in orthodontics was established in 1931 by Holly Broadbent of the USA and Herbert Hofrath of Germany.[7]

In the United States, there were two large studies that involved large orthodontic based patient sample which they investigated about the prevalence of skeletal facial types. Both studies revealed that prevalence of long face syndrome are 22%. Based on Angle's malocclusion, study conducted on Belgian orthodontic patients, their vertical growth pattern differs with the highest proportion belong to class III sample (35%) followed by class I sample (32%) and then class II division I (30%), class II division II (18%).[8] On another study, the researchers investigated the skeletal malocclusion among Brazilian samples and their findings were consistent with previous findings as mentioned before.[9]

Besides, one researcher found out prevalence of vertical maxillary excess (VME) is nearly 22% among ethnically diverse Asian population who received orthognathic surgery. This retrospective study was conducted on orthognathic patients based on patients' records examination from Dentofacial Deformities clinic in National Dental Centre in Singapore. In his study, distribution of VME were different according to classes of malocclusion and the lowest prevalence of VME owned by class III malocclusion (10%) while the highest occurred in class 1 malocclusion (50%) and 48% belong to class II malocclusion.[10] hence, this study was conducted to determine the prevalence and dentoalveolar features of high angle cases in Malay orthodontic patients treated in USIM specialist clinic.

Materials and methods

This study was a retrospective study. It was conducted at Polyclinic Universiti Sains Islam Malaysia (USIM), where the cases were taken from database in the USIM e-clinical system and respective images from Planmeca Romexis software. These cases included all males and females of Malay racial group. The target population included relevant cases (see below) received at the Faculty of Dentistry USIM during research period. Inclusion criteria in this study were patients of Malay ethnicity with complete treatment plan record. Exclusion criteria were patients with craniofacial anomalies. Sample size was determined using EPI-info version 5.4.1.1 with confidence level 95%, margin of error 5.0% and expected frequency 22.2%. Thus, sample size was 264. Non-probability purposive (convenience) sampling method was used in this study.

This study involved retrospective cases, where data from the selective Planmeca Romexis of lateral cephalogram radiograph were retrieved from the archived images server accordingly. The pre-treatment (diagnostic) records, 8x10 inches lateral cephalograms were traced on 8x10 inches acetate matte paper with a 3H sharp drawing pencil. The linear and angular measurements were made with the help of a millimeter ruler and protractor, respectively. Anteroposterior skeletal patterns were identified by using ANB angle (Figure 1) and subjects were divided into three skeletal groups according to the following criteria:

- Skeletal pattern I: Subjects with ANB value between 1º- 5º
- Skeletal pattern II: Subjects with ANB value > 5º
- Skeletal pattern III: Subjects with ANB value < 1º

Maxillo-Mandibular Plane Angle, MMPA (Figure 2) were used to identify subjects with high angle cases.

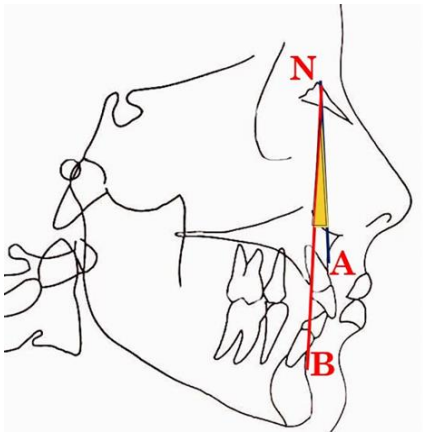

Figure 1: ANB angle.

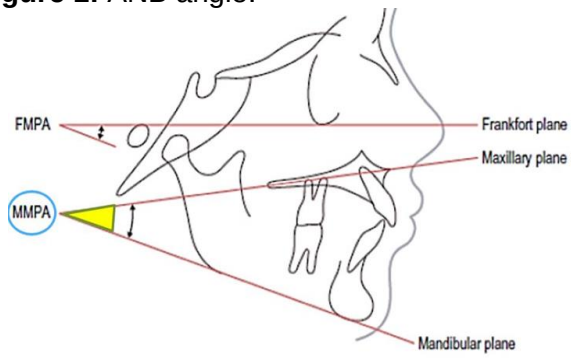

Figure 2: Maxillo-Mandibular Plane Angle (MMPA).

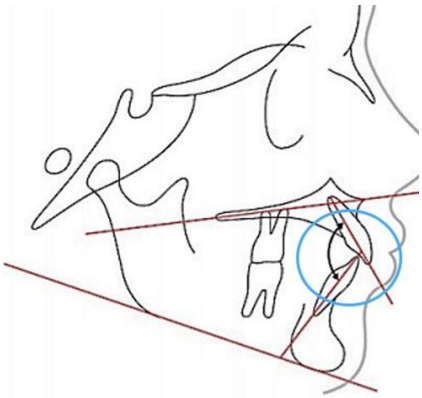

Figure 3: Interincisal Angle (IIA).

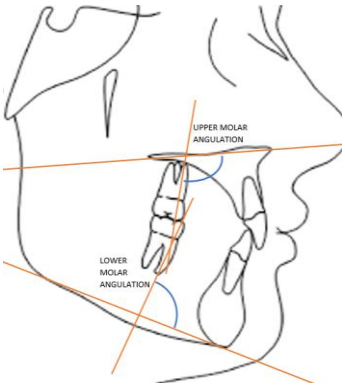

Figure 4: Molar Angulation (MA).

The Maxillary Mandibular Plane Angle (MMPA) was derived from the intersection of the mandibular plane and maxillary plane. This angle was traced and measured on a cephalogram. MMPA is in normal range if it is up to 26 ±5 degrees. All the readings for high angle cases were recorded according to the group of skeletal patterns. The mean value for each group was obtained. Then upper and lower incisor were traced and interincisal angle were obtained (Figure 3). Lastly lower first molar was traced and the angulation of lower first molar was obtained. All the tracings were done by two operators. Before proceeding with tracing, training session for tracing the lateral cephalogram were done before actual tracing. It was done under direct supervision by the orthodontist. After that, calibration test was done to achieve inter and intra-examiner reliability and reproducibility. Lateral cephalographs were viewed by the examiners and assessed under standardized conditions before the actual data examination. In doubtful cases, a consensus was reached by discussion with orthodontist.

Definition of landmarks:

Landmarks	Definition
Nasion (Na)	The junction of the nasal and frontal bones at the most posterior point on the curvature of the bridge of the nose.
A-point (A)	An arbitrary measure point on the innermost curvature from the maxillary anterior nasal spine to the crest of the maxillary alveolar process. A-point is the most anterior point of the maxillary apical base.
B-point (B)	An arbitrary measure point on the anterior bony curvature of the mandible. B point is the innermost curvature from chin to alveolar junction.
Anterior Nasal Spine (ANS)	The most anterior point on the maxilla at the nasal base.
Posterior Nasal Spine	The sharp posterior extremity of the nasal crest of the hard palate.
Menton (Me)	The lowest point on the symphysis of the mandible.
Orbitale (Or)	The lowest point of inferior margin of the orbit. Midpoint between right and left images.
Porion (Po)	The midpoint of th upper contour of the external auditory canal (Anatomic Porion) or a point midway between the top of the image of the left and right ear-rods of the cephalostat (Machine Porion).
Gonion (Go)	A point midway between the points representing the middle of the curvature at the left and right angles of the mandible
Interincisal angle (IIA)	Angle that is formed between the long axis of upper and lower central incisor
Molar angulation (MA)	Angle between the occlusal surface of the maxillary and mandibular first molar crowns and the palatal and mandibular planes

Results

Samples were analysed according to age, sex, anteroposterior skeletal pattern and vertical skeletal pattern. The mean age of the subjects was 19.94 ± 5.66 years old. The ratio of female to male was 2.62:1 as shown in Table 1.

	Frequency		
Gender	Female (%)	Male (%)	Age (mean ± SD)
	191	73	19.94 ± 5.659
Total	264 (100)		

Table 1. Demographic Characteristics of The Subjects.

The values of intraclass correlation coefficient measuring intra-examiner reliability were found to be in range between 0.894 to 0.979 for all variables suggesting that good to excellent reliability between two examiners. The scores were as shown in Table 2.

Measurements	Intraclass Correlation Coefficient (ICC)	
	Single Measures	Average Measures
SNA	0.866	0.928
SNB	0.818	0.900
ANB	0.952	0.979
MMPA	0.860	0.925
IIA	0.902	0.949
UMA	0.953	0.976
LMA	0.808	0.894

Table 2. Intraclass Correlation Coefficient (ICC).

The frequency of anteroposterior skeletal pattern Class I, Class II and Class III were 146(55.3%), 68(25.8%) and 50(18.9%) respectively. While for vertical skeletal pattern, the frequency of patients was 51 for hypodivergent/low angle MMPA (19.3%), 161 for normodivergent / normal angle (61%) and 52 for hyperdivergent / high angle (19.7%). (Table 3).

Characteristics	Frequency (%)			$\chi 2$ stats (df)	*P* - value
	Low angle	Normal angle	High angle		
Sk pattern I	38 (14.4)	91 (34.5)	17 (6.4)	23.608 (4)	<0.001
Sk pattern II	6 (2.3)	37 (14.0)	25 (9.5)		
Sk pattern III	7 (2.6)	33 (12.5)	10 (3.8)		

Table 3. Association Between Anteroposterior and Vertical Skeletal Patterns.

The prevalence of high angle cases in different skeletal pattern were shown using descriptive statistic. Total high angle cases from this study were 52 subjects with the highest prevalence belongs to Class II skeletal pattern for 25 subjects (48.1%) and the lowest prevalence shown in Class III skeletal pattern for 10 subjects (19.2%) while Class I skeletal pattern comprised of 17 subjects (32.7%).

This study showed the prevalence of MMPA for Class I skeletal pattern is the highest in normal angle (n=91,34.5%) compared to low angle (n=38,14.4%) and high angle (n=17,6.4%). Meanwhile, Class II and Class III skeletal pattern showed trend of highest percentage in normal angle followed by high angle and low angle. In Class II skeletal pattern, the prevalence of normal angle was (n=37,14.01%), high angle (n=25,9.5%) and low angle (n=6,2.3%). Whereas in Class III skeletal pattern, the prevalence of normal angle was (n=33,12.5%), high angle (n=10,3.8%) and low angle (n=7,2.6%). Pearson's Chi Square showed there was significant association between anteroposterior and vertical skeletal pattern χ^2 (4) = 23.608, *p*-value <0.001. (Table 3).

	IIA (mean ± SD)	UMA	LMA	N (%)	Total N (%)
Low angle					
Sk pattern I	115.671 ± 10.143	90.681 ± 8.499	89.447 ± 6.706	38 (14.4)	51 (19.3)
Sk pattern II	111.167 ± 13.761	95.333 ± 7.528	86.000 ± 5.329	6 (2.3)	
Sk pattern III	121.714 ± 9.393	92.643 ± 6.156	90.571 ± 6.901	7 (2.7)	
Average angle					
Sk pattern I	115.463 ± 10.713	87.467 ± 6.160	92.879 ± 7.840	91 (34.5)	161(61.0)
Sk pattern II	112.811 ± 9.75	88.189 ± 5.542	91.378 ± 8.466	37 (14.0)	
Sk pattern III	120.621 ± 9.875	89.439 ± 5.542	96.152 ± 8.466	33 (12.5)	
High angle					
Sk pattern I	111.853 ± 8.831	85.765 ± 9.228	95.647 ± 10.043	17 (6.4)	52 (19.7)
Sk pattern II	109.400 ± 9.506	82.996 ± 6.456	95.700 ± 8.958	25 (9.5)	
Sk pattern III	112.450 ± 11.036	85.900 ± 7.374	100.300 ± 9.911	10 (3.8)	
Total					
Sk pattern I	115.097 ± 10.368	88.089 ± 7.344	92.308 ± 8.026	146(55.3)	**264 (100)**
Sk pattern II	111.412 ± 10.826	86.910 ± 6.815	92.493 ± 8.535	68 (25.8)	
Sk pattern III	119.140 ± 10.412	89.180 ± 6.216	96.200 ± 8.868	50 (18.9)	
Total	**114.913 ± 10.766**	**87.992 ± 7.025**	**93.93 8.426**	**264(100)**	

Table 4. Total Number of Samples, Mean Values and Standard Deviation for IIA, UMA and LMA in

Vertical and Anteroposterior Skeletal Patterns.

The dentoalveolar features of high angle cases in different skeletal pattern were seen in three variables which are interincisal angle (IIA), upper molar angulation (UMA) and lower molar angulation (LMA) by comparing means(Figure 4). In Class I skeletal pattern, means value for IIA, UMA and LMA was 111.853° ± 8.8, 85.765° ± 9.22, 95.476° ± 10.04 respectively. Means value for IIA (109.4° ± 9.51), UMA (82.996° ±6.46) and LMA (95.7° ± 8.99) in Class II skeletal pattern. Class III skeletal pattern demonstrates means value for IIA (112.45° ± 11.04), UMA (85.90° ± 7.37) and LMA(100.30°±9.91). (Table 4).

Discussion

There are several authors have highlighted the importance of vertical growth, as it relates to anteroposterior growth in order to develop a proper skeletal proportion of the face. There was a study done by Ghafari et al (2013) theorized that the vertical problem can exacerbate or mask a discrepancy in the sagittal plane.[22] The present results showed similar results to study done by Silva et al (2019) which support that theories, since strong evidence of association (p <0.001) between sagittal and vertical skeletal pattern was found with all the three sagittal classification parameters.[23] They also mentioned that the Class II malocclusion group had a greater proportion of hyperdivergent (33.51 to 39.77%) than hypodivergent (7.95 to 13.83%) skeletal pattern.[23] Meanwhile, the Class III malocclusion group had a greater proportion of hypodivergent (27.59 to 29.66%) than hyperdivergent (6.90 to 12.41%) skeletal pattern.[23] Mouakeh et al (2001) also showed that patients with Class III malocclusion (clinical and dental evaluation) tended to have a significantly smaller vertical facial dimension and shorter lower anterior facial height.[24]

Based on the objectives of the study, we want to identify the association between the vertical and anteroposterior skeletal pattern. It can be concluded that there is significant association between vertical and anteroposterior skeletal pattern whereby p-value <0.001. The result showed the greater proportion of hyperdivergent (9.5%) in Class II compared to Class I (6.4%) and Class III (3.8%).

It is important to know the prevalence of high angle in different skeletal pattern as it will facilitate the clinicians in planning the treatment of the patient. Usually, clinicians tend to prioritize the sagittal problem when the correction could be more focused on the vertical problem. Based on the study done by Firouz et al (2000) stated that in Class II malocclusion with hyperdivergent skeletal pattern, therapeutic vertical control should be taken into account.[25] Therefore, it could be relevant to include the vertical growth control in the treatment protocols, such as using highpull headgear or transpalatal arch placed away from the palate.

There are various morphological characteristics that can assessed as predictors for vertical growth. It is important to know predictors of vertical growth as it might help in constructing treatment plan thus giving better treatment outcome. In one study by Qamar et.al (2020) stated that, mandibular morphology can be used to estimate the mandibular growth direction.[17] They also reported that there are other morphologic descriptors indicated by a researcher in his study which are mandibular symphysis, thickness of the cortical bone below the symphysis region, shape of lower border of mandible, mandibular canal curvature and also condylar head inclination.

In this study, it is shown that mean of upper molar angulation in high angle cases for Class II skeletal pattern is the lowest (82.996° ±6.46) compared to in Class I skeletal pattern (85.765° ± 9.22) and Class III skeletal pattern (85.90° ± 7.37) while for LMA, the angle is almost the same in those three type of anteroposterior skeletal pattern which are in skeletal pattern Class I (95.647° ± 10.04), Class II (95.7° ± 8.99), Class III (100.30° ± 9.91). These data suggested that UMA in high angle cases may be compensated to the maxillomandibular plane angle especially in skeletal pattern Class II.

Previous study by Davidovitch et.al (2016) stated that, in hyperdivergent cases, IIA for female (116.556° ± 12.611) while for male (117.556° ± 9.843).[27] In our study, we observed specifically for high angle cases in different skeletal pattern, mean values of IIA for skeletal pattern class I is 111.853° ± 8.831, class II (109.400° ± 9.506) and class III (112.450° ± 11.036). In conclusion, IIA in class II skeletal pattern is the lowest (acute) compared to others. Study by Noraina Hafizan Norman et al (2019) stated that Malay sample exhibited severe form

of protrusion with acute IIA and the range of dental protrusion may be a contribution to dental compensation in Class II and III skeletal discrepancy.[28] It is important to know few features that can be used as predictors of vertical growth. This might help the practitioner in constructing good treatment plan thus giving better treatment outcome for the patient especially in patients with skeletal pattern Class II.

Conclusions

Based on our study, it can be concluded that anteroposterior skeletal pattern can be influenced by the vertical growth. It showed statistically significant association between anteroposterior and vertical. Based on the sample and methods employed in this study, the result revealed that the prevalence of high angle cases was found higher in skeletal pattern Class II Class I and Class III respectively. For the dentoalveolar effect, three parameters have been evaluated which are interincisal angle, upper molar angulation and lower molar angulation. For this study we observed specifically on high angle where mean value of interincisal angle in skeletal pattern Class III is the highest followed by Class I and Class II. From this result, it is shown that in high angle cases, the interincisal angle in Class III has more obtuse angle than others. In upper molar angulation, the highest mean value is Class III followed by Class I and Class II. Most patients with class II skeletal pattern were found with high angle vertical dimension and acute interincisal angle and upper molar angulation which indicated high anchorage demand and long-term retention after orthodontic treatment.

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Declaration of Interest

The authors report no conflict of interest.

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