Cephalometric Norms of the Malay Population

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ABSTRACT

Objectives: To establish the cephalometric norms for the Malaysian Malay population and to determine the ethnic differences of cephalometric measurements between Malaysian Malay and Caucasian populations.

Design: Cross-sectional population study.

Materials and methods: This study sample consists of 100 subjects aged 15 to 30 on the basis of Class I skeletal pattern from Malaysian Malay pure ethnic groups (50 males, 50 females). Subjects were collected from records of orthodontic patients, Faculty of Dentistry, Universiti Teknologi MARA. 100 lateral cephalometric radiographs were analysed, with landmarks located and tracings were performed according to Eastman analysis using a Dolphin Imaging software. Cephalometric measurements were recorded with mean values statistically tabulated. Comparison between Malaysian Malay and Caucasian norm was performed, to further describe differences in the dentoskeletal features, using One sample t-test. Inter-reliability assessment using Interclass correlation (ICC) was done prior to statistical analysis.

Results: ICC showed excellent agreement between raters with value of correlation above 0.9. The Malaysian mean values were produced as standard norm with no statistical difference between male and female indicating that the data was well distributed and no bias. There was a significant difference of cephalometric measurement between Malaysian Malay and Caucasian norms for all values: SNA, SNB, UInc to MxPl, LInc to MnPl, inter-incisal angle, MMPA and facial proportion except for ANB.

Conclusion: Malaysian Malay norm was established. Significant differences were observed between Malaysian Malay and Caucasian for all values implying that the former was more prognathic than the latter. Thus, these norm values established in this study would help as a guide in orthodontic assessment, examination, diagnosis and consequently the treatment plan for Malaysian Malay population.

KEY WORDS

Malaysian Malay norm, Lateral cephalometric radiograph, Eastman analysis

INTRODUCTION

Historical Development and Types of Cephalometric Analysis

Prior to cephalometric radiography, orthodontists of earlier times used anthropometric measurements to help establish facial proportions. These measurements were made directly to the patients face during the clinical examination using either bow calipers or straight calipers and the anatomical points were measured in linear readings or in proportions or percentages⁴. This clinical anthropometry, was then replaced since the development of radiographic cephalometry in 1931 by Broadbent and Hofrath. It has been widely utilized as an essential tool for study of malocclusions. These cephalometric analyses became important clinical tools in orthodontic diagnosis and treatment planning. This allowed orthodontist to study skeletal, dental and soft tissue structures associated with human facial skeleton.

Most commonly used cephalometric analyses presented in their basic earliest forms; such as Downs (1948, 52) used to assess the anteroposterior skeletal discrepancy of an individual⁵ in profile orientation relating the dentition and the dental measurements to the cranial base using the facial plane (N-Pog). Downs incorporated the y-axis (S-GN) which indicate the direction of facial growth.

Whilst Steiner (1955) and Eastman (Mills 1970, 76) incorporated a composite analysis of Margolis, Thompson, Riedel, Wylie, Northwestern, Ballard and Downs to show both dental and skeletal discrepancies and relates one to the other using linear and angular measurements. The skeletal pattern is assessed anteroposteriorly by the ANB difference and vertically by the maxillomandibular planes angle and by the lower face height proportion giving excellent visualization of incisor position and facial profile and allows prediction of the type of tooth movement required as a built-in treatment planning facility.

In both Steiner and Eastman analyses, however, the variations in the cant and length of the SN plane may affect the ANB difference and lead to misinterpretations.

Along the same era, Bjork (1947) and Tweed (1946, 53, 54) introduced more complicated analyses using concepts of polygon and triangles; Tweed Triangle, respectively. The polygon N-S-Ar-Gn using the three angles: saddle (N-S-Ar), articular (S-Ar-Gn) and gonial (Ar-Gn-Gn) and the lengths of the sides of the polygon seems useful for superimposition and research purposes. The analysis also assesses the
antior and posterior face height relationship and enables a prediction of growth change in the lower face by the PFH:AFH ratio (Jarabak, 1972). Tweed Triangle, which is formed by the Frankfort mandibular and lower incisor axis planes. The angles contained by the triangle are used to calculate the optimal position of the lower incisors.

Further to that, Ricketts (1960, 1961) added an aesthetic plane to measure the soft tissue position, thereby portraying the harmony of the lips with nose and chin. The anteroposterior discrepancy between the maxilla and mandible is measured by facial convexity the relationship of point A to the facial plane (N-Pog). The facial axis, a modification of Downs’ y-axis, illustrates the general direction of facial growth and is an indicator of facial height. Ricketts has developed a computerized growth prediction and treatment planning service, which is based on averages collected over many years.

Wits (Jacobson, 1975), a diagnostic aid consists of a dental assessment, relating the jaws to each other utilizing their common plane the functional occlusal plane. It is useful when results given by other methods are confusing, for example, when the ANB difference does not reflect a clinical assessment of anteroposterior dysplasia.

As with many assessments limiting factors are still present and unavoidable. Difficulty in identification of landmarks such as sella, nasion, variations in the cant, length and planes as well as distortion of images may lead to human misinterpretations in some cases. However, this brief overview of the development of cephalometric analysis provides reasonable understanding of past trends, current analysis and usage.

**Cephalometric Norms: General Racial, Ethnic Characteristics and Diversity**

Divergence of the face is defined as an anterior or posterior inclination of the lower face relative to the forehead. Divergence from a true straight profile seen in Eastern European does not indicate facial or dental disproportions and often enough warrants treatment.

The problem statement on our local vicinity is that, these norms need to be established as they affect our diversified ethnic groups. In 2017, the total population of Malaysia is estimated at 32 million persons. The ethnic composition is made up of three main races, which are: Malays (63.1%), Chinese (24.6%) and Indians (7.3%). Studies on cephalometric norms of Malaysian Indian and Malaysian Chinese by Purmal K. et al have been conducted in 2013, whilst Malaysian Malay norm is limited in reference and very much in need.

No comprehensive study of the cephalometric norms of Malaysian Malay was investigated, formally researched and published, past works involved academic exercises in undergraduate book chapter, unpublished dissertation which benefits students referencing in local universities only or work performed based on not so commonly used analysis in contemporary orthodontics, therefore not applicable as a reference for diagnosis and treatment planning. The frequently used and taught analyses in many universities are based on Eastman analysis.

It is crucial to have data concerning relevant human group for purposes of clinical diagnosis and planning of treatment. These data of ethnic differences in facial profile and skeletal features should be considered during treatment, especially in orthodontics, maxillofacial surgery and prosthodontics. Thus, the objectives of this cross-sectional study were to:

1) Establish a cephalometric norm for the Malaysian Malay, as a reliable guide and point of reference for our local and overseas orthodontic practitioners delivering orthodontic treatment, and

2) Determine the ethnic differences of cephalometric measurements between Malaysian Malay and Caucasian norms.

**MATERIALS AND METHODS**

This was a cross-sectional study involving the collection and analysis of lateral cephalometric radiographs. Ethical approval for this study was obtained from UiTM Research Ethics Committee on 9th May, 2017.

The sample were collected from the students of University Teknologi MARA and dental patients in the Faculty of Dentistry, University Teknologi MARA. The study sample consist of subjects between 15 and 30 years old and they were divided into 50 males and 50 females. Initially, the total sample was 126. After some exclusion criteria, the sample were reduced to 100. The study sample were selected; their information such as dental history and lateral cephalometric radiographs retrieved from case records, with following criteria adhered.

A Class I skeletal pattern and Class 1 incisor relationship according to British Standards Institute classification excluding bimaxillary protrusion. All of the subjects had full set of permanent teeth in both jaws regardless of the third molars. Normal growth and development, well aligned or minimal crowding in the maxillary and mandibular dental arches. Good symmetry and balanced facial profiles. No symptoms related to TMJ disorder and no orthodontic treatment, plastic surgery or any types of surgical treatment as well as no prosthetic treatment or major conservative work.

Most importantly showed no need for orthodontic treatment according to index of orthodontic treatment need (IOTN) for both dental health and aesthetic component.

By using Dolphin Imaging software, each subject’s information was recorded and analyzed (patient’s name, age, gender and lateral cephalometric radiograph). Cephalometric landmarks were digitized directly from radiographs as shown in Figure 1. The following landmarks were digitized:

- **Skeletal**
  - Porion (Po)
  - Gonion (Go)
  - S.T. glabella
  - U6 Occlusal
  - Ramus point
  - S.T. nasion
  - L6 Occlusal
  - Mid ramus (R1)
  - Bridge of nose
  - Distal U6
- **Soft tissue**
  - R2
  - Tip of nose
  - Mesial U6
  - Sigmoid notch(R3)
  - Subnasale
  - Distal L6
  - Articulare
  - Upper lip
  - L1 labial gingival border
  - Nasion (N)
  - Condyion
  - Stormion superius
  - L1 tip
Seven angular measurements and one facial proportion were digitized and assessed according to Eastman analysis. The following cephalometric values were calculated: SNA, SNB, ANB, Maxillary Incisal Inclination (UInc to MxPl), Mandibular Incisal Inclination (LInc to MnPl), Inter-incisal angle, Maxillary-Mandibular Planes Angle (MMPA) and facial proportions.

Prior to the analysis of the landmarks, the tracings of 10 radiographs which were performed by two operators, double-checked with an orthodontist to ensure good inter-reliability assessments using Interclass correlation (ICC). Further statistical analysis was performed using One sample t-test to compare the outcome with Caucasian population norms.

RESULTS

The significant level for this study was set at $p < 0.05$. Inter-reliability assessments using ICC showed excellent agreement between raters (value of correlation was above 0.9).

The descriptive statistic result of all lateral cephalometric radiographs for seven angular measurements and one facial proportion for the whole sample (100 subjects) from both genders comparing Malaysian Malay and Caucasian population are presented in Table 1. All the measurements show $p$ value more than 0.05. Therefore, the cephalometric measurements of the skeletal and dental features reveal no significant difference between both genders. This suggests that the measurements are well distributed between male and female with no bias.

**DISCUSSION**

In this study, we have selected the sample based on the criteria as specified in the materials and methods whereby the emergence bimaxillary features were excluded from the sample. This was done to not deviate the range too much, creating weak mean and large standard deviation, thus failing to provide accurate and predictable norm values.

Cephalometric studies on Malaysian Malay population indicated that there were skeletal and dental differences when compared to Caucasian norms in Eastman analysis except for ANB value as analysed by One sample t-test.

SNA and SNB angle indicate the relationship of anteroposterior skeletal of the jaws to the nasion. The SNA and SNB angle was higher than Caucasian norms in Eastman analysis. It shows that both maxilla and mandible of Malaysian Malay population are more prognathic compared with Caucasian norms.

The skeletal pattern can be assessed by looking at angle ANB which shows 3.2° compared to Caucasian population. MMPA shows reduced value in Malay norms which is 24.8° while facial proportion has a slight difference with value of 55.7%. Dentally, the upper and lower incisors values were higher with reduced inter-incisal angle. The mean for UInc to MxPl for Malaysian Malay population is 117.3° while the LInc to MnPl value is 96°.

Using One sample t-test, the analysis suggests that there are significant differences between Malaysian Malay and Caucasian for all values: SNA, SNB, UInc to MxPl, LInc to MnPl, inter-incisal angle, MMPA and facial proportion except ANB which remain the same. These values suggest that the skeletal and dental features of Malaysian Malay were more prognathic from the Eastman standard.

Male and female cephalometric values of skeletal and dental features were compared using Independent t-test and the results are presented in Table 2. The cephalometric values are well distributed between male and female with no bias.

### Table 1. Result of cephalometric values between Malaysian Malay and Caucasian norms.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Eastman mean</th>
<th>Malay mean</th>
<th>SD</th>
<th>t-value</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNA (°)</td>
<td>81</td>
<td>84.5</td>
<td>4.0</td>
<td>8.9</td>
<td>0.000*</td>
</tr>
<tr>
<td>SNB (°)</td>
<td>78</td>
<td>81.2</td>
<td>4.1</td>
<td>8.0</td>
<td>0.000*</td>
</tr>
<tr>
<td>ANB (°)</td>
<td>3</td>
<td>3.2</td>
<td>1.2</td>
<td>1.7</td>
<td>0.099</td>
</tr>
<tr>
<td>UInc to MxPl (°)</td>
<td>109</td>
<td>117.3</td>
<td>6.5</td>
<td>12.8</td>
<td>0.000*</td>
</tr>
<tr>
<td>LInc to MnPl (°)</td>
<td>93</td>
<td>96.0</td>
<td>7.1</td>
<td>4.2</td>
<td>0.000*</td>
</tr>
<tr>
<td>Inter-incisal angle (°)</td>
<td>135</td>
<td>121.8</td>
<td>8.8</td>
<td>-14.9</td>
<td>0.000*</td>
</tr>
<tr>
<td>MMPA (°)</td>
<td>27</td>
<td>24.8</td>
<td>6.7</td>
<td>-3.3</td>
<td>0.001*</td>
</tr>
<tr>
<td>Facial proportion (%)</td>
<td>55</td>
<td>55.7</td>
<td>2.3</td>
<td>2.9</td>
<td>0.004*</td>
</tr>
</tbody>
</table>

*mean statistically significant difference

### Table 2. Result of male and female cephalometric values.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (Male)</th>
<th>SD</th>
<th>Mean (Female)</th>
<th>SD</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNA (°)</td>
<td>84.6</td>
<td>4.8</td>
<td>84.5</td>
<td>3.0</td>
<td>0.861</td>
</tr>
<tr>
<td>SNB (°)</td>
<td>81.3</td>
<td>4.7</td>
<td>81.2</td>
<td>3.4</td>
<td>0.932</td>
</tr>
<tr>
<td>ANB (°)</td>
<td>3.1</td>
<td>1.2</td>
<td>3.3</td>
<td>1.1</td>
<td>0.524</td>
</tr>
<tr>
<td>UInc to MxPl (°)</td>
<td>117.7</td>
<td>6.7</td>
<td>116.8</td>
<td>6.4</td>
<td>0.424</td>
</tr>
<tr>
<td>LInc to MnPl (°)</td>
<td>94.6</td>
<td>7.7</td>
<td>97.3</td>
<td>6.3</td>
<td>0.063</td>
</tr>
<tr>
<td>Inter-incisal angle (°)</td>
<td>122.6</td>
<td>10.2</td>
<td>121.1</td>
<td>7.1</td>
<td>0.415</td>
</tr>
<tr>
<td>MMPA (°)</td>
<td>24.7</td>
<td>7.2</td>
<td>24.9</td>
<td>6.2</td>
<td>0.893</td>
</tr>
<tr>
<td>Facial proportion (%)</td>
<td>55.9</td>
<td>2.4</td>
<td>55.5</td>
<td>2.1</td>
<td>0.377</td>
</tr>
</tbody>
</table>

*mean statistically significant difference
value shows the mutual relationship of the maxilla and mandibular base in sagittal plane\(^2\). Statistically, there is no significant difference in ANB value of Malaysian Malay population compared with Caucasian. This might be due to the forward protrusion of maxilla and mandible occurring concurrently thus, resulting in no difference in ANB value.

Significant differences between UInc to MxPl and LInc to MnPl in Malaysian Malay are higher compared to Eastman analysis. This difference shows that upper incisor and lower incisor of Malaysian Malay population are more proclined compared to Caucasian norms. Subsequent to the protrusion and proclination of upper incisor and lower incisor, the inter-incisal angle for Malaysian Malay population is significantly reduced.

Maxillary-Mandibular Planes Angle (MMPA) represents the inclination of the maxilla relative to the mandible. MMPA reflects both posterior or lower facial height and anterior lower facial height. MMPA of Malaysian Malay population shows a significant reduction compared to Caucasian.

Facial proportion is calculated as a percentage based on the ratio of the lower facial height to the total anterior facial height measured perpendicularly from the maxillary plane. Statistically, there is slight significant difference of facial proportion between Malaysian Malay population and Caucasian norms but the values almost similar to Caucasian with only 0.7% difference. This finding shows that there is a discrepancy between MMPA and facial proportion in terms of vertical relationship. Since MMPA reflects both posterior lower facial height and anterior or lower facial height, reduced MMPA with slight difference in facial proportion may suggests that the posterior lower facial height is increased rather than a decreased in anterior lower facial height.

No significant difference was observed for measurements between male and female as analyzed using Independent t-test. This finding suggests that the measurements are well distributed for both genders and the data are non-gender bias.

Simple and commonly used variables in this study had produced an accurate, controlled norm with an easy quick start for referencing and reproducibility. No doubt more variables; linear, angular proportions to be included to cater for more sophisticated analysis in research and surgical fields. With this controlled, non-gender bias data and careful exclusion of the emergence bimaxillary protrusion, Malaysian Malay population still displayed greater anteroposterior position of maxilla and mandible, greater axial incisors inclinations to respective planes and more acute interincisor angles compared to the Caucasian norm. Normal to mild skeletal-dental bimaxillary protrusion, forms a pragmatic and predictable configuration of Malaysian Malay ethnic norm.

CONCLUSION

To summarize, the Malaysian Malay standard norm has been established in this study. There are significant differences observed between Malaysian Malay population and Caucasian norms for all cephalometric values inferring that the Malays are more protrusive than the Caucasians. These differences in skeletal and dental features are unique to the Malay population and would assist in anthropomorphic assessment, orthodontic examination, diagnosis and consequently formulate a proper treatment plan.

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REFERENCES