

Research Report

Howe's dental cast analysis of students at the University of Sumatera Utara

Hilda Fitria Lubis and Tiopan Beltsazar Sinurat
Department of Orthodontics,
Faculty of Dentistry, Universitas Sumatera Utara,
Medan – Indonesia

ABSTRACT

Background: Cast analysis is the measurement of the upper and lower arch in a 3-dimensional occlusal relationship. Howe's Analysis can be used to observe total tooth material, arch length, and basal arch width. Howe's Analysis was conducted to analyse abnormalities of both teeth and the jaw to help diagnose and plan dental care. **Purpose:** To analyse the difference in total tooth material, arch length, basal arch width, and Howe's Index between male and female undergraduate students from the University of Sumatera Utara who are of Proto-Malay origin. **Methods:** Ninety-six samples comprised of 48 male and 48 female students were recruited through the purposive sampling method. All samples were undergraduate students at the University of Sumatera Utara and of Proto-Malay origin, aged between 18 to 26, and have met the exclusion and inclusion criteria. We measured the variables using a digital caliper to measure basal arch width and arch length and Moorrees' method to measure total tooth material. Data were analysed statistically using an independent t-test to compare means between groups ($p < 0.05$). **Results:** The male samples' average value of total tooth material 98.49 mm \pm 3.79, arch length 45.55 mm \pm 2.28, basal arch width 41.07 mm \pm 2.83, and Howe's Index were 41.71 % \pm 2.63, respectively. The female samples had a lower value compared to the male samples, 94.51 mm, 43.27 mm, 36.89 mm, and 39.05 % respectively. There was a significant difference in the total tooth material, arch length, basal arch width, and Howe's Index between male and female undergraduate students from the University of Sumatera Utara of Proto-Malay origin ($p = 0.001$; $p < 0.05$). **Conclusion:** The average measurement of total tooth material, arch length, basal arch width, and Howe's Index was higher in male than female undergraduate students from the University of Sumatera Utara of Proto-Malay origin.

Keywords: Howe's Analysis; Howe's Index; orthodontics; Proto-Malay

Correspondence: Hilda Fitria Lubis, Department of Orthodontics, Faculty of Dentistry, University of Sumatera Utara. Jl. Alumni No. 2, Medan 20155, Indonesia. Email: hildadrgusu@gmail.com

INTRODUCTION

Recently, there has been an increase in interest for orthodontic treatment not only in children, but also in adolescents and adults. In general, a patient's main request is to fix the alignment and arrangement of the dentition to provide a better facial appearance and to positive self-image. Orthodontic treatment is a long-term procedure that aims to reach optimum stability, function, and aesthetic. An abnormal alignment will become malocclusion.^{1–3}

One of the most common types of malocclusion is crowding, which can be found in 2/3 of the human population. Crowding is defined as the discrepancy between

tooth size and available space on the arch, so that the dentitions become crowded and rotated.⁴

Treatments of crowding are proximal stripping, expansion plates, proclination of anterior teeth, distalization, and extraction. According to Graber, the goal of orthodontic treatment is to prevent and fix malocclusion, provide a harmonious facial shape, and provide good mastication. To achieve that, a cast analysis can be used as a guide to determine the diagnosis and proper planning in an orthodontic treatment.^{5,6}

Cast analysis or study model analysis is the measurement of the upper and lower arch in a 3-dimensional occlusal relationship. The correlation between the total tooth

material, arch length, and basal arch width can be observed using cast analysis. One of analysis methods that is often used in orthodontic treatment is Howe's Analysis proposed by Ashley Howe.^{2,7}

Based on expert opinions, every race has its own distinctive features, especially in the head and face regions. Measurements using Howe's Analysis have been done in individuals of Caucasoid origin by Howe, however it is not yet known whether the same result applies to other races. Because of that, there is a need to measure the dentitions in the upper jaws of patients of different origins and compare them with Howe's findings.²

Indonesia has a variety of ethnic groups and cultures that divide the ethnic groups in Indonesia into five major groups: Negrito, Proto-Malayid, Dayakid, Deutero-Malayid, and Madagassians. The percentage of the Proto-Malay ethnic group in Medan city is 24.46% from a total of 2,210,624 people and has become the biggest ethnic group in Medan. The researchers chose the Proto-Malay ethnic group because Proto-Malay is the biggest ethnic group in Medan.^{8,9} Thus, the aim of this study is to analyse the difference of total tooth material, arch length, basal arch width, and Howe's Index between male and female undergraduate students from the University of Sumatera Utara of Proto-Malay origin.

MATERIALS AND METHODS

This study is a descriptive study on the measurement of the total tooth material, arch length, basal arch width, and Howe's Index. This study was conducted at the University of Sumatera Utara. The samples were recruited using a purposive sampling method based on the inclusion and exclusion criteria which consisted of 96 samples. The population in this study are the male and female undergraduate students at the University of Sumatera Utara of Proto-Malay origin aged between 18 and 26.

The inclusion criteria in this study were patients that were willing to participate in the research, signed their informed consent, were of Proto-Melayu race, 18 to 26

years old, of class I molar malocclusion, of class I canine malocclusion, had a complete number of teeth, had no history of orthodontic treatment, had crowding < 2-3 mm, and an ideal face profile. The exclusion criteria in this study were the patients that refused to participate, had caries, lesions or broken contacts, poor oral hygiene and a previous history of orthodontic treatment.

Measurements were taken after receiving consent from the participants. We took both maxillary and mandibular impressions of the samples chosen based on the purposive sampling method. We measured the basal arch width with a digital caliper and ruler according to Howe's method, total tooth material, and arch length. After obtaining the measurements, Howe's Index was calculated using the following formula⁶:

$$\text{Howe's Index} = \frac{\text{Basal arch width}}{\text{Total tooth material}} \times 100\%$$

Description:

Total tooth material = Sum of the mesio-distal width of 16-26 (mm)⁶

Basal arch width = Measurement of canine fossa from one side to another or between 14 to 24 (mm)⁶



Figure 2. Measurement of total tooth material which is obtained from the total width of the mesio-distal teeth of the right maxillary permanent first molar to the left maxillary permanent first molar.



Figure 1. Measurement of the basal arch width which is measured from the root tips of the first premolar teeth to the fossa of the right and left canines.



Figure 3. Measurement of premolar diameter.

Data collection were done with the consent of the samples in this study. Upper and lower alginate dental impressions were taken (mixing alginate powder with distilled water, which is the ratio following the manufacturer's recommendation) from the samples who were undergraduates from the University of Sumatera Utara obtained through purposive sampling method and who met the inclusion and exclusion criteria. The researcher collected the model to be analysed and prepared the tools necessary for the cast analysis. The variables measured were basal arch width with a digital caliper and ruler using Howe's method (Figure 1), tooth material according to Moorrees' method (Figure 2), and premolar diameter (Figure 3).^{10,11} Each day only 10 cast measurements were taken to avoid eye fatigue and the obtained data were further analysed.

RESULTS

In this study, we found that the average value of total tooth material, the arch length, the average basal arch width, and the average ratio of Howe's Index (Table 1) were all higher in male students compared to female students.

Statistical analysis using the Shapiro-Wilk Analysis showed that the data were normally distributed ($p > 0.05$) with p-value result of total tooth material ($p = 0.68$), arch length ($p = 0.68$), basal arch width ($p = 0.102$), and Howe's Index ($p = 0.051$). The results of the independent t-test showed a significant difference in the total tooth material, arch length, basal arch width, and Howe's Index between male and female undergraduate students from the University of Sumatera Utara of Proto-Malay origin ($p = 0.001$; $p < 0.05$).

Table 1. Mean and standard deviation of total tooth material, arch length, basal arch width, and Howe's Index for male and female students from the University of Sumatera Utara's Undergraduate Students of Proto-Malay Origin

Variables	Gender	Mean	SD	p-value
Total tooth material	Males (n=48)	98.49 mm	3.79	0.001
	Females (n=48)	94.51 mm	3.46	
Arch length	Males (n=48)	45.55 mm	2.28	0.001
	Females (n=48)	43.27 mm	2.37	
Basal arch width	Males (n=48)	41.07 mm	2.79	0.001
	Females (n=48)	36.89 mm	2.80	
Howe's Index	Males (n=48)	41.71 %	2.54	0.001
	Females (n=48)	39.05 %	2.85	

DISCUSSION

The orthodontic treatment of crowded teeth usually involves proximal stripping or grinding, expansion, proclination of the anterior teeth, distalization, and extraction. For that reason, we need an analysis of the study model or cast analysis. Cast analysis serves as a guide and has been the gold standard to determine proper diagnosis and treatment planning in orthodontic treatment for many years.^{5-7,12} Various methods have been used for measuring and analysing the study models, including calipers, rulers, and other measuring tools. The data obtained from the measurement results were calculated with the relevant formulas.¹² Howe's Analysis is one of the cast analysis developed by Ashley Howe. Howe discovered that the crowding of the teeth is generally due to a lack of width at the apical base, so that conditions where the width of the apical base is narrow can lead to irregular tooth arrangement. It was also found that there was a close relationship between the amount of tooth material and the width of the apical base, thus creating a formula for measuring Howe's Index.^{5-7,13}

In this study, we found that the average value of total tooth material, the arch length, the average basal arch width, and the average ratio of Howe's Index were all higher in male students compared to female students. This study had the same results as the study conducted by Pawar and Jayade in Karnataka Utara. Pawar and Jayade found that the male samples had a higher average measurement in total tooth material, arch length, basal arch width, and Howe's Index (89.46 mm \pm 3.20, 41.78 mm \pm 1.60, 42.28 mm \pm 1.49, 47.26 % \pm 1.59 respectively).¹³ However, the values in Pawar and Jayade's study had a lower value than the results we found in this study. The variations of the measurement results were due to the differences in the ethnic groups, hereditary traits, geographic locations, and cultural involvement between the two populations.^{13,14}

There was a significant difference in the total tooth material, arch length, basal arch width, and Howe's Index between male and female undergraduate students from the University of Sumatera Utara of Proto-Malay origin that indicated that there was a difference in the amount of dental material, the width of the dental arch, the width of the apical base, and the Howe's Index of the students at the University of Sumatera Utara of Proto-Malay origin which is significant between women and men. This study had a similar result as the study by Pawar and Jayade's and Burris and Harris's study in America that showed a different result between male and female samples.^{13,15} Studies of different ethnic groups also had been done by Eunike et al. in 30 patients in Maranatha Dental and Mouth Hospital which showed that there were significant differences in the measurements of the length and width of the dental arch and Howe's Index, whereas the measurement of the apical base showed no significant difference between the results of the study and the reference to the Caucasian race.² This study also differs from the study conducted by Govindaraj

et al. on 30 diagnostic models of patients at Saveetha Hospital in Chennai City in a South Indian population.¹⁴ A variation value was found in these ethnic groups due to influences in the size and shape of the dentition and the jaw, different culture, environment, and lifestyle in different places.^{2,13,14,16}

Anthropology experts believe that each race holds a distinctive feature in the head and neck regions. Howe's cast analysis was commonly evaluated in Caucasoid samples and the difference in the results with different ethnic groups is not yet known.² This study found that the average measurement of total tooth material, arch length, basal arch width, and Howe's Index was higher in males compared with female undergraduate students from the University of Sumatera Utara of Proto-Malay origin.

The results in this study of the Proto-Malay race of students at the University of Sumatera Utara showed that the amount of dental material in males had a greater value than females, which indicated that males had a wider tooth shape than females. The arch width of the teeth and the width of the apical base in men had a greater value than women which indicated that the upper jaw in men was wider than in women, and the Howe's index results obtained by men showed a greater value than in women. This difference was caused by hormonal factors and lifestyle. These results were similar to the results of a study conducted by Azlan et al. that showed a significant difference in intermolar width in Indonesia, where the intermolar width in men was greater than in women.¹⁷

From this study result, it can be concluded that the average measurement of total tooth material, arch length, basal arch width, and Howe's Index is higher in male than female undergraduate students from the University of Sumatera Utara of Proto-Malay origin. Indonesia consists of many races (many of which are mixed) which have various shapes and tooth sizes, thus the use of Howe's Analysis for diagnosing abnormalities of maxillary teeth in Indonesian people needs to be studied further for its importance in diagnosis and treatment planning. Further research is needed with a larger number of samples and it is necessary to conduct the study on other races, for example the Deutromelayu and mixed races. It is also necessary to do further research using samples with class I and class II malocclusion and samples with different age groups.

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