The comparison between the length of vertical dimension of occlusion and the length of thumb on undergraduate Mongoloid students

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ABSTRACT

The Thumb Rule of Leonardo da Vinci states that many proportions of the face show relationship with the length of thumb which is measured from the proximal tip of the proximal phalanx to the distal tip of the distal phalanx. Previous studies have shown that the length of vertical dimension of occlusion (VDO) is similar to the length of thumb among the Caucasoid race. The purpose of this study is to determine whether the length of VDO have correlations with the length of thumb among those of the Mongoloid race. This study took a survey method with analytical cross sectional approach. A total of 80 students of Faculty of Dentistry who have fulfilled all population criteria were randomly chosen to measure the length of VDO and the length of thumb. Results analyzed with Student's t-test statistic revealed that there was a significant difference between males and females in the length of VDO and the length of thumb, however there was no significant difference between the length of VDO and the length of thumb. There were very strong correlations ($P<0.05$) between the length of VDO and the length of thumb. As a conclusion, the length of thumb can be suggested as an objective method to determine the length of VDO in this population.

Key words: The Thumb Rule of Leonardo da Vinci, vertical dimension of occlusion, proximal-distal Phalanx

ABSTRAK

The Thumb Rule of Leonardo da Vinci, menyatakan bahwa banyak ukuran proporsi pada wajah yang menunjukkan hubungan dengan ukuran panjang ibu jari, yang diukur dari ujung proksimal dari phalanx sampai ujung distal dari phalanx. Penelitian-penelitian terdahulu menunjukkan bahwa ukuran dimensi vertikal oklusi (VDO) sama dengan ukuran panjang ibu jari pada ras Caucasoid. Tujuan dari penelitian ini adalah untuk menentukan apakah ukuran VDO mempunyai hubungan dengan ukuran panjang ibu jari pada ras Mongoloid. Penelitian ini memakai metode survei dengan pendekatan cross sectional analitik. Sebanyak 80 mahasiswa Fakultas Kedokteran Gigi Unpad yang telah memenuhi semua kriteria populasi dipilih secara acak, untuk diukur jarak VDO-nya dan panjang ibu jarinya. Hasil yang dianalisis secara statistik memakai Student's t-test menunjukkan adanya perbedaan yang signifikan antara pria dan wanita untuk jarak VDO dan panjang ibu jari, namun tidak ada perbedaan yang signifikan antara jarak VDO dan panjang ibu jari secara keseluruhan (pria+wanita). Sebagai kesimpulan, ukuran panjang

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ibu jari dapat disarankan untuk dipakai sebagai metode yang objektif untuk mengukur jarak VDO pada populasi ini.

Kata kunci: *The Thumb Rule of Leonardo da Vinci, dimensi vertikal oklusi, proksimal-distal Phalanx*

INTRODUCTION

Vertical dimension is a vertical measurement of the face between any two arbitrarily selected points, one above and one below the mouth, usually in the midline. The vertical dimension can be recorded in two positions which are vertical dimension of occlusion (VDO) and vertical dimension of rest (VDR).[1] VDO is defined as the vertical dimension of the face when the teeth are in natural maximum contact in centric occlusion.[2] VDR is a postural relationship of the mandible to the maxillae, also known as the physiologic rest position of the mandible. The natural teeth establish the VDO during jaw development.[3]

Prosthodontists and dentists are continually confronted with problems related to the determination of vertical dimension.[4] Restoring the proper vertical dimension is difficult because it has been found that vertical dimension varies after natural tooth contacts are lost.[5] Provision of an appropriate VDO is important because of the consequences which can stem from an over-or under-estimation of this value.[6] If VDO is not recorded accurately, there will be severe discomfort in the temporomandibular joint and the muscles of mastication.[7]

Planning an improvement of a patient's facial appearance requires guidelines, or some kind of generally agreed 'ideal' set of facial proportions.[8] Leonardo da Vinci described about the three sections of face, also known as facial trisection, in which the face can be divided into three equivalent lenghts. He found that many of the proportions of the face show relationship with the length of thumb and this relationship was called The Thumb Rule of Leonardo da Vinci.[9]

In a study conducted by Oguz[9], found that there was significant ($p<0.01$) correlations between the length of thumb and the proportions of the face examined in the study, namely the distance between the hairline and glabella or eyebrows, the distance between the glabella or eyebrows and the tip of nose, and the distance between the tip of nose and the tip of chin in both male and female groups.

Facial and thumb measurements offer significant prosthetic advantages because these are objective measurements rather than subjective criteria (such as resting jaw position or swallowing). Since there is no absolute method to determine VDO for all individuals, the facial and finger measurements are attractive because they require no radiographs or other special measuring devices.[10]

Factors that can affect the size and shape of the face are sex, race, age, genetic, and environmental factors. The 'average' male face differs from the 'average' female face by having a more protuberant nose/brow and more prominent chin/jaw.[11] In the study conducted by Oguz[9] and Misch[10], their research subjects were of the Caucasoid race. The theory of Leonardo da Vinci about facial trisection also relates to the Caucasoid race. However, the majority of Indonesians belong to the Mongoloid race.[12] There are a variety of differences between the Caucasoid race and the Mongoloid race, such as skin colour, hair texture, facial appearance, and stature.[13-15]

Therefore, the author was interested to study whether the length of VDO have correlations with the length of thumb among those of the Mongoloid race who are represented by the undergraduate Mongoloid students of Faculty of Dentistry in Universitas Padjadjaran (UNPAD).

METHODS

This study was a survey using analytical cross sectional approach with random sampling of sample from a population of undergraduate students from the class of 2006-2008 of Faculty of Dentistry in UNPAD. The sample size was calculated with a formula for population less than 10,000 and 0.1 degree of significance or 90% degree of confidence.[16,17] The total number of undergraduate students from the class of 2006-2008 of Faculty of Dentistry in UNPAD at the time of study was 442, with 85 males and 357 females. Undergraduate

students from the class of 2006-2008 of Faculty of Dentistry in UNPAD were chosen because the majority of students from those classes at the time of study were between the ages of 20 to 25 years old, thus fulfilling one of the population criteria stated below.

The population criteria included: Mongoloid race at least two generations above; age between 20 to 25 years old; undergraduate students of Faculty of Dentistry, class 2006-2008, UNPAD; normal Body Mass Index (BMI) between 18.5-24.9; no obvious deformities in the face and hand caused by inheritance, disease, or previous history of trauma; no previous history of tooth extraction or tooth lost on all teeth excluding the third molars; no extensive caries, attrition, abrasion, or clinical crown wear on the whole occlusal surface of teeth and no previous restorations that result in an increase or reduction in the length of VDO; no excessive tooth mobility; Angle's normal Class I molar relationship; normal overbite (1-3 mm) and normal overjet (2-3 mm); not currently undergoing orthodontic treatment or no previous history of orthodontic treatments; no temporomandibular joint disorders; and those who are prepared to participate in this study and have signed the informed consent.

Based on statistical calculations, the minimum amount of samples needed was 71 people, however, in this study, 80 samples were taken to round up the figure to a higher value of even number. Samples were randomly chosen and 15 males and 65 females were obtained.

Mouth mirror and vernier caliper were thoroughly disinfected by using tissue dipped in alcohol concentration of 70%. The Subnasion (sn) point of reference (at the angle between the septum and the surface of the upper lip at the median plane) and the Gnathion (Gn) point of reference (at the lowest point in the lower border of the mandible at the median plane) was marked with an ink pen.

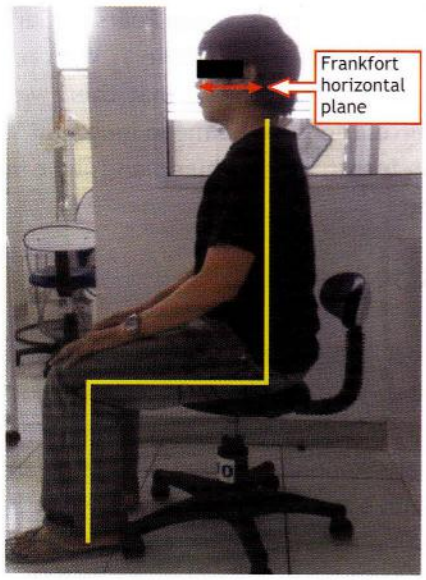

Figure 1. Position of sample during measurement.

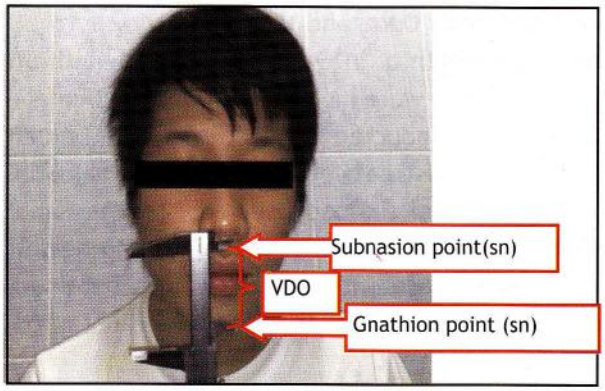

Figure 2. Measuring the length of VDO.

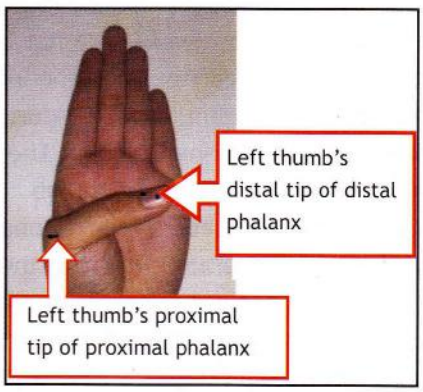

Figure 3. Reference points for thumb were marked with an ink pen.

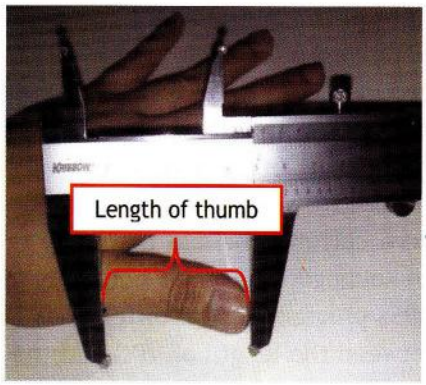

Figure 4. Measuring the length of thumb.

The samples were asked to occlude his/her teeth in centric occlusion by swallowing their saliva with their mouths closed. The occlusions of the samples were checked visually by slightly retracting his/her lips and cheeks to observe the occlusion at the molar regions. Centric occlusion was achieved when the molar regions occlude tightly together. When the position was ready to be measured, the samples were asked not to move his/her facial muscles as those can affect the measurement of VDO.

The samples were asked to sit straight while looking straight ahead with the Frankfort horizontal plane parallel to the floor (Fig. 1). The inside jaw of vernier caliper was positioned at both Sn and Gn points without pressure and the measurement between both points was recorded (Fig. 2).

The proximal tip of the proximal phalanx was determined by flexing the left thumb until the bony prominence of the proximal phalanx can be palpated. This point was marked with an ink pen (Fig. 3). The distal tip of the distal phalanx was determined at the most distal tip of the soft tissue of the left thumb and was marked with an ink pen (Fig. 3). The sample's left hand was pronated with the palm facing downward on a flat table in a relaxed and straight manner, then the length of thumb between both points was measured with outside jaw of vernier caliper (Fig. 4). The procedures were repeated for the right thumb.

All measurements above were done three times by the same operator utilizing the same instruments. The mean value for each measurement was then calculated. After all measurements were completed on one sample, instruments were cleaned with tissue dipped in alcohol concentration of 70% before proceeding to the next sample. In order to reduce or eliminate physical errors due to weariness of the operator, the number of samples were limited to 10 person a day.

The measurements collected from this study were analyzed statistically. The length of VDO and the length of right thumb and left thumb were measured on each sample and the mean values were calculated. Data normality test was done with Kolmogorov-Smirnov normality test, using the SPSS program18. The differences in mean values between the length of VDO and the length of both thumbs as well as the differences between male and female samples were analyzed using Student's t-test for independent samples.[19] Lastly, correlations between the length of VDO and the length of both thumbs were determined using Pearson Correlation test or also known as Product Moment Correlation test.[20] The results from the samples represent the population studied among the undergraduate Mongoloid students of Faculty of Dentistry in UNPAD.

RESULTS

The mean differences between males and females in the length of VDO, the length of left thumb, and the length of right thumb are shown in Diagram 1. Diagram 2 shows the mean comparison of the length of VDO, the length of left thumb, and the length of right thumb.

To determine whether there were any correlations in the mean length of VDO and the mean length of thumb examined in this study, a correlation test was done using Pearson Correlation test which can be seen in Table 1. With reference to Table 1, it can be noted that there were very strong correlations in the mean length of VDO and the mean length of left thumb and right thumb in this study.

DISCUSSION

When subjected to hypothesis testing, the results showed that there was significant difference in the mean length of VDO between male and female samples, as well as the mean length of left thumb and right thumb between male and female samples. This finding is consistent with the research done by Oguz9. The results from Oguz's research showed significant difference between sexes for the same parameter at $P<0.001$. The results of both Oguz and this study showed that the mean length of VDO and the mean length of thumb in males were higher than females. Numerous studies conducted have stated that sexual dimorphism exist between males and females in many portions of the body, such as stature, hand length, phalange length, foot length, and height of the lower face whereby the values obtained from males were higher than the values obtained from females.[21-23]

Results showed that there was no statistically significant difference between the mean

length of VDO, mean length of left thumb, and mean length of right thumb. This finding is consistent with the findings of Misch[10] in which he stated that the original VDO is most often similar to the distance between the tip of the thumb and the tip of the index finger when the fingers are pressed together, which coincidentally is the same length as the thumb. The results of this research are also consistent with the findings of Oguz[9] stating that the lower third of face (the distance between the tip of the nose and the tip of the chin) equals the distance between the thumb's proximal tip of the proximal phalanx and the distal tip of the distal phalanx. According to Ash and Nelson[24], the lower third of face is also known as the vertical dimension in Prosthodontic terms. Facial and body parts often have dimensions that are consistently similar to each other[10] and as it is in this study, the length of VDO is similar to the length of thumb. Although there are many differences between males and females, the proportion of one body part to another body part in one individual is the same for both sex groups. According to Van Der Beek, et al.[25] The pubertal growth spurt of body height and the growth spurt of facial dimensions are coincident. The length of thumb is proportionate to the length of VDO, regardless of the type of sex because the growth of human body is in proportion to each other.

This research has provided valuable insights into the correlations of mean values of length of VDO and length of thumb. When subjected to Pearson Correlation test, the length of VDO and the length of thumb revealed very strong correlations between one variable to another. This is consistent with the results obtained from Oguz's9 research in which significant ($P<0.01$) correlation was found between the length of thumb and the length between the tip of nose and the tip chin examined among Turkish males and females. Previous researches by Oguz[9] and Misch[10], whose work have inspired the author to conduct this research, were carried out among Caucasians who belong to the Caucasoid race. On the contrary, this research was conducted among undergraduate students of Faculty of Dentistry in UNPAD who belong to the Mongoloid race. Although numerous researchers have reported about the many significant differences in facial patterns between those of the Caucasoid race and those of the Mongoloid race[12,14,15,26], this research has proven that even among the Mongoloid study samples, the length of VDO have significant correlations with both right and left thumbs, similar to the results of researches carried out by Oguz[9] and Misch[10] among the Caucasoid research samples. This revelation shows that the correlation of length of VDO and length of thumb in this study was not related to the differences between the Caucasoid race and the Mongoloid race.

This study has proven that regardless of racial differences and sexual dimorphism between males and females, a proportional relationship exist between the length of VDO and the length of thumb. Therefore, in this population the length of thumb can be suggested to estimate the length of VDO and as an aternative measure to obtain the length of VDO when the length of VDO cannot be obtained directly due to several reasons like reduction in VDO, loss of pre-extraction record, and trauma to the jaws. The determination of VDO using the length of thumb provide many advantages due to its simple, noninvasive, low-risk, and inexpensive technique. It is an objective measurement rather than subjective criteria such as resting jaw position or swallowing. Since there is no absolute method to determine VDO for all individuals, the thumb measurement is attractive because it requires no radiographs or other special measuring devices.

Although there are numerous limitations in this study such as small sample size, non-digital measuring device, and sampling concentrating at only one faculty in Universitas Padjadjaran, it can still be suggested with similar results from previous researches that the proportion of length of VDO and the length of thumb among individuals of the Caucasoid race are the same as among the individuals of the Mongoloid race. Despite the relatively small sample size, the results obtained in this study support all the hypothesis, hence the length of thumb can be suggested to be used as an objective method to determine the length of VDO. Due to the frequent migrations of ethnic/racial groups between continents, ethnically and racially mixed populations are increasingly common. A simple proportion formulae of the different races and ethnic groups can provide better objective determination of body and facial proportions based on the norms of their racial or ethnic origin.

CONCLUSION

In this research can be concluded that, there was significant difference between male and female samples in the length of VDO and the length of thumb examined in this study; there was no significant difference between the length of VDO and the length of thumb examined in this study; and there was a very strong correlation between the length of VDO and the length of thumb examined in this study, therefore the length of thumb can be suggested as an objective method to determine the length of VDO in this population.

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