

An Anthropometric Analysis of Correlation of Occlusal Vertical Dimension to Measurements of Digits of Hand

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ABSTRACT

Purpose: The aim of the study was to assess the correlation between various anthropometric measurements of hand and the Vertical Dimension of Occlusion (VDO).

Methods: A total number of 500 dentate subjects were selected in a time span of six months for the study. The hand anthropometric measurements included the length of index finger, length of little finger, length of thumb and the distance between tip of thumb and tip of index finger for the left and the right hand. The distance between sub-nasale and base of chin was taken as control for assessing VDO. All measurements were recorded using a digital Vernier caliper with an accuracy of ± 0.01 mm.

Results: For males, the thumb length showed a highly significant correlation (Pearson correlation coefficient-0.258, p-value-<0.001) with the VDO. For females, the tip of thumb to tip of index finger length showed a highly significant correlation (Pearson correlation coefficient-0.306, p-value-<0.001) with the VDO. Accordingly regression formulae were derived.

Conclusions: In the absence of any pre-extraction records, thumb length in males and the tip of thumb to tip of index finger length in females can be used to derive the vertical dimension using the respective regression formulae reliably.

Keywords: vertical dimension, anthropometry, denture, thumb, fingers

INTRODUCTION

The determination of vertical dimension of occlusion (VDO) is considered one of the most important steps in complete denture construction. Improper estimation of VDO can have various deleterious effects. An excess of VDO can lead to premature tooth contacts resulting in clattering sounds, impaired speech, trauma to the underlying tissues, muscle fatigue, headache and fullness of the mouth leading to a strained facial appearance.^[1-3] On the other hand, a decrease in VDO may cause reduction in biting force, pre-senile

appearance and various temporomandibular joint disorders. Also, the tongue may fall back towards the throat and consequently the displacement of adjacent tissues may lead to obstruction of the eustachian tube and hence impaired hearing. Thus, the determination of correct vertical dimension becomes a very crucial and elusive step.^[4-6]

Past literature suggests various methods for the determination of VDO. These can broadly be divided into physiological and mechanical methods which include the use of physiologic rest position, swallowing, phonetics, aesthetics,

facial measurements, pre-extraction records, cephalometry and others. [7-9] However, none of the aforementioned methods have proven to be scientifically more accurate than the others. Most of the times a combination of methods is used for the correct estimation of VDO. The determining factors for adopting a particular method include time, cost effectiveness, instrument complexity, radiation exposure and other such factors. In this regard, various studies have been conducted to determine the reliability of using other methods like anthropometry and lateral profile photos for assessing the vertical dimension. [10]

Anthropometric measurements have proven to be effective for assessing the growth of dento-facial structures. They have also been used in complete dentures for determination of the vertical dimension and for teeth selection. [11-17] In this regard, Basnet et al. [3] found a correlation between VDO and thumb length. However, Bhandari et al., [18] Shah et al. [20] and Miran [22] linked it to little finger. Whereas, Kalra et al. [19] and Nazir et al. [21] linked it to the little finger in females and middle finger and index finger respectively in males. On the contrary, Helal et al. [4] stated that VDO was correlated to Willis measurement more than to any other anthropometric measurement. Majeed et al. [5] and Bajunaid et al. [15] found no significant relation between the hand anthropometric measurements and VDO. While, Rege et al. [16] found VDO to be more closely related to ear and nose length than any hand anthropometric measurement. Thus, various studies showed the existence of gender as well as racial differences in various hand anthropometric measurements.

Therefore, a study was conducted to assess the correlation between various anthropometric measurements of hand and the VDO in dentate subjects of Moradabad, North India. The null hypothesis of the present study was that no correlation existed between the hand anthropometric measurements and the VDO in dentate subjects of Moradabad, North India.

MATERIALS AND METHODS

A power analysis was conducted which determined analyzing a minimum of 500 participants for ensuring statistically significant results of the study. Ethical approval was obtained from the Institutional Ethics and Review Board (KDCRC/IERB/01/2019/12). The subjects for the study were selected in a time span of six months from the month of January to July 2019. The subjects comprised of 308 females and 192 males, aged between 18-28 years which were randomly selected from the outpatient department of dental college. All the subjects with a eugnathic jaw relation and definite centric stops with a minimum of 28 fully erupted and periodontally sound teeth were included in the study. The subjects with deformity of any of the fingers, open bite, deep bite, missing teeth, attrition, restorations, trauma and patients undergoing orthodontic treatment were excluded from the study. Informed consent was taken from the patients prior to the conduct of the study.

The control for assessing the correlation was the vertical dimension of occlusion (VDO) which was measured between the sub-nasale and the base of chin (figure 1). The hand anthropometric measurements included the length of index finger, length of little finger, length of thumb and the distance between tip of thumb and tip of index finger for the left and the right hand (figure 2 and 3). All the measurements were recorded using a digital Vernier caliper with an accuracy of ± 0.01 mm.



Figure 1: Measurement of occlusal vertical dimension using digital Vernier caliper

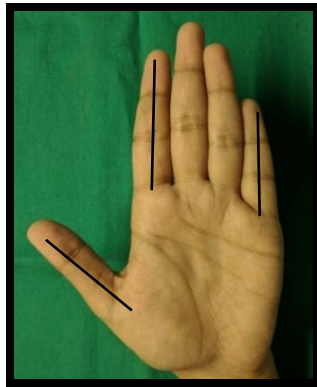


Figure 2: Thumb length, index finger length and little finger length

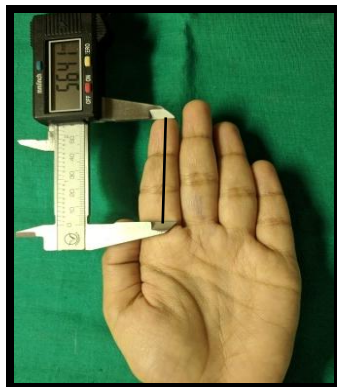


Figure 3: Distance from tip of thumb to tip of index finger

Measurements were made on the palmar aspect in supination, from the tip to the most distal crease on the finger. While taking all the finger measurements it was made sure that nails of the subjects were trimmed. For recording the VDO, the subjects were instructed to bite gently on the posterior teeth in centric occlusion. For measuring the distance between the tip of thumb and tip of index finger, a point was marked on index finger with the help of metallic ruler and marker pen which represented the tip of thumb. Then, the distance between tip of index finger and the marked point was measured with the caliper (figure 3). The average of measurements on both hands was calculated for comparison with the VDO.

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). For all the parameters of the study mean, standard deviation and range was calculated. The Unpaired t-test was used to

compare continuous variables. The Karl Pearson correlation coefficient was calculated. The linear regression equation was derived for VDO with the closest parameter. The p-value<0.05 was considered significant.

RESULTS

Based on the data obtained (table 1), it was found that all the values were significantly higher for males as compared to females.

Table 1: Comparison of various parameters between males and females

Parameter	Males		Females	
	Mean	SD	Mean	SD
VDO (mm)	65.13	4.60	59.67	4.29
Index finger length (mm)	70.85	4.07	64.53	4.23
Little finger length (mm)	59.82	3.95	53.35	5.19
Thumb length (mm)	64.85	4.51	57.07	4.42
Tip thumb to tip index finger (mm)	63.43	5.39	57.83	4.60

For males, a statistically significant (p<0.001) correlation of VDO was found with the thumb length and the index finger length (table 2). As Pearson's correlation was higher for thumb length in comparison to index finger length, a regression equation was derived for VDO estimation in males using the thumb length (figure 4):

VDO = 48.03 + 0.264×Thumb length (P-value<0.001; R²=0.062)

Table 2: Correlation of VDO with various parameters in males

	N	Pearson Correlation	P-value
Index finger length	192	0.253	<0.001**
Little finger length	192	0.156	0.031*
Thumb length	192	0.258	<0.001**
Tip thumb to tip index finger	192	0.170	0.018*

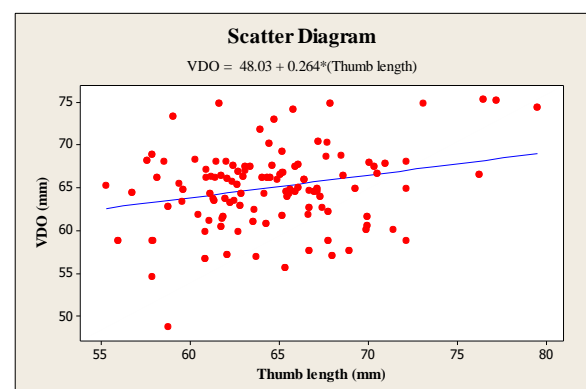


Figure 4: Scatter diagram along with regression line representing the VDO using thumb length in males

Similarly, in females, a statistically significant ($p < 0.001$) correlation of VDO was found with the tip of thumb to tip of index finger length and the index finger length (table 3). As, Pearson's correlation was higher for tip of thumb to tip of index finger in comparison to index finger length, a regression equation was derived for VDO estimation in females using and the tip of thumb to tip of index finger distance (figure 5):

$$\text{VDO} = 43.14 + 0.2859 \times \text{Tip of thumb to tip of index finger distance} \quad (P\text{-value} < 0.001; R^2 = 0.091)$$

Table 3: Correlation of VDO with various parameters in females

	N	Pearson Correlation	P-value
Index finger length	192	0.207	<0.001**
Little finger length	192	0.156	0.006**
Thumb length	192	0.09	0.116
Tip thumb to tip index finger	192	0.306	<0.001**

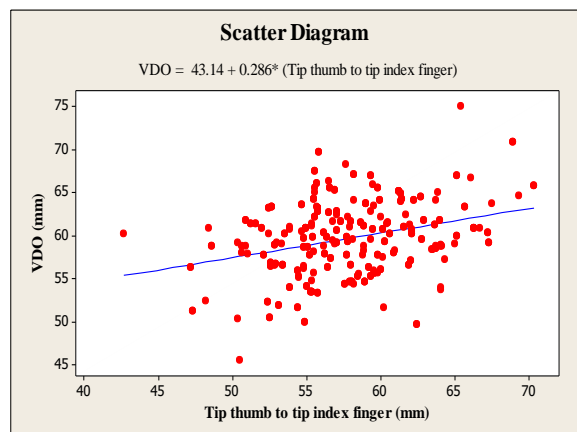


Figure 5: Scatter diagram along with regression line representing the VDO using tip of thumb to tip of index finger length in females

DISCUSSION

The null hypothesis that there exists no correlation between hand anthropometric measurements and VDO was rejected. A significant correlation was found between the VDO and various anthropometric measurements.

The results revealed a sexual dimorphism for all the measured parameters. This may be due to the hormonal changes during and after puberty (especially the androgens). The mean value of VDO was 65.13 ± 4.60 mm in males and 59.67 ± 4.29 mm in females. These were in

accordance with the studies of Helal et al. (mean of 64.6 ± 8.1 mm in males), [4] Ladda et al. (mean of 61.4 ± 4.2 mm in males and 56.7 ± 5.7 mm in females). [17] It was also supported by the results of Majeed et al. (mean of 62.7 mm for males), [5] Shah et al. (mean of 62.2 mm for males and 57.71 mm for females), [20] Kalra et al. (mean of 61.4 ± 4.2 mm in males and 56.7 ± 3 mm in females), [19] Bhandari et al. (mean of 61.09 ± 3.7 mm in males, 55.99 ± 2.93 mm in females) [18] and Miran et al. (mean of 68.3 mm for males and 61.97 mm for females). [22]

In males, thumb length showed a highly significant correlation (Pearson correlation coefficient-0.258, p -value- < 0.001) with the VDO. This was supported by the results of Basnet et al. [3] who found a positive correlation ($p \leq 0.05$) of the VDO with the thumb length in the population studied. On the contrary, Ladda et al. [17] and Nazir et al. [21] correlated VDO to the index finger length ($r = 0.406$ and $r = 0.804$ respectively). Whereas, Miran et al. [22] correlated VDO to the little finger length and Kalra et al. [19] found a correlation of VDO with the middle finger length.

In females, the tip of thumb to tip of index finger length measurement showed a highly significant correlation (Pearson correlation coefficient-0.306, p -value- < 0.001) with the VDO. However, this was contradictory to the findings of Ladda et al., [17] Miran, [22] Kalra et al., [19] Shah et al. [20] and Nazir et al. [21] who found a correlation of the vertical dimension with the little finger length.

Thus, the present study revealed a significant correlation of the vertical dimension with the thumb length in males and with the tip of thumb to the tip of index finger length in females. Various studies have also been conducted to correlate the VDO with anthropometric measurements other than those of hand. In this regard, many authors have found results correlating VDO to other facial anthropometric measurements. Prajapati et al. [23] correlated VDO to ear length whereas, Majeed et al., [5]

Helal et al. [4] and Rege et al. [16] found no correlation between hand anthropometric measurements and the vertical dimension.

The inconsistency of results of the current study with the other studies may be due to the differences in measuring techniques, ethnicities of the population and sample size studied. Nevertheless, the results indicated that hand anthropometric measurements can serve as a basic guide in estimating the lower facial height in the absence of any pre-extraction records. The method uses a simple caliper instrument rather than any complex equipment. Also, it offers significant advantages of being simple, practical, cost effective and time saving for everyday practice.

More research needs to be carried out on a larger sample size over a wider geographical area to establish a complete database of anthropometric measurements which can aid in restoring the lost vertical dimension.

CONCLUSIONS

Within the limitations of the study, the following conclusions were drawn:

1. A strong correlation of VDO with the thumb length was found in males. The VDO could be calculated in males by the following regression equation:
$$\text{VDO} = 48.03 + 0.264 \times \text{Thumb length}$$
2. A strong correlation of VDO with tip of thumb to tip of index finger length was found in females. The VDO could be calculated in females by the following regression equation:
$$\text{VDO} = 43.14 + 0.2859 \times \text{Tip of thumb to tip of index finger distance}$$

Thus, in the absence of any pre-extraction records, the aforementioned parameters could be used to derive the vertical dimension using the respective regression formulae reliably.

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How to cite this article: Tripathi S, Pandey M, Agarwal S et.al. An anthropometric analysis of correlation of occlusal vertical dimension to measurements of digits of hand. *International Journal of Research and Review*. 2019; 6(12):288-293.
