

# Determination of Vertical Dimension of Occlusion from Anthropometric Measurements of Fingers- An in vivo Study

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**Abstract:** The purpose of this study was to find the correlation between vertical dimension of occlusion (VDO) and length of fingers. Anthropometric measurements of VDO, length of middle finger, length of little finger, and distance from tip of thumb to tip of middle finger of right hand were recorded clinically using modified digital vernier caliper. Correlation between VDO and length of fingers was studied using Spearman's coefficient. VDO was significantly and positively correlated with all the parameters studied. Since the variations between VDO and finger lengths are within the range of 2-4 mm, VDO prediction through this method is reliable, and reproducible. Also the method is simple, economic, and non-invasive; hence, it could be recommended for everyday practice.

**Keywords:** middle finger, little finger, thumb, vertical dimension of occlusion.

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## INTRODUCTION:

Recording the correct vertical jaw relation is believed to be an elusive step, but its significance can't be overlooked if optimum function and aesthetics is to be achieved. Though the focus in Prosthodontics has shifted from removable to fixed prostheses with implants riding high, still the concepts like jaw relation remain at the baseline providing foundation to arbitrate our decisions for all the prosthetic rehabilitation procedures. Glossary of Prosthodontic Terms defines vertical dimension as the distance between the two selected anatomic or marked points (usually one on the tip of the nose and the other upon the chin), one on a fixed and one on a movable member. <sup>[1]</sup> It is the responsibility of the dentist to establish an appropriate lower facial height when lost, which should be within the range of patient's adaptability and acceptability. If VDO is registered too high or too low, it would end up deteriorating the existing patient's condition instead of improving it.

Although Prosthodontics as a whole has progressed leaps and bounds with variety of techniques being proposed and practiced for the evaluation of VDO, none of them is scientifically more accurate than other. Each method advocated has its own limitations. They are either tedious, time consuming, require special instrument/equipment, or expose patients to radiation. <sup>[2]</sup> Furthermore, radiographic set up to provide lateral cephalographs <sup>[3]</sup> or electromyographic machine <sup>[4]</sup> may not be available in most of the dental offices.

Leonardo da Vinci and McGee <sup>[5]</sup> correlated VDO with various anthropometric measurements. According to them original VDO is most often similar to the distance from the outer canthus of one eye to the inner canthus of the other eye, vertical height of the ear, twice the length of one eye, horizontal distance between the pupils, and vertical length of nose at the midline. Anthropometric measurements were used to determine proportions of body parts since antiquity, when sculptors and mathematicians followed the golden proportion, later specified as a ratio of 1.618:1. <sup>[6]</sup> In line with these observations, this study was designed to assess the possibility of any correlation between VDO and length of fingers in Indian population so that it can serve as a simple and precise method for estimating VDO. This feature of human anthropometry seems to remain an unturned stone in the field of dentistry. The research hypothesis was that there would be a significant relationship between the vertical dimension of occlusion and length of fingers.

## **MATERIALS AND METHODS**

For this study, 400 physically healthy dentate subjects comprising of 200 males and 200 females with the age range of 20 to 30 years having no deformity of fingers or eyes were selected randomly from OPD of P.G.I.D.S Rohtak. All the participants had eugnathic jaw relationship and a definite centric stop with at least 28 fully erupted, periodontally sound teeth in both jaws. Subjects with the following conditions were excluded from the study: Open bite or deep bite cases, teeth anomalies, attrition, extensive prosthesis or restorations in the oral cavity, temporomandibular joint disorders, or any other pathology in the maxillofacial region, history of trauma, orthodontic treatment or orthognathic surgery. Anthropometric measurements of vertical dimension of occlusion, length of middle finger, little finger and distance from the tip of thumb to the tip of middle finger of right hand were recorded clinically in millimeters using a modified digital vernier caliper with an accuracy of 0.01 mm.

To record VDO, the subjects were instructed to bite lightly on the posterior teeth with lips in repose and head well stabilized. We modified the tips of digital vernier caliper for recording VDO to allow a precise position in horizontal and vertical planes without causing any discomfort to the subjects. The lower modified extended tip of caliper was placed firmly below the chin so that the soft tissues were compressed by pressure exerted and thus caliper coming as close as possible to the lower border of mandible against the skin. Now the upper tip of caliper was raised until it lightly touched the base of nasal septum and the measurement was made [Figure 1].



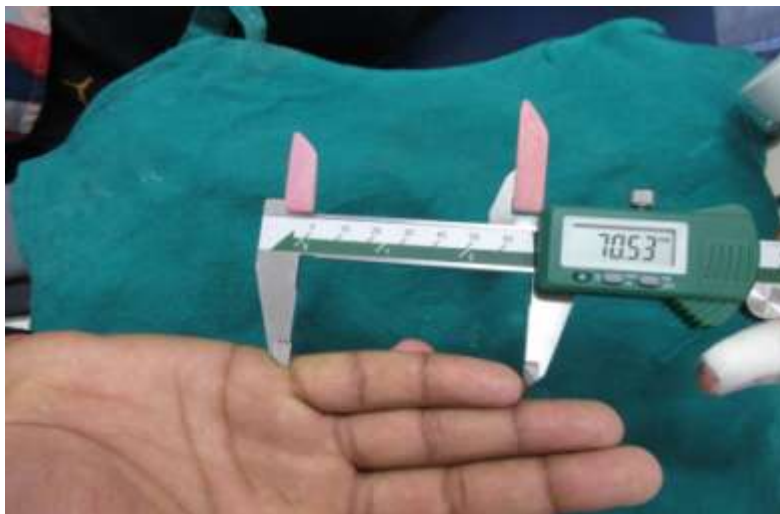
**Figure 1: Measurement of vertical dimension of occlusion**

Length of the middle finger of right hand was measured on palmar aspect (in supination) from tip of finger to the near most point on palmar digital crease with digital caliper [Figure 2].



**Figure 2: Measurement of length of middle finger**

In the same way, length of little finger of right hand was measured from tip of finger to the farther most point on palmar digital crease [Figure 3].



**Figure 3: measurement of length of little finger**

The measurements were taken with the hand straight and flat. Next, to measure the distance from tip of thumb to tip of middle finger, subjects were first told to place palmar aspect of the right hand in pronation firmly against a flat surface with the fingers and thumb adducted. A point was marked on index finger with the help of metallic ruler and marker pen which represented the tip of thumb. The distance was then measured with digital vernier caliper. While taking all these finger measurements it was made sure that nails of the subjects were trimmed.

For all the parameters of the study mean, standard deviation and range was calculated. Correlation was studied using Spearman's rank correlation coefficient method. For the execution of regression command and preparation of a prediction equation to estimate VDO Statistical Package for Social Sciences (SPSS) Software Version 11.5 was used.

## **RESULTS**

Descriptive statistics of the parameters studied is presented in [Table 1]. From [Table 1], it was observed that, in males the mean value of VDO was 61.4 mm with the range from 53.12 mm to 71.58 mm whereas in females, the mean value was 56.7 mm with the range from 49.89 mm to 63.76 mm. Thus, VDO was more in males compared to females. In males, the mean value of length of index finger was 71.6 mm with the range from 59.13 mm to 83.60 mm whereas in females, it was 65.9 mm with the range from 55.11 mm to 77.55 mm. Thus, males had longer middle finger as compared to females. In males, the mean value of length of little finger was 61.5 mm with the range from 53.33 mm to 72.55 mm whereas in females, the mean value was 56.3 mm with the range from 46.13 mm to 65.18 mm. Thus males had longer little finger as compared to females. In males, the mean value of distance from the tip of thumb to the tip of middle finger was 63.2 mm with the range from 52.15 mm to 74.13 mm whereas in females, it was 55.7 mm with the range from 37.84 mm to 68.73 mm. Thus this distance was more in males than in females.

The coefficient of correlation (r) by Spearman's method between the measured variables and VDO, at the probability level of 95% is presented in [Table 2]. From [Table 2], it was observed that in males and females, VDO is significantly and positively correlated with all the parameters studied. In males, correlation of VDO was strongest for the parameter-length of middle finger (r-0.406). In females; correlation of VDO was strongest for the parameter - length of little finger (r-0.385).

Regression analysis was performed for prediction of VDO using all the parameters [Figure 5]. From the Table 3, it was observed that it was observed that In males following regression equations were reliable to determine VDO:

- a.  $VDO = 31.123 + 0.423 \times \text{length of middle finger}$
- b.  $VDO = 33.075 + 0.461 \times \text{length of little finger}$
- c.  $VDO = 42.568 + 0.299 \times \text{distance from tip of middle finger to tip of thumb}$

In females following regression equations were reliable to determine VDO:

- a.  $VDO = 41.162 + 0.235 \times \text{length of middle finger}$
- b.  $VDO = 35.167 + 0.382 \times \text{length of little finger}$
- c.  $VDO = 48.228 + 0.152 \times \text{distance from tip of middle finger to tip of thumb}$

**Table-1 : Descriptive statistics of vertical dimension of occlusion, length of middle finger, length of little finger and distance from tip of middle finger to tip of thumb**

Sex	Measurements (mm)	Mean (mm)	SD (mm)	Min (mm)	Max (mm)
Male	VDO	61.4	4.2	53.12	71.58
	Length of middle finger	71.6	4.3	59.13	83.60
	Length of little finger				
	Distance from tip of middle finger to tip of thumb	61.5	3.7	53.33	72.55
		63.2	4.2	52.15	74.13
Female	VDO	56.7	3.0	49.89	63.76
	Length of middle finger	65.9	4.1	55.11	77.55
	Length of little finger				
	Distance from tip of middle finger to tip of thumb	56.3	3.3	46.13	65.18
		55.7	5.7	37.84	68.73

VOD= Vertical dimension of occlusion

**Table-2: Sex specific correlations between vertical dimension of occlusion and length of middle finger, length of little finger, distance from tip of middle finger to tip of thumb**

Sex	Correlation coefficient	A	B	C
Male VDO	R	0.406**	0.395**	0.306**
	P value	0.001	0.01	0.001
	N	200	200	200
Female VDO	R	0.257**	0.385**	0.265**
	P value	0.001	0.01	0.001
	N	200	200	200

Correlations (r) by Spearman's method,  $P < 0.05$  is considered to significant correlation. \*\* $P < 0.01$  (Highly significant correlation), A= Length of middle finger, B= Length of little finger, C=Distance from tip of middle finger to tip of thumb, VOD=Vertical dimension of occlusion.

**Table-3 : Sex specific regression analysis**

Sex	Dependent variable	Independent variable	Regression equation	R <sup>2</sup> (%)	SE
Male	VDO (Y)	A	$Y = 31.123 + 0.423 \times A$	19.1	$\pm 3.76$
		B	$Y = 33.075 + 0.461 \times B$	16.9	$\pm 3.81$
		C	$Y = 42.568 + 0.299 \times C$	8.9	$\pm 3.99$
Female	VDO (Y)	A	$Y = 41.162 + 0.235 \times A$	10.5	$\pm 2.86$
		B	$Y = 35.167 + 0.382 \times B$	17.5	$\pm 2.74$
		C	$Y = 48.228 + 0.152 \times C$	8.2	$\pm 2.89$

A= Length of middle finger, B= Length of little finger, C=Distance from tip of middle finger to tip of thumb, SE=Standard error, R<sup>2</sup>= coefficient of determination, VOD=Vertical dimension of occlusion.



Determination of VDO using regression equation for length of middle finger had a standard error of  $\pm 3.76$  and  $\pm 2.86$  in males and females respectively. Determination of VDO using regression equation for length of little finger had a standard error of  $\pm 3.81$  and  $\pm 2.74$  in males and females respectively. Determination of VDO using regression equation for distance from tip of middle finger to tip of thumb had a standard error of  $\pm 3.99$  and  $\pm 2.89$  in males and females respectively

## **DISCUSSION**

Losing teeth and acquiring an artificial prosthesis is not a pleasurable event for any individual. Nevertheless, the agony of the patient can be lessened to some extent by providing a prosthesis which restores the original facial appearance and functions akin to natural teeth. Unquestionably, establishing a correct vertical dimension of face is one of the important factors to be considered in accomplishing this objective. Literature review depicted that many methods have been described and used by professionals over the years for the purpose of vertical dimension determination, but none of them is fully accepted or considered completely correct. So far among pre-extraction records, methods like measurement of vertical and horizontal overlap of natural anterior teeth, speaking method and tattoo dot method are agreed to be the most reliable ones. But if no such records are available, one cannot even determine a starting point, the position mandible would occupy to restore occlusal vertical dimension. To overcome these difficulties an investigation was undertaken to find a simple yet feasible method by studying the relationship between VDO and length of fingers, taking into account that the growth of body parts takes place in proportion to each other. The results supported the research hypothesis that there would be a significant relationship between the VDO and the length of fingers.

The study revealed a sexual dimorphism with higher values for VDO as well as length of fingers in males compared to females. Sexual dimorphism in finger length is related to post-puberty levels of androgen exposure.<sup>[7]</sup> Also in this study measurements of only right hand fingers were recorded. This will not create any bias because it is a known fact that physiologically human body maintains symmetry. Also many investigators like Danborno<sup>[8]</sup> found no differences in the length of fingers of both hands. Length of middle finger of right hand measured in the present study showed a mean of 71.6 mm in males and 65.9 mm in females. This is in accordance with the findings of Danborno<sup>[8]</sup> who showed a mean value of 73.54 mm in males and 69.95 mm in females. Kanchanet *al.*<sup>[9]</sup> showed a mean value of 64.9 mm in males and 65.2 mm in females. Peters<sup>[10]</sup> showed a mean value of 72.9 mm in males and 66.9 mm in females. We found that length of middle finger was a reliable parameter in determination of VDO with a standard error of  $\pm 3.76$  in males and  $\pm 2.86$  in females.

In this study, the length of little finger of right hand showed a mean of 61.5 mm in males and 56.3 mm in females. This is in accordance with the findings of Nag<sup>[11]</sup> who showed a mean value of 56.3 mm in females. However, no comparative data of little finger dimensions in males was available. The study revealed that little finger can also be used for determination of VDO with a standard error of  $\pm 3.81$  in males and  $\pm 2.74$  in females. In this study, the mean value for distance from the tip of thumb to the tip of middle finger was 63.2 mm in males and 55.7 mm in females. However, we could not trace any studies wherein this parameter was considered. But we found that VDO can be estimated from this distance using regression equation with the standard error of  $\pm 3.99$  and  $\pm 2.89$  in males and females respectively.

To some extent the variations in all the measurements found may be due to the differences in measuring techniques, ethnicities of the population and sample size studied. Nevertheless the results indicated that anthropometric measurements like finger lengths can serve as a basic guide in estimating the lower facial height and offer significant prosthetic advantages. As these are objective measurements rather than subjective criteria's (such as resting jaw position<sup>[12]</sup> or swallowing<sup>[13]</sup>), the guesswork in VDO is eliminated. Moreover the VDO estimated using this method is within the range of 2-4 mm which is significantly less compared to other methods where a range of 0-14 mm is given.<sup>[14],[15]</sup> This method is attractive and practical because it is simple, economic, non-invasive, reliable, requires no radiographs or sophisticated measuring devices and provides reproducible values for future reference. Besides it does not require a great amount of time and experience to master which is another advantage it enjoys over previous methods.

The limitation of the study was that it was restricted to the subjects with class I malocclusion and other skeletal or dental malocclusions were not considered. Further the subjects were not categorized based on facial forms. Also the measurement is difficult to record when a patient has a round facial profile with excessive soft tissue bulk under the chin. To authenticate these findings further studies should be carried out comprising of a broad clinical research program that would include the similar analysis for dentulous population in other ethnic groups and then appropriate regression equations may be constructed which can be accepted universally. However, the operator should keep in mind that VDO is the result of a musculoskeletal balance. The correct VDO can be better described as a range instead of as a fixed point. Therefore, in order to evaluate the VDO, a pluralistic method should be adopted at all the stages of rehabilitation to maximize the benefits and minimize damage to the stomatognathic system

## **CONCLUSION**

The best parameter to predict the VDO in case of males was found to be the middle finger and in case of females it was little finger. Since the variations between VDO and finger lengths are within the range of 2-4 mm, VDO prediction through this method is reliable, and reproducible. Also the method is simple, economic, and non-invasive; hence, it could be recommended for everyday practice.

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