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An Anthropological Study to Evaluate Correlation between Occlusal Vertical Dimension and Other Facial Measurements

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ABSTRACT

Aim: Various techniques are practiced for evaluation of occlusal vertical dimension. And each of the method being practiced has its own restrictions. Various techniques are practiced for evaluation of occlusal vertical dimension in complete denture patients but, a fully precise method of determining the same is not present and each method that is being practiced has its own advantages and disadvantages. So, the objective of this study is to discover a relationship between occlusal vertical dimension and facial measurements.

Materials and methods: A study was conducted on 100 dentulous subjects. Anthropometric measurements of occlusal vertical dimension were recorded clinically using digital Vernier caliper. Similarly, distance between other facial landmarks (inter pupillary distance & length of ear) were also recorded. Using person's correlation, association was studied between the facial measurements and vertical dimension. Correlation coefficient (r)was obtained at the significant level ≤0.05 and confidence interval of 95% using Pearson's correlation. A software namely statistical package for social sciences(SPSS) 22.0 version was used for the execution of regression command and prediction equations being prepared to estimate VDO.

Results: VDO was significantly and positively correlated with all the parameters studied. Correlation of VDO was strongest for Interpupillary distance in males (r-0.570) and least for length of ear in females (r-0.319). The regression equation used to determine VDO got us a standard error of +2.2048 in male subjects and ±3.0179 in females for length of ear.

Conclusion: The study was aimed to get an association between VDO and facial measurements. This was done to discover the prospect of another method which will be helpful to determine VDO in completely edentulous patients along with the routine methods commonly used. This study showed that these facial measurements can be extremely helpful in clinical assessment of occlusal vertical dimension.

Keywords: Anthropometry, Jaw relation, Vertical Dimension of Occlusion, Anatomic landmarks, Pupil, Ear.

INTRODUCTION

The various components of the masticatory system which includes jaws and teeth, the temporomandibular joint and the muscles of mastication are inter related. The objective of prosthodontic rehabilitation is to replace the function of the lost teeth in both the dentulous and edentulous patients. Though the focus in Prosthodontics has shifted from removable to fixed prostheses with implants riding high, still the

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concepts like jaw relation remain the baseline for providing foundation to arbitrate our decisions for all the prosthetic rehabilitation procedures. [1] One of the major concerns in treating edentulous patients and patients with loss of vertical dimension is to achieve a proper vertical dimension.

Aesthetic correction is one of the primary objectives to restore the pleasing appearance of the patient. The lower one third of the face not only has functional appearance but also affects one's facial expressions and appearance. To get proper adaptation of complete denture to the masticatory system, it is necessary to obtain appropriate vertical dimension, stable occlusal contacts that are in harmony with the patient's temporomandibular joints and muscles od mastication, and consistent contours with the surrounding facial musculature. In clinical practice, a fully precise method of determining the exact vertical relation of occlusion does not exist.

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, occlusal vertical dimension as the distance between two selected points when the occluding members are in contact. And the vertical dimension at rest is defined as the distance between two selected points when the mandible is in the physiologic rest position. [2] In clinical practice, use of various techniques like pre-extraction records, [3] electrymyographic method, [4] and cephalometric radiograph give a wide range of variation among individuals. So, there is no universal rule for determining occlusal vertical dimension. [5,6]

An interrelation was found between soft tissue landmarks and occlusal vertical dimension. Since the extraoral facial landmarks are easily accessible and relatively unchanged throughout life, they can be reliably used to determine vertical dimension in patients. Previous studies have been done to correlate interpupillary distance with different extraoral landmarks like distance between eye and ear, interpupillary distance, length of fingers, distance between rima oris to pupil of eye etc. in different regions with various levels of significance. This study assessed the relationship between the interpupillary distance, ear length and chin nose distance, and determined the usefulness of this method for ascertaining occlusal vertical dimension.

MATERIALS AND METHOD

The study was presented before ethical committee and approval was taken. One hundred subjects (57 males and 43 females) between 18 and 30 years were selected from among the students, patients and relatives of the patients visiting the dental institute. The criteria for including the subjects in study were full set of dentition, absence of attrition of teeth, no malocclusion, and no history of orthodontic or prosthodontic treatment. The most prominent part of chin and tip of the nose were used to determine the occlusal vertical dimension using digital Vernier caliper (Aerospace 150mm) (Figure 1).

Similarly, Interpupillary distance was measured between pupils of eyes. The subject was instructed to seat upright with shoulders and head held straight. The subject looked straight forward and at that time, the location of pupils was transferred on to the upper border of the eyebrows on both the sides and then measured with digital Vernier caliper (Figure 2). The vertical height of ear was measured from highest point of helix to lowest point of lobule of ear which suggest the maximum vertical height of ear (Figure 3).

The same procedure was done for all one hundred samples (57 males and 43 females), and then the data were entered into Microsoft excel and analyzed with statistical package for social sciences (SPSS) 22.0 version software. Independent sample t test was performed to study difference of means of parameters. Using person's correlation, association was studied between the facial measurements and vertical dimension. Correlation coefficient (r)was obtained at the significant level ≤0.05 and confidence interval of 95% using Pearson's correlation. Then regression command was executed and the prediction equation to obtain VDO was prepared using the same software.

RESULTS

The various measurements were statistically analyzed; it was observed that VDO, interpupillary distance and ear length were more in males as compared to females. Table 1 shows that

the mean value of VDO in males was 60.57 with the range of 55-66 mm. While in females, the mean value was 58.34 with the range of 53-65 mm. The mean interpupillary distance in males was 60.30 with the range from 55mm to 67 mm, and in females the value was 58.79 with range of 53-65mm. And the length of ear in males has mean value of 60.02 with range of 56-66 mm and in females the mean was 58.02 with minimum of 54 mm and maximum of 64 mm values.

Table 2 shows the coefficient of correlation (r) by Pearson's method between the measured variables and VDO, at the probability level of 95%. VDO is significantly and positively correlated with all the parameters studied. The correlation with VDO was strongest with interpupillary distance in both males and females (r = 0.57 and 0.53 respectively). And with length of ear, the correlation value is (r = 0.49 and 0.32) for males and females respectively.

Table 3 shows Regression analysis which was performed for prediction of VDO using all the

parameters. It was observed that, following regression equations were reliable to determine VDO:

VDO = 30.696 + (0.490 × Interpupillary distance)

In males

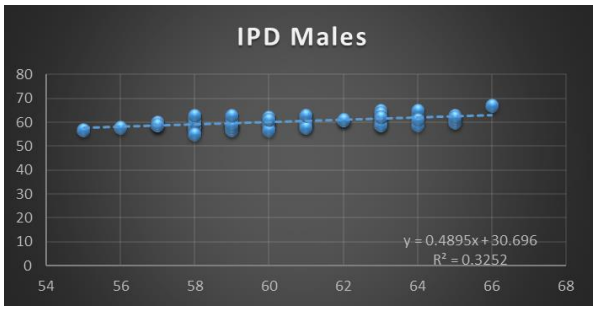
VDO = 33.380 + (0.441 × Length of ear)

VDO = 30.522 + (0.477 × Interpupillary distance)

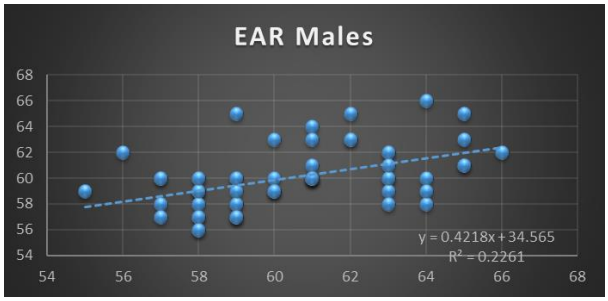
In females

VDO = 46.983 + (0.202 × Length of ear)

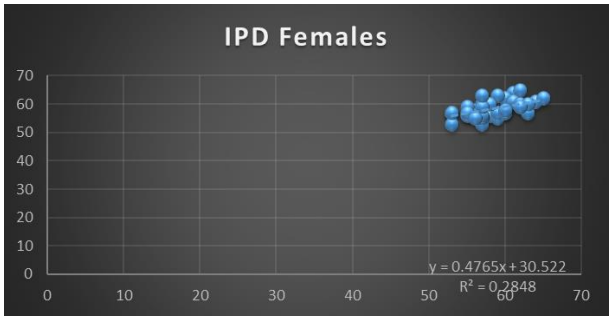
Determination of VDO using regression equation for interpupillary distance had a standard error of ±2.205 and ±2.69 in males and females respectively while determination of VDO using regression equation for length of ear had a standard error of ±2.35 and ±3.02 in males and females respectively. The Analysis is displayed in graph 1 and graph 2 for males and graph 3 and graph 4 for females for interpupillary distance and ear length respectively.



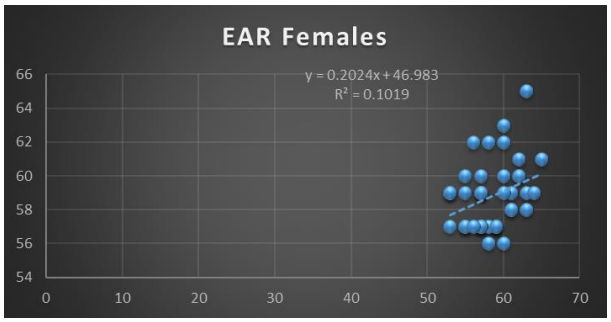
Graph 1: Regression analysis of VDO and Interpupillary distance (IPD) in males.



Graph 2: Regression analysis of VDO and Length of Ear in males.



Graph 3: Regression analysis of VDO and Interpupillary distance in females.



Graph 4: Regression analysis of VDO and Length of Ear in females.

Fig 1: Vertical occlusal dimension.

Fig 2: Interpupillary distance (Transferred on the upper border of eyebrows).

Fig 3: Length of ear.

DISCUSSION

The vertical dimension is appropriately measured when natural teeth (vertical stop) are present without attrition or any other pre-extraction records are available. [8] According to Silverman, closest speaking space is helpful in determining vertical dimension after 20 years of age. [9] When no pre- extraction records are available, anatomic landmarks of the face can also be used to determine the vertical dimension in patients. Instruments like the Dakometer or the Willis gauge are available for determining vertical dimension. [10] Pantographs can also be used for the same, which was developed by Turner. [11]

A clear resin mask of the lower part of the face can be constructed as described by Swenson. [12] Tallgren concluded that the vertical dimension of rest position changes in accordance with vertical dimension of occlusion in both dentulous and edentulous patients. [13] Tueller used an electronic method to determine the vertical separation of the jaws. [14] This method also studied by Feldman et al. [4] Other methods include the use of anterior teeth measurements, swallowing method, and patients' neuromuscular perception. [16,17,18] Cephalometric radiographs can also be used, though the device may not be available in all dental clinics. [5,6] Intraoral and extraoral anatomic landmarks and measurement of fingers can be used determine vertical dimension. [21,22] It was suggested by Goodfriend that the distance between the pupil of the eye and the rima oris was equal to the distance from the subnasion to the gnathion.[23,24] The three measurements, viz, the distance from the center of the pupil of the eye to a line projected laterally from the median line of the lips; the distance from the glabella to the subnasion; and the distance between the angles of the mouth with the lips in repose were associated with the vertical dimension of occlusion, by McGee.[25]

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. [26] It was observed that biologic features follow this ratio. Leonardo da Vinci later contributed several observations and drawings on facial proportions, which he called *divine proportions*. [27] Many different sources reveal many

Table 1: Descriptive measurements of Occlusal Vertical Dimension, Interpupillary Distance (IPD) and Length of Ear.

Sex	Measurements (mm)	Mean (mm)	SD (mm)	Min (mm)	Max (mm)
Male	VDO	60.5736	2.6599	55	66
	IPD	60.2982	2.2832	55	67
	Length of Ear	60.01754	2.3941	56	66
Female	VDO	58.3488	3.1463	53	65
	IPD	58.7907	2.8091	53	65
	Length of Ear	58.0145	1.9947	54	64

*** SD – Standard Deviation**
†VDO – Vertical dimension of Occlusion
‡ IPD – InterPupillary Distance

Table 2: Vertical Dimension of Occlusion (VDO), Interpupillary Distance (IPD) and Length of Ear in males and females.

SEX		Correlation Coefficient	IPD	Length of Ear
MALE	VDO	Pearson's r	0.5703	0.4894
		P value	0.0001	0.0002
		n	57	57
FEMALE	VDO	Pearson's r	0.5337	0.319
		P value	0.0002	0.0369
		n	43	43

*** VDO – Vertical dimension of Occlusion**
† IPD – InterPupillary Distance

Table 3: Regression Analysis.

Sex	Dependable Variable	Independent Variable	Regression Equation	% R^2	SE
Male	VDO (Y)	IPD(a)	Y = 30.696 + {0.490 × (a)}	32.52%	±2.2048
		Length of Ear (b)	Y = 33.38 + {0.441 × (b)}	23.95%	±2.3406
Female	VDO (Y)	IPD (a)	Y = 30.522 + {0.477 × (a)}	28.48%	±2.6930
		Length of Ear (b)	Y = 46.983 + {0.202 × (b)}	10.19%	±3.0179

*** VDO – Vertical dimension of Occlusion**
† IPD – InterPupillary Distance
‡ SE – Standard Error

correlations of features that correspond to the OVD. [28] There are various advantages of using this method which include: Firstly, it is an objective measurement, [29,30] secondly, it is simple, noninvasive method with no radiation exposure to the patient and reproducible values for future reference.

The lower third of face has poor appearance due to loss of vertical dimensions due to any reason. Also, when the vertical dimension of the patient is corrected it should have a harmonious relation with the upper part of face. In the literature, various methods are described for obtaining proper VDO, but, all the methods given, have some advantages and disadvantages. The undertaken study gave us

information on extraoral facial measurement and its use in obtaining appropriate vertical dimension. The study showed that there is sexual dimorphism with higher values of VDO as well as length of ear and IPD in males as compared to females.

In present study the occlusal vertical dimension was found 60.57±2.66 mm in male and 58.35±3.15 mm in female. These were found to be in accordance with the findings of Ladda et al. [3] and Kulakarni and Kohli in Indian population. [4] The data is lesser in value than findings of Basnet et al in Nepali population. [5] The interpupillary distance measured in this study showed a mean value of 60.30±2.28 mm in males and 58.79±2.81 mm in females. This is in accordance with the findings of various investigators like Pointer, Ladda et al. [3] Swan and Stephan observed a higher mean in males and females. [6]. Murphy and Laskin [7] and Basnet et al [5] also reported a mean of higher value. The length of ear measured in this study gives mean value 60.02±2.39 mm in males and 58.01±1.99 mm in females. Basnet et al showed greater values in Nepali population. [5]

The differences in measuring techniques, ethnicities of the population and sample size studied caused variations in the measurements which were found in different studies. However, the results of this study indicated that anthropometric measurements like IPD and length of ear can be very helpful in estimating the VDO in males as well as in females. The correlation was statistically highly significant and positive with IPD in both males and females. The correlation was also significant statistically with ear length but level of significance was lower than that of IPD.

The limitation of the study was that included only subjects with class I malocclusion and other types of malocclusions were excluded. In patients with a round facial profile and with excessive soft tissue bulk under the chin, it is difficult to determine vertical dimension. The other drawback is that in case of attached ear lobule, length of ear can't give good idea about the OVD.

The differences in measuring techniques, ethnicities of the population and sample size studied caused variations in the measurements which were found in different studies.

CONCLUSION

The outcomes of this study indicate, it is possible to measure occlusal vertical dimension using length of ear as well as interpupillary distance in both males and females. This method is simple and also economic and non-invasive. Within the limits of criteria selected in the present study, it can be concluded that the interpupillary distance and the length of ear can be reliably used to predict the vertical dimension. Among these parameters, interpupillary distance has stronger correlation both in males and females.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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