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ORIGINAL ARTICLE

An Anthropometric Correlation of Vertical Dimension of Occlusion and Linear Ear Length in Dentulous Subjects

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ABSTRACT

Objective: Anthropometric measurements have often been used for determining vertical dimension of occlusion (VDO). However, most of them seem to be subjective. This study was designed to evaluate the correlation between length of the ear and VDO in dentulous subjects.

Materials and methods: Two hundred participants (mean age 24.7) were included in the study. Vertical length was measured from the superior most point of the helix to the inferior most point of the lobule of external ear. Vertical dimension of occlusion was measured between two points on the base of nose and the most prominent point of the chin. All measurements were made with digital vernier caliper with a least count of 0.01 mm by two calibrated investigators. Mean readings were correlated using Pearson's correlation coefficient.

Results: An r-value of 0.640 was found to exist between the two variables measured. Correlation was more with respect to the male gender (r = 0.750) as compared to females (r = 0.570).

Conclusion: The linear vertical length of the external ear was found to be positively correlated to the VDO. With the help of regression equation one can know the VDO if ear length is known.

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INTRODUCTION

The human face has been the subject of study since man could first express himself. As civilizations have risen and subsequently faded away, one thing that has remained is art, in most cases, drawings, paintings, and so on of faces. Anthropological measurements have often formed the basis of art especially in the form of visual art considered to have been created primarily for esthetic purposes specifically, painting, sculpture, drawing, water color, graphics, and architecture and judged for its beauty and meaningfulness. The Renaissance saw revolutions in many intellectual pursuits, as well as social and political upheaval, it is perhaps best known for its artistic developments and the contributions of polymaths as Leonardo da Vinci, Duhrer and Michelangelo. Their extensive work on the human body revealed various proportions, and harmonies to exist.[1] Prosthodontics being the best confluence of art and science has used many of these measurements after scientific evidence.[1] However, as time passes these measurements have lost their significance and only a few relevant measurements are used in prosthodontics.

Establishing the vertical dimension is an invincible step in the protocol of treatment planning. Extraction often leads to a sequence of events to which the edentulous patient often has to get adapted. The relationship of the jaws to each other assumes positions and postures due to the absence of vertical stops once teeth are lost. Establishing the original dimension of occlusion is often a Herculean task and extraoral and intraoral landmark measurements are often resorted to. Pre-extraction aids for determining the vertical dimension of occlusion (VDO) are more accurate than post-extraction records; however, they are seldom available.[2]

Through the years prosthodontics has seen multitude of changes in material science and techniques. But there has not been any accurate method of registering the vertical dimension. Facial measurements, esthetics and phonetic evaluations still form the mainstay of clinical practice.[3] Esthetic and phonetic evaluations form subjective evaluations facial measurements are often relied upon with the Niswonger's technique being the most popular. Various correlations of facial measurements are mentioned in literature including eye, lip, nose and palm measurements.[4] Apart from the fact that these measurement techniques are often subjective to ethnic variations, mobility of the skin over the upper half and the lower half of the face and the laxity of the tissue associated with old age often lead to errors in measurement of the vertical dimension. With this background, a study was planned

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to evaluate the correlation between length of the ear and VDO in dentate subjects.

MATERIALS AND METHODS

Prior permission was taken from the ethics committee of Sumandeep Vidyapeeth, Piparia, Vadodara before conducting this study. Each participant was informed about the study and the involved procedure, orally as well as in the form of information sheet. A total of 200 participants (100 males and 100 females) between age group 20 and 30 years (24.7 years) were selected from KM Shah Dental College and Hospital, Piparia, Vadodara, Gujarat, India. Inclusion of the participants was set as having a full complement of teeth up to the second molars in both arches with Class I occlusion in first molars. Partially edentulous participants, participants with history of orthodontic movement of teeth, fracture or surgery of either of jaws, severe tooth wear, missing teeth, prosthesis for missing teeth, ear deformities or absence were excluded from the study. An informed consent form was obtained from each participant. Each participant was seated in dental chair with head erect. Participant was instructed to close his/her teeth in maximum intercuspation and hold till the measurement of VDO was recorded with digital Vernier calipers (Fig. 1). The vertical dimension of occlusion was measured from the point marked at the base of the nose to the point marked at the base of the chin at mid symphysis region with the teeth in maximum intercuspation (Fig. 2).

The second measurement was recording of the length of the right ear. It was recorded from upper border of ear to lower border of the pinna of the ear (Fig. 3). Each measurement was made by two investigators who were previously calibrated for the measurements. Mean of two measurements were taken as final length. After collections of data Pearson's correlation and linear regression analysis was done.

Fig. 1: Digital vernier calipers

Fig. 2: Measurement of vertical dimension of occlusion

Fig. 3: Measurement of linear ear length

RESULTS

Average measurements were calculated for each participant and subjected to descriptive statistics, Pearson's correlation, and linear regression analysis for male, female and overall including total participants irrespective of sex. Summary statistic of male, female and all participants are given in Tables 1 to 3 respectively.

An overall agreement between length of ear and VDO of 56% was observed for the participants enrolled in the study irrespective of the sex. Individually 53 female participants showed agreement between length of ear and VDO out of 100 and males showed 58% agreement between length of ear and VDO. For these participants equal measurements were obtained for both VDO and length of the ear (Table 4).

When a range difference of 1 mm was considered the overall agreement between length of ear and VDO obtained was 68.5% and individually 75% for male and 62% for female participants.

The Pearson's correlation between measured parameters for male participants was 0.750 and the same

for the female participants was 0.570. The overall Pearson's correlation irrespective of sex was 0.640 (Table 5). Individual regression model was plotted for male participants (Graph 1), female participants (Graph 2) and for overall participants including both male and female participants (Graph 3). It can be said that for male regression equation can be established as VDO = 26.203 + 0.556× Ear length.

For female the regression equation can be VDO = 25.655 + 0.560× Ear length and overall regression equation can be agreed as VDO = 25.758 + 0.561× Ear length. From all these calculations and analysis it can be said that ear length and VDO have positive correlation and when ear length is known VDO can be calculated using regression equation.

DISCUSSION

Leonardo da Vinci contributed several observations and drawings on facial proportions, he divided the face in three parts and concluded that all three parts, i.e. upper one third, middle one third and lower one third of the face can be divided equally and he called this measurement as 'divine proportions'.[5] There are various subjective and objective methods to determine the VDO. Some authors recommended the use of various facial measurements to determine the VDO.[6] McGee evaluated the relationship between 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. His observations stated that in 95% of

Table 1: Summary statistic of data of male participants

Model summary					
Model	R	R square	Adjusted R square	Std. error of the estimate	
1	0.750	0.562	0.558	2.50131	
Coefficients					
	Unstandardized coefficients		*Standardized coefficients*		*95% Confidence interval for B*
Model	*B*	*Std. error*	*Beta*	*t*	*Sig.*	*Lower bound*	*Upper bound*
1 (constant)	26.203	2.941	0.750	8.909	0.000	20.366	32.040
Ear length	0.556	0.050		11.222	0.000	0.457	0.654

Table 2: Summary statistic of data of female participants

Model summary					
Model	R	R square	Adjusted R square	Std. error of the estimate	
1	0.570	0.325	0.318	4.37697	
Coefficients					
	Unstandardized coefficients		*Standardized coefficients*		*95% Confidence interval for B*
Model	*B*	*Std. error*	*Beta*	*t*	*Sig.*	*Lower bound*	*Upper bound*
1 (constant)	25.655	4.756	0.570	5.394	0.000	16.217	35.094
Ear length	0.560	0.082		6.872	0.000	0.398	0.722

Table 3: Summary statistic of data of all participants (male and female)

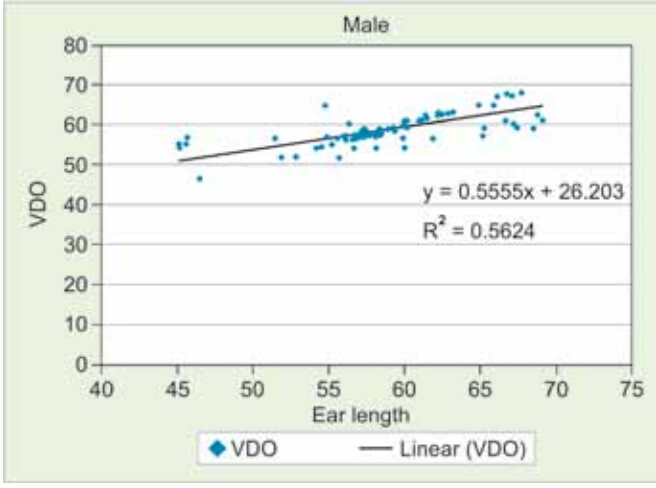
Model summary					
Model	R	R square	Adjusted R square	Std. error of the estimate	
1	0.640	0.409	0.406	3.54935	
Coefficients					
	Unstandardized coefficients		*Standardized coefficients*		*95% Confidence interval for B*
Model	*B*	*Std. error*	*Beta*	*t*	*Sig.*	*Lower bound*	*Upper bound*
1 (constant)	25.758	2.819	0.640	9.138	0.000	20.199	31.317
Ear length	0.561	0.048		11.713	0.000	0.466	0.655

Table 4: Agreement between ear length and VDO of male, female and overall participants

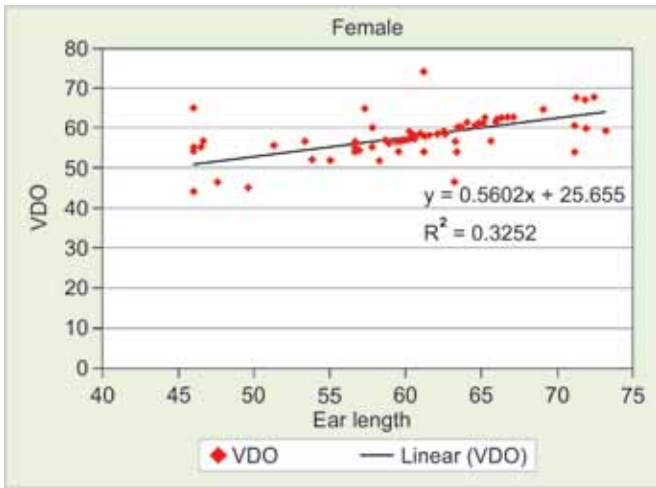
Sl. no.	*Participants group*	*Agreement in %*
1	Male	58
2	Female	53
3	Overall (male and female)	56

Table 5: Pearson's correlation of male, female and overall participants

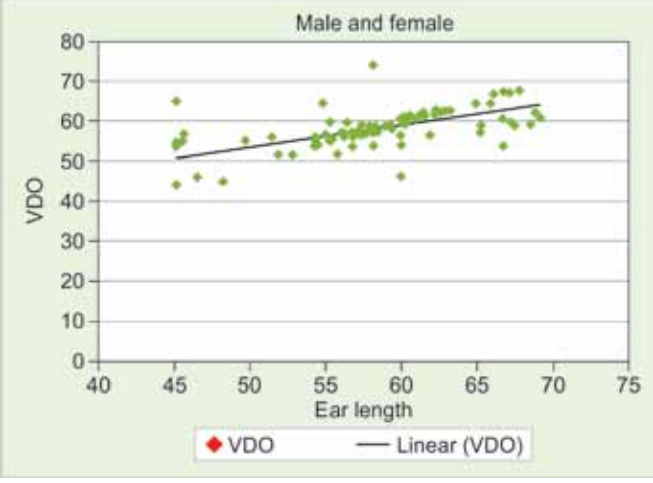
Sl. no.	*Participants group*	*Pearson's correlation*
1	Male	0.750
2	Female	0.570
3	Overall (male and female)	0.640



Graph 1: Linear regression model of length of ear and VDO for male participants



Graph 2: Linear regression model of length of ear and VDO for male participants



Graph 3: Linear regression model of length of ear and VDO for all (male and female) participants

the cases at least two of the three measurements coincided with the vertical dimension.[7]

Tina-Olaivar EO et al in 1998 reported a difference of 3 mm between the dimensions of the upper half of face and the lower half of the face which is in contradiction to the Willis measurement technique.[8] Another study by Geerts GA et al in 2004 reported a greater variance in vertical dimension measurements for the Willis gauge technique as against the caliper technique with most students recruited in the study.[9] Thus, there exists anonymity in the results of different researches and the need to evaluate unexplored landmark measurements to determine vertical dimension. Reports exist for prevalence of external ear defects as congenital disorders or malformation in 1 per 6000 births[10] and a range of 0.8 to 4.2 per 10,000 births.[11] As the prevalence of congenital auricular defects seems less it was decided to evaluate the relationship between the linear dimension of the external ear and the vertical dimension of occlusion as other objective measurements of eyes and lips are associated with more prevalence of deformities or asymmetries.

The results of the study show that a 56% correlation exists between the vertical dimension of occlusion and length of the ear with a better correlation seen in male participants. More correlation seen with male than female may be due to natural variations between sexes. The ear length association with VDO has not been evaluated in the past though it has been reported as a vital element of the Golden proportion. Hence, a comparison with similar studies' results cannot be done. The linear equation model developed may be helpful as a starting point to determine vertical dimension. However, the strict adherence to use of ear length may not be plausible unless the linear equation is retested to a wider population range. Darvell BW, Spratley MH in 1977 reported that use of formulae for determining vertical dimension as impractical. They evaluated the exactness of determining cephalometric landmarks by 10 operators. There existed a standard deviation value of 0.3 to 1.7 mm among the operators and the reason was attributed to tissue compressibility and inability to identify the landmarks. However, the results could have been improved provided the operators were calibrated to make these measurements.[12] Ladda R et al evaluated anthropological correlation between fingers and VDO. They used index finger, little finger and thumbs measurements to correlate with VDO. They concluded that the best parameter to predict the VDO in case of males was found to be the index finger and in case of females it was little finger.[13]

Based on the Pearson's correlation coefficient value of 0.640 the use of ear length may be used for initial prediction of the vertical dimension by using its value in the regression equation. However, a firm observance of the equation may not be advisable. A combined use of objective methods of average value of VDO established by ear length equation value, facial or finger measurements (all within a range of 1–2 mm) is recommended

as a starting point in the measurement. Further confirmation by subjective methods of esthetics, phonetics and swallowing threshold as suggested by Misch CE is deemed necessary.[4] The results of this study state that anthropological measurement of length of ear can serve as basis of determination of VDO and can offer significant prosthodontics advantage. Various subjective methods[14,15] have been used which incorporate some amount of guess work in determining final outcome. Measuring of ear length for determining VDO is objective method where guesswork is eliminated. Vertical dimension of occlusion estimated with this method is within acceptable range of 1 to 2 mm which is far reliable than other methods where difference range of 0 to 14 mm is given.[16,17] This method is easy to incorporate in practice. There is no need for any sophisticated tool or radiographs for this method. This method is economical, predictable, noninvasive and reproducible. Additional studies are required to replicate the present findings so as to confirm the relationship between the anthropometric parameter investigated and the vertical dimension of occlusion.

CONCLUSION

The conclusion of this study on young, fully dentate, class I occlusion individuals are as follows:

- Out of all participants, 56% of participants had exact agreement between the VDO and length of the ear.
- Out of all participants, 68.5% participants showed agreement between the VDO and length of ear within range of 0 to 1 mm.
- Nonetheless, the linear regression equation suggested may help dentists make an initial starting point in the determination of vertical dimension for edentulous patients.
- This method can be used as an adjunct to other methods in determining the VDO. This correlation presents as additional tool or guideline to the dentist to determine the proper VDO and adds to the body of evidence.

REFERENCES

1. Edward H, Angle MD. Treatment of malocclusion of the teeth and fractures of the maxilla. 6th ed. Philadelphia: SS Publishing Co; 1900. p. 15.
2. Atwood DA. A cephalometric study of the mandible Part I The variability of clinical rest position following the removal of occlusal contacts. J Prosthet Dent 1956;6(4):504-519.
3. Turell AJ. Clinical assessment of vertical dimension. J Prosthet Dent 1972;28(3):238-246.
4. Misch CE. Contemporary implant dentistry. 3rd ed. St Louis: Mosby; 2008. p. 236.
5. da Vinci L. The anatomy of man, drawings from the collection of Her Majesty Queen Elizabeth II, Windsor, UK, ca 1488. Available at: www.wikipaintings.org.
6. Turell AJ. The preextraction recording of the vertical dimension by an intraoral method. Dent Pract Dent Rec 1955;6:68-72.
7. McGee GF. Use of facial measurements in determining vertical dimension. J Am Dent Assoc 1947;35:342-350.
8. Tina-Olaivar EO, Olaivar OK. A comparative study of the upper and lower vertical facial measurements of the Filipinos as it is used in the Willis method for determining the vertical dimension of occlusion. J Philipp Dent Assoc 1998;50:44-48.
9. Geerts GA, Stuhlinger ME, Nel DG. A comparison of the accuracy of two methods used by pre-doctoral students to measure vertical dimension. J Prosthet Dent 2004;91:59-66.
10. Gosling S, Omenetter M. Bartel Friedrichs Congenital malformation of external and middle ear. Eur J Radiol 2009;69: 269-279.
11. Alasti F, Vancamp G. Genetics of Microtia and associated syndromes. J Med Genet 2009;46:361-369.
12. Darvell BW, Spratley MH. The inapplicability of formula to determine vertical Dimension. Aust Dent J 1979;24:48-51.
13. Ladda R, Bhandari AJ, Kasat VO, Angadi GS. A new technique to determine vertical dimension of occlusion from anthropometric measurements of fingers. Ind J Dent Res 2013;24:316-320.
14. Atwood DA. A critique of research of the rest position of the mandible. J Prosthet Dent 1966;16:848-854.
15. Ismail YH, George WA. The consistency of the swallowing technique in determining occlusal vertical relation in edentulous patients J Prosthet Dent 1968;19:230-236.
16. Silverman MM. Accurate measurement of vertical dimension by phonetics and the speaking centric space—Part I. Dent Dig 1951;57:261-265.
17. Benediktsson E. Variation in tongue and jaw position in 's' sound production in relation to front teeth occlusion. Acta Odontol Scand 1958;15(4):275-303.