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Original Research Article

Correlation between vertical dimensions of occlusion with accepted anatomical facial landmarks and digit measurements in dentulous subjects-A cross sectional study

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ABSTRACT

Background: Accurate recording of occlusal vertical dimension in edentulous patients is always a prime consideration for an operator but subjective in nature and depends on esthetics and phonetics. Although there are many techniques used for recording vertical dimension at occlusion; still, there is no objective reference point against which, the recorded OVD can be verified.
Aim: The aim of this study was to correlate the vertical dimension of occlusion with accepted anatomical facial landmarks and digit measurements in dentulous subjects.
Objectives: To derive a correlation between OVD and demographics (Age and gender); to validate specific facial and digit measurements which can be used to verify the recorded OVD.
Study design: Cross sectional study
Materials and Methods: 51 adult dentulous volunteers were selected for the study. Various facial and digit measurements were recorded and the correlation between OVD and these measurements was checked using independent sample t test. The correlation was analysed using Pearson's method**.**
Null hypothesis : There is no correlation between Vertical dimension of occlusion (OVD) and facial or digit measurements.
Results: The Pearson's product moment correlation coefficient was determined. Among the digit measurements, OVD was significantly (p-value<0.001) correlated with distance between tip of the thumb and tip of index finger, Length of thumb and Length of index finger with (r) of 0.796 [high], r=0.662 (moderate) & r=0.509; exhibiting moderate correlation respectively.
Among the facial measurements, OVD was significantly (p-value<0.001) correlated with Subnasion menton distance [SM], Centre of pupil to stomion [PS] and distance between Lateral corner of the mouth and lateral canthus of the eye [ME] with r=0.854 (high), r=0.728 (high), & r=0.709 (high) respectively.
Conclusion: Various facial and finger measurements can be utilised as adjuncts for the estimation and verification of occlusal vertical dimension.

1. Introduction

Vertical dimension of occlusion is an important parameter that determines and dictates the restoration of lost form, function and esthetics.[1] Evaluation and restoration of lost vertical dimension in essential in cases with generalised attrition, mutilated dentition, trauma to lower third of the face or state of complete edentulism. Recording VDO is a subjective in nature and numerous methods have been

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mentioned in the literature. The evaluation is affected by operator and patient variables such as mental and physical state of both, utilization of different measurements, tools and expertise of the operator on the subject.[2]

Various methods in the form of pre-extraction records, use of maximum bite force, electromyography and cephalometric radiographs have been used to determine and verify the vertical dimension of occlusion.[3] Each method possesses certain inherent disadvantages such as higher cost, longer time, difficulty in application and errors in measurement. Different anatomical and facial landmarks have been mentioned which give an accurate measure of VDO in dentulous subjects.

The objective of prosthetic rehabilitation as quoted by Dr MM DeVan is: "Perpetual preservation of what remains is more important than meticulous replacement of what is missing."

Prognosis and the success rate of any rehabilitation therapy is a result of multiple sequential procedures; maxillomandibular relationship recording, being one of the most important ones.[4] Vertical dimension of occlusion exists in dentulous as well as edentulous patients. An accurately recorded VDO results in successful rehabilitation and restoration of the lost or missing esthetics, phonetics, form and function along with the health of stomatognathic system as a whole. The change in the facial appearance is due to loss of lip support provided by teeth and alveolar processes and not due to reduced vertical dimension. Restoration of lost vertical dimension must be in harmony with the stomatognathic system and as close to pre-extraction state as possible. Failure to record an optimum vertical dimension can lead to functional and esthetic complications such as cheek biting, difficulty in swallowing, decreased lower facial height, pain around the TMJ, angular cheilitis, loss of lip fullness and Costen's syndrome.[5] Increased vertical dimension can cause premature contact of teeth, trauma to tissues, TMJ problems, affect phonetics, swallowing difficulties and stretched appearance of face. Numerous methods have been suggested and utilised but there does not exist a consensus on the objective evaluation and confirmation of the recorded OVD (Table 1)

Hence, this study was designed and conducted to derive a correlation between VDO and various accepted anatomical and facial landmarks in dentulous subjects so as to utilise the same as a verification tool during rehabilitation in dentulous & edentulous subjects.

The null hypothesis of the present study was; no correlation exists between Vertical dimension of occlusion (OVD) and facial or digit measurements.

2. Materials and Methods

The study was conducted among adult individuals who reported to the department of dental surgery & Prosthodontics clinics at tertiary care hospital of western Maharashtra. The methodology was explained to them and 51 volunteers between the age groups of 20-40 years were selected from the population and an informed consent was obtained from them. Inclusion criteria for the subjects were complete natural dentition (third molar not taken into account), intact upper and lower teeth without any artificial partial or full coverage crowns, straight profile on visual examination. Exclusion criteria was any history of Prosthodontic/Orthodontic /surgical treatment, presence of large carious lesions, abnormality or absence of thumb/any digit, hormonal abnormalities (eg, gigantism, acromegaly).

2.1. Facial measurements

For measuring OVD, participants were seated comfortably upright in a chair with head supported with headrest and ala tragus line horizontal to the floor. The facial measurements were determined by the average distances between various facial landmarks.[14,15] The points included were Glabella, Subnasion, tip of the nose, center of the pupil marked on the skin of the upper eyelid, Rima oris and Menton. The facial measurements recorded were between Glabella and Subnasion, Pupil and Rima Oris, Chin and tip of the nose, center of the Pupil to Stomion, between two angles of the mouth, distance between lateral canthus of the eye and ear as seen in Figures 1, 2, 3, 4, 5 and 6. The relevant soft tissue points were palpated and marked on each subject's face with an indelible pencil. The measurements were made using a digital sliding vernier calliper by the observer and verified by the second independent observer.

2.2. Digit measurements[16]

Each subject was asked to place his or her hand on a paper with palm facing upwards and fingers separated. The proximal point on radial side of the proximal crease over the first metacarpal phalangeal joint and the distal point of the finger were marked and measured. The measurement of length of thumb, index finger, middle finger, ring finger, little finger and length of the gap between the thumb were recorded as seen in Figures 7, 8 and 9.

The data obtained were tabulated (Tables 2 and 3) and subjected to statistical analysis to derive a correlation with OVD of the dentulous subjects.

2.3. Statistical data analysis

The data on categorical variables is shown as n (% of cases) and the data on continuous variables is as mean ± standard deviation (SD). The inter-group statistical significance of difference of means of continuous variables was tested using independent sample t test. The correlation analysis was performed using Pearson's method. The underlying normality assumption of study variables was tested before subjecting the study variables to t test and Pearson's

Table 1: Methods to determine OVD

Niswonger 1934,1938 [5]	Rest position - Neutral position of mandible
Thompson JR 1942 [6]	Studied factors attributing to position of mandible effect of muscle tension on mandible
Leof M 1950 [7]	Stressed upon need to maintain inter-occlusal clearance
Shanahan Thomas 1955 [8]	Swallowing threshold
Silverman Meyer M 1956 [9]	Outlined significance of pre-extraction records
Douglas and Maritato1965 [10]	Open rest method for VDO
Pound and Murrell 1974 [11]	Studied the phonetics on anterior teeth esthetics and occlusion
Majid Bissasu 1999 [12]	Studied dentate subjects to use anatomical landmark to determine VDO
Ladda et al 2014 [13]	Anthropometric measurement to determine vertical dimensions
Basnet et al 2018 [14]	Conducted anthropometric study to determine VDO with dimensions of thumb.

Table 2: Facial measurements used to determine OVD in the study

Chin-nose distance [C N] (OVD)	Pupil-rima oris distance [P R]	Glabella-subnasion distance [G S]	Subnasion-menton distance [S M]	Lateral corner of the mouth and outer canthus of the eye. [M E]	Centre of the pupil to stomion [P S]	Two angles of mouth [AA]	Ear–Eye distance [E e]

Table 3: Digit measurements used in the study

Length of thumb	Length of index finger	Length of middle finger	Length of ring finger	Length of little finger	Length of gap between thumb and index finger

Table 4: Age and sex distribution of cases studied.

	Male (n=34)		Female (n=17)		Total (n=51)	
Age group (years)	**n**	**%**	**n**	**%**	**n**	**%**
20 – 30	17	50.0	8	47.1	25	49.0
30 – 40	17	50.0	9	52.9	26	51.0
Total	34	100.0	17	100.0	51	100.0

Table 5: Distribution of means of facial measurements and the correlation analysis with Chin nose distance

	Whole group, n=51		Correlation With Chin nose distance [CN]	
Parameters (mm)	**Mean**	**SD**	**r-value**	**P-value**
Glabella subnasion distance [GS]	63.12	2.50	0.475	0.001^{***}
Pupil rima oris distance [PR]	66.92	3.64	0.662	0.001^{***}
Chin nose distance [CN]	67.18	5.20	–	–
Subnasion menton distance [SM]	67.27	5.10	0.854	0.001^{***}
Lateral corner of the mouth and lateral canthus of the eye [ME]	69.42	3.85	0.709	0.001^{***}
Centre of pupil to stomion [PS]	67.83	3.27	0.728	0.001^{***}
Two angles of mouth [AA]	55.16	3.97	0.028	0.847^{NS}
Ear eye distance [Ee]	74.63	2.92	0.468	0.001^{***}

Correlation analysis by Pearson's method. P-value less than 0.05 is considered to be statistically significant correlation. *P-value<0.05, ***P-value<0.001, NS – Statistically non-significant.

Table 6: Distribution of means of digit measurements and the correlation analysis with Chin nose distance

	Whole group, n=51		Correlation With Chin nose distance [CN]	
Parameters (mm)	**Mean**	**SD**	**r-value**	**p-value**
Length of thumb	66.92	3.64	0.662	0.001^{***}
Length of index finger	69.42	3.85	0.509	0.001^{***}
Length of middle finger	81.55	6.53	0.254	0.072^{NS}
Length of ring finger	75.30	4.07	0.217	0.126^{NS}
Length of little finger	62.98	3.03	0.048	0.736^{NS}
Length of gap between index finger and thumb	65.99	4.19	0.708	0.001^{***}

Correlation analysis by Pearson's method. P-value less than 0.05 is considered to be statistically significant correlation. *P-value<0.05, ***P-value<0.001, NS – Statistically non-significant.

correlation analysis.

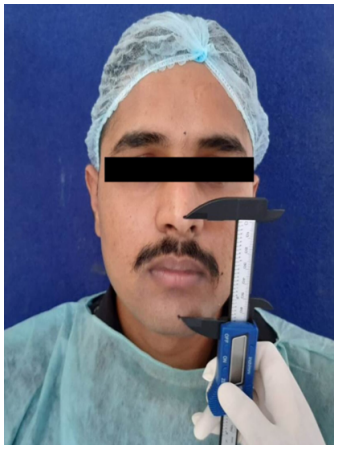

Fig. 1: Chin nose distance [CN]

Fig. 2: Pupilrima oris distance [PR]

Fig. 3: Subnasion menton distance[SM]

Fig. 4: Lateral corner of the mouth and lateral canthus of the eye [ME]

Fig. 5: Two angles of mouth [AA]

Fig. 6: Ear eye distance [Ee]

Fig. 7: Length of thumb

Fig. 8: Length of index finger

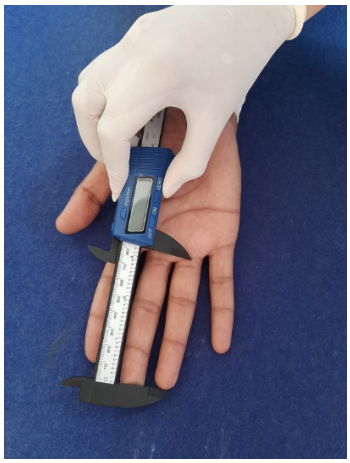

Fig. 9: Length of ring finger

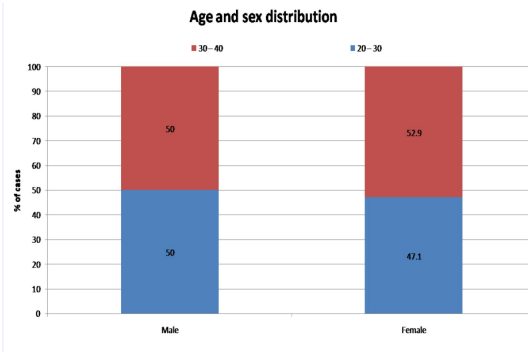

Fig. 10: Age andgender distribution

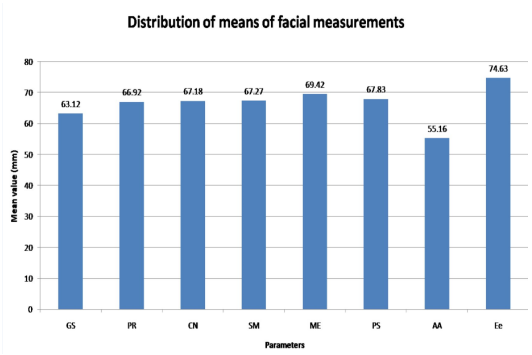

Fig. 11: Distribution of means of facial measurements

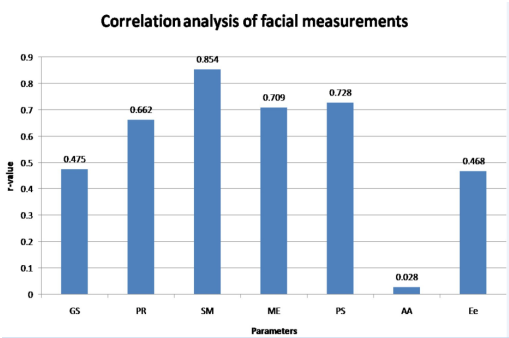

Fig. 12: Correlation analysis of facial measurements

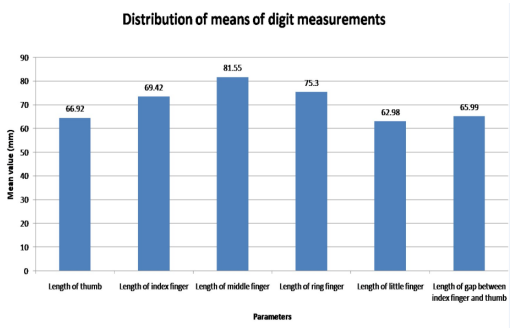

Fig. 13: Distribution of means of digit measurements

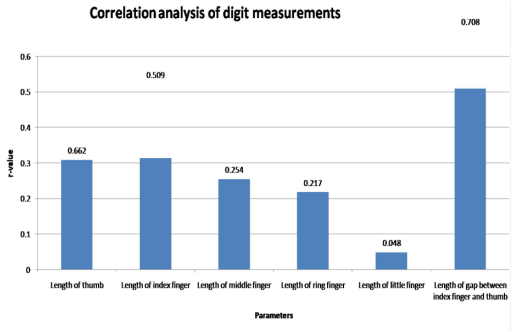

Fig. 14: Correlation analysis of digit measurements

In the study, p-values less than 0.05 were considered statistically significant. All the hypotheses were formulated using two tailed alternatives against each null hypothesis (hypothesis of no difference). The entire data was statistically analyzed using Statistical Package for Social Sciences (SPSS ver 22.0, IBM Corporation, USA) for MS Windows.

3. Results

51 volunteers were selected for this study. Out of, 34 male cases studied, 17 (50.0%) were in the age group between 20 – 30 years and 17 (50.0%) between 30 – 40 years.

Of 17 female cases studied, 8 (47.1%) were in age group of 20 – 30 years and 9 (52.9%) were in the age group of 30 – 40 years. (Table 4 & Figure 10)

Correlation analysis of facial measurement with chin-nose distance [CN] Table 5 & Figures 11 and 12

Glabella subnasion distance [GS] showed statistically significant positive correlation with chin-nose distance [CN]; correlation coefficient being r=0.475, P-value<0.001.

Pupil rima oris distance [PR] showed statistically significant positive correlation with chin-nose distance [CN] with correlation coefficient being r=0.662, P-value<0.001.

Subnasion menton distance [SM] showed statistically significant positive correlation with chin-nose distance [CN] with correlation coefficient being r=0.854, P-value<0.001.

Lateral corner of the mouth and lateral canthus of the eye [ME] showed statistically significant positive correlation with chin-nose distance [CN] with correlation coefficient being r=0.709, P-value<0.001.

Centre of pupil to stomion [PS] showed statistically significant positive correlation with chin-nose distance [CN] with correlation coefficient being r=0.728, P-value<0.001.

Two angles of mouth [AA] did not show statistically significant correlation with chin-nose distance [CN] with correlation coefficient being r=0.028, P-value>0.05.

Ear eye distance [Ee] showed statistically significant positive correlation with chin-nose distance [CN] with correlation coefficient being r=0.468, P-value<0.001.

Correlation analysis of digit measurement with chin-nose distance [CN] (Table 6 , Figures 13 and 14)

Length of thumb showed statistically significant positive correlation with chin-nose distance [CN] with correlation coefficient being r=0.662, P-value<0.05.

Length of index finger showed statistically significant positive correlation with chin-nose distance [CN] with correlation coefficient being r=0.509, P-value<0.05.

Length of middle finger did not show statistically significant correlation with chin-nose distance [CN] with correlation coefficient being r=0.254, P-value>0.05.

Length of ring finger did not show statistically significant correlation with chin-nose distance [CN] with correlation coefficient being r=0.217, P-value>0.05.

Length of little finger did not show statistically significant correlation with chin-nose distance [CN] with correlation coefficient being r=0.048, P-value>0.05.

Length of gap between index finger and thumb showed statistically significant positive correlation with chin-nose distance [CN] with correlation coefficient being r=0.708, P-value<0.001.

Age and gender specific correlations of facial & digit measurements with chin-nose distance [CN]

No age specific correlations have been observed between various measurements and CN distance in our study. However gender specific results have been obtained. In males, GS, PR, SM, ME, PS, Ee & length of gap between index finger and thumb exhibited correlation with CN.

In Females, SM, angle of mouth, PS & length of index finger showed correlation with CN.

4. Discussion

Clinical measurements and statistical analysis of the data revealed statistically significant positive correlations between length of gap between thumb and index, length of thumb & length of index finger. High correlation was observed for length of gap between thumb and index & OVD with Pearson's correlation values of 0.708.

Statistically significant positive correlations were observed between Subnasion menton distance [SM], Centre of pupil to stomion [PS], Lateral corner of the mouth and lateral canthus of the eye [ME], Pupil rima oris [PR], Glabella Subnasion [GS] & ear eye distance [Ee]. High correlation values were observed for SM, PS & ME with Pearson's correlation values of 0.854, 0.728 & 0.709 respectively.

Various methods to record the physiologic rest position of mandible are facial measurements after swallowing and relaxing, tactile sense, measuring anatomical landmarks, facial expressions and phonetics. The mechanical methods that can be used to record VDO include ridge relationships, pre-extraction records, measurements from former dentures, craniometry.[17] The physiologic methods used for evaluation are physiologic rest position, power point method by Boos,

phonetics, esthetics, swallowing threshold, tactile sense or neuromuscular perception.[18]

Out of these, OVD can be best measured using pre-extraction records. But storage and maintenance of those records can be space and time consuming and not feasible practically. This study was designed and conducted to derive a correlation between the OVD (measured at the chin-nose distance) with the other facial measurements and the length of fingers. Considering the disadvantages of previously used methods, this study was undertaken to find a simple and feasible measurement tool to estimate VDO by studying the relationship between VDO, facial measurements and length of the fingers.

Keeping in mind, the known physiological fact that human body maintains symmetry; measurements of the right hand were recorded. This also prevents creation of any bias. The mean values as shown in literature vary between 64mm to 73mm for males and 65mm to 69mm in females.[19] In our study, mean values for distance from the tip of thumb to the tip of index finger was 65.59 mm in males and 65.80 mm in females which are in consonance with the other authors.

The study revealed that distance between tip of thumb to tip of index finger can also be used for determination of VDO in edentulous patient. In our study, OVD is compared and correlated between conventional method and anthropometric method so as to utilise in completely edentulous as well as dentulous (Cases of trauma and generalised attrition where reference or starting point is lost). There is no significant difference in mean scores among genders. The various digit measurements shown to be correlated with OVD are length of little finger, length of index finger & distance between tip of the Thumb and Tip of the index finger. However in our study, correlation of OVD was seen with all the digit measurements except with that of little finger.

4.1. Strength, limitations & recommendations

Standardised measurements with no operator bias (same measuring technique, measuring device) and evaluation and assessment of multiple facial and all digit measurements are the strengths of the study conducted. However a small sample size and inclusion of only surrounding ethnic group are some of the limitations. Subject to the aforementioned limitations, the results obtained were not in agreement with the null hypothesis, hence proving a correlation between the vertical dimension of occlusion and various parameters assessed.

It is recommended that multicentre studies be conducted on larger sample size with subjects from different racial subsets and ethnicity so as to derive positive and validated correlations between the facial and digit measurements and vertical dimension of occlusion which are age and gender specific.

5. Conclusion

This study method is attractive and practical because it is simple, economical, non-invasive, reliable, requires no radiographs or sophisticated measuring devices, time efficient and provides reproducible values for future reference.

Within the limitations of the study, the following conclusions can be drawn-

1. OVD is significantly and strongly correlated with distance between tip of the thumb and tip of index finger.
2. OVD is significantly correlated with Subnasion menton distance [SM].
3. Age and gender specific consonance could not be validated.

Hence proving that various facial and finger measurements can be utilised as adjuncts for the estimation and verification of occlusal vertical dimension effectively.

6. Conflict of Interest

None.

7. Source of Funding

None.

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