IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 18, Issue 8 Ser. 9 (August. 2019), PP 40-53
www.iosrjournals.org

To Correlate and Compare Vertical Dimension of Occlusion from Anthropometric Measurements of Fingers in Dentulous Subjects of Selected Population of up West Region.

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Abstract: ***Purpose: -*** *To find the correlation between vertical dimension of occlusion (VDO) and length of fingers in U.P. West region.*
Material and Method: - *A Cross-sectional study was conducted on 200 medically fit dentate subjects comprising of 100 males and 100 females. Anthropometric measurements of Vertical dimension of occlusion, length of little finger and distance from tip of thumb and tip of index finger of right hand were recorded clinically using Digital Venire Caliper. Correlation between VDO and Length of fingers was studied using Spearman's Coefficient. For the execution of regression command and Preparation of prediction equations to estimate VDO, IBM statistical package for social sciences software version 24.0 was used.*
Result*:-The length of the Index finger can be helpful in estimating VDO of females and little finger for males in estimating VDO. As concluded by the literature, this method is reliable, reproducible, simple, economic and non-invasive.*

Keywords: *Anthropological, hormone, neuromuscular system, stomatognathic system*

Date of Submission: 06-08-2019 Date of Acceptance: 22-08-2019

I. Introduction

With an objective criterion, it is easy to develop an analytical and critical appraisal of elements present in universe or this materialistic world such as their proportion, symmetry and pleasing variations seen in different phases of dentistry as well as in anthropological studies[1].However, it has been noticed an innumerable no. of times that a coin has two faces similarly our body has two proportions which may be symmetrical or asymmetrical according to the hemispherical geometry. A hemispherical asymmetry has likely basis on the amount of androgen hormone release affecting the digit ratio as well as the dental a proportion where it indicates a uniform amount of mandibular movements. Fewer studies provided supportive evidence towards asymmetries associated with the regions of primary motor cortex which are linked to handedness which are preferred for performing various activities or maintaining a habit in day to day life.[2] For dentate individuals, the vertical dimension of occlusion is largely determined by occluding dentition or arch proportion. Although, a static relationship in principle which is initially determined by the interaction of the genetic growth potential of the craniofacial tissues, environmental factors and the dynamics of the neuromuscular system function during the growth period as well as maintaining throughout the ageing process**.**[3,4] .To restore the effected occluding arch of an individual, it is mandatory to record and measure thoroughly a correct vertical dimension of occlusion. Though, there is consensus in the literature concerning the position of the mandible in the horizontal plane which on final analysis involves assessment and procedures linked to the concept of the centric relation and the centric occlusion. But positioning of the mandible in vertical plane, the literature still remains divided on the issue especially with regard to those individuals who have suffered some form of change in relation to the height of the posterior teeth. This is exemplified by the large number of techniques described to determine the vertical dimension of occlusion (VDO), as well as the vertical dimension of rest. In this study, a fixed ratio has been found which can be used universally.[7]Since; there is no absolute method to determine OVD for all individuals. The facial and finger measurements are attractive because they require no radiographs or other special

measuring devices.[4] Hence, this dissertation was taken based on anthropometric measurements to find or evolve a precise technique to define vertical dimension of occlusion to harmonize functions with pleasing appearance.

II. Materials

1. Metallic scale (i.e. accuracy 0.5 mm) (fig. 1)
2. Pointer pen (fig. 1)
3. Digital vernier caliper (Company: - Aerospace, accuracy: - 0.01 mm) (fig.1)

Selection criteria for participants for this study:-

The patient should be medically fit and must have 28 fully erupted teeth which should be periodontally sound in both the jaws.

Inclusion Criteria

1. Angle's class-I occlusion
2. Age between 18-35 years
3. Males and females

Exclusion criteria

1. Class-II and Class-III malocclusions
2. Skeletal deformities
3. Congenital deformities like cleft lip and palate
4. Para-functional habits
5. Open bite or deep cross bite
6. Tooth anomalies
7. Nasal defect
8. History of trauma
9. Any other pathology in the maxillofacial region
10. Orthodontic treatment or Orthographic surgery.

Fig. (1) Armamentarium used:-

1. Scale (0.5mm)
2. Digital vernier caliper

DIGITAL VERNIER CALIPER

A digital vernier caliper with an accuracy of 0.01 mm was used to measure distance from different facial reference points. The digital vernier caliper as shown in (fig. 2). Thus, having two sets of jaws internal and external which are used to hold the Objects to be measured. The distance between the two jaws is displaced o n the LCD display. The display portion of the vernier caliper has a digital expression of distance between the two jaws in millimeters and in inches, which can be controlled with the initial set. There is a locking screw that fixes the external and internal jaws when required.

Fig. (2) Digital Vernier Caliper

III. Method

This cross-sectional study was conducted on 200 medically fit dentate subjects who were selected randomly from U.P. west region. It comprises of 100 males and 100 females with a mean age range from 18-35 years with no deformity of face and fingers. Ethical approval was taken from the institution and informed consent was signed by the participating patients. Anthropometric Measurements related to the vertical dimension of occlusion with Ange's class I occlusion, length of Index fingers, length of little fingers and distance from tip of thumb to tip to index fingers of right hand were recorded clinically using digital vernier caliper with an accuracy of 0.01 mm. Correlation between VDO and length of fingers was studied using spearman's coefficient. For the execution of regression command and preparation of prediction equations to estimate VDO and Statistical Package for Social Sciences Software Version 24.0 was used. The measurement of the face and fingers involves the lower facial height to attain the vertical dimension of occlusion in dentate subjects. By asking the subject to bite lightly on the posterior teeth with lips reposed, head well stabilized and unsupported. Then, the lower tip of caliper is extended and placed firmly below the chin. So, that the soft tissues are compressed by the pressure exerted below the lower border of the mandible and upper tip extended to the junction (of columella & philtrum) and measurements were drawn from the digital caliper.(fig.3) Then to record the measurements of the fingers, ask the patient to keep the hand in supine position. The tip of the caliper is extended on the palmer aspect from the tip to Index finger (2D) to the farthest most point on the palmer digital crease with digital vernier caliper (fig. 4),the tip of the caliper from the tip of the little finger (5D) to the farthest most point crease (fig.5), To,record the distance between the tip of the thumb and the tip of the index finger (2D), by asking the patient to keep the hand in pronation firmly against a flat surface with the fingers and thumb (1D) adducted in neutral position (fig. 6). Then, with the help of a pointer, mark point on the tip of the thumb and the index finger and record the measurement on the scale (fig. 7)

Fig. (3) Measurement of vertical dimension of occlusion

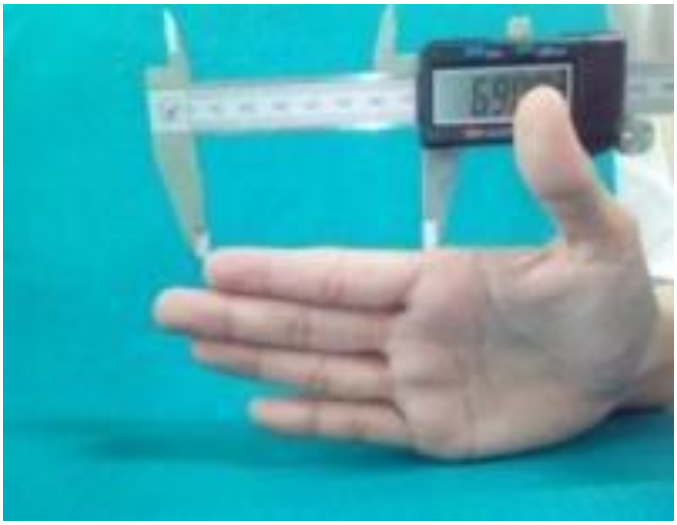


Fig. (4) Measurement of length of Index Finger

Fig. (5) Measurement of length of the little finger

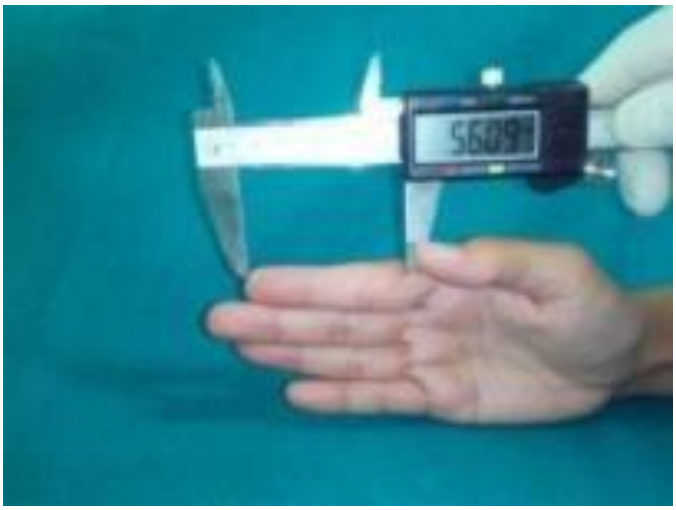


Fig. (6) Measurement of distance from tip of Index finger to tip of thumb

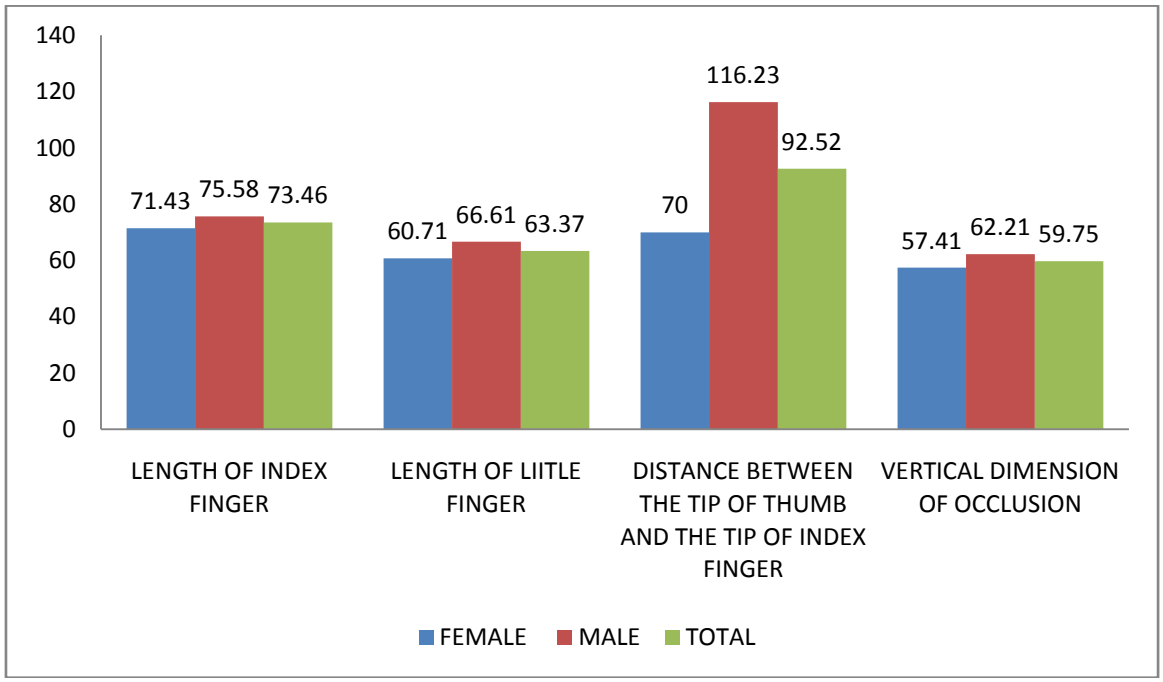
Fig. (7) Measurements of distance from Tip of Index Finger and tip of thumb

IV. Results

Descriptive statistics of the parameters studied is presented in Table1.

Table 1: Descriptive statistics of vertical dimension of occlusion, length of index finger, length of little finger and distance from thetip of the thumb to the tip of index finger.

Variables	Females (mm)	Males (mm)	Total (mm)
Length of Index Finger	71.43	75.58	73.46
Length of little finger	60.71	66.16	63.37
Distance between the tip of Thumb and the tip of Index Finger	70.00	116.23	92.52
Vertical Dimension of Occlusion	57.41	62.21	59.75



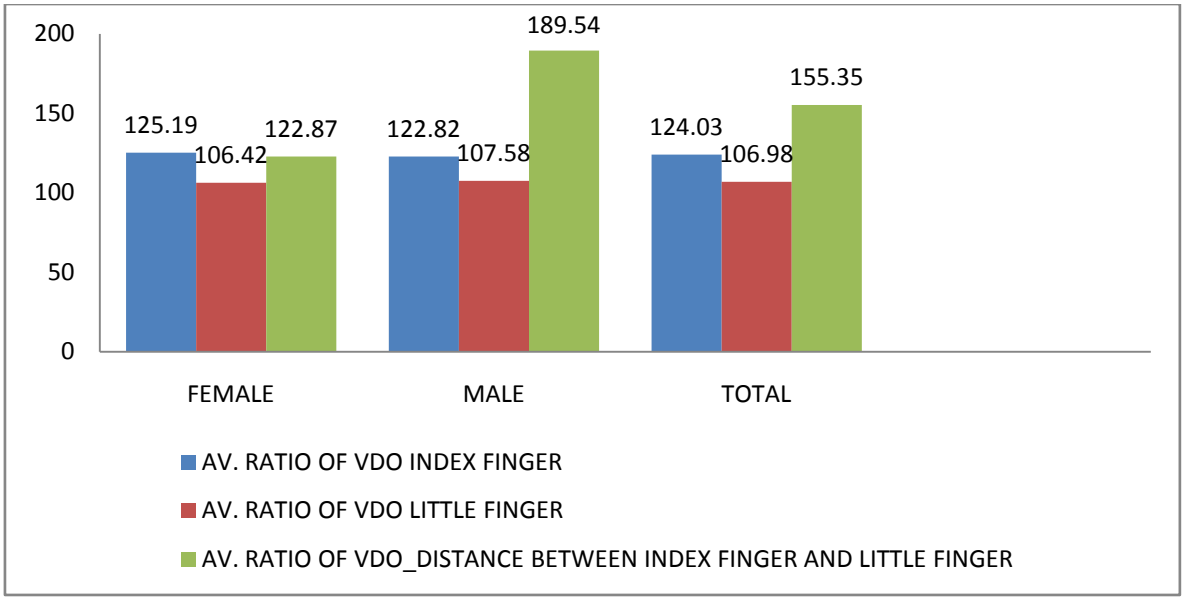
Graph 1: Showing descriptive statistics of vertical dimension of occlusion, length of index finger, length of little finger and distance from the tip of the thumb to the tip of index finger

The above mentioned graph and table shows the mean average between male and female in which the mean average is closely related to Males as length of Index finger is 75.58mm, length of Little

finger is 66.16mm and distance between thumb with length of Index finger is116.23mm with relation to VDO is 62.21mm, whereas females mean average shows the length of index finger to be 71.43mm, length of little finger is 60.71mm and distance between thumb in relation to index finger is 70.00m

Table 2: Average ratio of vertical dimension of occlusion from the measurements of length of fingers

VDO	Females (mm)	Males (mm)	Total (mm)
Average Ratio of VDO_Index Finger	125.19	122.82	124.03
Average Ratio of VDO_Little Finger	106.42	107.58	106.98
Average Ratio of VDO_Distance between the tip of Thumb and the Tip of Index Finger	122.87	189.54	155.35



Graph 2: Showing average ratio of vertical dimension of occlusionfrom the measurements of length of fingers.

The total average mean ratio between genders with respect to their vertical dimension of occlusion with measurements of fingers described in this method shows the results haverelation to the length of fingers. As, there is a significant difference found between the ratios of males: females with total ratio of about 0.6:0.56 with respect to little finger(1:1.069

Table 3: Sex specific correlation between The Length of Index finger, Length of Little finger and Distance from The Tip of Thumb to The Tip of Index Finger.

Sex	VDO vs			
	Statistical measures of Thumb and Index finger	Index finger	Little finger	Distance between tip
Females	r value	0.288	0.244	0.014
	p value	<0.001	<0.001	<0.001
Males	r value	0.194	0.102	-0.043
	p value	<0.001	<0.001	<0.001

The coefficient correlation (r) measured by Spearman's method between the variables and VDO, at the probability level of 95% is presented in Table. 3. In females, correlation of VDO found strongest for the

parameter-length of index finger (r = 0.288). In males, correlation of VDO found strongest for the parameter - length of little finger (r = 0.102).

Regression analysis was performed for prediction of VDO using all the parameters and it was observed that:-

Table 4: Sex Specific Regression Analysis

Gender	Dependent Variable	Independent Variable	Regression Equation (%)	RSquare	SE(Stand ard error)
Male	**VDO(Y)**	A	Y= 46.36+0.21*A	0.021	17.9
		B	Y= 56.13+0.09*B	0.003	19.8
		C	Y= 73.64–0.15*C	0.054	6.2
Female	**VDO (Y)**	A	Y=36.66+0.29*A	0.071	14.3
		B	Y=42.87+ 0.24*B	0.047	14.4
		C	Y= 57.18+ 3.29E-3*C	4.013E - 5	5.2

A = LENGTH OF INDEX FINGER, B = LENGTH OF LITTLE FINGER, C = DISTANCE BETWEEN TIP of THUMB TO TIP of INDEX FINGER, SE = STANDARD ERROR, R^2 = COEFFICIENT OF DETERMINATION, VDO = VERTICAL DIMENSION OF OCCL

It is observed that, in males, the mean value of VDO was 62.30 mm within the range from 45.61 mm to 95.53 mm and whereas in females, the mean value of VDO is 57.40 mm within the range from 45.33 mm to 75.38 mm. Thus, VDO was more in males compared to females mentioned in table 1 along with the graph 1.

In males, the mean value of length of index finger is 75.62 mm within the range from 64.10 mm to 87.30 mm and whereas in females, it was 71.43 mm within the range from 56.32 mm to 81.31 mm. Thus, males had longer index finger as compared to females.

In males, the mean value of length of little finger was 65.58 mm within the range from 54.75 mm to75.70 mm and whereas in females, the mean value was 60.71 mm within the range from 43.96 mm to 71.88 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 index finger is 77.12 mm within the range from 35.37 mm to 100.55 mm and whereas in females, it was 70.00 mm within the range from 49.99 mm to 88.93 mm. Thus, this distance was more in males than in females mentioned in table 2 along with the graph 2.

In Males,
VDO = 46.36 + 0.21 * Length of Index Finger VDO = 56.13 + 0.09 * Length of little finger
VDO = 73.64 – 0.15 * Distance between the tip of thumb to the tip of index finger

In Females,
VDO = 36.66 + 0.29 * Length of Index Finger
VDO = 42.87 + 0.24 * Length of Little Finger
VDO = 57.18 + 3.29E-5 * Distance between the tip of thumb to the tip of index finger

Determination of VDO using regression equation for length of index finger had a standard error of ± 17.9 in males and ± 14.3 in females respectively. Table 4
Determination of VDO using regression equation for length of little finger hadstandard error of ± 19.8 in males and ± 14.4 in females respectively.
Determination of VDO using regression equation for distance from the tip of thumb to the tip of index finger had a standard error of ±6.29 in males and ± 5.2 in females respectively. Table 4

V. Discussion

To maintain harmony in the stomatognathic system, vertical and horizontal distance should be maintained within the structures through jaw relation between them. The determinants of vertical dimension of occlusion correspond to tooth wear or absence of teeth which gives us an aim to find its correlation with the other body parts. It was reviewed in literature that there is no accurate method to define volume of tissues involved whether hard or soft in the absence of pre-extraction records as facial height is a normal variation within and between racial types. Thus, the determinants gave us the opportunity to collect data in references to these anthropometric measurements to rediscover the proportionality with the existing vertical dimension. So, it

was proved by **Lammie and Osborne[30], Moyers and Wainright[32]** that craniofacial morphology, growth and dental morphology accounts for the variations in the dental arch or vertical dimension of occlusion of an individual till the age of 12 years. Also **Lavergne and Petrovic[29]** stated 3 aspects of development of occlusion i.e. through the magnitude of tissue and cell growth, the spatial ordering of the facial skeleton and the dental occlusion as it affects the rate, amount and direction of mandibular growth. It has been proved by **Dellow et al and Nakamura et al[26]** mandibular movements are regulated by the central pattern generator located in the brain stem due to lateralization. The body symmetry corresponds to the flexor muscles of mandible same as the flexor muscles of hand has stronger effect in stress situations such as clenching than extensors while in empty movements .On the other hand, functional occlusion of the dentition occurs within the border movements of the mandible and generally begins with the mandible in a physiologic rest position. The clinical rest position is highly variable and can be influenced by a number of factors including cranial-cervical position, the presence or absence of dentures, speech, and stress as the vertical position of the mandible. This rest or postural position is generally in the range of 2 to 4 mm relative to the intercuspal position. In this position, the mandibular condyles are in an acquired centric position, anteriorly positioned along the condylar translation pathway. In this regard, most clinicians agree that the postural position should not be used as starting point in the determination of the vertical dimension of occlusion.[29, 30]But the patients undergoing prosthodontic treatment of worn dentition before establishing the correct VDO should have in record about clinical rest position and closest speaking space. So, the concept of vertical dimension of occlusion refers to a measure in the vertical plane that establishes the relation between the maxilla and the mandible when the posterior teeth, both from the maxillary and the mandibular arches, are occluded, regardless of whether they are natural or prosthetic, healthy or restored. It is the facial height covering the lower third of face measured from sub nasal to mention with all the teeth in occluded position. It is established when the forces acting on the teeth at the time of eruption from their respective alveolar origins, to gain the vertical space for maintaining crown height in respect to root i.e. crown: root ratio within the "power thrust" of the surrounding muscles of mandible at their elevating capabilities to a point at which they are brought up short against their opponent jaw and at this eruption sequence ceases and vertical dimension of occlusion is established and considered to be in the *functional equilibrium*.[24]As **Turner and Missirlian** gave a classification to identify the level of the tooth wear which is described as it is:-

Category 1:- Excessive wear with loss of VDO.
Category 2:- Excessive wear without loss of VDO but with space available.
Category 3:- Excessive wear without loss of VDO but with limited space.

In typical **Category 1,** patient with loss of VDO, the closest speaking space is more than 4 mm and some loss of facial contour that includes drooping of the corners of the mouth. In typical **Category 2,** patients having a long history of gradual wear caused by bruxism, moderate or at habits or other environmental factors. In typical **Category 3,** there is excessive wear of anterior teeth, which has occurred over a long period. There is minimal wear of posterior teeth. Centric relation and Centric Occlusion are co- incidental with a closest speaking space of 1 mm and an interocclusal distance of 2-3 mm. There are various methods to evaluate the vertical dimension of occlusion as it is critical to verify the loss of vertical dimension beforefabrication of the restorations. It can be established by various subjective or objective means as subjective methods explains the evaluation of aesthetics, phonetics, swallowing, mastication and patient comfort whereas objective methods comprised of electromyographical records, biting power ,cephalometric roentgen graph and various other anthropometric measurements. The use of facial measurements in relation to dentistry was mentioned by **Ivy**[24]. He suggested that the face could be simply divided into four equivalent proportions from top of head to front root of hair, from hair to root of nose, from nose of bottom of nose and from bottom of nose to bottom of chin. The closest speaking space to measure the vertical dimension varies from other methods such as tattoo dot method and recording free-way space which is more time consuming as it is recorded when the muscles are in rest position and often require cephalographic roentgenograms for the approximation of vertical dimension. Even **Pound[6]** supported speaking sound „S" to attain mandibular movement as it assumes to be the most forward speaking position and the anterior teeth are in their most intimate relation with one another. Secondly, lower teeth must move downward out of their centric occlusal position to attain degree of movement and intimacy of teeth depending upon the volume and speed of the desired speech effects. The mandibular movement of speech is directly related with restoring original mandibular tooth position, phonetic sharpness and occlusal harmony i.e. the vertical overlap, the horizontal overlap, lower anterior teeth display, former class of occlusion, maximum usable vertical dimension, an accurate index for incisal guidance and the maximum service cusp height. This "s" sound can be recorded by anterior teeth other methods studies shows boos bimeter was the best device because it was a simple and reliable device for determining the vertical dimension of rest position. **Burnett and Clifford[28]** supported several phonetic tests to use as a guide for occlusal vertical dimension. The vertical component of the closest speaking space determined to have a mean value of 2.0 mm with the range of

0.1 mm to 4.1 mm. **Benediktsson**[26] documented the /s/ position as having a range of 0 to 14 mm for 246 patients with a mean of 206 mm. **Gillings**[27] determined the minimum jaw opening of 22 young adults as 1.1 mm with a range of 0 to 3mm. **George**[28] recorded near/s/ position, which equates with the closest speaking space of 1.8 mm for 31 patients who had skeletal and occlusal class I relationships. **Howell**[31] published a value of 3.1 mm with a range of 0.0 to 8.0 mm for 95 patients. His results were more appropriate for /s/ position on general articulation test, so-called "rainbow passage". **Ignic et al**[18] claims to draw VDO from VDR by using the vowels 'O' and 'E' by subtracting 5.5mm from the measure of 'OLO' word and 7.5mm from 'ELE'. Nakamura et al studied to examine the changes in the mandibular movements and the activity of the masticatory muscles accompanied by alterations in the starting or ending point of the masticatory stroke associated with increased VDO. Electro-myography considered more accurate than in jaw closing to attain vertical dimension of occlusion. Studies were conducted by **Widmalm**[13] in which the electromyography activities falls indicating that less number of muscles fibers is contracting within the range of 1-2 mm near the clinical rest position which was found to be the suppressed position referred as useful clinical landmark. But this loss of tooth structure and decrease in height of the lower third of the face significantly compromises function, facial aesthetics and effects on quality of life. Cephalometric estimation considered to be more correlating than average values as they are more specific for each patient as mentioned in literature concerning the orientation of occlusal plane, the curve of spee, the anterior teeth positions and the anterior guidance. So, to gain more accuracy in gaining the relationship of the size of the gonial angle with respect to sex, age, the cortical thickness of the angle, height of mandibular residual body and the period of edentulism on adults. In this study, length of fingers guided as a basic guideline for estimating the vertical dimension of occlusion to maintain gonial angle and mandibular plane and fingers less than 2.5 cm is regarded normal for complete flexion. For this research, male and female population of U.P. west region with Angle's class I occlusion, as age group of minimum 18 year old as estimated to have skeletal maturity completed and maximum age was 35 years was taken into consideration.This study reported a sexual dimorphism with average values of VDO with length of fingers in males compared to females. It is due to post-puberty level of androgen hormone exposure. As compared to other investigators like **Danborno**[14] found no difference in the length of both the hands. Jackson revealed more correlation towards right hand fingers i.e. 2D:4D ratio. The difference can be attributed to the racial variation of body size, methods of measurements, and anatomic landmarks were measured. In this research hypothesis, we have drawn measurements of right hand fingers measurement (Index finger 2D, Little finger 5D and distance between thumb and Index finger 1D and 2D. In this study, the mean value of vertical dimension of occlusion for male is 62.30 mm, whereas for females it is 57.40 mm which is in accordance with the **Shah et al**[23] which is 62.20 mm, for females it is 57.71 mm. **Kumar et al**[21] showed a mean value range of 70.50 mm for males, 65.20 mm for females. **Basnet B B et al**[17] found OVD to be 68.12 mm for males, whereas for female 63.78 mm. **Ladda et al**[16] showed the mean value of 61.40 mm for males and 56.70 mm for females. **Lindawati et al** showed VDO to be 67.40 mm with the help of the formula Sn- Gn distance = 16+0.65. **Bhandari J et al**[15] reported VDO to be 61.09mm for males, for females the mean value was showed 55.99 mm. **Alhajji et al**[22] showed VDO to be 65.93 mm in females. **Yamashita et al** used cephalometric analysis to predict lower facial height and formulated an equation that could be used within a height range of 37 mm and 59 mm. In this study, the mean index value for male index finger is 75.62 mm,females 71.43 mm which is in accordance with **Shah et al**[23] showed 70.20mmfor males, 66.99 mm for females. **Ladda et al**[16] showed for index finger males 71mm, females it is 65.9 mm. **Alhajji et al**[22] found 2D to be 68.98 mm for females in his study. So, the index finger can also be estimated as a guide for gaining OVD in males and females, as measured the graph shows more positive correlation for males. But, we found that the length of index finger was a reliable method for determining the vertical dimension of occlusion with a standard error of ±0.47 for males and ±0.45 for females with standard deviation of4.72 mm for males and 4.57 mm for females. Length of index finger shows the highest correlation with VDO in males ($r = 0.194$, $p \leq 0.001$**) and females ($r = 0.288$, $p \leq 0.001$**). So, the length of Index finger shows more reliability in females of U.P. west region which is supported by the average ratio (1:1.2519).In this study, the mean index value for male's little finger is 65.58 mm, for females 60.71 mm which is correlated to **Ladda et al**[16] showed mean value for 61.5 mm in males, 56.3 mm for females. **Shah et al**[23] showed 59.99 mm for males, for females it is 56.90 mm. **Bhandari J et al**[45] showed the mean value for little finger is53.42 mm for males, for females it is 56.22 mm. **Alhajji et al**[22] reported little finger to be 57.17 mm. **Nag**[12] showed a mean value of 56.3 mm in females. Little finger can also guide in determining the OVD for male group ($r = 0.102$, $p \leq 0.001$**) and female group ($r = 0.244$,$p \leq 0.001$**) with a standard error of ±0.42 for males and ±0.44 for females. But, it concludes that length of little finger was more closely correlated to VDO for males than females as described by the average ratio graph i.e.1:1.0758. In this study, the distance between the tip of thumb and tip of index finger was measured 77.12 mm, for females it is 70.00 mm which shows a linear graph and corresponds towards VDO that can be measured for both genders at ($p \leq 0.5$). The coefficient (r^2) is weak but correlated for male group ($r = 0.054$) with an average ratio of 1:1.8954. The total average ratio between genders shows more close correlation with female group with respect to VDO with the length of fingers

(i.e.1:1.2403) which shows that it can be used with accuracy in estimating the two variables. As, reviewed in literature that the gonial angle in U.P. west region in accordance with lower third of face, the maximum correlation at the level of 0.001** found which shows the placement of prosthesis and its volume determining with less time consumption and easily for anterior and posterior guidance. It was found to be more correlated for female compared to males. **Dey S and Kapoor A K**[19] showed the hand index for male to be (44.23 mm) and mesocheir as per climatic conditions of U.P. west and Uttrakhand region as compared to other states of India. Similarly, we found that the male hand index in this study (43.0 mm) correlates with the above in the U.P. west region. Unpaired‟ test showed that VDO was significant and positively correlated with all the parameters studied in females and males. So, it is an elaborative technique which involves the greatest accuracy & approximation for estimating the VDO for other techniques if any pre-extraction or post–extraction records including closest speaking space, profile tracing, lingual frenum attachment, and intra-oral tattoo dot method in dentulous patients.

VI. Conclusion

In this study, vertical dimension of occlusion was closely correlated to the length of index finger for females.
In this study, vertical dimension of occlusion was closely correlated to the length of little finger in males.

The study was conducted on total population of 200 subjects comprising of males and females of U.P. west region which infers that a uniform pattern of ratio exist between males (i.e.1:1.07) and for females (i.e.1:1.24) in this population with total average ratio (i.e.1:1.0698). Hence, this ratio can be used in comparing anthropometric measurements with the existing vertical dimension of occlusion in all the subjects. So to authenticate the results, further studies should have to be carried out comprising of a board clinical research program that would indicate the similar analysis for the dentulous population in other ethnic groups and then appropriate regression equations may be constructed which can be accepted universal.

Conflict of Interest

The authors declare no conflict of interest.

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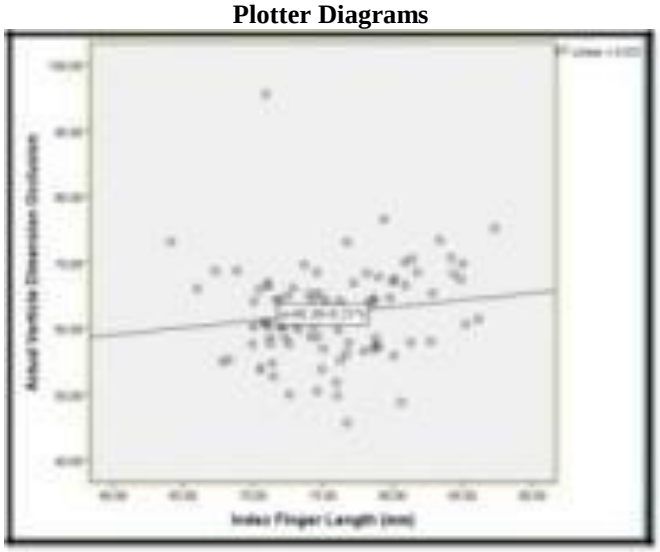
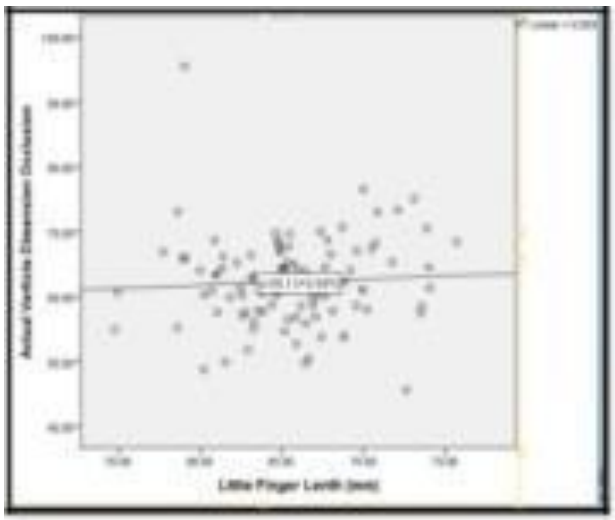
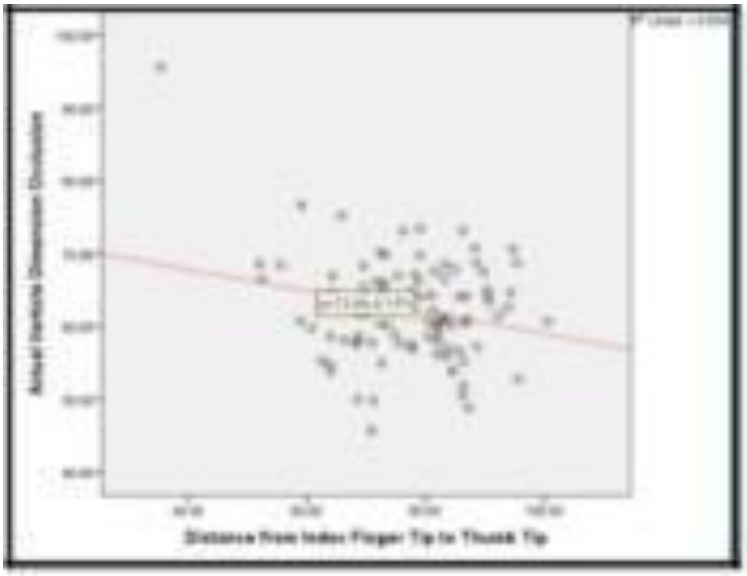
Plotter Diagrams



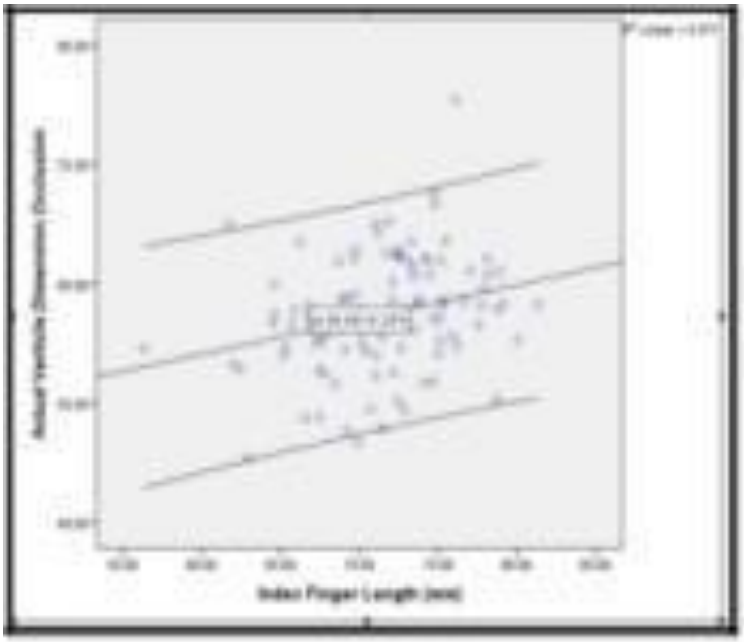
GRAPH 3: SCATTER PLOT FOR MALES ANALYSING THE INDEX FINGER WITH VERTICAL DIMENSION OF OCCLUSION



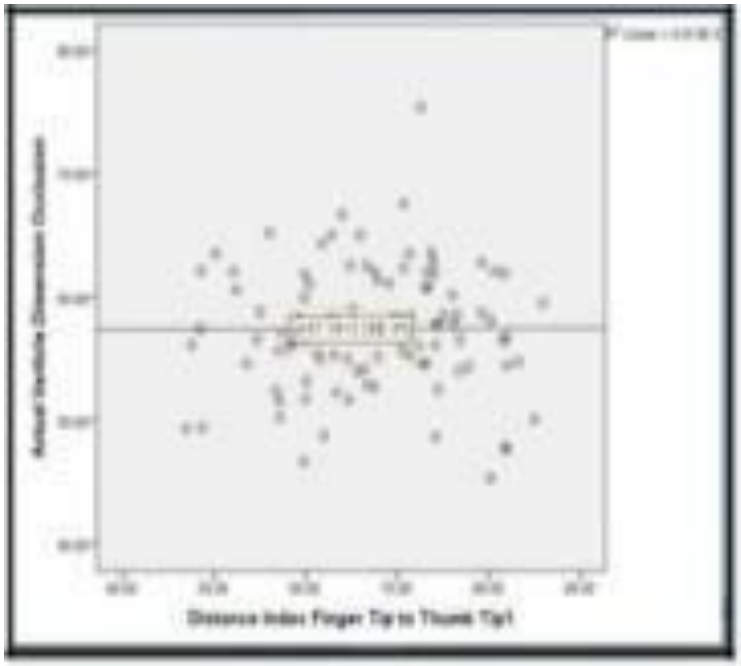
GRAPH 4: SCATTER PLOT FOR MALES ANALYSING THE LITTLE FINGER WITH VERTICAL DIMENSION OF OCCLUSION



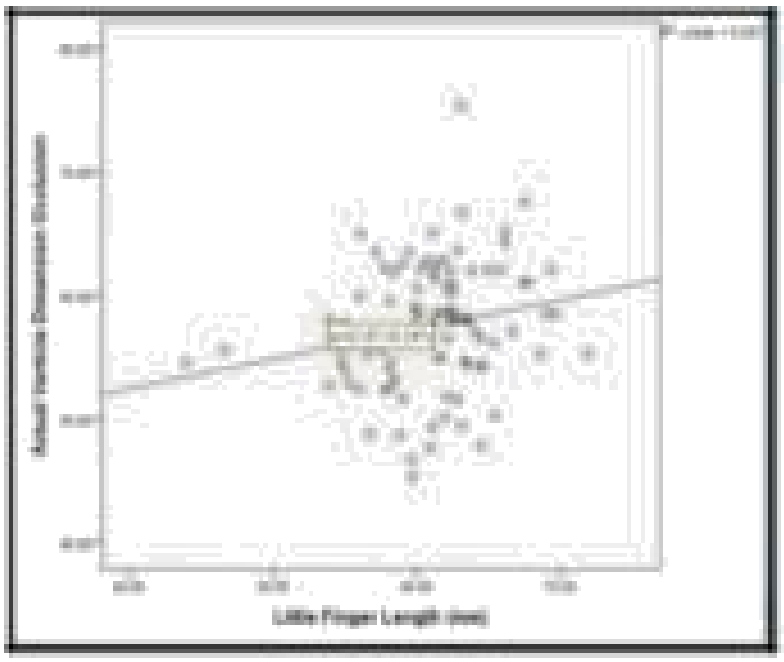
GRAPH 5: SCATTER PLOT FOR MALES ANALYZING THE DISTANCE BETWEEN THE TIP OF THUMB TO THE TIP OF INDEX FINGER WITH VERTICAL DIMENSION OF OCCLUSION



GRAPH 6: SCATTER PLOTS FOR FEMALES ANALYSING THE INDEX FINGER WITH VERTICAL DIMENSION OF OCCLUSION



GRAPH 7: SCATTER PLOTS FOR FEMALES ANALYSING THE LITTLE FINGER WITH VERTICAL DIMENSION OF OCCLUSION



GRAPH 8: SCATTER PLOT FOR FEMALES ANALYSING THE DISTANCE BETWEEN THE TIP OF THUMB AND THE TIP OF INDEX FIN

Study Design