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Evaluation of relationship between anthropometric measurements and occlusal vertical dimension as an aid to determine occlusal vertical dimension in South Indian population

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ABSTRACT-*Vertical relation or vertical dimension refers to the degree of separation between the mandible or lower jawbone and the maxillae or upper jaw-bone. Craniofacial measurements play an important role in determining the vertical dimension of occlusion. To evaluate the relationship between various anthropometric measurements and occlusal vertical dimension to aid in determination of occlusal vertical dimension. A total of 200 adult South Indian subjects (100 male and 100 female) in the age group of 21 –50 years were randomly selected. The 12 variable measurements recored were Horizontal distance between pupils, Vertical distance from the pupil to Stomion, Vertical distance from the eye brow to ala of the nose, Vertical length of the nose at midline, Horizontal distance from one corner of the lip to the other, Distance between eyebrow to hairline, Distance between outer corner of one eye to inner corner of other eye, Vertical height of the ear, Distance between tip of the thumb and the tip of the index , The distance between the outer canthus of eye and Middle tragus of ear, Twice length of one eye, Twice the distance between inner canthus of both eyes, The distance between the outer canthus of eye and Middle tragus of ear and occlusal vertical dimension.* ***Results****: There was a definite relationship between the VDO and seven of the anthropometric measurements such as the horizontal distance between the pupils, eye brow to ala, pupil to Stomion, eye brow to hair line, distance between outer corner to inner corner of the eye, twice the length of the eye, the distance between the outer canthus to the ear in both the sexes. In addition to the seven measurements, Chelion to Chelion in males and vertical distance of the nose at midline for females were statistically significant. Highly significant values for males were the horizontal distance between the pupils, pupil to Stomion and the distance between the eye brow to hairline.*

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Highly significant values for females were the horizontal distance between the pupils, pupil to Stomion and the distance between outer canthus of the eye to the ear. The sex variation was statistically significant showing a higher value for males than the females for all the twelve anthropometric measurements made. ***Conclusion****: Anthropometric measurement found in this study can be used to cross check the OVD obtained by other means during the jaw relation procedures for determining the vertical dimension during denture construction procedure.*

Key words: *Anthropometric measurement, occlusal vertical dimension, south india*

I. INTRODUCTION

Vertical relation or vertical dimension refers to the degree of separation between the mandible or lower jawbone and the maxillae or upper jaw-bone[1]. While Occlusal vertical dimension (OVD) is defined as the vertical dimension of the face when the teeth are in natural maximum contact in centric occlusion, i.e., with the posterior teeth fitting tightly together[1]. Determination of the occlusal vertical dimension establishes the reference position from which all other horizontal jaw relation positions are recorded[2]. But there is difficulty existing in determining the vertical dimension in the edentulous patients due to pronounced change in face height after extraction and role of the musculature in controlling the posture of the mandible[3].

Various instruments have been used for making facial measurements, including Sorenson's profile guide and the Willis device, more sophisticated approaches, such as radiographic techniques and electromyography have also been used but cannot be expected in all clinics. In addition, the patient's swallowing threshold, closest speaking space, phonetics, tactile sense, parallelism of the ridges in the posterior region of the jaw have been used with varying degrees of success. Anthropometric measurements have been used as a valuable guide for determining occlusal vertical dimension by *G.F. McGee[4],* Tsau Man Chou et al[5] and Knebelman[1].

Craniofacial measurements play an important role in determining the vertical dimension of occlusion. According to Webster's dictionary; Anthropometry means "measurements of the human body to determine differences in races, individuals etc" to understand human variation. In the year 1883 the term Anthropometry was coined by Alphone Bertillon, to a system of identification depending on the persistent character of certain parts of human face measurement. Craniofacial anthropometry involves measurement of the skull and face.

The various anthropometric measurements[6] include the horizontal distance between pupils, the vertical distance from the outer canthus of eye or pupil to corner of mouth, the vertical distance from the eye brow to ala of the nose, the vertical length of the nose at midline, horizontal distance from one corner of the lip to the other, the distance between eyebrow to hairline, the distance between outer corner of one eye to inner corner of other eye, vertical height of the ear, distance between tip of the thumb and the tip of the index finger when the finger are pressed together, twice length of one eye, twice the distance between inner canthus of both eye and the distance between the outer canthus and the ear.

The available literatures indicate the difference of anthropometric measurements in racial and ethnic group with sexual variation [7-9]. It is also reported in the literature that the racial and sex difference in the facial form exist in White and Asian population[5]. Hence, this study was carried out in South Indian population to evaluate the relationship between various anthropometric measurements and occlusal vertical dimension to aid in determination of occlusal vertical dimension.

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II. MATERIALS AND METHODS

A total of 200 adult South Indian subjects (100 male and 100 female) in the age group of 21 –50 years were randomly selected. An informed consent was obtained from all the subjects included in the study. According to Inclusion criteria subjects who were South Indians of age between 20 years and 50 years, Patients who had definite centric stop with their natural dentition and Patients with normal jaw relations were included in the study. Those subjects with proclination and retroclination, with a history of congenital anomaly (cleft lip, microtia, squint), trauma, or facial surgery, Patients those who had undergone orthodontic treatment and Patients who had suffered posterior bite collapse as a result of loss of teeth were excluded from the study. To eliminate inter- examiner variability single operator did all the measurements. The following 12 variables were recored:

- Horizontal distance between pupils: A Digital vernier caliper was used for the measurements. The subjects were asked to fix their sight at one point (to prevent movement of eye) and then the measurement was noted.
- Vertical distance from the pupil to Stomion: One arm of the Digital vernier caliper bisects the pupil horizontally and the other arm is moved up to the junction of the lips (not the corner of the mouth) and the readings are noted.
- Vertical distance from the eye brow to ala of the nose: Arms of Digital vernier caliper were adjusted so that they were in gentle contact with the highest point on the lower border of the eye brow and the ala of the nose.
- Vertical length of the nose at midline [4]: The arms of the caliper were adjusted so that they were in gentle contact with the Glabella and Subnasion.
- Horizontal distance from one corner of the lip to the other(Chelion to Chelion)[4]
- Distance between eyebrow to hairline
- Distance between outer corner of one eye to inner corner of other eye
- Vertical height of the ear: The arms of the caliper were adjusted so that they were in gentle contact with the highest and lowest points of the ear. Digital vernier caliper was removed and the readings were noted.
- Distance between tip of the thumb and the tip of the index finger when the fingers are pressed together
- Twice length of one eye: The arms of the caliper were adjusted so that they were in gentle contact with the outer canthus and the inner canthus of one eye. Digital vernier caliper was removed and the readings were noted and multiplied with two.
- Twice the distance between inner canthus of both eyes: The arms of the caliper were adjusted so that they were in gentle contact with inner canthus of both eyes. Digital vernier caliper was removed and the readings were noted and multiplied with two.
- The distance between the outer canthus of eye and Middle tragus of ear
- Measuring occlusal vertical dimension[4]: Occlusal vertical dimension is the distance measured from Subnasion (the angle between the nasal septum and the surface of the upper lip) to gnathion (the most anterior point on the median line of the lower border of the mandible

III. STATISTICAL ANALYSIS

The mean and standard deviation for each parameter were calculated to describe the data. One way analysis of variance was carried out to compare the mean values for the three age groups. 'Tamhane multiple comparison' test were applied for the statistically significant results to compare which age group differs comparatively. Student's't' test were applied to compare the mean of the parameters for male and females. Pearson correlation of coefficient was applied separately for male and female to find out the relationship between occlusal vertical dimension and all other parameter. Stepwise multiple regression analysis was carried out to predict the occlusal vertical dimension values based on the selected parameter.

IV. RESULTS

Mean values of all the studied variables within different age Group are tabulated in table 1.

Table 1: Mean and Standard Deviation by Age Group for the Selected Variables

Variables	21-30 yrs (72)		31-40 yrs (59)		41-50 yrs (69)		'F' value	'P' value	Tamhane multiple comparison
	Mean	S.D	Mean	S.D	Mean	S.D			
Interpupilary	63.14	3.11	63.48	3.51	63.15	3.08	0.232	0.793	-
Pupil to corner of mouth	61.62	3.58	61.51	3.50	62.55	4.05	1.581	0.208	-
Eye brow to ala of nose	62.89	3.56	62.28	3.94	62.46	4.20	0.435	0.648	-
Nose at midline	57.66	3.13	57.75	3.43	57.60	3.97	0.029	0.972	-
Chelion to Chelion	56.79	4.04	58.83	3.41	59.31	4.71	7.405	0.001	1vs 2 Vs 3
Eyebrow to hairline	49.75	5.93	49.45	6.58	50.95	5.54	1.159	0.316	-
Outer corner of one eye to inner corner of other eye	63.33	4.15	63.92	3.35	62.69	3.07	1.881	0.155	-
Ear	60.04	3.27	60.44	3.84	60.83	4.67	0.692	0.502	-
Tip of the thumb to index finer	61.16	5.79	62.57	9.16	60.93	6.22	0.977	0.378	-
Twice length	65.26	3.73	64.94	3.98	63.06	3.33	7.245	0.001	1,2 Vs3

of one eye									
Inner canthus of both eye (twice)	63.61	3.89	63.45	4.67	63.14	4.38	0.215	0.807	-
Outer canthus of eye to ear	75.33	3.31	76.39	5.02	76.79	4.54	2.185	0.115	-
OVD	58.86	4.46	58.49	4.84	60.39	4.91	2.997	0.052	-

All the variables when studied within groups were found t be similar in all the 3 age groups. While other variables with varying results were as follows: The mean distance between the Chelion to Chelion was increasing as age advances which was significant. The mean twice the length of one eye decreases as age advances which was significant. The mean occlusal vertical distance indicated changes in the occlusal vertical distance as age advances which is not significant.

The mean and standard deviation by sex for the selected variables were recorded tabulated in table 2. It was observed that the various anthropometric measurements were higher for the males than the females and this was statistically significant.

Table 2: Mean and Standard Deviation by Sex for the Selected Variables

Variables	Male		Female		't' value	'P' value
	Mean	S.D	Mean	S.D		
Interpupilary	64.42	3.07	62.07	2.92	5..561	<0.001
Pupil to corner of mouth	63.51	3.38	60.31	3.39	6.684	<0.001
Eye brow to ala of nose	63.69	3.98	61.43	3.47	4.273	<0.001
Nose at midline	58.47	3.62	56.86	3.21	3.325	<0.001
Chelion to Chelion	59.56	4.00	56.97	4.11	4.510	<0.001
Eyebrow to hairline	51.96	5.50	48.19	5.93	4.662	<0.001
Outer corner of one eye to inner corner of other eye	64.40	3.36	62.18	3.49	4.584	<0.001
Ear	61.73	3.73	59.14	3.77	4.875	<0.001
Tip of the thumb to index finer	63.75	7.72	59.25	5.57	4.732	<0.001
Twice length of one eye	65.39	3.91	63.43	3.41	3.769	<0.001

Inner canthus of both eye (twice)	64.73	4.04	62.08	4.12	4.589	<0.001
Outer canthus of eye to ear	77.54	4.07	74.75	4.13	4.821	<0.001
OVD	61.40	4.53	57.15	4.03	7.007	<0.001

Relationship between occlusal vertical distance and the selected variables for males showed a significant relationship between occlusal vertical distance and interpupillary distance (ratios being interpupillary distance 1: 0.266 OVD), between occlusal vertical distance and distance from pupil to corner of the mouth (ratios being pupil to corner of the mouth 1: 0.491 OVD), between occlusal vertical distance and distance between eye brows to the ala of nose (ratio being eye brows to the ala of nose 1: 0.204 OVD), between occlusal vertical distance and Chelion to Chelion (ratios being Chelion to Chelion 1: 0.280 OVD), between occlusal vertical distance and eye brows to hair line (The ratios being eye brows to hair line 1: 0.299 OVD), between occlusal vertical distance and distance between the outer corner of one eye to inner corner of other eye. (1: 0.228 OVD), between occlusal vertical distance and twice the length of the inner cantus of both the eye (1: 0.196 OVD), and between occlusal vertical distance and distance between outer cantus of one eye to ear (1: 0.231 OVD).

Similarly relationship between occlusal vertical distance and the selected variables for females showed a significant relation with almost all the variables except between occlusal vertical distance and Chelion to Chelion, between occlusal vertical distance and vertical distance of ear, between occlusal vertical distance and the distance between tip of the thumb to the tip of the index figure and between occlusal vertical distance and the distance between Twice the length of one eye.

Further, all the twelve variables were used to predict the occlusal vertical dimension separately for males and females using a step wise multiple regression

Regression model for males showed that among the twelve variables, three variables have been identified as the most highly significant with occlusal vertical dimension which were: Pupil to corner of the mouth and Eyebrow to ala of the nose and Eyebrow to hair line. 'R' square value was 0.315 which indicates, 31.5 % of times we can predict the occlusal vertical dimension based on the three values.

The multiple regression analysis for female showed that among the twelve variables the following three variables have been identified as the most highly significant with occlusal vertical dimension: Pupil to corner of the mouth, Eyebrow to ala of the nose and Outer canthus of eye to the ear. 'R' square value was 0.498 which indicates, 49.8 % of times we can predict the occlusal vertical dimension based on the three values.

V. DISCUSSION

Anthropometric measurements have been used as a guide for determining vertical dimension as early as 1947 by McGee[4] and he found that center of the pupil to Stomion, Glabella to Subnasion and Chelion to Chelion distances can be used successfully to determine the occlusal vertical dimension.

In this study the patients were selected from the age group of 21 to 50 years with a mean of 31.19 years. The patients were selected in this age group is due to the fact that the craniofacial growth is completed by 20 years of age[10].

In our study the various anthropometric measurements were higher for the males than the females and this is statistically significant (P<0.001). Regarding the changes in the measurement as age advances only two variables namely horizontal distance from one corner of the lip to the other and twice the length of an eye bears a statistical significance. The horizontal distance from one corner of the lip to the other increases as the age advances and vice versa. For variable twice the length of an eye there is a decrease in the length of the eye as age advances.

In this study the mean OVD is 59.24 mm, this finding is lesser than the value reported by Farkas[9], McGee[4], Sidney I. Silverman[11] and Knebleman[1] Thi.s study value is greater than the values reported by Bayan Baynov[4] and Greets[11]. These variations may be due to the ethnicity and racial difference of the population.

Sex variation has been reported for most of the racial groups with the males exhibiting a higher value than the females. The mean value of OVD in this study for male is 61.40 mm and female is 57.15 mm with the OVD being higher for male than the female which was statistically significant (P<0.001). This is in accordance with the study by Bayan Baynov[12]. The age did not have any statistical significance on the OVD in this study.

The result of this study inferred that out of the twelve anthropometric measurements made a statistical significant relationship existed between OVD and eight of the measurements which are the horizontal distance between pupils (0.266), the vertical distance from the outer canthus of eye or pupil to corner of mouth (0.491), the vertical distance from the eye brow to ala of the nose (0.204), horizontal distance from one corner of the lip to the other (0.280), the distance between eyebrow to hairline (0.299), the distance between outer corner of one eye to inner corner of other eye (0.299) and twice the distance between inner canthus of both eye (0.196) in males.

In females, the statistical significance existed between OVD and the horizontal distance between pupils (0.358), the vertical distance from the outer canthus of eye or pupil to corner of mouth (0.641), the vertical distance from the eye brow to ala of the nose (0.229), the vertical length of the nose at midline (0.371), the distance between eyebrow to hairline (0.322), the distance between outer corner of one eye to inner corner of other eye (0.340), twice the distance between inner canthus of both eye (0.240) and the distance between the outer canthus and the ear (0.336). Using Pearson correlation of coefficient a definite ratio has been calculated for VDO and the specific variables,

In the previous study done by McGee[4], correlation existed between the vertical distance from the outer canthus of eye or pupil to corner of mouth (70.21 mm) to that of OVD (70.11 mm) which is also similar to this study, where VDO is 61.24 mm and the vertical distance from the outer canthus of eye or pupil to corner of mouth is 61.89 mm. In the study done by Tsau-man Chou et al[13], correlation existed between OVD and the distance between the outer canthus and the ear (0.87 for females and 0.75 for males). However in this study the correlation between OVD and the distance between the outer canthus and the ear was significant in females (0.336) and not in males (0.231).The variation in the result of this study when compared with that of the previous study may be explained with reference to the racial and ethnic variation in the study population.

However, when a Step wise regression analysis was done which is used to predict the dependent variable, in both males and females the relationship between OVD to that of the horizontal distance between pupils and the vertical distance from the outer cantus of eye or pupil to corner of mouth was found to be highly statistically significant. In addition, the distance between eyebrow to hairline in male and the distance between the outer canthus and the ear in females were found to bear a highly significant relationship with that of occlusal vertical dimension.

However, the 'R' square value which is the predictable ratio obtained through regression analysis was 31.5% and 49.8% for males and females respectively, which infers that, by using the formula and obtained / measured reading, OVD can be calculated with an accuracy of 31.5% for male population and 49.8% for female population in South India.

VI. CONCLUSION

However the predictable ratio obtained in this study is a very small percentage for determining the VDO in South Indian population. Unless a higher ratio is obtained anthropometric measurements cannot be relied upon as a sole method for determining the OVD. Therefore the anthropometric measurement found in this study can be used to cross check the OVD obtained by other means during the jaw relation procedures for determining the vertical dimension during denture construction procedure. Further studies should be conducted comparing other anthropometric measurements in determining OVD for construction of complete denture.

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