ORIGINAL ARTICLE

The correlation between Occlusal Vertical Dimension and Anthropometric Finger Measurements

Corrélation entre la Dimension Verticale de l'Occlusion et les Mesures Anthropométriques des Doigts

Manel Ferjani[1,2], Rim Kallala[1,2], Hana Malla[2], Soumaya Touzi[1,2]

1. University of Monastir, Research Laboratory of Occlusodontics and Ceramic Prostheses LR16ES15, 5000, Monastir, Tunisia
2. Faculty of Dental Medicine, Department of Dental anatomy, Monastir, Tunisia

Abstract

Introduction: The occlusion vertical dimension (OVD) is a fundamental parameter in prosthetic rehabilitation. The clinicians use a variety of methods to restore it. In this scope, finger length is a new method to predict OVD in many populations.
Aim: This study aimed to check the correlation between the anthropometric finger measurements and the occlusal vertical dimension among a sample of the Tunisian population.
Methods: A cross-sectional study was conducted on 154 dental students randomly selected from the faculty of dental medicine in Monastir, Tunisia. The OVD was clinically recorded using a sliding vernier caliper. Each participant was invited to put his right hand on a piece of paper to measure the five finger's lengths. The correlation between OVD and the finger length was analyzed using Pearson's coefficient and linear regression analysis through the SPSS version 20 software
Results: The mean OVD was 69.69± 6.06 mm. Statistically no significant differences were reported according to sex. OVD was significantly and positively correlated with the thumb length, the index length and the Middle finger length in females with respectively r=0.270 r=0.269, r=0.297. No significant correlations were found in males.
Conclusion: The length of the thumb, the index, and the middle finger could be suggested to estimate the occlusal vertical dimension, and it could be used as an alternative measure to obtain the lost occlusal vertical in female patients. However, larger sample studies are needed to find precise reproducible regression equations.

Keywords: Anthropometry, North Africa, Prosthodontics, Tunisia, Vertical dimension.

Résumé

Introduction : La dimension verticale d'occlusion (DVO) est un paramètre fondamental en réhabilitation prothétique. Les cliniciens utilisent diverses méthodes pour la restaurer. Dans ce contexte, la longueur des doigts est une méthode nouvelle pour prédire la DVO dans de nombreuses populations.
Objectif : Cette étude vise à vérifier la corrélation entre les mesures anthropométriques des doigts et la dimension verticale d'occlusion au sein d'un échantillon de la population tunisienne.
Méthodes : Une étude transversale a été menée sur 154 étudiants en chirurgie dentaire, sélectionnés de manière aléatoire à la faculté de médecine dentaire de Monastir, en Tunisie. La DVO a été enregistrée cliniquement à l'aide d'un pied à coulisse. Chaque participant a été invité à poser sa main droite sur une feuille de papier pour mesurer la longueur des cinq doigts. La corrélation entre la DVO et la longueur des doigts a été analysée à l'aide du coefficient de corrélation de Pearson et d'une analyse de régression linéaire via le logiciel SPSS version 20.
Résultats : La DVO moyenne était de 69,69 ± 6,06 mm. Aucune différence statistiquement significative n'a été rapportée selon le sexe. La DVO était significativement et positivement corrélée à la longueur du pouce, de l'index et du majeur chez les femmes, avec respectivement r = 0,270 ; r = 0,269 ; r = 0,297. Aucune corrélation significative n'a été trouvée chez les hommes.
Conclusion : La longueur du pouce, de l'index et du majeur pourrait être suggérée pour estimer la dimension verticale d'occlusion, et pourrait être utilisée comme mesure alternative pour retrouver la DVO perdue chez les patientes. Cependant, des études sur des échantillons plus larges sont nécessaires pour établir des équations de régression précises et reproductibles.

Mots-clés : Anthropométrie, Afrique du Nord, Prothèse dentaire, Tunisie, Dimension verticale

Correspondance
Manel Ferjani
University of Monastir, Research Laboratory of Occlusodontics and Ceramic Prostheses LR16ES15, 5000, Monastir, Tunisia
Email: ferjanimanel@outlook.fr

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Introduction

The occlusion vertical dimension (OVD) is defined as the height of the lower face. It refers to the distance between two selected anatomic or marked points (usually one on the tip of the nose and the other on the chin). Its loss is an evident consequence of teeth loss. It can also occur in case of severe tooth wear (1). During the prosthetic rehabilitation of edentulous and partially edentulous patients, the respect of the OVD is mandatory (2). In this issue, many methods have been proposed, citing the rest vertical dimension technique, the phonetic technique, the swallowing technique, the cephalometric method, and the use of the existing old dentures. The rest vertical dimension technique, based on mandibular manipulation and a central-bearing-point device, is highly age-related. Facial changes and physiological factors often compromise the validity of the results (3). Furthermore, the significant variation and instability of the mandible at its rest position make the physiologic rest position technique unreliable for determining the OVD (4). The phonetic technique relies on the pronunciation of the "S" sound. During the phonation of this syllable, the upper and lower teeth achieve maximum proximity, ensuring minimal phonetic space (4). The swallowing technique, on the other hand, is used to determine the OVD in centric relation for edentulous patients. During swallowing, the mandible elevates to its habitual closing position. As saliva is propelled posteriorly into the pharynx by the tongue, the mandible moves back to its physiological-centric relation (5). This method lacks accuracy because it is dependent on both the duration of swallowing and the softness of the wax cones (6). The cephalometric technique, requiring a cephalometer and six radiographs, is a complex, time-consuming, and costly method for determining OVD and centric occlusion (7). Moreover, this technique requires unnecessary radiation exposure (6). The old denture method is unsuitable for patients with worn dentition or resorbed residual ridges (6).

Scientifically, none of the mentioned methods have demonstrated clear superiority, and each presents its limitations (4). Prosthodontists have long sought an ideal method for determining OVD that is efficient in terms of cost, time, and instrumentation (5). Recent worldwide cross-sectional studies have increasingly focused on anthropometric measurements (the scientific study of human body measurements and proportions) in the search for a more precise method of determining OVD. Correlating anthropometric finger length with OVD offers the potential for accurately determining a patient's OVD using a simple equation based on finger measurements. This method is advantageous as it is unaffected by physiological changes in the patient and requires neither sophisticated equipment nor significant time to implement. Finger length is a reliable and relatively stable measurement in the human body.

Therefore, the aim of the study was to assess the relationship between the OVD and the length of the fingers in a Tunisian population and, to develop an equation to predict the OVD if a correlation existed.

Methods

Study design

A cross-sectional study was conducted at the faculty of Dental Medicine (Monastir-Tunisia), according to STROBE guidelines (8). The ethical approval was obtained from the institutional ethical committee of the faculty with approval number: IORG0009738N°97/OMB0990-0279. Informed consent was obtained from participants before enrolling in the data collection procedure.

Sample size

The sample size was calculated with 95 % confidence interval and 12 % error margin using this formula:

$$n = (Z\ score)^2 * SD * (|1 - SD|) / (error\ margin\ percentage)^2$$

The standard deviation (SD) of OVD was equal to 3.88 according to Shafkat al Hussein et al. (4). Thus, the ideal sample size was estimated to be 154.

Study population

The study was conducted among dental students randomly selected from the faculty of Dental Medicine (Monastir-Tunisia). The following inclusion criteria were respected: Age >=18 years, correct occlusal vertical dimension, no orthodontic treatment, trimmed nails, and no finger deformities. Foreign students were not included.

Measurements Recording Procedure

Age and sex were recorded. The participant was asked to bite lightly on his posterior teeth and to keep his head in an orthostatic position. Using a vernier caliper (Arduino Carbon Fiber Micrometer), the OVD was measured as the distance between the lower tip, placed firmly beneath the chin, and the upper tip, raised until it lightly touched the base of the nasal septum. The base of the nose and the chin served as reference points (Figure 1). Then, the participant was asked to place their right hand on a piece of paper, and the operator traced its outline. The length of each finger was then measured between two defined reference points (Figure 2).

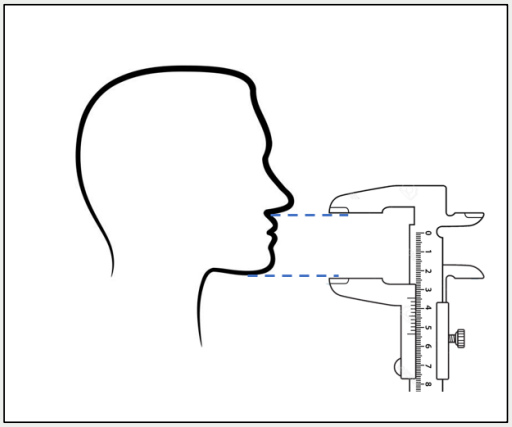

Figure 1. OVD measurement

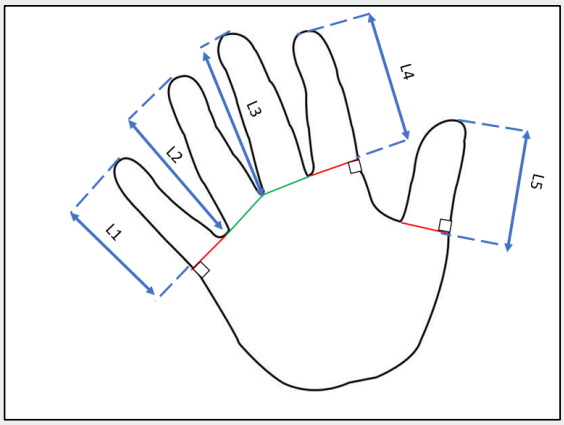

Figure 2. Method used for fingers' measurements
L: Length 1: little finger 2: Ring 3: Middle finger 4: Index 5: Thumb

Data Analysis

All data were collected and then analyzed using SPSS 20 software. Data normality was checked using the Kolmogorov-Smirnov test. Descriptive results including the mean (Me), the maximum (MAX), the minimum (MIN), and the standard deviation (SD) were calculated. Independent t-test was used to compare the mean length of each finger, as well as, the mean OVD between males and females. The Pearson coefficient (r) between OVD and the length of fingers. Univariable linear regression analysis was performed for the prediction of the OVD using the middle finger length, the thumb length, and the index length. The significance level was fixed at p = 0.05.

Results

A total of 154 participants agreed to take part in this investigation. The sample consisted of 74.7% females with a mean age of 20±2 years. Descriptive statistics for the measured parameters are presented in (Table 1). Males exhibited the highest finger lengths for all fingers, with statistically significant differences observed for the thumb and ring fingers (p<0.05). Males also presented higher OVD measurements, although this difference was not statistically significant.

For all participants, OVD showed a significant positive correlation with the length of all five fingers. In females, the index, thumb, and middle fingers were positively correlated with OVD (p<0.01). However, no significant correlations were found in males (Table 2). Across all participants, all fingers exhibited a significant positive correlation with OVD, with the strongest correlation observed for the middle finger. The regression analyses for the reported significant correlations are presented in (Table 3).

Table 1. Fingers length and OVD measurements

	All participants				Males				Females				p value*
	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD	Min	Max	
Little finger	59.23	5.44	75.00	47.00	57.96	5.08	71.00	47.00	62.96	4.26	54.00	75.00	0.72
Index	73.47	5.72	88.00	59.00	72.17	5.40	85.00	59.00	77.30	4.92	67.00	88.00	0.36
Middle finger	80.67	6.09	98.50	66.00	79.02	5.46	98.50	66.00	85.55	5.23	77.00	98.50	0.91
Ring	70.94	6.57	88.00	53.00	69.61	6.53	88.00	53.00	74.87	4.99	67.00	88.00	**0.03****
Thumb	57.69	4.83	74.50	46.00	57.08	5.04	74.5	46.00	59.50	3.64	55.00	71.00	**0.05****
ovD	69.69	6.06	86.00	51.00	69.53	5.76	82.70	51.00	73.10	5.70	63.70	86.00	0.78

*comparison of measurements between females and males using Independent t-test;**: p<0.05

Table 2. Sex-specific correlations between the OVD and the length of the five fingers of the right hand

	Female			Male			All participants		
Correlation	**r**	**p-value**	**n**	**r**	**p-value**	**n**	**r**	**p-value**	**n**
IndeX	0.269**	0.004	115	0.114	0.381	39	0.337**	0	154
Thumb	0.270**	0.003	115	0.110	0.505	39	0.291**	0	154
Ring	0.161	0.085	115	-0.11	0.948	39	0.226**	0.005	154
Middle finger	0.293**	0.001	115	0.168	0.308	39	0.373**	0	154
Little finger	0.165	0.077	115	0.046	0.782	39	0.250**	0.002	154

r: The Pearson coefficient; **Correlation is significant at the level 0.01 (Two tailed)

Table 3. Regression analysis for the index length, the thumb, and the middle finger for females

Dependent variable	Independent Variable	Regression equation	R^2	SE (standard error)
OVD (Y)	**Index length (I)**	Y=47.860+0.287*I	0.072	5.57
	Thumb length (T)	Y=50.911+ 0.309*T	0.073	5.57
	Middle Finger length (M)	Y=44.082+0.309*M	0.078	5.53

Discussion

The present investigation aimed to assess the relationship between the OVD and finger length. The main finding could be summarized as follows: the OVD was 73.11±55.70. Males reached the highest values in fingers' length and OVD. The correlation between measurements of the thumb, the index finger, and the OVD was significantly positive only in females, reaching values of 0.27, 0.27, and 0.29, respectively.

The reported mean OVD is close to that found by Alhajj et al. (9). However, other researchers have reported lower values (1, 10, 11) (Table 4). The observed variations in results could be attributed to differences in the studied populations, including racial variations. Furthermore, discrepancies may arise from variations in measurement techniques. In the present study, as well as the study by Ladda et al. (1), the tips of the vernier caliper were positioned at the base of the nasal septum and below the chin. This placement allowed for compression of the soft tissues, enabling the caliper to be positioned as close as possible to the lower border of the mandible against the skin. However, Munshi et al. (3) and Rege et al. (10) placed it on the tip of the chin. Differences in sample characteristics across the various studies could also explain these discrepancies (Table 4).

Table 4. Comparison of OVD and finger lengths across different populations

Study	N	Town (Country)	Mean OVD (mm)			Index (mm)		LF (mm)		Correlations in females		
			Total	M	F	M	F	M	F	Index	MF	Thumb
Ladda et al (1)	400	Loni (India)	NR	61.4	56.7	71.6	65.9	61.5	56.7	0.257	NR	NR
Munshi et al (3)	200	Pakistan	NR	65.3	60.33	70.52	69.29	63.94	59.66	0.285	NR	NR
Jhanvi Rege et al (10)	320	Karad, India	NR	59.41	55.34	NR	NR	58.92	54.30	0.23	NR	NR
Alhajj et al (9)	117	Sudan	67.4± 4.9	NR	68.19	NR	68.98	NR	57.17	0.362	NR	NR
Bajracharia et al (12)	115	Kathmandu Valleyviz (Nepal)	NR	64.57 ± 4.68	60.28 ± 3.90	NR	NR	NR	NR	0.319	0.28	0.461
Hussein Yazdanie et al (4)	250	Lahore Pakistan	NR	70.81	61.32	70.92	66.67	NR	NR	0.819	NR	NR
Basutkar N et al (6)	500	Saudi	NR	68.16	61.18	68.61	66.09	62.47	57	0.49	NR	0.53
Basnet et al (5)	500	Dharan, Nepal	NR	68.12±4.63	63.78±4.47	NR	NR	NR	NR	NR	NR	0.874
Harsha Vardhan et al (11)	100	Chennai, South India	NR	65.68	59.46	68.02	62.29	64.52	57.96	0.207	NR	NS
Sihuaytorres et al (13)	114	Lima (Peru)	64.03			65.63		55.62		NS	NR	NS
Rahmi et al (14)	336	Indonisia	63.36	NR		NR		60.78		NR	NR	NR
Current Study	154	Monastir (Tunisia)	69.69±6.06	73.10 ±5.70	69.53 ± 5.76	72.17	77.3	57.96	62.96	0.269	0.29	0.270

*NR: not reported NS: not significant

Mean finger lengths of the right hand were recorded in this study (Table 1). Given that previous research has mainly investigated the index and little fingers, this work contributes a novel analysis by examining the length of all fingers. Consistent with previous research (4, 5), this study found that mean finger lengths were consistently greater in males than females. This sex-based difference can be attributed to post-pubertal androgen exposure levels (15) (Table 4).

Regarding specific finger lengths, the mean index finger length in males in this study is similar to values reported by Ladda et al. (1), Munshi et al. (3), and Yazdanie et al. (4). However, our findings show higher values than those reported by Vardhan et al. (11) and Basutkar et al. (6). Concerning the little finger, the mean length in males was lower compared to other studies, with the closest value found by Torres et al. (13). Notably, the little finger length in females in our study was among the highest reported across all studies (Table 4).

Moreover, OVD was positively correlated with finger length for all participants, which is consistent with the findings of Basnet et al (5). and Bajracharya et al (12). (Table 2).

According to sex, it demonstrated, also, a significant positive correlation with finger length only in females (Table 2). This finding aligns with the results of previous studies (3,9). However, others (1,4) reported significant correlations for both males and females. This discrepancy is understandable considering the variations in the studied populations. Specifically, for the index finger, the correlation coefficient with OVD was approximately 0.269. This value is similar to those reported in previous studies (1, 3, 9) (Table 6). Notably, the correlation was strongest for Pakistani women, reaching 0.819. Tunisian women's thumb length also showed a significant positive correlation with OVD, reaching 0.270, although other studies reported higher correlations of 0.53 and 0.46 (6, 12) (Table 6). The correlation between the length of the middle finger and OVD was the highest in our study (r = 0.293), which is consistent with the values found in Bajracharya's study (12). These variations in correlations across studies may be explained by differences between the studied populations.

All these differences between studies may also be attributable to differences in the populations studied. In addition to potential population differences, it's important to note a key methodological distinction: this study used a customized measurement technique. Specifically, measurements were taken indirectly from tracings on paper, whereas all other studies measured fingers directly on the participants' hands.

The mean age of the participants in this study was 20 years, making this population younger than those in other investigations, where mean ages ranged from 24 to 30 years (4, 5). This age range was chosen as it represents the period following the completion of mandibular and finger growth in both sexes.

This study is the first investigation conducted among North African population. Nevertheless, it has several limitations. First, the sample was predominantly female. Second, the margin of error used for sample size calculation appears to be high. Third, the study would have benefited from categorizing subjects according to their facial shapes (13).

Conclusion

A positive correlation was found between OVD and the length of the middle finger, as well as the index and thumb fingers, but only in females. No such correlation was found in males. Therefore, the lengths of the thumb, index, and middle fingers could potentially be used to estimate OVD and offer an alternative method for determining lost OVD. However, as this is the first such study in the Tunisian population, larger studies with more representative samples are needed to develop precise and universally applicable regression equations.

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