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Article

Relationship between the occlusal vertical dimension and anthropometric measurements of the fingers.

Relación entre la dimensión vertical oclusal y las medidas antropométricas de los dedos de la mano.

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Abstract: The alteration of the vertical dimension can deteriorate the facial harmony, and it can be measured through objective and subjective methods, although many of which are not reliable. Objective: Relate the anthropometric fingers length with the measurement of the vertical occlusal dimension (VOD). Material and Methods: Cross-sectional, observational study that included 114 students from the School of Dentistry with class I malocclusion and complete dentition. The VOD was evaluated as the measurement between the subnasal points and the mental point; anthropometric measures included the length of the fingers (from the most mesial fold to the most distal edge) and the distance projected between the thumb and the index finger. Results: The average VOD was 64.03±5.15mm. A correlation was found between the VOD and the index finger length (p<0.01, r=0.29), between the VOD and middle finger length (p<0.01, r=0.31) and correlation between the VOD and the length of the little finger (p<0.05, r=0.23). No correlation was found between the VOD and the ring finger lengths (p=0.051) or thumb (p=0.12). Conclusions: The anthropometric measurements of the index finger, middle finger, little finger and the projection of the thumb on the index finger correlated with the length of the vertical occlusal dimension.

Keywords: Anthropometry; dental occlusion; mandible; maxilla; vertical dimension; malocclusion.

Resumen: La alteración de la dimensión vertical puede deteriorar la armonía facial, su medición puede realizar a través de métodos objetivos y subjetivos; sin embargo muchos de ellos no son confiables. Objetivo: Relacionar las longitudes antropométricas de los dedos de la mano con la medida de la dimensión vertical oclusal (DVO). Material y Métodos: Estudio transversal, observacional que incluyó a 114 estudiantes de la Facultad de Odontología con maloclusión de clase I y dentición completa. La DVO fue evaluada como la medida entre los puntos subnasal al punto mentoniano; las medidas antropométricas incluyeron a la longitud de los dedos (desde su pliegue más mesial hasta su borde más distal) y la distancia proyectada entre el pulgar al índice. Resultados: La DVO promedio fue de 64,03±5,15mm. Se encontró correlación entre la DVO y la longitud del dedo índice (p<0,01; r=0,29), entre la DVO y la longitud del dedo medio (p<0,01; r=0,31) y correlación entre la DVO y la longitud del dedo meñique (p<0,05; r=0,23). No se encontró correlación entre la DVO y las longitudes de los dedos anular (p=0,051) y pulgar (p=0,12). Conclusiones: Las medidas antropométricas del dedo índice, medio, meñique y la proyección del dedo pulgar sobre el dedo índice se correlacionaron con la longitud de la dimensión vertical oclusal.

Palabras Clave: *Antropometría; Oclusión dental; Mandíbula; Maxilar superior; Dimensión vertical; Maloclusión.*

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INTRODUCTION.

The appropriate vertical dimension, together with stable occlusal contacts, harmony in the temporomandibular joints (TMJs), and masticatory muscles, as well as consistent contours of the facial muscles help in the adaptation of the partial or complete denture to the masticatory system.[1] Its accurate measurement plays a role in the functional rehabilitation of the lower third of the face, as well as facial expression and appearance.

The stomatognathic system works by means of a permanent functional balance between the temporomandibular joint (TMJ), anatomical facial height, dental occlusion, chewing, swallowing and the individual adaptation response. In patients who are totally or partially edentulous, this balance is disturbed, which leads to pathologies that involve TMJ, teeth, periodontium, muscles, speech and facial aesthetics.

In general the natural vertical occlusal dimension (VOD) is the most frequently used feature when making a complete prosthesis; however, in clinical practice there is no absolutely accurate method to determine the exact vertical dimension of occlusion.[2]

Different methods have been proposed for the registration of VOD in completely edentulous patients: the use of photographic records before extraction,[3] the use of anatomical reference points that correlate with vertical dimension measurement, the use of simple pantographs,[4] the use of transparent resin masks,[5] electronic methods,[6] as well as anthropometric methods such as the distance between the pupils[7] that equals the distance between the subnasion point to the gnathion.[8]

The distance between the angles of the mouth with the lips at rest, the distance of the glabella to the subnasion, as well as the distance from the edge of the eye to the oral cleft have also been used.[9]

Some authors have also suggested that anthropometric measurements of the fingers[10-12] and facial proportions correlate with the VOD. These methods are based on the harmony of the human body, and that there are relatively constant proportions without changes as the person ages.[13]

Correlation studies between thumb length and lower facial height length can help the dentist establish the correct VOD in the treatment of patients who require complete dentures. It has been found that if anthropometric measurements of a body area are strongly related to VOD in a specific population, these measures could be used when making decisions about the oral rehabilitation of a total edentulous patient.

Although there are multiple materials and techniques for the measurement of VOD, many are not science-based, accurate and accepted for use in the evaluation of edentulous patients, therefore clinical judgment continues to play an important role in this regard. If it is possible to establish that a specific anthropometric measurement, such as hand measurements, is the most accurate method, these data will allow this characteristic to be used in the treatment plan to rehabilitate a total edentulous patient.

For the abovementioned reasons the study of the possible relationships between anthropometric measurements with VOD becomes relevant. In the present study the relationship between the VOD and the anthropometric measurements of the fingers was determined. The purpose is to propose new accurate, objective and exact methodological alternatives to determine the vertical occlusal measurement in a total edentulous patient.

MATERIALS AND METHODS.

A prospective, cross-sectional and observational study was conducted at the undergraduate facilities of the School of Dentistry at Universidad Nacional Mayor de San Marcos (Lima, Perú) during 2018.

Data related to age, sex and academic year were obtained from interviews. Then an intra-oral clinical evaluation was performed in order to establish the inclusion criteria.

One hundred fourteen students enrolled in the 2018-II period were included during June-July 2018. The sample size was obtained considering 95% confidence level, 80% statistical power and a correlation between the finger length index and the VOD of 0.385 (Pearson's r) according to Ladda *et al.*,[14] Sample selection was made through snowball sampling following the inclusion criteria.

Inclusion criteria included students with complete natural dentition (with or without third molars) and with the presence of maximum stable.

Those who presented severe class II and III dentofacial deformities, had undergone orthodontic, surgical treatment, or extensive restorative or rehabilitative treatments, in which the vertical occlusal dimension had been modified

were excluded.

Students with vertical dentomaxillary abnormalities such as open bite or deep bite; with wear facets greater than grade II; those who had suffered craniofacial trauma; presented severe dental crowding, students with the presence of an excessive amount of soft tissue under the chin and/or subjects with beards that could prevent the location of the reference points, as well as those who presented any abnormality of shape or size in the fingers of the right hand were also excluded.

Observation was used as the data collection method and mechanical instruments (Electronic Vernier, Mitutoyo®) as measuring devices. The variables analyzed were: facial biotype, vertical occlusal dimension, and anthropometric measurements of the fingers.

After signing the informed consent to participate in the study, the facial biotype was described. For this record, the Facial Morphological Index (FMI)[15] was used. This index measures the relationship between the vertical and horizontal length of the face according to the following formula: FMI=(Facial height/Facial width)x100%.

The facial height was considered as the distance between the ophryon (point located in the midline at the height of the supraorbital arches) and the gnathion (most anterior inferior point of the jaw symphysis). (Figure 1A)

The facial width was represented by the bizygomatic distance in the soft tissue. According to the results of the division, the measurement was categorized as: brachifacial (<97%), mesofacial (97%-104%) and dolichofacial (>104%). (Figure 1B)

The location of the craniometric points was made with an indelible marker, and the measurement was performed with a digital vernier caliper. For the recording of the VOD, the digital vernier caliper was used to measure from the base of the nose (subnasal point) to the lower part of the chin (chin point). (Figure 1C)

To record the length of the fingers, the digital vernier caliper was used to measure from the tip of each finger to its last lower fold. (Figure 1D)

In the case of the index finger, the distance from the projection of the thumb (Figure 1E) to the most distal point of the digit (Figure 1F) was also measured. The right hand was used for the study. All measurements were recorded in millimeters and were performed by a single previously trained examiner (KST).

The data collected were tabulated in the MS Excel 2003 program (Microsoft Corporation, Redmond, USA) and analyzed with the statistical package SPSS version 21. The correlation between the vertical occlusal dimension and the anthropometric measurements was carried out through Pearson's correlation analysis.

The comparison of anthropometric and vertical dimension measurements according to the facial biotype was performed through the analysis of variances (ANOVA). The Kolmogorov-Smirnov normality distribution test was performed as well as the homogeneity analysis of variances between the groups to be compared and related. A level of significance of 0.05 was accepted for the refutation of the null hypothesis.

RESULTS.

Of the 114 students, 56.1% were female; 55.3% (n=63) presented a brachifacial facial biotype, 40.4% (n=46) mesofacial, and 4.4% (n=5) a dolichofacial biotype.

The mean VOD was 64.03±5.15mm, while the mean lengths of the thumb, index, middle, ring and little finger were: 55.77±4.7mm, 65.63±4.23mm, 74.21±4.5mm, 69.8±5.02mm and 55.62±4.71mm, respectively. The mean length of the thumb projection over the length of the index finger was 49.18±5.6mm. (Table 1)

All numerical data had a normal distribution Kolmogorov-Smirnov test with Lilliefors correction (p>0.05). A correlation was found between the VOD and the index finger length (p<0.01; r=0.29) (Figure 2A), between the VOD and the middle finger length (p<0.01; r=0.31) (Figure 2B), and correlation between the VOD and the length of the pinky finger (p<0.05; r=0.23). (Figure 2C)

No correlation was found between the VOD and the ring finger length (p=0.051), or thumb length (p=0.12). The projection of the thumb on the length of the index finger showed a positive correlation with the VOD (p<0.01; r=0.24). (Figure 3)

The mean VOD of the mesofacial individuals was 64.03±5.36mm, in the brachifacial individuals, 63.77±514mm, while in the dolichofacial individuals it was 67.33±0.55mm. Thumb length showed significant differences between the mesofacial-dolichofacial and brachifacial-dolichofacial groups (p<0.05). (Table 2)

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Table 1. Mean and variability values of VOD and digit lengths (mm).

Statistics	VOD	Thumb	Index	Middle	Ring	Little	Thumb-Index
Mean	64.03	57.77	65.63	74.21	69.8	55.62	49.18
S.D	5.15	4.7	4.23	4.5	5.02	4.71	5.6
S.E	0.48	0.44	0.39	0.42	0.47	0.44	0.52
CI 95%	63.07-64.98	56.89-58.64	64.85-66.42	73.38-75.05	68.86-70.73	54.74-56.49	48.14-50.22

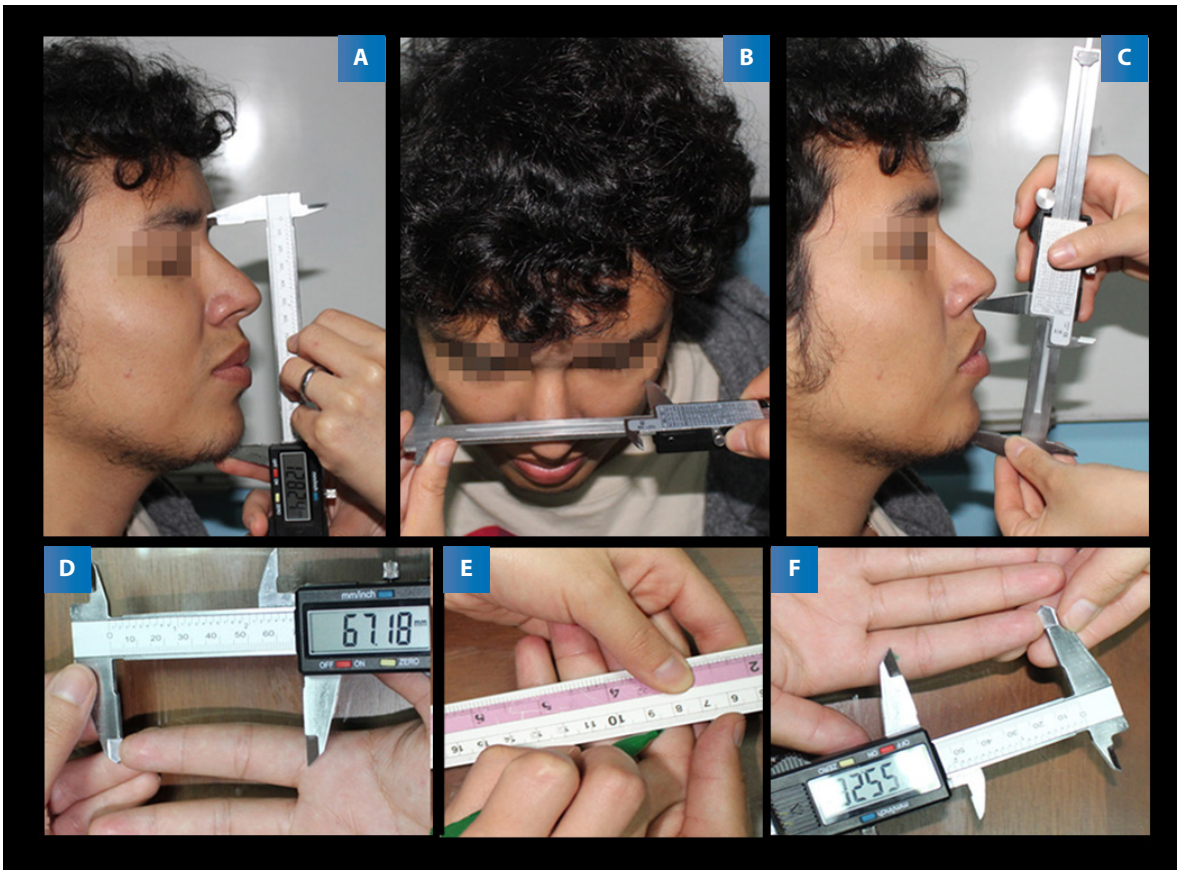
VOD: Vertical occlusal dimension. **S.D:** Standard deviation. **S.E:** Standard Error. **CI:** Confidence interval.

Table 2. Average lengths measured according to facial biotype (mm).

Lengths	Mesofacial	Brachifacial	Dolichofacial	*p*-value
Vertical occlusal dimension	64.03±5.36	63.77±5.14	67.33±0.55	0.332
Thumb	57.89±3.93*	57.21±4.76*	63.71±7.08	0.011
Index	65.53±3.83	65.37±4.3	69.96±5.43	0.063
Middle	74.36±3.96	73.84±4.9	77.57±2.65	0.198
Ring	69.9±5.52	69.43±4.67	73.4±3.3	0.233
Little	56.33±5.35	54.81±4.17	59.14±1.63	0.056
Thumb-Index	49.73±5.55	48.56±5.58	52.06±6.18	0.284

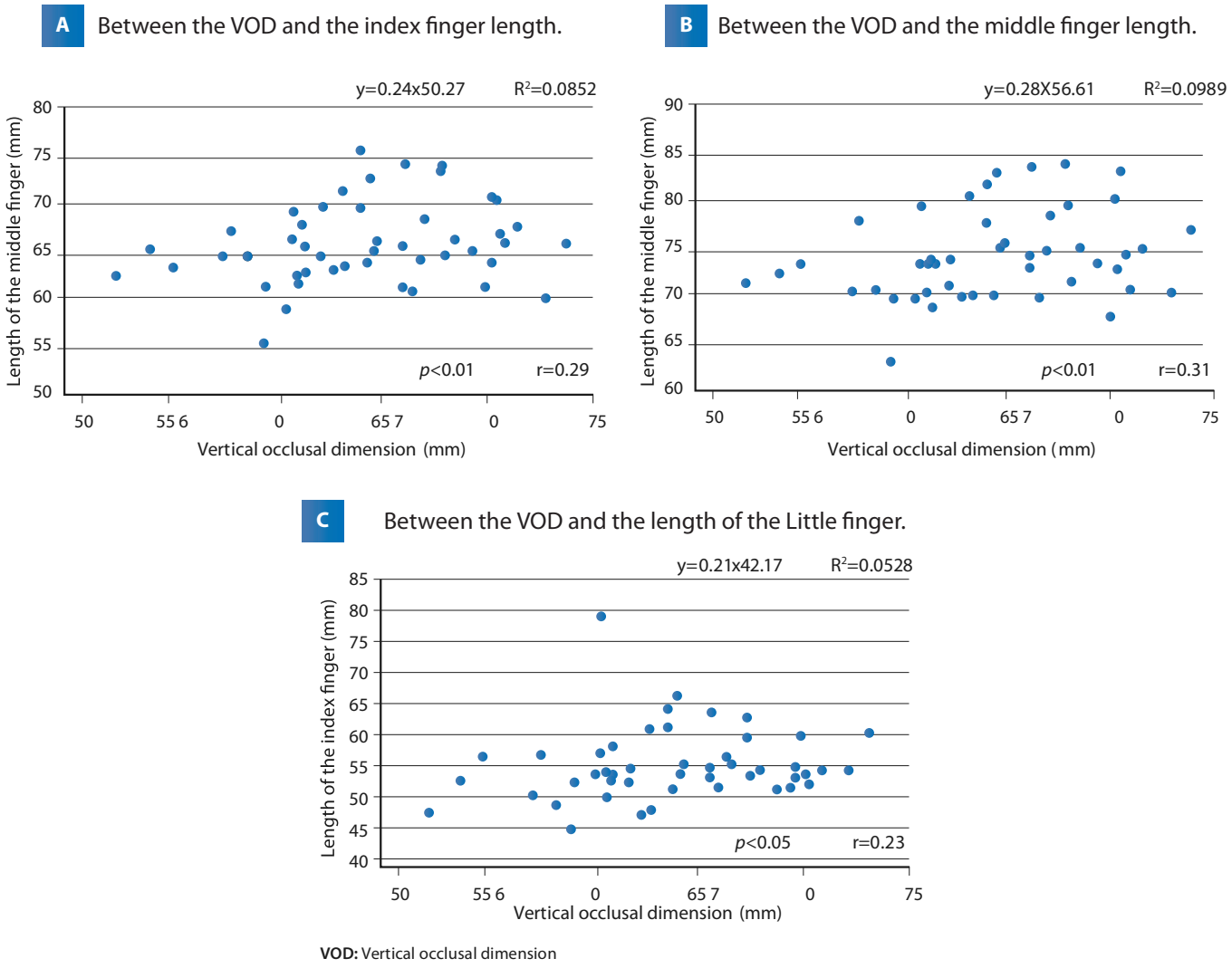
*: p<0.05 ANOVA of a factor for independent groups, Tukey's post hoc.

Figure 1. Description of the facial biotype, occlusal vertical dimension and finger length.



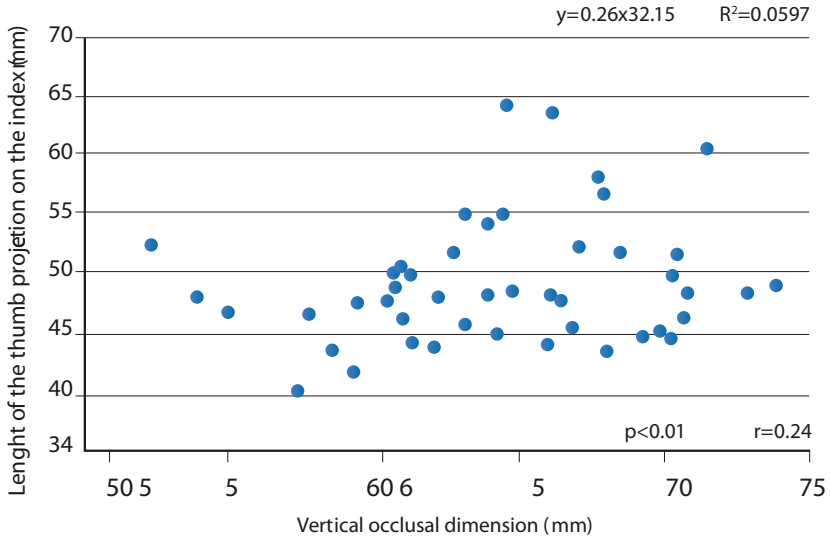
A: Measurement of facial height. **B:** Measurement of facial width. **C:** Measurement of the occlusal vertical dimension. **D:** Length of index finger. **E:** Projection of the tip of the thumb on the index finger. **F:** Distance from index finger to thumb.

Figure 2. Correlation graphs.



VOD: Vertical occlusal dimension

Figure 3. Positive and significant correlation between the VOD and the length of the thumb projection on the length of the index finger.



VOD: Vertical occlusal dimension

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DISCUSSION.

Dental loss and subsequent rehabilitation through artificial prostheses are often not pleasant experiences for the patient. One way to reduce these discomforts is to restore teeth in the most similar way to the original function and appearance of the dental and periodontal tissues. In the total edentulous person the measurement of a correct vertical dimension is one of the key points to achieve this objective; however, no method of obtaining this measure is fully accepted or considered completely appropriate.[14] Among the most reliable methods are measurements recorded before tooth loss, and phonation records. However, in the absence of such data, body proportions that relate to the vertical occlusal dimension (VOD) can be used. In this way, in order to overcome the difficulties of the subjective methods, the present study related the VOD with anthropometric measurements of the subjects' fingers.

The present study found a correlation between the measurements of the index, middle and little finger with the VOD. Ladda *et al.,*[14] found a significant relationship between the VOD and the length of the fingers, the length of the index finger being more reliable for determining the VOD. Basnet *et al.,*[16] actually found a strong correlation between the VOD and the length of the thumb (r=0.874). They also noted correlations between other anthropometric measures such as the distance between the ear tragus and the canthus of the eye, and the edge of the eye-mouth commissure, although these were weak correlations.

On the other hand, Ladda *et al.,*[14] found that it was possible to use the length of the little finger, as well as the projection of the thumb to the index finger. The present study corroborates these data establishing a correlation with the projection of the thumb to the index.

The correlations found are explained because from birth the human body grows proportionally, and in adulthood these proportions remain relatively stable, therefore they can be used as references in the prediction of other body measurements.

The relationships found can serve as guides to estimate lower facial height with the resulting advantages of being an objective method instead of subjective criteria, such as resting jaw position[17] or swallowing,[18] being practical, simple, economical, reliable, without requiring radiographs or sophisticated measuring devices with reproducible values for future studies in addition to not requiring much experience and excessive time to master the technique. There are several advantages of using this method. In addition, the estimated VOD is within the range of 2-4mm compared to other methods where a range of 0-14mm is given.[19,20]

The restoration of the vertical occlusal dimension must be in harmony with the facial dimensions without producing tensions on the patient's face or causing discomfort. In the present study the average VOD was 64.03±5.15mm; for Alhajj *et al.,*[21] it was 65.93mm from point Sn to point Me.

Al-Dhahery *et al.,*[22] found a mean of 65.27mm, while Pointer[23] found an average VOD of 60.14mm in men and 57.33 in women. Variations in measurements found in different studies may be due to differences in measuring techniques, ethnicities of the population and the size of the sample. However, the results of this study indicate that anthropometric measurements such as finger measurement may be useful for estimating VOD.

The alteration of the VOD is generally associated with the loss of several teeth or their severe wear.[24,25] This situation produces alterations in the stomatological system such as: temporomandibular dysfunction, masticatory dysfunction, alteration in phonetics, alteration in musculature, and lack of dental aesthetics.[26] Facial harmony is altered because the height of the lower third of the face is inadequate, the jaw protrudes, the labiomandibular and mentolabial creases are accentuated, and the lip vermilion is diminished.[27]

Some studies also associate the loss of vertical dimension with neuromuscular, proprioceptive and postural problems. Symptoms such as subjective noise (tinnitus), pain in the ears, dizziness, decreased hearing, blocked ears, headaches and neck pain, among others, can be generated by a total prosthesis that does not match the height relationship between the jaw and the maxilla. For these reasons, it is very important that the rehabilitation treatment returns patients their appropriate VOD. In this way the balance and harmony of the lower third of the face will be achieved, producing an ideal stomatological system function.[28,29]

The present study was only limited to subjects with class I malocclusion, without considering other types of

malocclusions. They were also mestizos, all were dentistry students and young (between 20-27 years old), whose round facial profiles or an excess of soft tissue below the chin made the measurements difficult to obtain. It must be taken into account that the compressibility of the points on the chin and the subnasal area cannot be avoided so it can affect the measurements.[30]

The findings of this study apply to young adults; changes in older patients may be more evident by soft tissue alterations induced by aging. Another limitation of this method is that an appropriate number of dolichofacial individuals was not achieved.

Larger sample sizes are recommended. Further studies should also include other ethnic groups, broaden the age range and follow up on patients to assess possible changes in VOD even in dentate patients.

Therefore, there is scope for additional research that may confirm its applicability in different populations before developing an appropriate regression equation that can be universally accepted.

CONCLUSION.

It can be concluded that the anthropometric measurements of the index, middle, little finger and the projection of the thumb on the index finger were correlated with the length of the vertical occlusal dimension. These correlations were significant but with weak correlation forces, so they cannot always be replicated in older patients; however, they represent a valid objective alternative for the estimation of the VOD.

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REFERENCES.

1. Kuć J, Sierpińska T, Gołębiewska M. Alveolar ridge atrophy related to facial morphology in edentulous patients. Clin Interv Aging. 2017;12:1481-94.
2. Marin DO, Leite AR, de Oliveira Junior NM, Compagnoni MA, Pero AC, Arioli Filho JN. Reestablishment of Occlusal Vertical Dimension in Complete Denture Wearing in Two Stages. Case Rep Dent. 2015;2015:762914.
3. Vinnakota DN, Kanneganti KC, Pulagam M, Keerthi GK. Determination of vertical dimension of occlusion using lateral profile photographs: A pilot study. J Indian Prosthodont Soc. 2016;16(4):323-7.
4. Enkling N, Enkling-Scholl J, Albrecht D, Bornstein MM, Schimmel M. Determination of the occlusal vertical dimension in edentulous patients using lateral cephalograms. J Oral Rehabil. 2018;45(5):399-405.
5. Swenson MG. Complete Dentures. 4th Ed. St Louis, MO: Mosby; 1959.
6. Tueller VM. The relationship between the vertical dimension of occlusion and forces generated by closing muscles of mastication. J Prosthet Dent. 1969;22(3):284–8.
7. Goodfriend DJ. Symptomatology and treatment of abnormalities of the mandibular articulation. Dent Cosmos. 1933;75:844: 947-1106.
8. Willis FM. Features involved in full denture prostheses. Dent Cosmos. 1935;77:851–4.
9. Watarai Y, Mizuhashi F, Sato T, Koide K. Highly producible method for determination of occlusal vertical dimension: relationship between measurement of lip contact position with the closed mouth and area of upper prolabium. J Prosthodont Res. 2018;62(4):485-9
10. Majeed MI, Haralur SB, Khan MF, Al Ahmari MA, Al Shahrani NF, Shaik S. An Anthropometric Study of Cranio-Facial Measurements and Their Correlation with Vertical Dimension of Occlusion among Saudi Arabian Subpopulations. Open Access Maced J Med Sci. 2018;6(4):680-6.
11. Ladda R, Kasat VO, Bhandari AJ. A new technique to determine vertical dimension of occlusion from anthropometric measurement of interpupillary distance. J Clin Exp Dent. 2014;6(4):e395-9.
12. Mishra MK, Singh RK, Suwal P, Parajuli PK, Shrestha P, Baral D. A comparative study to find out the relationship between the inner inter-canthal distance, interpupillary distance, inter-commissural width, inter-alar width, and the width of maxillary anterior teeth in Aryans and Mongoloids. Clin Cosmet Investig Dent. 2016;8:29-34.
13. Moreno Uribe LM, Ray A, Blanchette DR, Dawson DV, Southard TE. Phenotype-genotype correlations of facial width and height proportions in patients with Class II malocclusion. Orthod Craniofac Res. 2015;18 Suppl 1:100-8.
14. Ladda R, Bhandari AJ, Kasat VO, Angadi GS. A new technique to determine vertical dimension of occlusion from anthropometric measurements of fingers. Indian J Dent Res. 2013;24(3):316-20.
15. Proffit WR. The etiology of the orthodontic problems. In: Proffit WR, Fields HW, eds. Contemporary Orthodontic. 3th Ed. St. Louis: Mosby, 2000: 13-144.
16. Basnet BB, Parajuli PK, Singh RK, Suwal P, Shrestha P, Baral D. An anthropometric study to evaluate the correlation between the occlusal vertical dimension and length of the thumb. Clin Cosmet Investig Dent. 2015;7:33–9.

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17. Atwood DA. A critique of research of the rest position of the mandible. 1966;16(5):848-54.
18. Ismail YH, George WA. The consistency of the swallowing technique in determining occlusal vertical relation in edentulous patients. J Prosthet Dent. 1968;19(3):230-6.
19. Silverman MM. Accurate measurement of vertical dimension by phonetics and the speaking centric space, Part I. Dent Dig. 1951;57:265.
20. Benediktsson E. Variation in Tongue and Jaw Position in "S" Sound Production in Relation to Front Teeth Occlusion. Acta Odontol Scand. 1958;15(4):275-303.
21. Alhajj MN, Musaad NJ, Ismail IA. Correlation between Finger Length and Occlusal Vertical Dimension in Adult Sudanese Women. Bull Tokyo Dent Coll. 2016;57(4):215-21.
22. Al-Dhaher HA, AL-Huwaizi AF. Determination of the vertical dimension by cranio-facial measurement using clinical and cephalometric analysis (comparative study). J Bagh College Dentistry. 2009;21:44–7.
23. Pointer J. The far interpupillary distance. A gender specific variation with advancing age. Ophthal Physiol Opt. 1999;19:317-26.
24. Harper RP. Indicaciones clínicas para modificar la dimensión vertical en oclusión, consideraciones funcionales y biológicas para la reconstrucción de la oclusión dentaria. Quintessence Internacional. 2001; 14(4):242-6.
25. Oliveira E, Martin EM, Falcón RM, Chagas A. Prótesis dental en el paciente anciano: Aspectos relevantes. Rev Estomatol Hered. 2007;17(2):104-7.
26. García-Fajardo C, Cacho A, Fonte A, Pérez JC. La oclusión como factor etiopatológico en los trastornos temporomandibulares. RCOE. 2007; 12 (1-2): 37-47.
27. Preti G. Rehabilitación protésica. Tomo 1. 1st. Ed. Colombia: Amolca; 2007.
28. Marcé M, Lorente M, Galera MT, Figueras O, Badet A, Padullés E, Giner L, Cortada M. Prótesis Completa: Técnica Cortada. A propósito de un caso. Dentum. 2004; 4 (2): 55-61.
29. Bissasu M. Pre-extraction records for complete denture fabrication: a literature review. J Prosthet Dent. 2004;91(1):55-8.
30. Nagpal A, Parkash H, Bhargava A, Chittaranjan B. Reliability of different facial measurements for determination of vertical dimension of occlusion in edentulous using accepted facial dimensions recorded from dentulous subjects. J Indian Prosthodont Soc. 2014;14(3):233-42.