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ARTICLE

CORRELATION BETWEEN VERTICAL DIMENSION OF OCCLUSION AND DIFFERENT FACIAL MEASUREMENTS AMONG A SAMPLE OF SUDANESE ADULTS.

Correlación entre la dimensión vertical de la oclusión y diferentes medidas faciales en una muestra de adultos sudaneses.

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ABSTRACT:

Aim: This study aimed to evaluate the correlation between vertical dimension of occlusion (VDO) and various facial measurements in a sample of Sudanese adults.

Material and Methods: A total of 113 dental students (33 males and 80 females) with a mean age of 21.7±1.26 years were enrolled in this study. Different facial measurements including (Eye-Mouth, Eye-Eye, Eye-Ear, and Ear Height) were compared with two different measurements of VDO: N-Gn (from the tip of the nose to the tip of the chin), and Sn-Me (from the base of the nose to the bottom of the chin). Pearson's correlation coefficient test was utilized for the correlation between the measured parameters. A p-value of less than 0.05 was considered significant for all analyses.

Results: A significant positive correlation was shown between all measured facial distances and both measured VDO distances. Though, the strongest correlation was seen for the eye-mouth distance ($r= 0.725$, $p<0.001$), while the weakest was for ear height ($r= 0.254$, $p= 0.007$). A paired t-test revealed a significant longer N-Gn distance than Sn-Me distance. Also, it has been shown that there were no significant differences between right and left sides of the face.

Conclusion: The distance measured from the outer canthus of the eye to the angle of the mouth can be used to predict Subnasale-Menton (Sn-Me) distance.

KEYWORDS:

Prosthodontics; vertical dimension; anthropometry; face; dental occlusion; complete denture.

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RESUMEN:

Objetivo: Este estudio tuvo como objetivo evaluar la correlación entre dimensión vertical oclusal (DVO) y varias medidas faciales en una muestra de adultos sudaneses.

Material y Métodos: Un total de 113 estudiantes de odontología (33 hombres y 80 mujeres) con una edad media de 21,7 ± 1,26 años se inscribieron en este estudio. Se compararon diferentes medidas faciales que incluyen (ojo-boca, ojo-ojo, ojo-oído y altura de la oreja) con dos medidas diferentes de DVO: N-Gn (desde la punta de la nariz hasta la punta del mentón) y Sn -Yo (desde la base de la nariz hasta la parte inferior del mentón). Se utilizó la prueba del coeficiente de correlación de Pearson para la correlación entre los parámetros medidos. Un valor de p inferior a 0,05 se consideró significativo para todos los análisis.

Resultados: Se mostró una correlación positiva significativa entre todas las distancias faciales medidas y ambas distancias DVO medidas. Sin embargo, la correlación más fuerte se observó para la distancia ojo-boca (r=0,725, p<0,001), mientras que la más débil fue para la altura de las orejas (r=0,254, p=0,007). Una prueba de t pareada reveló una distancia N-Gn significativamente más larga que la distancia subnasal-mentón. Además, se ha demostrado que no hubo diferencias significativas entre los lados derecho e izquierdo de la cara.

Conclusión: La distancia medida desde el canto externo del ojo hasta el ángulo de la boca puede utilizarse para predecir la distancia subnasal-mentón.

PALABRAS CLAVE:

Prostodoncia; dimensión vertical; antropometría; cara; oclusión dental; dentadura completa.

INTRODUCTION.

Loss of natural dentition and subsequent bone loss will undoubtedly lead to a lack in vertical height of the face, compromised esthetics and mastication as well as lowered self-esteem.[1-3] The use of a newly made prosthesis introduced to a patient is highly dependent upon the correct registration of the vertical dimension of occlusion (VDO).[4] VDO can be recorded when the patient is in the dentate state and preserved for later use in life (pre-extraction records).[5,6]

But the trendier situation is that when the patient presents at the clinic, they would already be in the edentulous state without any form of pre-extraction records. Hence, the clinician has no choice other than guessing the lower facial height by applying the post-extraction methods to approximate the ideal VDO.[7]

The importance of VDO is clearly manifested by Tench's statement "The ease with which immediate dentures are worn when the natural vertical dimension is accurately copied, is proof of the wisdom of avoiding bite-opening procedure beyond that permitted by the natural functioning length of the muscles of mastication as related to the resistance of the alveolar bone to muscle tension in function for a given individual".[8] Currently there is no single method for determining the vertical dimension of occlusion that is universally accepted, and the previously introduced techniques remain controversial.

In fact, the dentist's knowledge, experience, and wise judgment should be called into play when the vertical dimension registration step is about to be carried. Since the early 1940s, till now, many investigators have studied different soft tissue

facial measurements to find an accurate indicator for VDO. These methods are mainly based on the fact that facial proportions are constant throughout life.[9] The golden ratio concept was first discovered by the Greeks and later appeared in the paintings of the famous artist Leonardo Da Vinci who drew faces in proportions following the ratio concept.[10]

Later, this idea inspired the researchers to find correlations between different measurable craniofacial distances and VDO, and the first suggestion appeared was that the distance from the pupil to rima oris would be equal to the chin-nose distance. This suggestion was studied later by many researchers who proved its reliability in determining the VDO.[9] 7Depending solely on anatomic landmarks of the face gave rise to public disagreement. Whereas some proved correlation between different anatomical landmarks and VDO, as mentioned before, others contradicted its use as they depend on soft tissue measurements. Instead, variation due to gender and racial differences may arise.[5]

As a rule, the choice of the proper method of VDO registration could be achieved according to their accuracy, repeatability of measurements, the adaptability of techniques, type and complexity of equipment and duration of registration.[11] Indeed, a combination of more than one method would be a judicious decision to test the accuracy of the readings. Moreover, it is advisable to consider all determinants of VDO as tentative until the try-in stage to get a clearer picture.

Clinicians may face a considerable challenge while finding the correct VDO because the method used the most is through VDR determination, which may be difficult as it relies on mobile soft tissue landmarks. Therefore, this study was designed to find a simple and precise method to predict VDO using different alternative facial measurements.

MATERIALS AND METHODS.

A total of 113 dental students (33 males and 80 females) with a mean age of 21.7±1.26 years were enrolled in this study. Subjects were recruited from the Faculty of Dentistry, University of Khartoum, Sudan. Inclusion criteria included: full permanent dentition set (except third molars) with no attrition, bruxism, trauma, or extensive restorations, class I Angle's relationship, periodontally healthy teeth, and harmonious relatively symmetrical face. However, the exclusion criteria were: previous or current orthodontic treatment, previous major stomatognathic or plastic surgery, or disfigurement of the face or ear.

Ethical approval was obtained from the ethical committee of the Faculty of Dentistry, and signed informed consent was acquired from each subject before starting this study. The subjects were asked to sit in an upright position on a chair and instructed to occlude their teeth in maximal intercuspal relation. The VDO was evaluated by measuring two distances using a digital caliper: N-Gn (from the tip of the nose to the tip of the chin), and Sn-Me (from the base of the nose to the base of the chin) (Figure 1).

For accurate measurement of Sn-Me distance, a tongue depressor was placed in a steady horizontal position lightly, below the chin to which the lower tip of the caliper was placed.[9] The following distances (Figure 2) were also measured with the digital caliper for both right and left sides: 1) distance from the outer canthus of the eye to the inner canthus of the other eye (OCI-ICE),

2) distance from the outer canthus of the eye to the external meatus of the ear (Eye-Ear),

3) distance from the outer canthus of the eye to the angle of the mouth (Eye-Mouth), and

4) ear height (EH). All measurements were carried out three times by one examiner, and the mean was calculated and recorded.

IBM SPSS program for Windows (version 20, IBM, USA) was used for statistical analyses. The data were first subjected to a normality test which revealed normal distribution of the data (Shapiro-Wilk test; $p>0.05$). Accordingly, Pearson's correlation coefficient test was utilized for the correlation between the measured parameters. A paired t-test was performed to test the differences

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between the means for the study parameters, while a simple linear regression test was carried out to formulate the prediction equation.

A *p*-value of less than 0.05 was considered significant for all tests.

RESULTS.

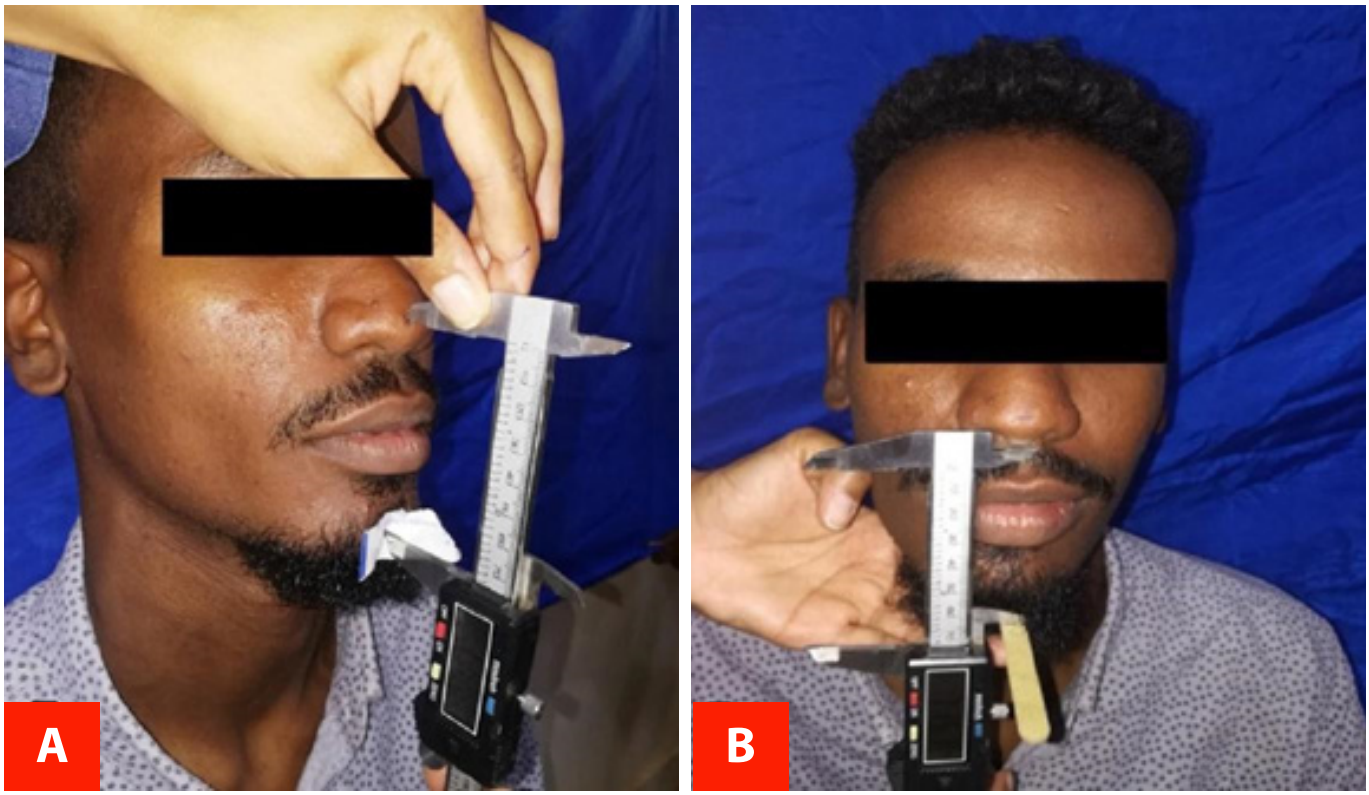
The mean measurement of N-Gn distance was 69.05±4.83 mm, while the mean of Sn-Me distance was 67.42±5.04 mm. Paired sample t-test used to compare between the means of the two measured VDO distances showed a significant difference between the two measurements (t=7.447; $p<0.001$) with a higher value for N-Gn distance.

There were no significant differences between Right and Left facial measurements on the same subjects except for the Eye-Ear distance (Figure 3).

The correlations between both measured VDO distances and all facial measurements (Rt & Lt) were found statistically significant. Nevertheless, the correlations of the distance Eye-Mouth were stronger than the others, whereas the least correlation values were seen for EH (Table 1).

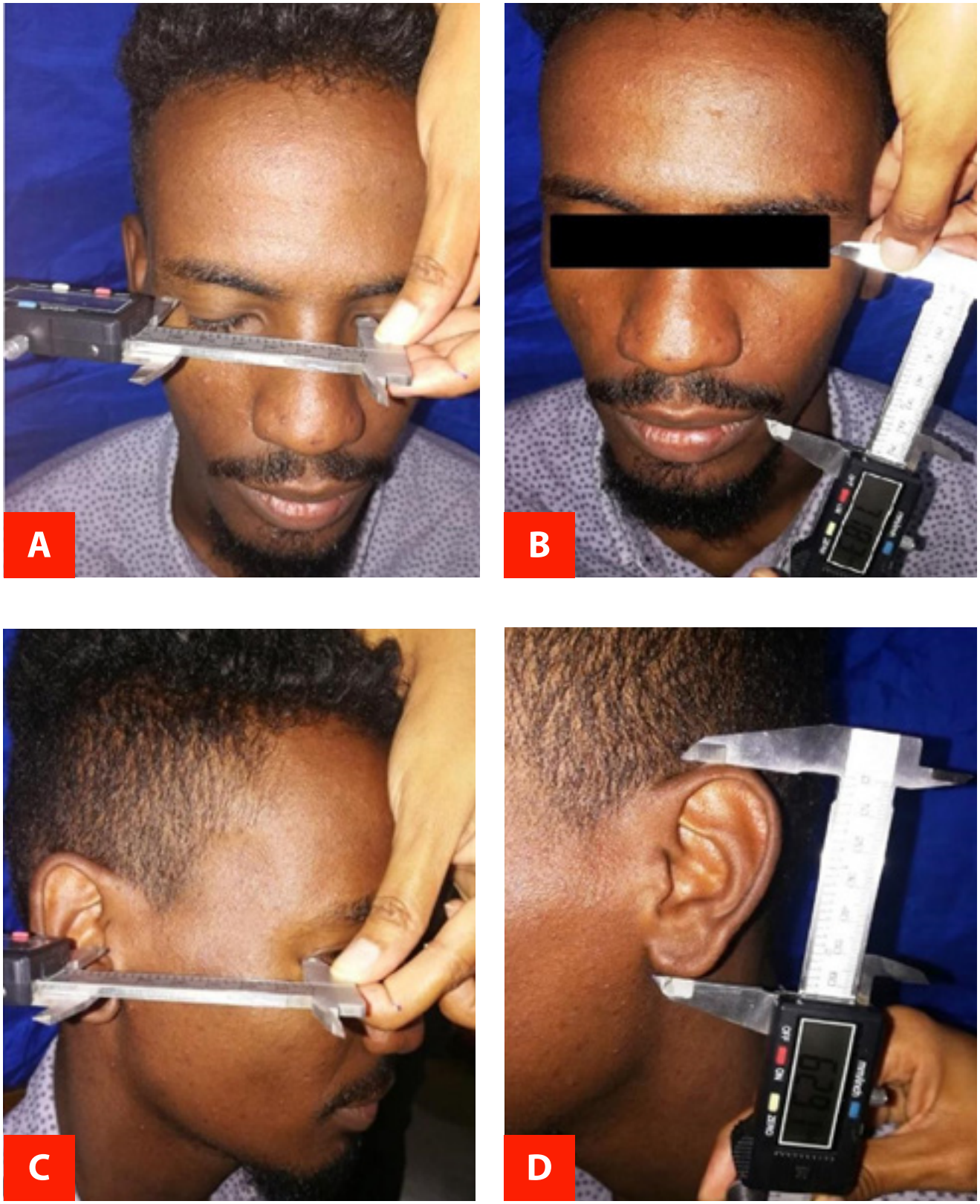
Linear regression was used to find out an equation based on Eye-Mouth distance and Sn-Me distance as they have the highest correlation figure (r=0.725, $p<0.001$). In the regression model, the coefficient of determination R2 showed that 97.7% of the variation in the dependent variable (Sn-Me) was explained by the distance Eye-Mouth distance. Accordingly, the proposed equation could be: [Sn-Me= 0.948*Eye-Mouth distance].

Figure 1. Measurements of the Vertical dimension of occlusion (VDO) distances.



A. Tip of the nose to the tip of the chin (N-Gn).
B. Base of the nose to the base of the chin (Sn-Me).

Figure 2. Taking the measurements of the facial distances.



A. Eye-Eye. **B.** Eye-Mouth.**C.** Eye-Ear. **D.** Ear height.

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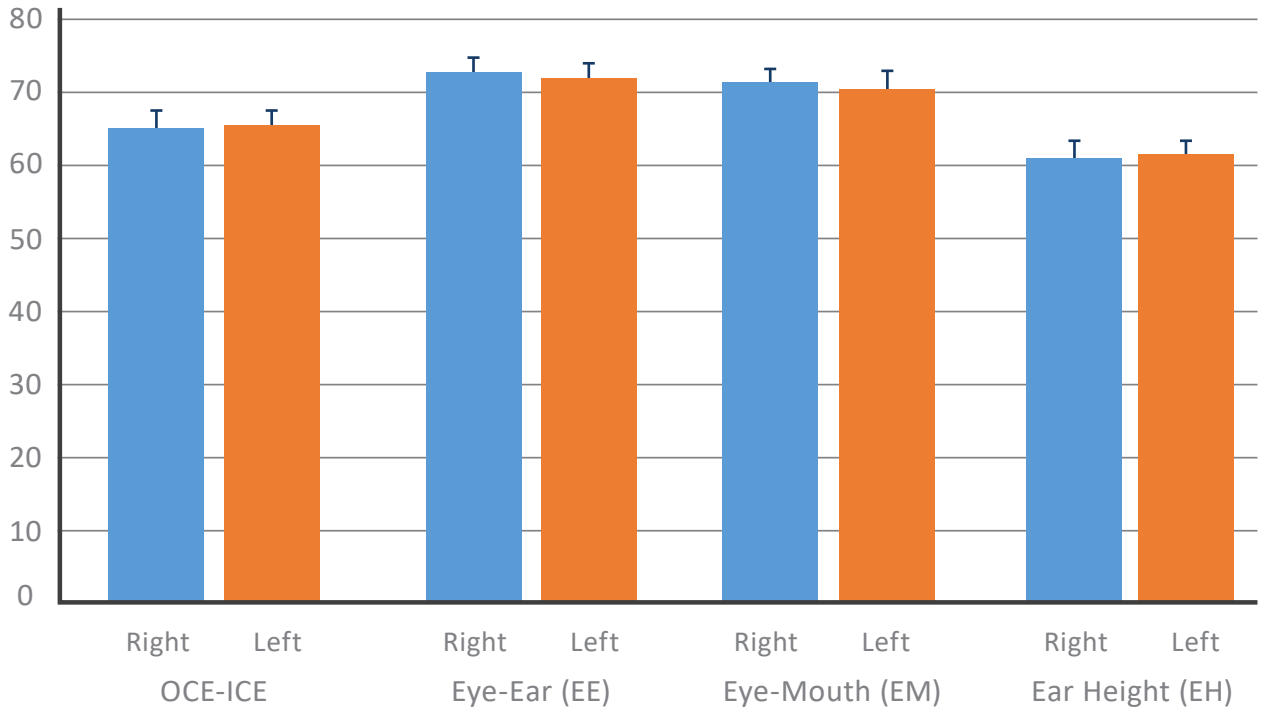
Figure 3. : Right and left facial measurements, in millimeters.



OCE-ICE: Outer canthus of the eye to the inner canthus of the other eye

Table 1. Pearson's correlation between the facial measurements and the two measured distances of VDO.

MEASUREMENT	N-Gn distance				Sn-Me distance			
	Right		Left		Right		Left	
	Correlation	*p*-value	Correlation	p-value	Correlation	*p*-value	Correlation	*p*-value
OCE-ICE	0.397	<0.001	0.366	<0.001	0.415	<0.001	0.403	<0.001
Eye-Ear	0.506	<0.001	0.463	<0.001	0.472	<0.001	0.429	<0.001
Eye-Mouth	0.707	<0.001	0.694	<0.001	0.719	<0.001	0.725	<0.001
Ear Height	0.274	0.003	0.254	0.007	0.290	0.002	0.274	0.003

OCE-ICE: Outer canthus of the eye to the inner canthus of the other eye. N-Gn: tip of the nose to the tip of the chin. Sn-Me: base of the nose to the base of the chin. VDO: Vertical dimension of occlusion.

DISCUSSION.

The present study assessed the relationship between the vertical dimension of occlusion and different facial measurements. In the current study, the VDO distance as measured from subnasale to menton (Sn-Me) showed a mean value of (67.42±5.04mm) which is similar to results of Alhajj *et al.*,[9] in a Yemeni population and of Miran *et al.*,[12] in Iraqi subjects. Conversely, this result is not in agreement with Majeed *et al.*,[13] in Pakistani individuals.

The VDO regarding N-Gn distance showed a mean value of (69.05±4.83 mm), which is in accordance with Bajunaid *et al.*,[14] Alhajj *et al.*,[12] and Abdul-Rassol15 in Saudi Arabian, Yemeni and Iraqi populations, respectively. In contrast, it is higher than the mean distance of the Nepali population measured by Basnet *et al.*,[16] Apparently, these results are in disagreement with South-Asian populations. This may be attributed to ethnic variations that make their facial topography different from the population in this study. The VDO measured from the tip of the nose to the tip of the chin was longer than that measured from the septum of the nose to under the chin.

This is in accordance with previous studies carried out by Bhat *et al.*,[17] and Alhajj *et al.*,[9] Pearson's correlation test showed a positive correlation between all facial measurements selected for this study, and both measured VDO distances.[18]

This simply means that if the face is large, there is a chance that the VDO would be long and vice versa. The facial measurements were recorded on both right and left sides to check the validity of any possible correlation. However, both right and left measurements showed approximate values of correlation, which may lead us to conclude that either side can be used to estimate the lost VDO safely.

Moreover, the comparison between the means of facial measurements of both sides declared statistically insignificant results except for eye-ear distance.

Actually, this can be warranted by the normal asymmetry reported by McGee[8] and Nagpal *et al.*,[19] as there was no obvious asymmetry or disfigurement recorded in our study subjects, and the means of either side were too close. All measured variables were found to be significantly correlated with both VDO distances with slightly higher correlations with Sn-Me distance.

Moreover, because of individual variations within the population, no variable had r= 1, rather they were <1, suggesting that none of the facial measurements is fully reliable for determination of VDO.[20]

The distance measured from the outer canthus of the eye to the corner of the mouth showed the strongest correlation with VDO, while the least correlation was for the vertical height of the ear. These results were similar to the results of Basnet *et al.*,[16] but contrasted the study done by Delić *et al.*,[20] in Croatian subjects in which the correlation of Eye-Ear distance was stronger than pupil to rima oris distance.

Whilst a comparison between current results and Majeed *et al.*,[13] results revealed that among the four measurements, only the outer canthus of the right eye to the inner canthus of the left eye had close approximation to VDO in their study.

Regarding Eye-Mouth distance, the study results were consistent with Mcgee,[8] Alhajj *et al.*,[9] Bajunaid *et al.*,[14] and Nagpal *et al.*,[19] Though an agreement with Chou *et al.*,[21] Abdul-Rassol *et al.*,[15] Nagpal *et al.*,[19] and Alhajj[22] considering the validity of Eye-Ear distance was noticed, a variance with Miran *et al.*,[12] and Bajunaid et al.14 results was reported. In view of vertical ear height, the coefficients of correlation in Prajapati *et al.*,[23] and Rege *et al.*,[24] studies were (r= 0.640) and (r=0.500), respectively, which import superior figures to these study observations (r= 0.290). On the other hand, Bajunaid *et al.*,[14] reported a weak correlation for this parameter.

The confines of this study are the small sample size collected from a convenient sample frame that may have been too young to be used as

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considerable data for patients with lost VDO. Moreover, the anatomical differences between males and females were not in the scope of this study.

Additional limitations of the study are that the results are only applicable for class I subjects, and other classes were not investigated; besides, different facial forms were not considered. Further studies are highly recommended with larger sample size and different age groups as well as to include edentulous subjects for comparison purposes.

CONCLUSION.

Within the limitations of this study, it could be concluded that facial measurements could be utilized in predicting VDO. The distance measured from the outer canthus of the eye to the angle of the mouth can be used to predict Subnasale-Menton (Sn-Me) distance.

Conflict of interests:

The authors declare no conflict of interests.

Ethics approval:

Study was approved by the Ethics Committee of the Faculty of Dentistry, University of Khartoum.

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Authors' contributions:

Sultan NM contributed in conceptualization, methodology, formal analysis, and writing – original draft. Ismail IA contributed in contributed in conceptualization, methodology, supervision, and writing – review and editing.

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