

Horizontal Morphological Linear Skeletal Distance Measurement Method in Predicting the Occlusal Vertical Dimensions in Edentulous Patients- A Clinical Radio-Morphometric Study

Saurabh Chaturvedi^{1*}, Fahad Saad Fahad Alqahtani², Abdulaziz Saleem Abdullah Alqarni³, Mohamed Khaled Addas⁴, Nasser M. Alqahtani⁵, Saeed M. Alqahtani⁶, Nasser M. Al Ahmari⁷, Mansoor Mustafa⁸

¹Assistant Professor, Department of Prosthetic Dentistry, College of Dentistry, King Khalid University, Abha, Saudi Arabia

²Intern, College of Dentistry, King Khalid University, Abha, Saudi Arabia.

³Intern, College of Dentistry, King Khalid University, Abha, Saudi Arabia.

⁴Assistant Professor, Department of Prosthetic Dentistry, College of Dentistry, King Khalid University, Abha, Saudi Arabia

⁵Associate professor, Department of Prosthetic Dentistry, College of Dentistry, King Khalid University, Abha, Saudi Arabia.

⁶Assistant Professor, Department of Prosthetic Dentistry, College of Dentistry, King Khalid University, Abha, Saudi Arabia

⁷Assistant Professor, Department of Prosthetic Dentistry, College of Dentistry, King Khalid University, Abha, Saudi Arabia

⁸Assistant Professor, Department of Prosthetic Dentistry, College of Dentistry, King Khalid University, Abha, Saudi Arabia

Corresponding Author:

Dr. Saurabh Chaturvedi,

MDS, PhD, Fellow-ICOI

Assistant Professor,

Department of Prosthodontics,

College of Dentistry

King Khalid University, Saudi Arabia.

Email- survedi@kku.edu.sa

Abstract-

Background- Various methods have been proposed to determine the vertical dimension of occlusion (VDO) but still today, there is no general or scientific agreement for it in completely edentulous patients.

Purpose- The purpose of this study was to Assess the efficacy of the newer linear skeletal distance measurement method [between nasion (Na) to sella (Se)] in predicting the vertical dimension of occlusion in edentulous patients.

Material and methods- Out of 120 patients, 90 (51 males and 39 females) were considered. For each patient complete denture was fabricated and Avr-VDO was calculated by taking average of the values of VDO obtained by three pre-established methods - Physiologic rest position method, Swallowing method, Closest speaking space method. At first recall visit lateral cephalograms were taken with dentures inside the mouth. The linear skeletal distance between the Na and Se and vertical distance between ANS to Me were measured and correlated with Avr—VDO in lateral cephalographs. Unpaired and paired- t tests along with Pearson correlation coefficient & linear regression analysis was used for statistical analysis with p-value as significant when less than 0.05.

Results- The average distance from Na-Se for males was 66.70 ± 6.46 and for females was 62.05 ± 6.39 which was higher than the average distance between the ANS-Me and Avr-VDO for both genders. The results revealed statistically significant differences between Na-Se & ANS-Me; Na-Se & Avr-VDO and significant positive correlation between the measured parameters for the whole sample and also in both males and females.

Conclusions- The distance measured from Na to Se in a cephalometric radiograph is significantly correlated with the distance from the anterior nasal spine to the Me and occlusal vertical dimension determined clinically in both genders in studied population. This distance can be used as a helpful and reliable landmark to determine the OVD during complete denture fabrication.

Key words- Occlusal Vertical dimension, Cephalometry, Jaw Relation.

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INTRODUCTION-

Stomatognathic system is a highly complex and integrated¹. Each structure associated with it plays an important role in maintaining the wellbeing of an individual. Loss of teeth results in complete disruption in this system and thus affects the overall physiology². The complete denture prosthodontics helps in restoring the integrity of this system and also facial appearance, function, and mastication resulting in adequate oral and general health.³⁻⁵

In complete denture fabrication one of the important step is vertical jaw relation. Various methods have been proposed to determine the vertical dimension of occlusion (VDO) but still today, there is no general or scientific agreement for the determination of the VDO in completely edentulous patients³. The methods available are subjective based on clinicians experience and judgement and there is no sufficient reliability and reproducibility to ensure that the correct VDO has been recorded⁴. Because of these reasons, it has been recommended that combination of methods should be used while determining the VDO⁵.

Commonly used methods in determining the VDO includes the physiologic rest position, the swallowing technique,^{6,7} the closest speaking space method,⁸ finger length,⁹ and various facial reference points.¹⁰ The Physiological mandibular rest position method, which is used as reference is changeable and affected by many factors, such as position of head, overall body posture or fatigue.⁴ Also it has been documented that it is not a lifelong constant,¹¹ its position changes after alterations of the VDO of the denture.¹² and also facial muscles and thus facial height get adapt to any changes in the VDO.¹³ The swallowing technique,^{1,2} of determining VJR depend on the repeatability of mandibular movements during swallowing throughout patient life^{14,15}. Shanahan¹⁴ utilized this theory for determining VDO, by attaching soft cone-shaped waxes on the mandibular occlusal rim. But, it has certain limitations as this method is largely affected by the duration of the swallowing and the softness of the wax cones. In addition, no consistency was found in the final position of the mandible.¹⁶ In the closest speaking space method, the minimum interocclusal distance of 1 mm in the region of the first premolars during the pronunciation of sibilants is judged¹⁷, which is highly subjective in nature, further with the variations in linguistic and pronunciations of the consonants and vowels among different populations it might be very challenging to uniformly apply this method for determining VJR.⁵

Thus, in general all these methods are effective but still lacks reproducibility and are arbitrary. The reference points found on soft tissues are not stable and definite; therefore, the use of bone reference points increases the accuracy of the measurements. The cephalometric method for determining VDO is one of the objective method determining the correlation between certain craniofacial components (points, lines, and/or angles), which remain relatively unchanged even after tooth loss.¹⁸

Researchers had proposed various craniofacial indicators to correlate with the VDO. These indicators included points, lines, angles measurement and complicated calculations. Orthlieb,¹⁸ stated that cephalometric studies have always showed large data's dispersions, this was associated with distortion of radiographic images, superimposition of anatomical structures, improper tracing of cephalograms, resulting in questionable clinical accuracies.

To overcome the problems of complex calculations and various measurements in cephalometry, Alhajj¹⁹ proposed a newer simple measurement of alternative distance between two points for predicting VDO. This alternative distance is practical, time-saving, straightforward, and measured directly without the use of any other additional measurements, instruments, or equations. Moreover, the difference between the measured and predicted distances for VDO was minimal. The linear distance between two cephalometric points nasion (Na) [the most anterior point of the frontonasal suture in the median plane] and sella (Se) [the point representing the midpoint of the pituitary fossa] and occlusal vertical dimension from the anterior nasal spine (ANS) [the tip of the bony anterior nasal spine in the median plane] to menton (Me) [the lowest midline point on the mandibular symphysis] on cephalometric radiographs were measured and it was reported that this distance from Na to Se can be used as an additional aid in estimating the occlusal vertical dimension for men in the study population. But, one of the major limitations of study was that it was conducted only in dentulous subjects and Yemeni population, therefore it was recommended that before application of this method in edentulous subjects for complete denture fabrication a clinical study in edentulous patients is must. Thus, present study was planned with the aim to assess the efficacy of the newer linear skeletal distance measurement method (between Na and Se) in predicting the vertical dimensions of occlusion in edentulous patients. The null hypothesis formulated was that newer linear dimension method could not be used for determining VDO in edentulous patients.

MATERIALS AND METHODS-

This study was conducted in strict accordance with the recommendations of the National Institutes of Health's Guide for the Care. The study was conducted at King Khalid University College of Dentistry (KKUCOD), Abha, Saudi Arabia. The ethical approval (SRC/ETH/2018-2019/070) was taken from the scientific research ethical committee of the KKUCOD and written informed consent was obtained from all subjects.

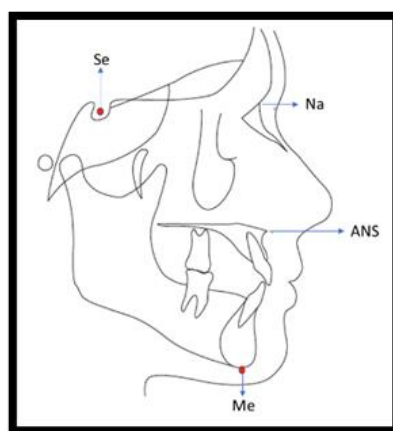


Fig.-1 – Cephalometric Points and Planes used in the study – ANS- anterior nasal spine ; Me- menton ; Na- nasion ; Se- sella.

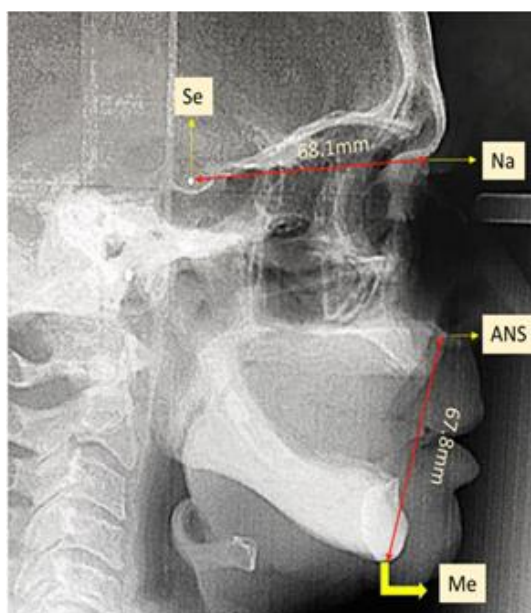


Fig.-2 – Tracing of lateral cephalograph of edentulous subject.

The samples were collected from the KKUCOD, outpatient department (OPD), in a period of 6 months (January 2018 -June 2018). In this cross sectional study, single examiner selected all samples on the basis of inclusion and exclusion criteria from the pool of patients in OPD with the age range of 45-60 years. A total of 120 patients were selected for study. During selection, the following inclusion criteria were considered: Cooperative patient, Completely edentulous patient, Patient with proper speech and pronunciation, Patient without any history of previous maxillofacial trauma, normal masticatory muscles and TMJ movements and class 1 ridge relation. The exclusion criteria were -cleft lip and palate, history of maxillofacial surgery, muscle dystrophy or related disorder, any intraoral or extra oral pathology.

Out of 120 selected subjects, 90 were considered in the study because 10 subjects left in middle of study and 20 subjects were identified as class 2 and 3 during jaw relation. For each patient complete denture was fabricated by calibrated research team members under supervision of a senior Prosthodontist who was blinded from the research objectives. The complete dentures were made following the standard conventional established protocol. Due precautions were taken during the jaw relation record, the Avr-VDO was calculated by taking average of the values of VDO obtained by three pre-established methods - Physiologic rest position method, Swallowing method, Closest speaking space method.⁵⁻⁸

During first recall visit routine denture assessments and required modifications were carried out. Special care was taken to assess the vertical jaw relationship and patient feedback was taken for the same. If any discrepancy in vertical jaw relationship or negative feedback from, the patient new dentures were fabricated.

Following this digital lateral cephalogram was taken for all subjects with dentures inside the mouth. The vertical and horizontal measurements were recorded from the digital radiographs using software pre-built software. The linear skeletal distance between the nasion (Na) to sella (Se) and vertical distance between ANS to Me were measured. For an intra-rater test of reliability, distances were measured twice on 15 cephalograms at 15-days intervals. Data were analysed using the intraclass correlation coefficient (ICC) test. The results revealed a significant level of reliability and reproducibility (ICC=0.895, P<.001) .

The data so obtained was tabulated and results were analyzed using descriptive statistics (mean & SD) and making comparisons among the various groups. Unpaired t test was used to compare parameter measurements between the groups, paired t test was used to compare various measurements within a single sample. Pearson correlation coefficient & linear regression analysis was used to find relationships between variables. The p-value was taken significant when

less than 0.05 ($p < 0.05$) and Confidence interval of 95% was taken. All tests were made with statistical software (IBM SPSS Statistics v22; IBM Corp).

RESULTS-

The study samples included 51 (56.7%) males and 39 (43.3%) females, making total of 90 subjects. The average distance from Na-Se for males was 66.70 ± 6.46 and for females was 62.05 ± 6.39 which was higher than the average distance between the ANS-Me (65.02 ± 6.15 ; 60.79 ± 5.23) and Avr-VDO (64.79 ± 5.83 ; 60.54 ± 5.35) for both genders respectively. The results of the unpaired student's-t test indicated significant differences between males and females in each of these measured distances. (Table-I)

Table No. I : Comparison of Cephalometric Parameters between Males & Females using Unpaired student's-t test.

Parameter	Male		Female		t-value	p-value
	Mean	SD	Mean	SD		
DIST. B/W Na-Se	66.7	6.46	62.05	6.39	3.4	0.001
DIST. B/W ANS-Me	65.02	6.15	60.79	5.23	3.44	0.001
Avr-VDO	64.79	5.83	60.54	5.35	3.55	0.001

On comparing the measured parameters under consideration using paired student's-t test, in whole sample and individually both in males and females, statistically significant differences were found between Na-Se & ANS-Me, (diff= 1.50 ± 4.10 , $p = 0.001$; diff= 1.68 ± 4.39 , $p = 0.009$; diff= 1.26 ± 3.74 , $p = 0.042$); Na-Se & Avr-VDO (diff= 1.73 ± 3.39 , $p < 0.001$; diff= 1.91 ± 3.49 , $p < 0.001$, diff= 1.51 ± 3.28 , $p = 0.007$) respectively. However, insignificant differences were found between ANS-Me & Avr-VDO for whole sample (diff= 0.23 ± 2.58 , $p = 0.390$), in males (diff= 0.22 ± 3.03 , $p = 0.603$) and in females (diff= 0.25 ± 1.87 , $p = 0.406$) (Table-II).

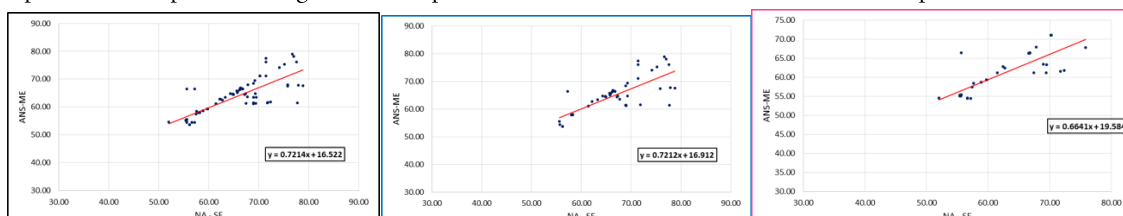
Table No. 2: Comparison between Cephalometric Parameters under study using paired student's-t test

Group	Parameter pair	Mean Diff.	SD	t-value	p-value
Overall	Na-Se & ANS-Me	1.5	4.1	3.46	0.001
	Na-Se & Avr-VDO	1.73	3.39	4.85	<.001
	ANS-Me & Avr-VDO	0.23	2.58	0.86	0.39
Male	Na-Se & ANS-Me	1.68	4.39	2.74	0.009
	Na-Se & Avr-VDO	1.91	3.49	3.89	<.001
	ANS-Me & Avr-VDO	0.22	3.03	0.52	0.603
Female	Na-Se & ANS-Me	1.26	3.74	2.1	0.042
	Na-Se & Avr-VDO	1.51	3.28	2.88	0.007
	ANS-Me & Avr-VDO	0.25	1.87	0.84	0.406

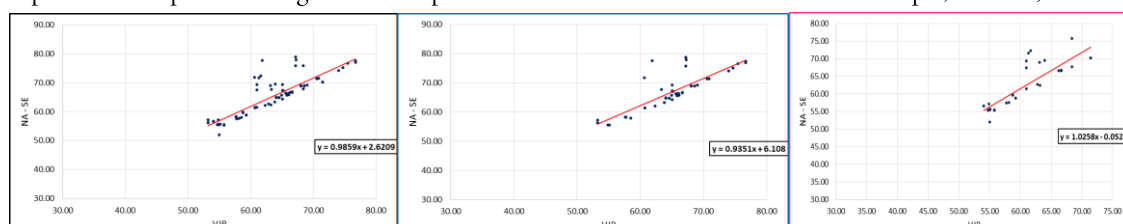
The Pearson correlation coefficient test results showed a significant positive correlation between the measured parameters for the whole sample and also in both males and females. The maximum positive correlation was found between Avr-VDO and ANS-Me (WS-r=0.909; M-r=0.873; F-r=0.867), followed by the correlation between Na-Se and Avr-VDO & (WS-r=0.867; M-r=0.843; F-r=0.859) and between Na-Se and ANS-Me (WS-r=0.803; M-r=0.758; F-r=0.811). All the three correlations were highly significant ($p < 0.001$) (Graph-1,2,3). The linear regression equation for predicting ANS-Me (y) on the basis of Na - Se (x) was given by, $y = 0.7214x + 16.522$; $y = 0.7212x + 16.912$; $y = 0.6641x + 19.584$ for whole sample, males and females respectively. (Graph-1-a,b,c). For predicting Na - Se (y) on

the basis of Avr-VDO (x) was given by, WS- $y = 0.9859x + 2.6209$, M- $y = 0.9351x + 6.108$, F- $y = 1.0258x - 0.0527$ (Graph-2-a,b,c) and or predicting ANS - Me (y) on the basis of Avr-VDO (x) was given by, WS- $y = 0.9285x + 4.7351$, M- $y = 0.9208x + 5.3562$, F- $y = 0.9169x + 5.2805$ (Graph-3-a,b,c).

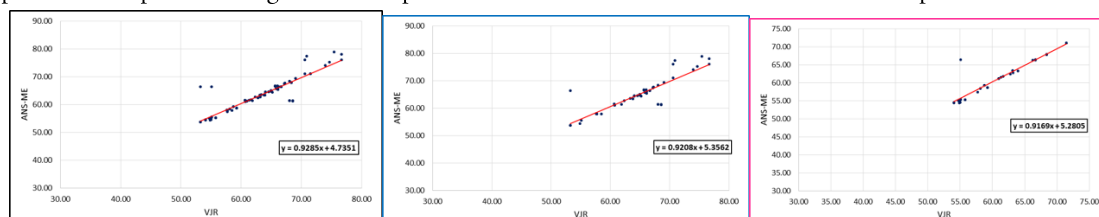
Graph-1 – Scatterplot Showing Relationship between Na-Se& ANS – Me for a-whole sample; b-males, c-females.



Graph-2– Scatterplot Showing Relationship between Avr-VDO & Na-Se for a-whole sample; b-males, c-females.



Graph-3– Scatterplot Showing Relationship between Avr-VDO & ANS-Me for a-whole sample; b-males, c-females.



DISCUSSION-

Vertical dimension of occlusion is one of the most important determinants of successful prosthetic reconstruction. One of the important concern in complete dentures fabrication is lack of reproducible and repeatable reference landmarks for determination of VDO, occlusal plane orientation and its position.²⁰ Among the various proposed methods, cephalometric analysis is one of the objective method which can be reproduced repeatedly and can also help in assessment of the curve of Spee, occlusal plane orientation, anterior teeth positions and anterior guidance.²¹

The present study was unique and first of its kind where linear distance between Na to Se, was compared with vertical distance from ANS to Me in completely edentulous subjects in Saudi population. It was aimed to assess whether the newer suggested method of using linear distance between Na to Se for determining VDO in dentulous patients could be used for determining the VDO in edentulous patients also, while fabricating complete dentures. Results of our study rejected the null hypothesis and showed that there was no statistically significant difference between the linear distance from Na to Se and vertical distance from the ANS to the Me in completely edentulous subjects in Saudi population, thus it can be used in determining the VDO in edentulous subjects.

The samples for the study were selected on the basis of inclusion and exclusion criteria, so that subjects with any abnormality in the maxillofacial area would not get included and affect the results. Many clinical methods have been described for the determination of VDO, but no single method has proved superior. In the present study for determining the VDO, three commonly used methods were used and then average of the of three values was considered.

The correlation between the linear distance between Na to Se and vertical distance between ANS to Me and Avr-VDO was tested in edentulous Saudi subjects. The results revealed average distance from Na-Se for males was 66.70 ± 6.46 and for females was 62.05 ± 6.39 which was higher than the average distance between the ANS-Me

(65.02±6.15; 60.79± 5.23) and Avr-VDO (64.79±5.83; 60.54±5.35) for both genders respectively and difference were statistically significant. Higher values were recorded in men than women, this difference might be due to the gender related developmental changes in cranio-facial anatomy. Similar difference between both sexes were also noted in studies conducted in Yemeni,²² Iraqi,^{23,24} and Moroccan²⁵ individuals.

In the present study, the results of Pearson correlation coefficient test showed that there was significant correlation between the distances of Na-Se, ANS-Me and Avr-VDO for all samples taken together and also for males and females both (P<0.05). On analysing results the value of maximum positive correlation was more in females compared to male between both Na-Se and Avr-VDO & (M-r=0.843; F-r=0.859) and between Na-Se and ANS-Me (M-r=0.758; F-r=0.811) suggesting the difference in distances between Na-Se and ANS-Me and Avr-VDO were more closer to each other in females compared to males. Thus this newer linear dimension method is valid in whole population, more specifically for females for determining VDO in edentulous Saudi patients. This part of the result was in contrast to the study of Alhajj and Daer¹⁹ as they reported no significant correlation between NA-SE and ANS-ME in females. But overall Alhajj and Daer suggested that this method is objective in nature, simple, straightforward and reproducible for future use and can be used effectively without any specific instruments.¹⁹

Even though the study was conducted in a synchronised manner but a number of factors limiting the study needed to be considered. The cross-sectional design and limited sample size made a major constraint for generalizing the results of the study. Also it was conducted in subjects with a class I ridge relationship. So, future studies with a larger sample size and in class II and III ridge relationship should also be conducted to confirm its widespread applicability. Effect of race and gender should be considered while using this method as these factors may affect features in relation to skeletal, dental and soft tissues morphology.^{25,26} The results of the present study, could be applied only to Saudi population, future studies with different population should be performed to quantify this method for easy determination of VDO.

CONCLUSION-

Within the limitations of the study it could be concluded that the linear dimension method of determining VDO in dentulous subjects can also be applied in edentulous subjects. The linear distance between Na-Sewas positively correlated with ANS-Me and Avr-VDO thus it can be directly used in predicting VDO in males and females and more specifically in females for the study population.

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