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ORIGINAL ARTICALE

THE EFFECT OF MISSING POSTERIOR TEETH ON THE VERTICAL DIMENSION OF OCCLUSION (CEPHALOMETRIC STUDY)

Areej Mufeed Abdulalmajeed[1], Rana Rabee Aziz[2], Hala Mowwafaq Al-Katib[3], Faehaa Azher Mohealdeen Almashhadne[4]

1- Department of Prosthodontics, College of Dentistry, University of Mosul, Iraq areej.mufeed@uomosul.edu.iq,
2- Orcid: https://orcid.org/0009-0003-0267-2759
3- Department of Prosthodontics, College of Dentistry, University of Mosul, Iraq rana2009@uomosul.edu.iq, orcid:https://orcid.org/0000-0001-5074-6714 .
4- Department of Prosthodontics, College of Dentistry, University of Mosul, Iraq halamowwafaq@uomosul.edu.iq ,
5- Orcid: https://orcid.org/0000-0003-3834-1321
6- Department of Pharmacology, College of Dentistry, University of Mosul, Iraq faehaaazher@uomosul.edu.iq,
7- Orcid: https://orcid.org/0000-0001-5122-2170

**Corresponding Author:* Areej Mufeed Abdulalmajeed Department of Prosthodontics, College of Dentistry, University of Mosul, Iraq areej.mufeed@uomosul.edu.iq, Orcid: https://orcid.org/0009-0003-0267-2759 Phone numbers: 07701731221,

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Background: Neuromuscular harmony could be maintained and a well-established anterior incisal edge position could preserve the vertical dimension. Aim of the study: improve the proper relationship of anterior teeth with the lips, and stable TMJ would maintain the accurate comfort range of vertical dimension. **Material and method:** cephalometric radiographs were taken to two groups the first group was composed of 20 volunteers (10 male, 10 female) who were considered the control group the criteria for this group were as follows: The age range was from 30 to 50 years. All subjects were chosen based on a Class I dental relationship, with normal TMJ showing no obvious discrepancies. The other group was composed of 20 subjects (10 male, 10 female) which was the study group who had posterior teeth missing while maintaining anterior teeth stopper to investigate the effect of losing posterior teeth upon the comfort scale of vertical dimension of occlusion forward and backward, upper and lower face heights were measured as indicator of vertical facial relationships. **Results**: An independent t-test among the groups indicated that the difference in the vertical dimension of occlusion was non-significant statistically at about $p>0.05$ before and after the loss of posterior teeth. **Conclusions:** The VDO is established when the eruptive force is terminated by the recurrent position of the mandible to the maxilla. The vertical dimension of occlusion could be preserved by the anterior guidance and correct centric position of the condyle

***Keywords*:** vertical dimension of occlusion, posterior guidance, cephalometric study

INTRODUCTION

Vertical dimension is a dimension that describes how the lower jaw is separated from the upper jaw in two conditions, the first one is when the teeth are occluded so here it is called occlusal vertical dimension (OVD), and the other situation is when the teeth are separated mean the mandible at rest position where the vertical dimension is called rest vertical dimension/physiology. Ascertainment of OVD is determined by natural teeth when they still exist in the oral cavity and are occluded.[1] During growth, a musculoskeletal equilibrium leads to the development of the VDO (vertical dimension of occlusion), The mandibular skeletal morphology is linked to the elevator muscles' configuration (pattern).[2]

The vertical dimension is not controlled by teeth, even if the VDO takes place when teeth are interdigitated. Reasonably, they are set on due to the available space between the fixed maxilla and the muscle-positioned mandible.[3]

The occlusion is either static or dynamic which are both important in clinical evaluation, once the mandible is moving in relative to the maxilla the contacts between the teeth are designated by dynamic occlusion.[4,5]

Neuromuscular control, the occlusal surfaces of anterior teeth (the anterior determinants), and temporomandibular joints (the posterior determinants) all impact dynamic occlusion.[6]

Considering the principles of occlusion allows us to correctly restore, reposition, and replace teeth.[4,5]

The size of the face as governed by the jaws' degree of separation is its vertical dimension. The teeth and alveolar bone could cause a change to VD (vertical dimension). The loss or wear of teeth may change both the occlusal vertical dimension and the vertical dimension of rest.[7]

The clinical use of the information currently available on interocclusal space (IOS), the positional steadiness of rest vertical dimension (RVD), and the impact of changing the OVD form the foundation for prosthodontic treatment.[8]

Proper VDO (vertical dimension of occlusion) ensures effective chewing and swallowing in prosthetic reconstruction. Ideal vertical dimensions also make the proper alignment and contact of the teeth during mastication possible and improve occlusal relationships of speech and aesthetics[9]

The cephalometric radiographs detected OVD by measuring the distances among specific craniofacial landmarks (sites, outlines, and/or angles), that remain relatively unaffected after tooth missing. For this reason, its use was promoted as a method of measurement or positioning of vertical dimension.[10, 11]

Cephalometric radiographs are used in dentate patients to define selected craniofacial markers associated with the OVD in measuring the OVD[12]. Later these pointers can be used in edentulous patients during complete or partial denture treatment.[13, 14]

Cephalometry is a standardized technique of assessing facial and dental proportions and their relativity. Moreover, a unique form suited to each patient can be established through a cephalometric examination of the vertical dimension of the face. Every patient's document has to include a permanent copy of this analysis.[15]

In this study, it was hypothesized that missing or lost posterior teeth would not lead to an alteration or decrease in the vertical dimension of occlusion.

Subjects and methods

Ethical approval code UoM.Dent. 23/47 and an Agreement of Consent for Research Participants was obtained 40 cephalometric radiographs were taken and divided into two groups the first group was composed of 20 volunteers (10 males, 10 females) considered as control groups the inclusion criteria for these groups were as follows: the control group: The age range was from 30 to 50 years. All subjects were chosen based on a Class I molar relationship (Angles classification), with normal TMJ showing no obvious discrepancies.

Whole dentition in each jaw (lack of one tooth for each quadrant was accepted also wearing multiple crowns was tolerated) provided that it does not affect the terminal rest position of TMJ and maximum intercuspation of posterior teeth.

The other group was composed of 20 subjects (10 males, 10 females) which were the study group the inclusion criteria for this group were: had posterior teeth missing meaning no opposing teeth occluded in the posterior segment of the arch while maintaining anterior teeth with no sign of wear, the degree of an overbite and overjet at 1-2 mm represent class I incisor relationship, aesthetic of upper and lower anterior teeth was accepted. These teeth act as anterior stoppers to investigate the effect of losing posterior teeth on the comfort level of the vertical dimension of occlusion in other words does loss of posterior teeth lead to a decrease in VDO?

The exclusion criteria were the participants had no contraindication for an X-ray procedure, were not classified as class II or III dental malocclusion, and had no sign of TMJ anomalies or dysfunction.

Samples were selected from different population groups using the random sampling method so each sample has the same probability as other samples to be selected to serve as a representation of an entire population.

In this study, cephalometric measurement was assessed or evaluated to obtain the result.

Cephalometric radiograph

The lateral skull radiographs were taken routinely, using a CS 9000 extraoral imaging machine, the cephalic part of the Digital Dental Care Stream (CS 9000) extraoral imaging machine) under the following standardized condition: Nominal value of the inherent filtration 2.5 mm (0.10) eq. Al (equivalent aluminum), tube voltage about 60kV, exposure level 15mAs, dose radiation emission 27.04mGy.cm2 0° film focus distance 100 cm, and exposure time 0.1 to 3.2 sec.

Cephalometric measurements

The measurement was done using CS Imaging Software version 7.0.3 Care Stream Health. In this study, the vertical jaw relationship can be assessed in several ways. Anterior and posterior, upper and lower face heights were measured as indicators of vertical

facial relationships.

Skeletal and dental landmarks that Steiner promoted were used in this study for cephalometric analysis, upper and lower, anterior and posterior facial height were measured according to a study performed by Strajni L[11].

Steiner's analysis was selected for our study because it is a commonly used cephalometric analysis that offers a variety of linear and angular data for both skeletal and dental measurement[16]

Its limitation is that it requires a long time in the fulfillment, and reliability on the nasion point.

Linear measurements:

Cephalometric points were used as follows (Figure1)

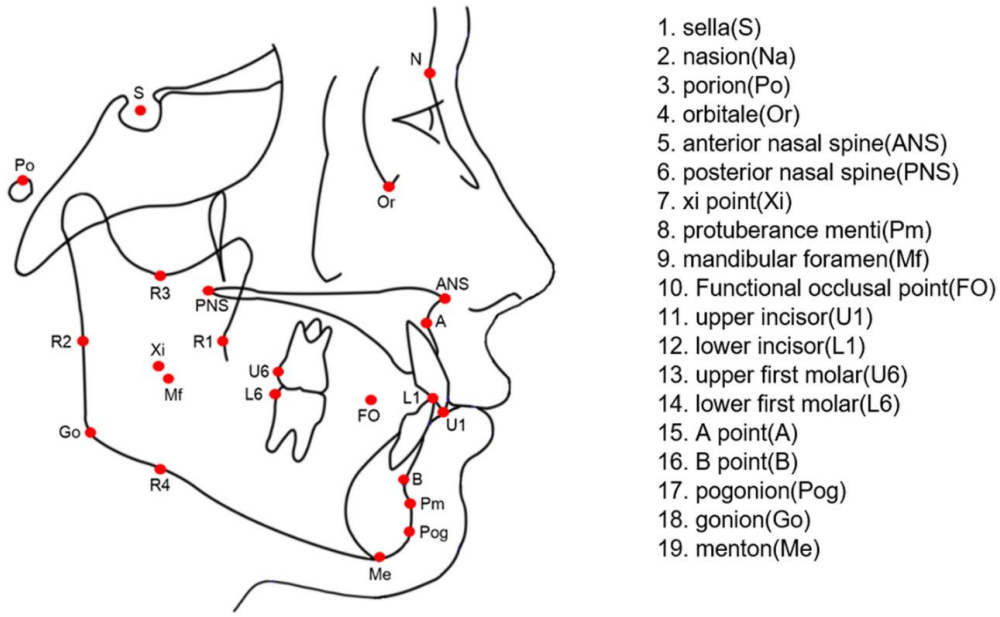


Figure 1. Cephalometric points

(Hyeong Kim J., Ho Kim Y, Jin Kim S, Sung J., Song YM., Won Shin J., Hyun Park J. & Sung Chae H. Twin study—genetic comparison of matrix versus intramatrix rotation in the mandible and three different occlusal planes. *Progress in Orthodontics*.2020; **21**(1): 44 DOI: 10.1186/s40510-020-00344-2)

Nasion (N)	the most frontal point of the nasofrontal suture in the midsagittal plane (the site of deepest concavity at the intersection of the frontal and nasal bones)
Sella (S)	the medial point of the Sella turcica
Subspinale (A)	This is the deepest concavity point on the frontal profile of the maxilla
Supramental (B)	The deepest concavity site on the forward of the mandibular symphysis
Anterior nasal spine (ANS)	This is the tip of the anterior prominence of the maxilla and is located at the lower border of the nasal aperture.
Posterior nasal spine (PNS)	this is the tip of the posterior nasal spine of the maxilla.
Gonion (Go)	the most inferior posterior point on the angle of the mandible.
Menton (Me)	The lowest point of the shadow outline of the symphysis in the midsagittal plane
Incisor superior (Is)	the incisal tip of prominent maxillary central incisor
Incisor inferior (is)	the incisal tip of prominent mandibular central incisor
Prosthion (Pr)	the lowermost area on the alveolar projection in the medial plane above the upper incisors
Infradentale (Id)	the highest and anterior point on the alveolar process in the medial plane between mandibular central incisors

The skeletal linear cephalometric parameters that were analyzed were:

• Anterior total facial height (N-Me) – the longitudinal gap from nasion (N) to Menton (Me)(Figure 2, line 1),

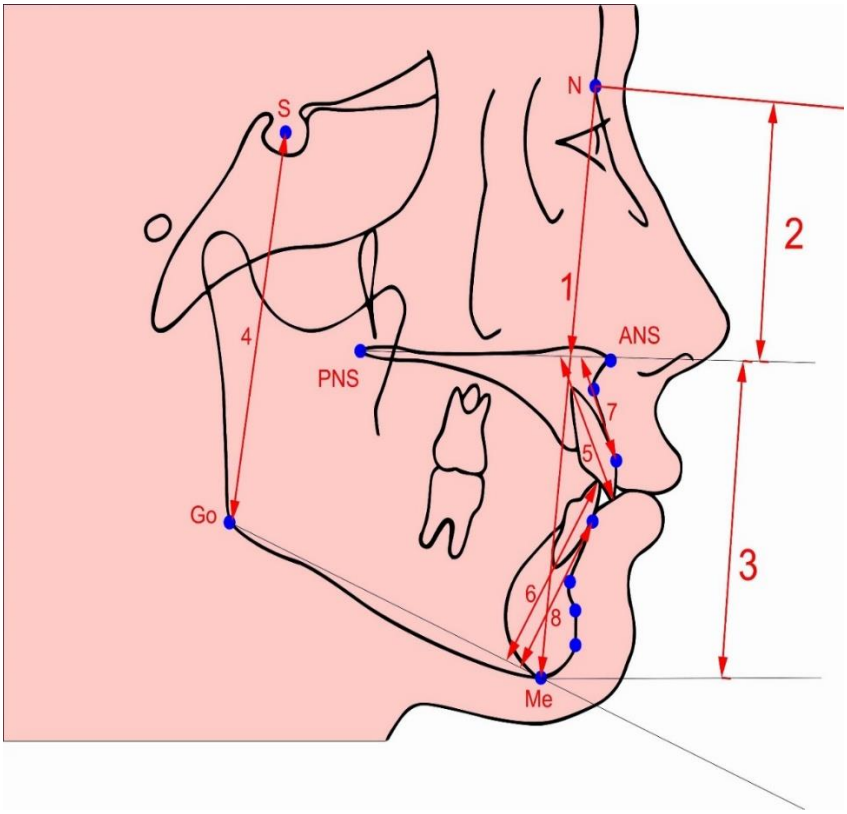


Figure 2. Linear cephalometric parameters were examined.
(Strajnic L, Stanisic-Sinobad D, Markovic D, Stojanovic L. Cephalometric indicators of the vertical dimension of occlusion. *Coll Antropol*. 2008; 32: 535-41. https://pubmed.ncbi.nlm.nih.gov/18756907)

• Posterior total facial height (S-Go) – the longitudinal gap from Sella (S) to gonion (Go)(Figure 2, line 4),

• Anterior upper facial height (N-ANS) – the linear space between nasion (N) and perpendicular projection of the anterior nasal spine site (ANS) to plane N-Me (Figure 2, line 2),

• Anterior lower facial height (ANS-Me) – the linear space between the perpendicular projection of the anterior nasal spine (ANS) to plane N-Me and Menton (Me) (Figure 2, line 3),

• Anterior upper dentoalveolar height (Is-ANS) – the vertical linear space between the anterior nasal spine (ANS) and the tip of the incisal edge of the upper incisor (Is), upright to the palatal plane (PP)(Figure 2, line5)

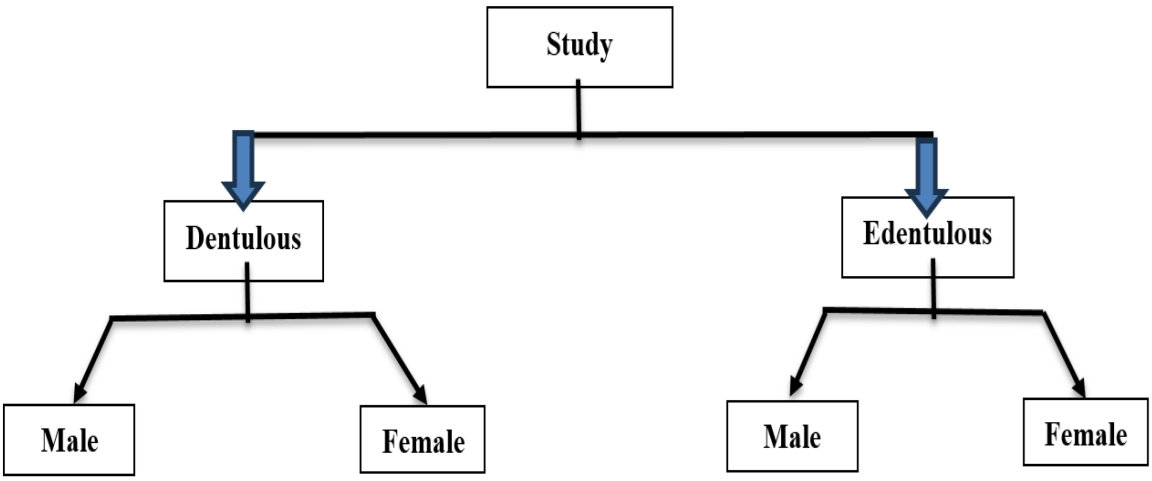
• Anterior lower dentoalveolar height (is-MP) – the vertical linear space between the tip of the incisal edge of the lower incisor (is) and mandibular plane (MP), upright to plane MP(Figure 2, line 6),

• Anterior upper alveolar height (Pr-PP) – the vertical linear distance between *prosthion* (Pr) and palatal plane (PP), upright to plane PP(Figure 2, line 7),

• Anterior lower alveolar height (Id-MP) – the vertical linear distance between infradentale (Id) and mandibular plane (MP), upright to plane MP(Figure 2, line 8).

RESULTS

In this cephalometric study, the groups were classified as two main dentulous and edentulous, subclassified according to sexes into male and female as shown in the following diagram.



The linear cephalometric measurements used to determine the occlusal vertical dimension were tested statistically by SPSS 25 using an independent t-test for comparison between the same sex between the two main groups (dentulous and edentulous)

The mean, standard deviation, t-value, and Statistical significance for the four subgroups of dentulous and edentulous main groups are illustrated in (Tables 1, and 2).

Table 1. Independent t-test for comparing vertical dimension of occlusion of male group

	factor	N	Mean	Std. deviation	t	Sig
N_ME	1 dm	10	120.0800	5.17468	-0.674	0.509
	3 edm	10	122.0100	7.43168	-0.674	0.510
S_GO	1 dm	10	81.9600	5.62913	2.085	0.052
	3 edm	10	76.5600	5.95095	2.085	0.052
N_ANS	1 dm	10	51.7900	3.31074	0.608	0.551
	3 edm	10	50.7000	4.60097	0.608	0.551
ANS_ME	1 dm	10	72.6500	3.34772	0.032	0.975
	3 edm	10	72.5900	4.87703	0.032	0.975
IS_ANS	1 dm	10	28.6800	1.75106	-2.993	0.008
	3 edm	10	32.0100	3.05121	-2.993	0.009
is_MP	1 dm	10	42.0600	1.37695	-1.589	0.129
	3 edm	10	43.7000	2.95935	-1.589	0.137
PR_PP	1 dm	10	18.0200	1.68048	-1.592	0.129
	3 edm	10	19.9100	3.35640	-1.592	0.135
ID_MP	1 dm	10	31.8800	1.86536	-0.597	0.558
	3 edm	10	32.7000	3.92400	-0.597	0.561

Factor 1,3 (1 dm represents the dentulous male group, 3 EDM represents the edentulous male group), N: number of cases, sig: Statistical significance

Table 2. Independent t-test to compare vertical dimension of occlusion of female groups

	factor	N	Mean	Std. deviation	t	Sig
N_ME	2 df	10	112.6000	5.53514	-0.594	0.560
	4 edf	10	114.3100	7.23025	-0.594	0.560
S_GO	2 df	10	70.6200	5.72690	-0.984	0.338
	4 edf	10	73.6300	7.79972	-0.984	0.339
N_ANS	2 df	10	48.8300	3.11272	0.359	0.723
	4 edf	10	48.3900	2.30239	0.359	0.724
ANS_ME	2 df	10	65.4300	5.23111	-0.688	0.500
	4 edf	10	67.3800	7.27519	-0.688	0.501
IS_ANS	2 df	10	28.7600	2.02989	-0.603	0.554
	4 edf	10	29.6800	4.37564	-0.603	0.557
is_MP	2 df	10	39.1400	3.68426	-0.794	0.437
	4 edf	10	40.6200	4.59995	-0.794	0.438
PR_PP	2 df	10	17.0700	3.29917	-1.636	0.119
	4 edf	10	19.5700	3.53178	-1.636	0.119
ID_MP	2 df	10	29.5000	3.00851	-1.427	0.171
	4 edf	10	31.5600	3.43485	-1.427	0.171

Factor 2,4 (2 df represent dentulous female group, 4 edf represent edentulous female group), N: number of cases, sig: Statistical significance

As shown in (Table 1) and (Table 2) independent t-tests among the groups indicate that for all the parameters there was a slight difference in means value and standard deviation of the facial (biological) parameters used in the cephalometric linear measurement of occlusal vertical dimension at a significant value larger than (p= 0.05) between dentulous and edentulous group within the same sexes. In other words, the difference in the vertical dimension of occlusion was non-statistically significant at $p>0.05$ before and after the loss of posterior teeth.
So there was no significant difference in comparison between occlusal vertical dimensions after loss of posterior support.

DISCUSSION

Methods of vertical dimension measurement are complex and multifactorial. Because the vertical dimension has numerous interrelated components. A study by Abdelrahim et al (2022) showed excellent reliability for UAFH (upper anterior facial height and LAFH (lower anterior facial height) measurements in both manual and digital tracing methods, separately (ICC >0.8), concluding that the measurements were consistently reproduced and that the landmarks' location was uncomplicated. Nevertheless, all the linear measurements were statistically tested so we can rely more on the result[17]

Cephalometric analysis can be useful due to its ability to functionally relate Craniofacial landmarks to skeletal profile and occlusion, investigate various skeletal and dental relationships, and correlate radiographic measurements with clinical surveillance, besides its role in prosthetic reconstruction (diagnosis, and treatment planning).[18, 19]

It permits the precise assessment of the VDO concerning the portions of the craniofacial skeleton that did not alter following tooth loss.[11]

VDO (vertical dimension of occlusion) could not be or could be reduced following loss of posterior occlusal support According to Hwa-Jung Lee et al, (2021), posterior teeth loss and the extraction of the opponent teeth lead to a falling of the occlusal plane, also the absence of posterior support leads to the acute wearing of the persisting teeth. So the prosthetic restoration must be restored at the place (site) of the original vertical dimension.[20]

Where Calamita et al, (2019) demonstrated the effect of the state and situation of the posterior teeth if they are responsible for preserving the OVD. In general, if they are well positioned with few marks of attrition, it is improbable that a change of OVD has resulted.[21]

Carlsson explained that the natural teeth establish the O.V.D. while they are developing and in place, but when the teeth are lost during their lifetime, the O.V.D. will be diminished. He also reported that any information about O.V.D. with natural teeth should not be ignored.[22]

Wylie WL. Stated that the mandibular musculature is the determining factor in the total face height, and muscles of the face dynamically maintain the vertical dimension[23], loss of muscle tone over time would lead to changes in

the vertical dimension.[21]

However, missing posterior teeth may cause occlusal instability which is considered a predisposing factor for TMD temporomandibular disease. Occasionally, to gain occlusal stability the mandible may protrude thus the anterior teeth and TMJ may be overloaded. However, this has not been confirmed to usually decrease VDO.[24]

It would be inappropriate to differentiate between an anterior and a posterior VDO as only one VDO pertains to the entire mandibular corpus. The distinction between the loss of occlusal posterior support and the loss of VDO was made evident by Okeson (1989). It is therefore likely that these two scenarios will be confused.[25]

Comfort zone is the better term used to describe physiologic OVD as a series instead of a static point or site and the extension of that may contrast among persons according to their adaptive capacity.[26]

Morales stated that the vertical comfort range concept is mostly believed, that the spreading of outcomes may be explained by the concept of a vertical comfort range.[26]

According to the patient's facial morphological type, the OVD is increased or decreased vertically in the second molars region, so the overbite and the overjet of anterior dentition will be affected and changed.[27]

Anterior teeth contact is a critical factor in deciding whether or not to change the VDO, it should also be noted that posterior teeth be adjusted until anterior contact is achieved in centric relation.

Besides being the most visible part of the smile, the association of the anterior teeth in function is the principal determinant of posterior occlusal form. How well the anterior guidance is matched to discrete patterns of function governs each patient's comfort. We now know that it is also critically important to the coordinated muscle function of the entire masticatory system. [3]

Based on this difference in the probability of change OVD the authors–tried in this study to figure out whether the vertical dimension is affected by the loss of teeth. Especially posterior teeth.

Within the limitation of this study according to the result, the authors found that the vertical dimension is not affected by the loss of posterior teeth as long as there is no wear of remaining anterior teeth, the aesthetic of anterior teeth is improved, no Temporomandibular disorders (TMDs), and the condyles are in their respective normal position.

CONCLUSIONS AND SUGGESTION

The VDO is established when the eruptive force is terminated by the recurrent relation of the mandible to the maxilla. This dimension results from the consistent length of the elevator (closing) muscles during repetitive shrinkage through their power cycle. It can rely on anterior guidance provided by anterior teeth to maintain and predict the vertical dimension of occlusion.

Further studies are required to compare the effect between anterior and posterior missing teeth on the vertical dimension of occlusion.

DECLARATIONS

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None.

Competing of interest

The authors declare there is no conflict of interest

Ethical approval and consent to participate and publication

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