Evaluation of Divine Proportion Ratio as a Method for Registration of Rest Vertical Dimension Using Statistical Analysis in Completely Edentulous Patients

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ABSTRACT

Aim: *This study aimed to present a reliable way to determine the arbitrary relation using the **divine proportion method**. The study relied on statistical analysis between different conventional ways to put the patient at rest versus the use of divine proportion method.*

Methods: *One hundred completely edentulous patients were selected to determine the correct rest vertical dimension using the divine proportion method versus three other conventional methods which are the lip moisten and the relax, swallowing and phonetics through the letter (M).*

Results: *There was marked statistical significant difference between the recorded rest vertical dimension between the divine proportion method and the other three conventional methods while on comparing the conventional methods to each other the results showed no statistical significant difference.*

Conclusion: *The results of this study suggested the use of more than one method for determination of rest vertical dimension to assure proper measurement.*

Since the divine proportion method depends on fixed and unchanged anatomical landmarks occupying the middle third of the face, it should be the method of choice for measuring the rest vertical dimension.

KEYWORDS

Mandibular rest position, Vertical and horizontal jaw relation, Edentulous patient, Divine proportion, Vertical dimension of speach.

INTRODUCTION

The recording of jaw relations in the treatment of edentulous patients aims at facilitating the adaptation of the complete dentures to the masticatory system to give an optimal and comfortable function. To achieve this goal, the recording must include an appropriate vertical dimension of occlusion and stable occlusal contacts in harmony with the TMJ, masticatory muscle functions and finally with the relationship between the prosthesis and the oral and the facial musculature.[1,2]

Innumerable patients can not wear complete dentures then have continual difficulty in using them, principally because accurate vertical dimension of the natural dentition was not reproduced in complete dentures. Vertical dimension is in reality the most fundamental consideration in treatment planning. It is related, to the masticatory, respiratory and deglutitive function.[3,4]

Occasionally a patient with complete dentures will display an obviously reduced vertical dimension of occlusion. When faced with the challenge of making new dentures in this situation, it is desirable for the dentist to reestablish the patient's optimum vertical dimension of occlusion.[5] As if the vertical dimension was too great the patient will complain of soreness of the residual ridges, tightness of the facial muscles and clicking of the dentures during speech, also it induces an increased rate of resorption of the remaining alveolar bone.[4,6,7]

The necessity of a correct vertical dimension for the health of the temperomandibular joint is considered as basic knowledge. The profession still remembers "Costen's syndrome" and ear and facial pains caused by closed vertical dimensions.[8]

Facial height, or vertical dimension, consists of two components: **(1)** the more objective VDO, which is the shortest measure of facial height involving centric occlusion contacts; and **(2)** a more subjective measure of facial height termed rest position without tooth contact.[9] Neuromuscular posturing of the mandible establishes this slightly greater measure of facial proportion.

Muscular activity further divides the rest position into two components, clinical and EMG rest. If the total facial height is considered beyond the Vertical dimension in occlusion, the clinical rest position is less and only 1 to 3mm greater than the VDO. This Interocclusal distance varies as it is controlled by tonic muscle activity.[10] Airway, Posture, and tension can influence this position,[11-13] but all normal functions of the mandible originate from clinical rest.

Fenlon *et al.*[14] stated that in complete denture prosthesis, one of the main problems that must be given consideration to is the separation that will be best tolerated by the patient and at the same time be acceptable for function and esthetics.[15] This problem is intimately related to the occlusion present whether they are occlusion of natural or prosthetic teeth or occlusion developed with rims of wax.[16-19]

In the literature, the divine proportions were first mentioned about ad 300 by the Greek mathematician Euclid[20] in his second and perhaps best-known book, Elements.[1] some examples of divine proportions are the Parthenon, the Dionysian Procession, and Leonardo da Vinci's painting of the Mona Lisa.[21,22]

Divine proportions result from a specific geometric sectioning of a distance: a line (AB) is sectioned at point C in accordance with the golden ratio when the 2 subsections (AC to CB) correspond to each other as does the whole distance AB to the section AC. This relationship is called phi (1.618).[23,24]

(Fig 1) *Arithmetic expression of the golden ratio: AB/AC =AC/CB =1.618 (phi)*

Prevailing literature regarding oral reconstruction suggests a reasonably static lower facial height, limited by the clinical rest position of the mandible.[2,3,17,25-27] Changes in rest position can be considered slight and clinically difficult to measure with the passage of time. However, the literature is replete acknowledging that facial height is neither static nor limited by the clinical resting length of the masticatory muscles.[11,15,18,28,29] An immediate increase in resting facial height can be correlated to an elevation in the VDO.[30,31] An Interocclusal distance obliterated by an increased VDO is evident after a single occlusal contact occurs. Immediate change in the resting length of the muscles is under neuromuscular control and consistent with efficient function.[32]

By years there have not been an exact and accurate measure to establish the proper vertical dimension for patients suffering of lost vertical dimension, so this study aimed to present a way where it could be possible and reliable to determine that arbitrary relation by using *the divine proportion* method. The study relied on statistical analysis between different conventional ways to put the patient at rest versus the use of divine proportion method.

MATERIAL & METHODS

One hundred completely edentulous patients were selected from Dental Prosthetic Clinic, Faculty of Dentistry, King Abdulaziz University. Their age ranged from 50 to 65 years old, with comparable adequate ridge height and a normal class I skeletal jaw relation. Patients having no history of previous denture experience and having no significance of temperomandibular disorders were included.

For every patient vertical dimension at rest will be recorded by the following ways.

1. The patient was asked to moisten his lips and close in comfortable position.
2. Patient was asked to swallow and relax without separating the lips
3. Patient was asked to repeat the letter 'M' or the word 'EMMA'.
4. Divine proportion ratio using le divine mean caliper (*le divine mean caliper, UK*). The gauge bows are being opened for a specific measurement it opens automatically the other bows. The first bow will point to the inner canthus of the eye the second bow points on the ala of the nose (1) and automatically the third bow will open to reach the base of the chin (menton) (1.618). **(Fig 2)**

(Fig 2) *Measuring the Vertical dimension at rest by the caliper*

(Fig 3) *Calculating the measurement using Bolly's gauge*

(Fig 4) *Using Bolly's Gauge to measure VDR*

The patients were induced to relax while sitting in a comfortable upright position without support of the back or head rest.

The resulted measurements will be recorded using Bolly's gauge in mm. **(Fig 3,4)**

Scoring index used to compare the two conventional methods to divine proportion method used for determination of vertical dimension at rest.

0= Conventional method compatible with divine proportion method.
1= Conventional method is 1-2mm higher than divine proportion method.
-1= Conventional method 1-2mm lower divine proportion method.
2= Conventional method is more 2mm higher than divine proportion method.
-2= Conventional method is more 2mm lower than divine proportion method.
The resulted data were collected, tabulated to be statistically analyzed.

RESULTS

The results of Comparison between the four methods of determination of vertical dimension at rest in mm.

On comparing the divine proportion to lip moisten method, the results showed that the mean±SD is 7.35±0.55 and 7.19±0.61 respectively. Where, statistical significance difference was observed between both methods of determination of vertical dimension at rest $t(p)$=<0.001*as shown in **table 1**.

Also the results showed on comparing the divine proportion to swallowing method that the mean±SD is 7.35±0.55 and 7.19±0.56 respectively. Where, statistical significance difference was observed between the two methods of determination of vertical dimension at rest $t(p)$=<0.001*as shown in **table 1**.

Also the results showed on comparing the divine proportion to phonetics method that the mean±SD is 7.35±0.55 and 7.21±0.57 respectively. Where, statistical significance difference was observed between the two methods of determination of vertical dimension at rest $t(p)$=<0.001*as shown in **table 1**.

While on comparing the three conventional methods together the lip moistening, swallowing and phonetic methods, the results showed the mean±SD is 7.19±0.61, 7.19±0.56 and 7.21±0.57 respectively. Where, no statistical significance difference was observed between the three methods of determination of vertical dimension at rest $t(p2)$=0.987, 0.561 and $t(p3)$=0.372 as shown in **table 1**.

A marked significant variation has been observed in **figure 5** between the divine proportion compared to the other three conventional methods while on comparing the conventional methods to each other there were no statistical significant difference.

The scoring system results were collected in a scoring system which was done according to the following:
On comparing the patient's reading of determination of vertical dimension at rest using divine proportion method and the moistening lips method, forty one patients out of hundred showed that by the moistening lips method the readings were lower than the reading obtained by divine proportion method by a difference of 1-2mm giving a percentage (%) of 41% as shown in **table 2**.

Also, twenty nine patients out of hundred showed that by the moistening lips method the readings were lower than the reading obtained by divine proportion method by a difference of more than 2mm giving a percentage (%) of 29%. While, only eighteen patient out of the hundred showed compatibility between both methods' reading giving a percentage of 18% as shown in **table 2**.

While on comparing the patient's reading of determination of vertical dimension at rest using divine proportion method and the moistening lips method, ten patients out of hundred showed that by the moistening lips method the readings were higher than the reading obtained by divine proportion method by a difference of 1-2mm giving a percentage (%) of 10% as shown in **table 2**.

Also, two patients out of hundred showed that by the moistening lips method the readings were higher than the reading obtained by divine proportion method by a difference of more than 2mm giving a percentage (%) of 2% as shown in **table 2**.

On comparing the patient's reading of determination of vertical dimension at rest using divine proportion method and the swallowing method, fifty two patients out of hundred showed that by the swallowing method the readings were lower than the reading obtained by divine proportion method by a difference of 1-2mm giving a percentage (%) of 52% as shown in **table 2**.

Also, twenty seven patients out of hundred showed that

(Table 1) *Comparison between the four methods of determination of vertical dimension of rest in (mm)*

	Divine	Moisten	Swallowing	Phonetics
Range	6.30 – 8.50	5.80 – 8.50	5.90 – 8.30	6.10 – 8.60
Mean ± SD	7.35 ± 0.55	7.19 ± 0.61	7.19 ± 0.56	7.21 ± 0.57
Median	7.30	7.30	7.20	7.25
p1		<0.001*	<0.001*	<0.001*
p2			0.987	0.561
p3				0.372

p1: *p value for Wilcoxon signed ranks test between divine and other methods*

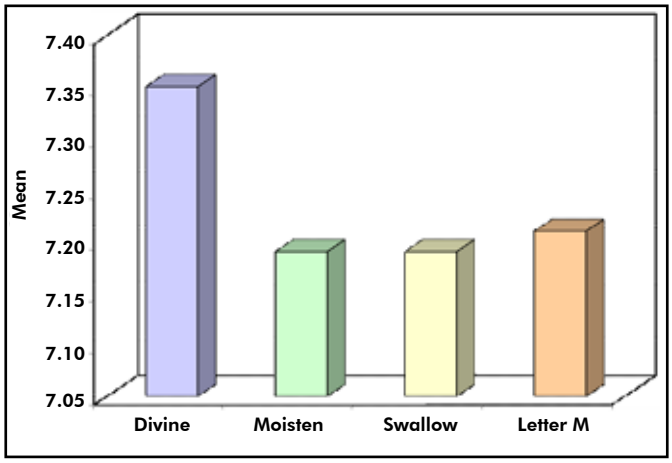
p2: *p value for Wilcoxon signed ranks test between moisten and other methods*

p3*: p value for Wilcoxon signed ranks test between swallow and letter M method*

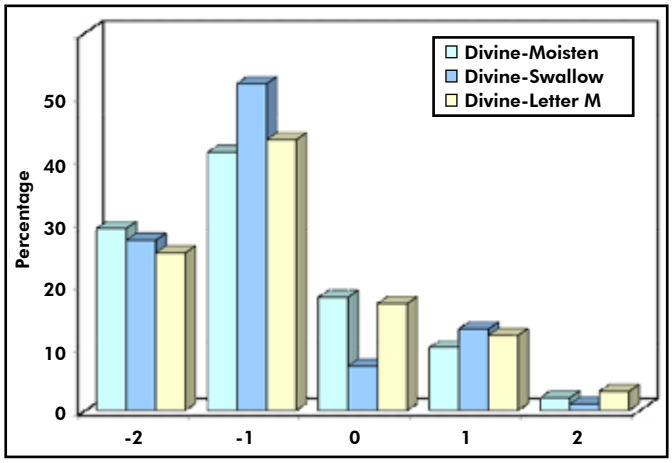
****:*** *Statistically significant at p≤0.05.*

(Table 2) *Comparison of the scoring index between the divine proportion method and the three conventional methods used for determination of VDR*

	Score					
	Divine-Moisten		Divine-Swallow		Divine-Letter M	
	No	%	No	%	No	%
-2	29	29.0	27	27.0	25	25.0
-1	41	41.0	52	52.0	43	43.0
0	18	18.0	7	7.0	17	17.0
1	10	10.0	13	13.0	12	12.0
2	2	2.0	1	1.0	3	3.0
p1			0.684		0.548	
p2						0.118



(Fig 5) *Comparison between the four methods of determination of vertical dimension at rest*



(Fig 6) *The scoring index of the four methods of determination of vertical dimension at rest*

by the swallowing method the readings were lower than the reading obtained by divine proportion method by a difference of more than 2mm giving a percentage (%) of 27%. While, only seven patient out of the hundred showed compatibility between both methods' reading giving a percentage of 7% as shown in **table 2**.

While on comparing the patient's reading of determination of vertical dimension at rest using divine proportion method and the swallowing method, thirteen patients out of hundred showed that by the swallowing method the readings were higher than the reading obtained by divine proportion method by a difference of 1-2mm giving a percentage (%) of 13% as shown in **table 2**.

Also, one patients out of hundred showed that by the swallowing method the readings were higher than the reading obtained by divine proportion method by a difference of more than 2mm giving a percentage (%) of 1% as shown in **table 2**.

On comparing the patient's reading of determination of vertical dimension at rest using divine proportion method and the phonetics method, forty three patients

out of hundred showed that by the phonetics method the readings were lower than the reading obtained by divine proportion method by a difference of 1-2mm giving a percentage (%) of 43% as shown in **table 2**.

Also, twenty five patients out of hundred showed that by the phonetics method the readings were lower than the reading obtained by divine proportion method by a difference of more than 2mm giving a percentage (%) of 25%.While, only seventeen patient out of the hundred showed compatibility between both methods' reading giving a percentage of 17% as shown in **table 2**.

While on comparing the patient's reading of determination of vertical dimension at rest using divine proportion method and the phonetics method, twelve patients out of hundred showed that by the phonetics method the readings were higher than the reading obtained by divine proportion method by a difference of 1-2mm giving a percentage (%) of 12% as shown in **table 2**.

Also, three patients out of hundred showed that by the phonetics method the readings were higher than the reading obtained by divine proportion method by a difference of more than 2mm giving a percentage (%) of 3% as shown in **table 2**.

DISCUSSION

Although techniques and materials are continuously advancing in prosthodontics, no accurate method for assessing the vertical dimension at rest in edentulous patients is yet available to dentists. Clinical judgment plays a major role in the assessment of this important component in the construction of dentures.

This study was undertaken to determine some of the characteristics of the described changes in the vertical dimension of the mandibular rest position. In addition, it includes a comparison between facial and skeletal measurements using the divine proportion method and the existing three conventional methods (moisten the lips, swallow then relax and pronouncing letter M) to obtain mandibular rest position.

The results obtained from this study showed that there was a significant difference in determination of the vertical dimension at rest from one hundred patients using the divine proportion method compared to the other three conventional methods. There was no statistical significant difference between the latter methods.

This result may be due to that, the divine proportion method was used depending on the middle part of the face, which is unchangeable and depending on the patient's rest state that has been found on skeletal evidences.[33]

This result was supported by Tallgren[34] who tested the accuracy of three methods, which are fatiguing the jaw musculature, phonetics and the "no command" method of physical and mental relaxation in establishing the vertical dimension of rest position cephalometrically on people with normal dentitions. Cephalometric radiographs showed no significant statistical difference when comparing these three methods.

It was against Atwood[35] who contended that the rest position is a dynamic rather than a static concept and that it varies from person to person and within each person. He stated that the vertical zone of suppressed electromyographic activity found by Jarabak[36] supported this concept of a postural range.

The result was also supported by Soliman[37] who tested the use of divine proportion method versus phonetics and physiologic methods in determination of vertical dimension at rest on 20 completely edentulous patients. She stated that the difference between the VDR determined by conventional methods and divine proportion method were significant. The Divine proportion method should be considered as a method of determination of rest vertical dimension.

Bowman and Chick[38] discussed the use of facial measurements to determine the vertical dimension for edentulous patient. Good friend[39] also suggested that the distance from the pupil of the eye to the junction of the lips equaled that from the subnasion to the gnathion. However, Willis[40] has given the credit for popularizing these measurements.

Since such facial measurements have been used by many investigators for determination of VDR, therefore the divine proportion ratio can be applied to determine the VDR based on facial approximation concept.

SUMMARY

The present study was undertaken on one hundred completely edentulous patients to correlate the determination of vertical dimension at rest using the divine proportion method versus three conventional methods which are lip moistening, swallowing and pronunciation of letter M.

The results showed the reliability of the divine proportion method to be used in determination of vertical dimension at rest in completely edentulous patient. Where its important for construction of denture to prevent any muscular or TMJ disorders.

CONCLUSIONS

1. The vertical dimension at rest should be determined accurately for construction of complete denture.
2. The difference between vertical dimension at rest determined by divine proportion method and other conventional methods were significant.
3. More than one conventional method for determination of vertical dimension at rest should be used in order to assure proper measurements.
4. The Divine proportion method should be considered as a method of determination of rest vertical dimension.

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