A PHOTO CEPHALOMETRIC ANALYSIS OF VERTICAL DIMENSION

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Abstract

Background: Assessment of facial vertical proportions plays a crucial role in orthodontic diagnosis, treatment planning, and evaluation of treatment outcomes. Traditional cephalometric radiographs provide reliable skeletal measurements; however, photogrammetric analysis offers a non-invasive, radiation-free, and cost-effective alternative for evaluating facial vertical dimensions.

Aim: To compare the vertical dimension recorded clinically cephalometrically and photographically and analysis of anterior and posterior facial height.

Result: The One way ANOVA analysis, no statistically significant difference between the control group of Clinical VDO with mean of 65.62±7.22 and Soft tissue cephalometric VDO with mean of 65.71±6.70 followed by Skeletal cephalometric VDO with mean of 65.05±6.91 and Photographic VDO with the mean of 64.74±7.19 which inferred that the Soft tissue Cephalometric VDO is a method which gives a measurement similar to the Clinical method of VDO followed by Skeletal Cephalometric VDO and with a slight margin of error Photographic VDO can be also used as an less invasive method to record VDO. Skeletal cephalometric Upper Anterior Facial Height with the mean of 53.98±5.95 and Soft tissue cephalometric Upper Anterior Facial Height with the mean of 67.00 ±6.62. The interpretation shows that after the independent t test, there is significant difference (p=0.000). Skeletal cephalometric Lower Posterior Facial Height with the mean of 50.13±7.24 and Clinical Lower Posterior Facial Height with the mean of 51.23 ±2.27. Thus, the interpretation shows that after the independent t test, there is no significant difference (p=0.703).

Conclusion: The Clinical method of determining the vertical dimension of occlusion can be evaluated and corelated with the post prosthodontic rehabilitation measurements. Cephalometric method of determining the vertical dimension of occlusion which can be employed in cases where it is difficult to determine. Photographic method is an easy, convenient and minimally invasive method for recording the VDO.

Keywords: Vertical Dimension of Occlusion, Facial height, Lateral Cephalogram, Photograph, Pre extraction record.

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INTRODUCTION:

Vertical Dimension is the distance between two selected anatomic or marked points (usually one on the tip of the nose and the other on the chin), one on a fixed and one on a movable member. (1) Even though the vertical dimension of occlusion occurs when the teeth are fully articulated, the teeth are not the determinants of vertical dimension. Rather, their position is determined by the vertical dimension of the space available between the fixed maxilla and the muscle-positioned mandible. The mandible goes

repetitiously to the position dictated by the contracted elevator muscles, and the upper and lower teeth erupt into the space until they meet at that occlusal relationship. The repetitive-contracted length of the elevator muscle sets the maxillomandibular relationship. (2) The accurate determination of the vertical dimension of occlusion forms a critical part of recording the jaw relation, and the precision can give an idea for the practitioner to understand the direction of treatment. Several methods for determining the lost VDO, which depend on either muscular activity or skeletal morphology, have been reported. However, as the facial morphology is easier and simpler to assess than these methods, this study was planned to correlate the landmarks to analyse the VDO. (3)

The methods to determine the vertical dimension of occlusion are broadly classified as Pre and Post extraction methods. The proposed Pre-extraction methods are Pre-extraction diagnostic casts, Pre-extraction phonetics, Cephalometric radiograph, Profile tracing of the lower third of the face. Reliability of these techniques are entirely dependent on the patient presentation in a dentate state. The pre-extraction methods are effective provided acceptable VDO, stable occlusion and satisfactory aesthetics prior to edentulism. (4, 5)

A word “cephalon” comes from Ancient Greek, where “kephale” means head. Nowadays the term is employed to describe the head part of an arthropod (cephalon) or the study of human head measurements. (6, 7)

Profile views, especially the soft tissue profile that can be obtained from a lateral cephalogram, have been used. Researchers have used a variety of approaches with this basic technique, i.e., making serial tracings from a collection of radiographs as well as superimposing cephalometric tracings, So, it is possible to record and analyze serial tracings from the photographic profile outline. (8)

Photography has now penetrated all the segments of science, medicine, industry, fashion designing, communication, and arts, and it is difficult to imagine any form of existence without photography. It has influenced the conscience of people so much that the saying “An image is worth a thousand words” is accepted as an undeniable fact. Standard still photographs are obtained by positioning the patient in standard facial views for accurate preoperative and postoperative facial analysis. Although this method provides accurate assessment of facial ratios whole measurements, may not meaningfully be translated from photographs to operating room table. (9) Vertical dimensions included Anterior Facial Height and Posterior Facial Height, Vertical dimension of occlusion. It is a very important, to regain the proper function, physiology and aesthetics and any errors in the vertical dimension can affect the stomatognathic system. Reconstruction of original occlusion and Vertical Occlusal dimension by a proper prosthesis leads to a

better adaptation, recovery of the functions with satisfaction. (10)

. The main aim of this research is to analyze the Vertical Dimension of Occlusion, with the aid of Cephalometry and Photography. Thus, the hypothesis is to analyse the corelation (if any) exists between the clinical method of determining the VDO, Cephalometric method of determining the VDO and Photographic method of determining the VDO.

MATERIAL AND METHDOLOGY

INCLUSION CRITERIA: Dentulous subjects are selected for the study between the age of 20-40 years with full complement of teeth till second molar are selected with no developmental anomalies, no pathological migration, traumatic occlusion should be present, no history of Oro facial surgery.

EXCLUSION CRITERIA: Subjects with the history of disorder of temporomandibular joint and muscle of mastication, who have undergone radiation therapy, orthodontic treatment, presence of any congenital and acquired orofacial deformities like cleft lip and presence of facial asymmetry are excluded.

LINICAL METHOD OF MEASUREMENT OF VERTICAL DIMENSION OF OCCLUSION:

The subjects were instructed to stand straight with their head in natural position, and teeth in their normal occlusion. For orientation, the interpupillary line, must be parallel with the horizontal plane. The vertical dimension of occlusion is it is the vertical position of the mandible in relation to maxilla when the occluding members are in contact, and it is clinically measured from the most prominent

portions on the tip of the nose and chin with the aid of Vernier Caliper in the mid sagittal plane

CEPHALOMETRIC METHOD OF MEASUREMENT OF VERTICAL DIMENSION OF OCCLUSION:

Subjects are positioned within the cephalostat ear rods, exerting moderate pressure on the external auditory meatus. The subject's Frankfort plane is parallel to the floor. Before the exposure, subject's standing position and orientation reference lines were verified using the laser lights provided by the system. After setting the optimum position, radiographs were prepared with maximum radiation condition (68.0kV, 5mA, 17s). Radiographs with improper visual characteristics (contrast and resolution) were excluded from the study and radiographs

were taken again by improving the exposure condition. The skeletal cephalometric landmarks

Figure 1 Clinical VDO measurement

and soft tissue cephalometric landmarks are traced, identified, and labelled.

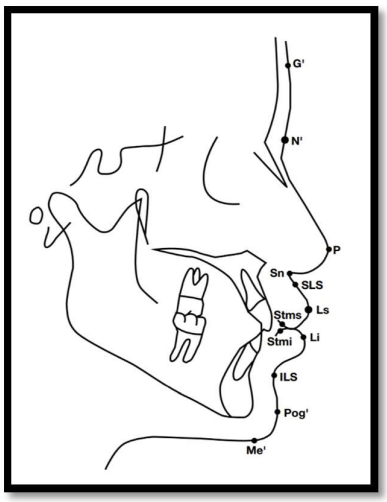
MEASUREMENT OF VERTICAL DIMENSION OF OCCLUSION: SKELETAL CEPHALOMETRICS

A: Vertical Dimension of Occlusion: Anterior Nasal Spine (ANS) To Menton (Me)

B: Total Anterior Facial Height: Nasion (N) To Menton (Me)

C: Upper Anterior Facial Height: Nasion(N) to Anterior nasal spine (ANS)

D: Lower Anterior Facial Height: Anterior Nasal Spine (Ans) To Menton (Me)



E: Total Posterior Facial Height: Sella (S) to Gonion (Go)

F: Upper Posterior Facial Height: Sella (S) to Articulare (Ar)

G: Lower Posterior Facial Height: Articulare(Ar) to Gonion(Go)

MEASUREMENT OF VERTICAL DIMENSION OF OCCLUSION: SOFT TISSUE CEPHALOMETRICS

A': Vertical Dimension of Occlusion: Pronasale (Pn) to soft tissue Pogonion (Pog')

B': Total Anterior Facial Height: Glabella (G) to soft tissue Menton (Me')

C': Upper Anterior Facial Height: Glabella (G) to Subnasale (Sn)

D': Lower Anterior Facial Height: Subnasale (Sn) to soft tissue Menton (Me')

MEASUREMENT OF VERTICAL DIMENSION OF OCCLUSION: PHOTOGRAPH METHOD

The frame of the photograph in the upper part must encompass the crown, and in the lower part the whole neck to the collarbone must be visible. For orientation the distance between the outer canthus of the eye and upper edge of the ear should be parallel with the horizontal plane. The inner and outer edge of the eye and only one side of the face should be completely visible on the photograph. The ideal position for the camera is when the line of the central lens to the eyes is parallel with the horizontal plane. The lateral profile image is viewed with the aid of

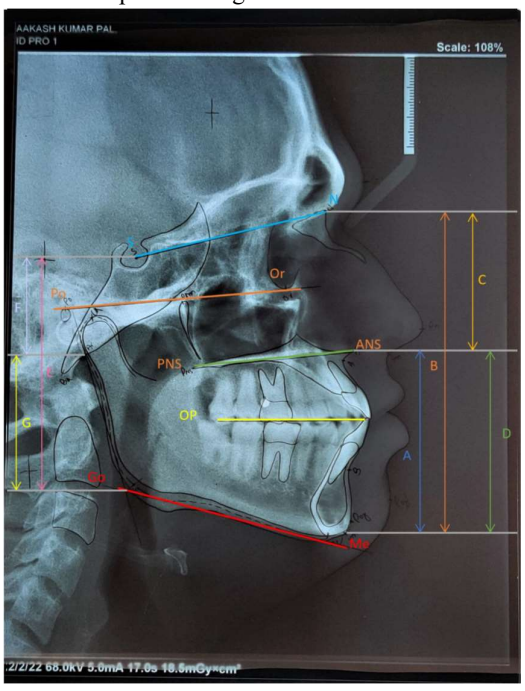
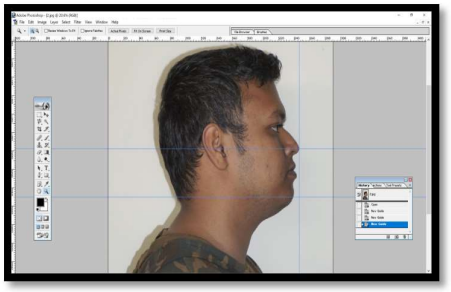


Figure 4 Soft Tissue Landmarks

Figure 3 Soft Tissue Landmarks

Adobe Photoshop, ruler setting are changed to millimetres and guide lines are drawn from the selected landmarks and Vertical Dimension of Occlusion is measured from the most prominent points on the nose to chin in a lateral profile photograph.



RESULTS

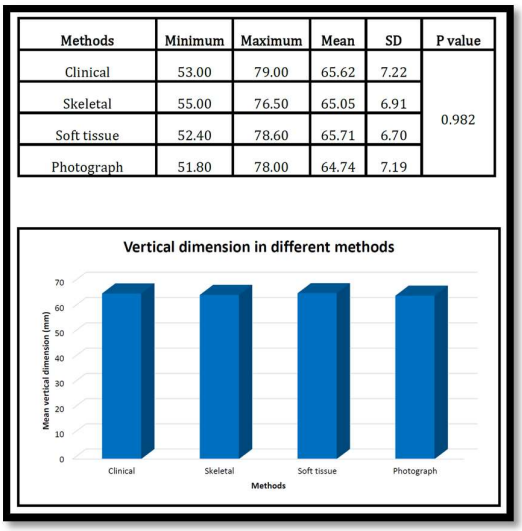
This study was conducted on 30 patients who are categorized in three categories based on their method of determining vertical dimension.

The data is tabulated in Microsoft excel and analysed with SPSS V.24 software.

The variables are presented with mean and standard deviation. Independent t test, one way ANOVA and Tukey post hoc test are used for the comparisons. The p value ≤0.05 is considered as statistically significant.

COMPARISON OF VERTICAL DIMENSION (MM) BETWEEN DIFFERENT METHODS USING ONE WAY ANOVA

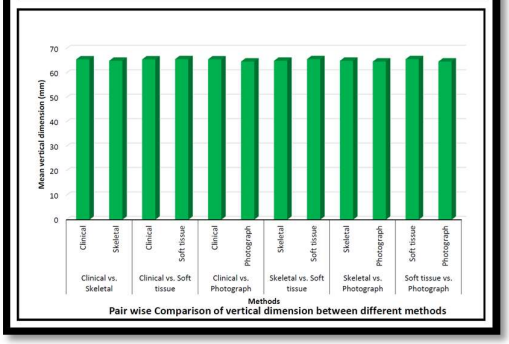
Methods	Minimum	Maximum	Mean	SD	P value
Clinical	53.00	79.00	65.62	7.22	0.982
Skeletal	55.00	76.50	65.05	6.91	
Soft tissue	52.40	78.60	65.71	6.70	
Photograph	51.80	78.00	64.74	7.19	



Thus, the interpretation shows that after the test of significance, no significant difference between the control group of Clinical VDO and Soft tissue cephalometric VDO followed by Skeletal cephalometric VDO and Photographic VDO.

PAIR WISE COMPARISON OF VERTICAL DIMENSION BETWEEN DIFFERENT METHODS USING TUKEY POST HOC TEST

Methods		Mean	SD	P value
Clinical vs. Skeletal	Clinical	65.62	7.22	0.997
	Skeletal	65.05	6.91	
Clinical vs. Soft tissue	Clinical	65.62	7.22	1.000
	Soft tissue	65.71	6.70	
Clinical vs. Photograph	Clinical	65.62	7.22	0.989
	Photograph	64.74	7.19	
Skeletal vs. Soft tissue	Skeletal	65.05	6.91	0.995
	Soft tissue	65.71	6.70	
Skeletal vs. Photograph	Skeletal	65.05	6.91	0.999
	Photograph	64.74	7.19	
Soft tissue vs. Photograph	Soft tissue	65.71	6.70	0.985
	Photograph	64.74	7.19	



In the group Skeletal versus Soft tissue, the p=0.995 and no statistical difference was observed.

In the group Skeletal versus Photograph, the p=0.999 and no statistical difference was observed.

In the group Soft tissue versus Photograph, the p=0.985 and no statistical difference was observed.

In the group Clinical versus Skeletal, the p=0.997 and no statistical difference was observed.

In the group Clinical versus Soft tissue, the p=1.00 and no statistical difference was observed.

In the group Clinical versus Photograph, the p=0.989 and no statistical difference was observed.

RESULTS

This study evaluated the vertical dimension of occlusion (VDO), anterior facial height, and posterior facial height using clinical, cephalometric (skeletal and soft tissue), and photographic methods in 30 subjects. Data were analyzed using SPSS (v24) with significance set at $p \leq 0.05$.

Vertical Dimension of Occlusion (VDO): The mean VDO values were comparable across all methods: clinical (65.62 ± 7.22 mm), skeletal (65.05 ± 6.91 mm), soft tissue (65.71 ± 6.70 mm), and photographic (64.74 ± 7.19 mm). One-way ANOVA showed no statistically significant difference (p = 0.982). Pairwise comparisons using Tukey post hoc test also revealed no significant differences among any methods ($p > 0.05$).

Total Anterior Facial Height: A statistically significant difference was observed between skeletal (122.06 ± 7.97 mm) and soft tissue (137.68 ± 11.56 mm) measurements (p = 0.001), with soft tissue values being higher.

Upper Anterior Facial Height: Soft tissue measurements (67.00 ± 6.62 mm) were significantly greater than skeletal measurements (53.98 ± 5.95 mm), showing a highly significant difference ($p < 0.001$).

Lower Anterior Facial Height: No statistically significant difference was found between skeletal (67.91 ± 5.93 mm) and soft tissue (70.66 ± 9.96 mm) measurements (p = 0.400).

Lower Posterior Facial Height: Comparison between skeletal (50.13 ± 7.24 mm) and clinical (51.23 ± 2.27 mm) measurements showed no significant difference (p = 0.703).

DISCUSSION

The determination of Vertical Dimension of Occlusion (VDO) is critical for successful prosthodontic rehabilitation, influencing both function and aesthetics. However, due to significant individual variation, no single universally accepted method exists for its accurate determination. Consequently, a combination of clinical techniques—such as physiologic rest position, phonetics, facial measurements, and cephalometric analysis—is often recommended.

Pre-extraction records play a vital role by preserving essential information regarding tooth morphology, position, and lip support, thereby serving as a reliable reference for rehabilitation. Facial landmark measurements, historically advocated by researchers like Willis and McGee, have shown meaningful correlation with VDO and remain clinically relevant.

Cephalometric methods, including both skeletal and soft tissue analyses, have been widely supported as reliable, simple, and cost-effective adjuncts. The present study found no statistically significant difference between clinically measured VDO and cephalometric measurements, reinforcing their complementary role. This finding contrasts with some earlier reports suggesting discrepancies between skeletal and soft tissue analyses, but aligns with studies demonstrating strong clinical correlation.

Additionally, facial height parameters—such as total, upper, and lower anterior facial heights—showed no significant variation, supporting the concept that VDO exists within a physiological range rather than as a fixed value. The proportional stability of lower facial height further validates its importance in diagnosis and treatment planning.

Overall, the study emphasizes that a multifactorial approach integrating clinical judgment, facial measurements, and cephalometric evaluation provides a more reliable framework for determining optimal VDO in prosthodontic treatment.

SUMMARY

The methods to determine the vertical dimension of occlusion are broadly classified as Pre and Post extraction methods. The proposed Pre-extraction methods like Pre-extraction diagnostic casts, Pre-extraction phonetics, Cephalometric radiograph, Profile tracing of the lower third of the face. Reliability of these techniques are entirely dependent on the patient presentation in a dentate state.

Cephalometry has been a diagnostic medical tool for more than 70 years. Its first application was the assessment of facial part of the skull growth pattern assessment. Nowadays it is used in bone age assessment, diagnosis of surgical, orthodontic, or prosthetic treatment planning.

Photography has now penetrated all the segments of science, medicine, industry, fashion designing, communication, and arts, and it is difficult to imagine any form of existence without photography.

There is need to establish a more reliable and accurate technique to record vertical dimension of occlusion which is less invasive and accurate with the reproduction of details.

CONCLUSION

Within the limitations of this study, the various methods used to determine the vertical dimension of occlusion (VDO)—clinical, skeletal cephalometric, soft tissue cephalometric, and photographic—demonstrated strong correlation, particularly in relation to anterior and posterior facial heights. No statistically significant differences were observed among these methods, indicating that all can provide comparable and reliable measurements of VDO.

Among them, soft tissue cephalometric analysis showed the closest agreement with the clinical method, followed by skeletal cephalometric analysis. The photographic method, while showing a slightly greater margin of variation, proved to be a practical, non-invasive, and accessible alternative for VDO assessment.

Significant differences were noted between skeletal and soft tissue measurements of total and upper anterior facial heights, whereas lower anterior facial height and posterior facial height measurements showed no significant variation. These findings highlight the variability between hard and soft tissue landmarks in facial height assessment.

Clinically, the conventional method of measuring the distance between the tip of the nose and the chin remains a simple and effective approach. However, cephalometric methods may be particularly useful in cases where clinical determination is challenging, despite being more time-consuming. The photographic method offers a quick, convenient, and minimally invasive option for routine use.

This study was limited to dentulous subjects with established VDO, and its applicability to edentulous patients remains uncertain. Further research is recommended to explore these methods across different patient groups and to enhance their role in prosthodontic diagnosis and treatment planning.

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