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Original Article

Correlation Between Mean Values of Occlusal Vertical Dimension and Mandibular Basal Bone Height in Dentate Patients

Muhammad Sajjad, Maira Afzal*, Aqsa Akhtar Khan, Ammara Sharafat*, Maria Komal Ghumman***, Amna Amjad****

Department of Prosthodontics, 20 Military Dental Centre, Multan Pakistan, *Department of Prosthodontics, CIMS Dental College, Multan Pakistan, **Department of Prosthodontics, Rawal Institute of Health Sciences, Islamabad Pakistan, ***Department of Prosthodontics, Nishtar Institute of Dentistry, Multan Pakistan

ABSTRACT

Objective: To evaluate the correlation between occlusal vertical dimension (OVD) and mandibular basal bone height (MBH), and to determine their average values in relation to age and gender among dentate patients.
Study Design: Cross-sectional study.
Place and Duration of Study: Department of Prosthodontics, Armed Forces Institute of Dentistry Rawalpindi, Pakistan from Mar to Sep 2019.
Methodology: One hundred and seventy patients, aged between 20 to 40 years, were selected after consent. OVD was measured from the nose tip to the chin prominence using a calliper with the teeth in contact. MBH was measured from the lower border of mandible to the most prominent point of chin.
Results: The mean OVD for males was 71.03±6.00 mm and for females it was 64.56±5.00 mm (p<0.001). The mean MBH was 14.94±2.6 mm for males while for females it was 12.63±1.86 mm (p<0.001). Notably, significant differences in OVD were observed across the 20 to 25, 31 to 35, and 36 to 40 age groups, while MBH differences were significant in all age categories. The value of correlation coefficient was r=0.077 (p=0.320) between OVD and MBH.
Conclusion: Males exhibited significantly higher occlusal vertical dimension and mandibular basal body height than females across all age groups while OVD and MBH showed no significant statistical correlation with each other. These findings highlight the importance of considering gender and age in clinical assessments related to these measurements.

Keywords: Mandible, Mandibular Basal Bone Height, Mandibular Reconstruction, Occlusal Vertical Dimension.

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INTRODUCTION

The mandible, which contains the basal bone, is a horseshoe-shaped bone that houses teeth. Occlusal conditions and ageing can alter its shape.[1] Regardless of age, males and females have different mandibular shapes, and their growth corresponds with changes in the maxilla, cranial base expansion, and dental development.[2] Because the maxilla remains stationary, mandibular movement is crucial for chewing. The mandible's mobility enables it to actively engage in both mastication and occlusion.[3,4]

It has been demonstrated that a decrease in bone volume following tooth extraction, leads to both horizontal and vertical shrinkage.[5] The term occlusal vertical dimension (OVD) describes the separation of two distinct facial landmarks, one located on the most prominent part of the nose and the other on chin.[6] The correct OVD during prosthetic restoration depends on the precise measurement of basal bone height. Changes in this affects the OVD. A decrease in height can raise OVD, causing issues like lip incompetence, speech problems, and temporomandibular disorder (TMD) while an increase in height can lower OVD, leading to overclosure, drooling, cheek biting, angular cheilitis, and temporomandibular joint (TMJ) discomfort.[7] Costen syndrome, characterised by otological, oral, and neurological symptoms such hearing loss, ear fullness, dry mouth, altered taste, headaches, and vertigo may be brought on by a reduced occlusal vertical dimension.[8]

For effective mandibular reconstruction following atrophy and tumor, it is imperative to know the estimated height of the basal bone and to make sure that this height coincides with the achievement of an optimal occlusal vertical dimension during the rehabilitation.[9,10] The purpose of this study was to assess baseline values, to identify the patterns of variation in occlusal vertical dimension and mandibular basal bone height and to assess the correlation between them in patients reporting to the hospital.

Correspondence: Dr Muhammad Sajjad, Department of Prosthodontics, 20 Military Dental Centre, Multan Pakistan
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METHODOLOGY

This cross-sectional study was carried out at the Prosthodontics Department of the Armed Forces Institute of Dentistry Rawalpindi, Pakistan, from March to September 2019. Prior approval was obtained from the AFID Ethical Review Committee (IERB LETTER#918/TRG 13).

Inclusion Criteria: Patients of either gender, aged between 20 and 40 years possessing complete anterior and posterior dentition were included.

Exclusion Criteria: Patients having tooth surface loss, those who have had maxillary and mandibular fractures or have undergone orthognathic surgery were excluded.

Sample size was calculated using the G-power software, considering a mean OVD value of 42.10±5.34 and 39.72±5.25 mm among males and females, respectively.[11] This came to 170 participants.

All patients presenting to the OPD had their history taken and were examined by a post graduate resident of prosthodontics and those patients who fulfilled the inclusion criteria were referred to the prosthodontics department for further record taking.

The individuals with definite centric stops and 28 permanent teeth with Angle's class I molar relation were included. All teeth were periodontally sound. The subjects with the history of orthodontic treatment, open bite, deep bite, teeth anomalies, attrition, TMJ disorders, trauma, prosthesis and restorations were excluded.

Each participant was instructed to sit up straight and occlude their teeth. The occlusal vertical dimension was assessed using Niswonger's method, where two marks were placed, one on the tip of the nose and the other on the most prominent part of the chin. A calliper was then used to determine the distance between these two locations. Another reading was taken from the point of most prominent part of chin till the lower border of mandible. This indicated the mandibular basal bone height.

Data was entered and analyzed using Statistical Package for Social Sciences (SPSS) version 23. Normality of data was assessed visually by histogram plot, and statistically by Shapiro-wilk test. The data was found to be normally distributed for both dependent variables i.e. OVD and MBH values. The descriptive statistics of continuous and categorical variables were presented as mean and standard deviation, and frequency and percentage respectively. The correlation between OVD and MBH was performed by using Pearson's Correlation test, results were reported in terms of coefficient of correlation and significance values. The mean OVD and MBH values were compared between gender using independent samples t-test. Similarly, mean OVD and MBH values were compared between age groups using one-way ANOVA, with post-hoc Bonferroni correction. A *p*-value of ≤ 0.05 was considered statistically significant

RESULTS

There were 170 participants enrolled in the study, out of which 70(41.2%) were males and 100(58.8%) were females. The mean age was 30.41±6.12 years, where the age range was between 20 to 40 years. In terms of age categories, majority of the participants, 40(241%) belonged to the age group of 26-30 years. The age distribution of the study participant is given as Figure-1.

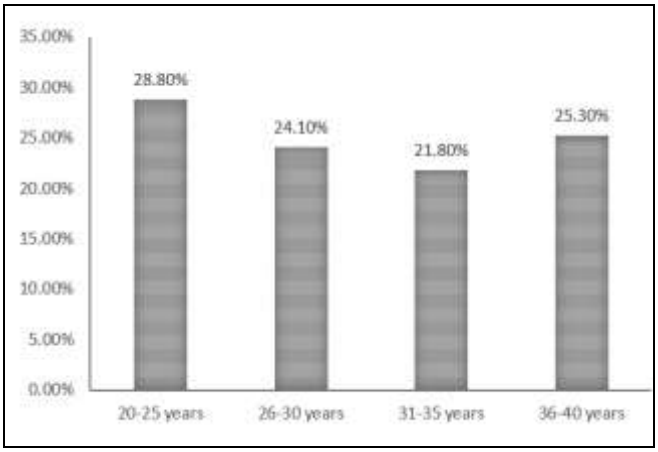

Figure-1: Age Distribution of Study Participants (n=170)

There was no significant correlation found between OVD and MBH, where the value of correlation coefficient was r=0.077 (p=0.320) as shown in Figure-2. Overall, the mean OVD and MBH values were 67.22±6.3 mm (ranging from 50 –87 mm), and 13.58±2.4 mm (ranging from 8–21 mm) respectively. These values were compared between genders, where significant difference was found for both OVD and MBH mean values as given in Table-I. The mean OVD was significantly higher among males (71.03±6.0 mm, p<0.001) as compared to the females (64.56±5.0 mm, p<0.001) with a mean difference of 6.46 mm, standard error of 0.87, 95% CI 4.73-8.20 mm. Similarly, the mean MBH was also significantly higher among males (14.94±2.6 mm, p<0.001) as compared to the females (12.63±1.86 mm, p<0.001) with a mean difference of

2.31 mm, standard error of 0.36 and 95% CI 1.59-3.03 mm. The effect size was reported in terms of Cohen's d where the value was 1.18 (95% CI 0.85-1.51) and 1.04 (95% CI 0.72-1.37) for OVD and MBH, respectively.

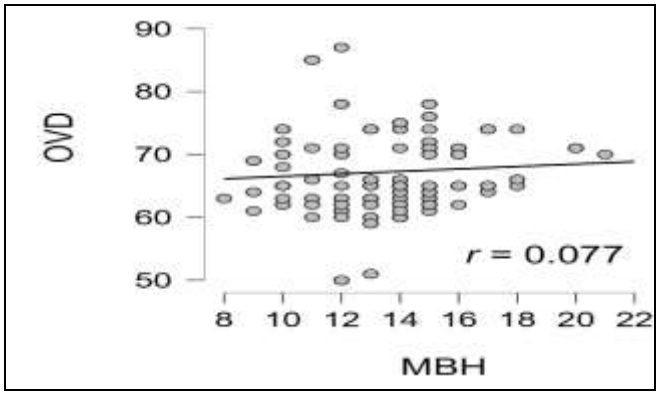

Figure-2: Scatter Plot of Mandibular Basal Bone Height (MBH) and Occlusal Vertical Dimension (OVD) (n=170)

The mean OVD and MBH values were also compared between different age groups as given in Table-I and intergroup comparison is given in Table-II. A significantly higher mean OVD value was observed among greater age groups (p<0.001), while lower mean MBH values were noticed among greater age groups (p=0.046).

The mean OVD and MBH values among two genders were also stratified for age categories to explore the effect of age and gender on OVD and MBH as given in Table-III.

Among males, the highest mean OVD value was among participants belonging to age group of 31-35 years, similarly, among females, the highest mean OVD was among 26-30 years age group. The highest MBH value among males and females was reported for participants belonging to age group of 36-40 years. There were significant differences reported for mean OVD among males and females belonging to age group of 20-25 years (p<0.001), 31-35 years (p<0.001) and 36-40 years (p<0.001). Similarly, significant differences were reported for mean MBH in males and females of all age groups.

DISCUSSION

The occlusal vertical dimension (OVD) differs from facial proportions of lower face since the extent of any artificial prosthesis does not go beyond the lower margin of mandible. This study aimed to examine the effect of age and gender on mandibular basal bone height and occlusal vertical dimension (OVD) in a cohort of patients aged 20 to 40 years. The mean age was 30.41±6.12 years, reflecting a relatively young adult population. The mandibular basal bone height varied from 8-21mm, with a mean of 13.58±2.4 mm. The OVD ranged from 50-87 mm, with a mean of 67.22±6.3 mm, underscoring its impact on facial

Table-I: Comparison of mean Mandibular Basal Bone Height (MBH) and Occlusal Vertical Dimension (OVD) in relation to Age Categories and across Genders (n=170)

Parameters	Gender groups		*p*-value	Age groups				*p*-value
	Males (n=70) Mean±SD	Females (n=100) Mean±SD		20-25 years (n=49) Mean±SD	26-30 years (n=41) Mean±SD	31-35 years (n=37) Mean±SD	36-40 years (n=43) Mean±SD	
OVD (mm)	71.0±6.0	64.5±5.0	<0.001	68.0±5.3	67.4±5.0	69.5±7.4	64.0±6.3	<0.001
MBH (mm)	14.9±2.6	12.6±1.8	<0.001	12.7±3.1	13.8±2.1	13.7±2.4	14.0±1.6	0.046

Table-II: Intergroup Comparison of Mean Mandibular Basal Bone Height (MBH) and Occlusal Vertical Dimension (OVD) with Age Categories (n=170)

Group Comparison	20-25 years vs 26-30 years *p*-value	26-30 years vs 31-35 years *p*-value	20-25 years vs 31-35 years *p*-value	26-30 years vs 36-40 years *p*-value	20-25 years vs 36-40 years *p*-value	31-35 years vs 36-40 years *p*-value
OVD (mm)	1.00	0.79	1.00	0.69	0.13	<0.001
MBH (mm)	0.18	1.00	0.32	1.00	0.65	1.00

Table-III: Comparison of Mean Mandibular Basal Bone Height (MBH) and Occlusal Vertical Dimension (OVD) in Relation to Age Categories among Genders (n=170)

Age Groups	n (%)	OVD (mm) Mean±SD		*p*-value	MBH (mm) Mean ± SD		*p*-value
		Male	Female		Male	Female	
20-25 years	49 (28.8%)	70.6±4.9	64.9±3.9	<0.001	13.9±3.2	11.4±2.4	0.004
26-30 years	41 (24.1%)	68.7±5.4	66.5±4.7	0.192	15.6±1.5	12.6±1.7	<0.001
31-35 years	37 (21.8%)	75.8±7.8	65.7±3.7	<0.001	15.3±2.9	12.9±1.6	0.010
36-40 years	43 (25.3%)	69.7±3.9	61.9±5.8	<0.001	16.0±0.9	13.3±1.2	<0.001

structure and function. A key finding was the significant difference between the means of OVD and mandibular basal bone height, suggesting that these parameters do not directly correspond to one another. This indicates that other factors, such as muscle tone and dental occlusion, may influence OVD independently of basal bone height.

According to a study by Akinbami *et al*. conducted in Nigeria, contrast amongst both genders of means revealed that both the occlusal vertical dimension and mandibular bone height are greater in men than in women.[11] These results were in accordance with our study. Ural *et al*.'s study, which primarily examined the correlation between the size of alveolar processes of maxillary and mandibular bone and its effects on the values of vertical dimension of occlusion, also supports our findings.[12] According to this study, assessment of the OVD and MBH measurements revealed that there was significant difference present in the maxillary and mandibular heights after tooth loss. It also stated that the decrease in edentulous mandibular height is more prominent in females than males. These results indicate that significant variability is likely due to genetic and environmental factors.

Another study supported our findings of mandibular basal bone height was where radiographic assessment was utilized, and concluded that men tend to exhibit greater measurements for height of mandibular basal bone in comparison to women because of the differences in masticatory muscle power and the effects of sex hormones between the two genders which can have an effect on the basal bone height. Additionally, basal bone of mandible has the tendency to grow in size as the individual ages.[13]

However, there were some differences in the recorded values of vertical dimension of occlusion compared to certain previous studies conducted. Saleem *et al*. studied Pakistani population where facial measurements were utilized, and determination of occlusal vertical dimension was done using three parameters: hair line to right eyebrow line, center of pupil of right eye to center of pupil of left eye, and outer canthus of right eye to inner canthus of right eye (x2).[14] No marked difference was seen between the values of occlusal vertical dimension amongst males and females.

According to a study by Yemitan *et al*., facial height measurements obtained from cephalometric radiographs revealed barely any variations in the readings of face height characteristics between males and females, when categorized according to the differences in skeletal pattern.[15] This was not in correspondence with our study.

Various anthropometric measurements have been used in literature to assess occlusal vertical dimension. Methods like the Willis, Wright's, and Sears methods rely on these landmarks to orient artificial dentures. Research by Shetty *et al*. deduced that the space between the inner canthi is a helpful indicator of determining the active vertical dimension in edentulous individuals.[16] Willis suggested that the separation between the inferior margin of mandible and the bony shelf underneath the nasal area during the articulation of teeth should be equal to the separation between the eye's pupil and the rima oris, or the lip's dividing line. Furthermore, it has been suggested that the vertical dimension of occlusion should be calculated in conjunction with the force of greatest chewing impact.[17]

The stomatognathic system operates optimally within precise physiological and anatomical constraints. The occlusal vertical dimension (OVD) plays a pivotal role in maintaining equilibrium among the structures in the stomatognathic system. Clinically, these results highlight the importance of individualized assessment in treatments affecting facial vertical dimensions, such as in cases of tooth surface loss or in prosthetic rehabilitation after orthognathic surgery. While there may be differing opinions among practitioners regarding the level of precision required in this estimation, there is a consensus regarding the necessity of determining it.[18] A vertical variation of 1 to 2 mm typically has minimal impact on facial aesthetics but is significant in terms of mechanical or occlusal considerations.[19]

Enhancing occlusal vertical dimension requires accurate alignment of the mandibular condyles in centric relation and must respect each patient's neuromuscular limits. The challenge lies in precisely recording these variables and transferring them to a system that can reliably simulate the patient's functional occlusion.[20]

This study provides specific normative data for MBH and OVD in this population, which can serve as a reference for future studies or clinical assessments. This can help in establishing more precise benchmarks for these measurements with respect to gender and specific age group. The finding that MBH and OVD differ significantly and do not correlate with each

other suggests that these two dimensions might be relatively stable across these demographic factors and may be influenced by different biological or environmental factors. This can help in simplifying diagnostic and treatment planning processes.

LIMITATIONS OF THE STUDY

The data in this study was only of a tertiary care hospital of Rawalpindi. Data from different regions and a more elaborate age group should be collected and assessed for better estimation of the mean values amongst our population. Only one modality i.e. facial measurements were utilized to determine the averages values for OVD and MBH. Other clinical and radiographic methods should be employed as well which can further provide more definitive measurements.

CONCLUSION

Males exhibited significantly higher occlusal vertical dimension and mandibular basal body height than females across all age groups, with large effect sizes indicating substantial differences, while there was no statistically significant correlation among OVD and MBH. These findings highlight the importance of considering gender and age in clinical assessments related to these measurements.

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Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

MS & MA: Conception, study design, drafting the manuscript, approval of the final version to be published.

AAK & AS: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

MKG & AA: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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