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Mandibular Symphyseal Height Determination in Various Vertical Patterns

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ABSTRACT

The mandibular symphysis is a crucial anatomical structure influencing facial aesthetics and harmony. Its morphology is pivotal in determining optimal lower incisor positioning, especially in borderline orthodontic cases requiring meticulous treatment planning. **Objective:** To determine and compare symphyseal dimensions in different vertical patterns of skeletal class I cases. **Methods**: The study was designed as a cross-sectional study. Data was analyzed using SPSS 25, with mean and standard deviations used for quantitative variables and frequency and proportions for qualitative data. Statistical significance was assessed using chi-square tests for gender and ANOVA for symphysis height and vertical facial patterns, with a P-value ≤0.05 considered significant. **Results:** Male subjects with Hypodivergent (↓D), Normodivergent (ND)and Hyperdivergent (↑D) profiles showed no statistically significant difference in Id-Me, whereas female subjects showed statistically significant difference in Id-Me between (↓D) and (↑D) subjects. Additionally, a notable sex difference was observed in Id-Me, with significant variations between males and females. In contrast, the differences in LI between males and females were found to be statistically non-significant (P > 0.05). **Conclusion:** This article reflected that males show longer chin than females.

INTRODUCTION

The mandibular symphysis is a critical anatomical structure within the mandible, encompassing the lower incisors and anterior chin [1, 2]. Morphologically, it comprises two distinct regions: the dentoalveolar symphysis, which is comprised of the alveolar processes and lower anterior teeth, and the basal symphyseal area [1, 2]. The symphysis plays a pivotal role in achieving facial harmony and aesthetics, and its evaluation is essential in orthodontic treatment planning, particularly in cases requiring precise lower incisor positioning [3]. The dimensions of the dentoalveolar symphysis, specifically its thickness and length, are crucial considerations in orthodontic treatment planning, particularly when planning incisor movements such as protraction or retraction [4, 5]. This is due to the limited accommodative capacity of the symphysis for the lower incisors. Failure to

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account for these dimensions may result in iatrogenic complications, including fenestrations, dehiscence, gingival recession, and mobility [5, 6]. In orthodontic camouflage cases, with or without extractions, careful consideration of tooth movement boundaries is crucial during treatment planning. Specifically, the inclinations of the lower incisors can significantly influence post-treatment stability, underscoring the importance of precise planning in orthodontic therapy [7, 8, 10]. These compensations can manifest sagittally through proclination or retroclination of the incisors, or vertically through modifications in symphysis length or incisor eruption [9, 11, 12]. Whenever the maxilla or mandible deviates from the normal skeletally defined growth pattern, dental compensation occurs to camouflage the discrepancy and establish a normal incisor relationship [8, 13-15]. Research by Handleman has demonstrated that patients with high vertical facial patterns exhibit reduced alveolar width compared to those with normal and low facial heights, highlighting the complex interplay between skeletal and dental relationships in malocclusion [16-21]. Traditional cephalometric analysis is a cornerstone in orthodontics, facilitating the evaluation of diverse facial profiles through various linear and angular measurements on intraosseous landmarks. These measurements enable the quantification of anteroposterior jaw and incisal positions, providing valuable insights for treatment planning [13, 16, 17]. Achieving normal occlusion in patients with varying facial patterns relies heavily on dental compensations. Conversely, insufficient dentoalveolar compensation can lead to malocclusions [18]. Thus, accurate alignment of the incisors in both the upper and lower jaws is vital for successful treatment strategy, diagnostic evaluation, long-term durability, and superior results following treatment [19]. A significant correlation exists between the morphology of the symphysis and lower facial height. Specifically, individuals with increased lower facial height tend to exhibit a narrower and more elongated symphysis, suggesting a strong association between these two anatomical parameters [20]. Therefore, the shape and assessment of symphysis in growing individuals may be predictive of adult lower facial height, hence determining overall developing facial pattern in adults [20, 21]. In light of the limited availability of local data and the acknowledged importance of mandibular symphysis in orthodontic treatment, this study seeks to explore the comparison of vertical dimensions of the mandibular symphysis in different vertical patterns of Class I malocclusions within the Pakistani population. By doing so, it aims to determine the anatomical limitations that may influence lower incisor movement and contribute to more stable and effective orthodontic treatment outcomes.

The objective of the study was to determine and compare symphyseal dimensions in different vertical patterns of skeletal class I cases.

METHODS

The study was conducted over a duration of six months, from January 2016 to June 2016, as a cross-sectional study (IRB Reference #: FMH-03/02/2025-IRB-1599) in the dental outpatient department of Fatima Memorial Hospital, College of Medicine and Dentistry. The sample size was determined using the World Health Organization's (WHO) formula/calculator. Based on an expected mean symphysis height of 32 mm with a standard deviation of 0.39 mm in patients with skeletal Class I malocclusion, a total sample size of 90 subjects was calculated. This calculation was performed at a 95% confidence level with a desired precision (d) of 0.13 [22]. Participants included in the study were aged between 12 and 30 years and were skeletal class I patients of Pakistani descent presenting to the outpatient department for orthodontic treatment, with an ANB angle between 0 and 4 degrees. Only those with a clinically symmetric face were selected. Exclusion criteria comprised a history of prior orthodontic treatment, any previous maxillofacial surgery, and evidence of root resorption on orthopantomogram (OPG), gingival recession, periodontal problems, or the presence of missing or supernumerary teeth. Vertical facial patterns were classified according to the Go-Gn-SN angle, with high angle defined as ≥37°, normal angle as 28–36°, and low angle as ≤27°. The Id-Menton measurement was defined as the distance in millimeters from the midpoint of the anterior alveolus of the lower incisor to the menton point, while LI referred to the linear distance in millimeters of bone inferior to the apex of the lower incisor, measured according to Handleman's criteria. Demographic data was recorded for all participants. A non-probability consecutive sampling technique was employed. The skeletal Class I subjects were further stratified into three subgroups based on their vertical growth patterns, as determined by cephalometric analysis. Symphyseal dimensions were subsequently measured on lateral cephalograms for each subgroup. To ensure accuracy and reliability, the symphysis height measurements obtained in this study were reevaluated and confirmed by the supervisor. This quality control measure helped to minimize errors and ensure the precision of the data. The collected data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 25. Quantitative variables, such as age, were summarized using means and standard deviations. Qualitative data, including gender and vertical patterns, were presented as frequencies and proportions. A comprehensive statistical analysis was conducted, incorporating both descriptive and inferential statistics as warranted. To identify significant differences in symphyseal dimensions between groups, various statistical tests were employed. Specifically, categorical

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variables such as gender were analyzed using chi-square tests, while analysis of variance (ANOVA) was applied to continuous variables, including symphyseal dimensions, symphysis height, vertical facial patterns, and ANB angle to assess differences between groups (Hypodivergent (↓D), Normodivergent (ND)and Hyperdivergent (↑D). Statistical significance was set at a p-value of 0.05 or less

RESULTS

This study comprised a total of 90 Skeletal Class I cases. The study population had a Mean Age (MA) of 18.34 years, with a Standard Deviation (SD) of 3.45 years. Frequency distribution of facial divergence according to SN-MP and MMA showed that 43 subjects were (ND), 25 were (↓D) and 22 were (↑D). The percentages for (ND), (↓ D) and (↑D) were 47.78%, 27.78% and 24.44% respectively. The (MA) LI of the subjects were 19.66±3.06mm. The (MA) ID-Me of the subjects were 29.57±3.09mm [Table I]. The (MA) and (SD) of LI in (↓ D) subjects were 19.28±3.26mm. The (MA) and (SD) of LI in (N D) subjects were 19.56±2.56mm. The (MA) and (SD) of LI in (↑D) subjects were 20.27±3.7mm [Table I]. The (MA) and (SD) of Id-Me in (↓ D) subjects were 28.98±3.7mm. The (MA) and (SD) of Id-Me in (N D) subjects were 29.53±2.8mm. The (MA) and (SD) of Id-Me in (↑D) subjects were 30.36±2.8mm [Table 1].

Table 1: Descriptive Statistics of Id-Me and LI, Between Genders in Various Vertical Profiles

Causes	Gender	Mean ± SD	SN-MP	Mean ± SD
Inferior to Apex (LI)	Male	20.28 ± 2.82	(↓D)	19.28 ± 3.26
			(ND)	19.56 ± 2.56
	Female	19.14 ± 3.17	(↑D)	20.27 ± 3.71
			Total	19.66 ± 3.06
Anterior Alveolus to menton (ID-Me)	Male	30.70 ± 2.96	(↓D)	28.98 ± 3.71
			(ND)	29.52 ± 2.80
	Female	28.63 ± 2.90	(↑D)	30.36 ± 2.82
			Total	29.57 ± 3.09

Analysis of variance (ANOVA) showed LI, ID-Me between (↓D), (N D) and (↑D) subjects were statistically insignificant [Table 2].

Table 2: Analysis of Variance among Groups (ANOVA)

Variables	Group 1 Hypodivergent (Mean ± SD)	Group 2 Normodivergent (Mean ± SD)	Group 3 hyperdivergent (Mean ± SD)	ANOVA p-Value
LI	19.280 ± 3.2630	19.569 ± 2.5625	20.272 ± 3.7184	0.526
ID-Me	28.980 ± 3.7122	29.523 ± 2.8050	30.363 ± 2.8249	0.310

Lower Incisor (LI) measurements between groups were statistically insignificant in both males and females. (P > 0.05). The analysis revealed that the ID-Me measurement did not exhibit significant variations among males across the (↓D), (ND), and (↑D) groups, yielding statistically insignificant results (P > 0.05). Similarly, females demonstrated comparable results for ID-Me, with statistically insignificant differences (P > 0.05) [Table 3].

Table 3: Comparative Statistics for LI and Id-Me between Genders

Variables	Gender	Categories	Sum of Squares	Mean Square	Significance
Inferior to Apex (LI)	Male	Between Groups	3.915	1.958	0.791
		Within Groups	316.109	8.319	
		Total	320.024	-	
	Female	Between Groups	40.410	20.205	0.135
		Within Groups	444.590	9.665	
		Total	485.000	-	
Anterior Alveolus to menton (ID-Me)	Male	Between Groups	0.883	0.442	0.953
		Within Groups	350.105	9.213	
		Total	350.988	-	
	Female	Between Groups	39.673	19.836	0.093
		Within Groups	364.715	7.929	
		Total	404.388	-	

Further analysis using independent T-tests showed that ID-Me measurements varied significantly between males and females (P < 0.05). However, the comparison of symphysis dimensions, specifically lower incisor (LI) measurements, between males and females were statistically insignificant (P > 0.05) [Table 4].

Table 4: Independent t-test for Variables

Variables	Male (Mean ± SD)	Female (Mean ± SD)	t-value	p-Value
LI	20.280 ± 2.8285	19.142 ± 3.1787	1.777	0.079
ID-Me	30.707 ± 2.9622	28.632 ± 2.9025	3.346	0.001*

DISCUSSION

Research found that roughly 70% of the population possessed a mesomorphic facial morphology, whereas the remaining 30% were divided fairly evenly between brachyfacial and dolichofacial types. Notably, a significant gender-based difference was observed, with long facial types being more prevalent among females and short facial types more common among males. Furthermore, their study demonstrated that symphysis height was significantly greater in individuals with long facial types, a finding that held true for both males and females [I]. Our study revealed that (ND) were about 48% whereas, (↓D) and (↑D) were 51% (27.78% and 24.44% respectively). Mandibular symphysis in males displayed gender dimorphism with longer chin.Shortest symphyseal length was present in females with (↓D) pattern.Evangelista K *et al.*, reported significant findings from their research, indicating that symphysis height was 10% greater in males and was strongly associated with vertical skeletal pattern and gender [4]. Collectively, these factors accounted for 43.6% of the variation observed.Moreover, the investigation disclosed that the basal symphysis exhibited sexual dimorphism, with males displaying a significantly larger structure. Additionally, the morphology of the basal symphysis underwent a transformation with increasing age, characterized by a downward shift and reduction in

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vertical dimension. Notably, sagittal and vertical skeletal patterns demonstrated the correlation with alveolar symphysis, whereas gender and age influenced the vertical position of the symphysis. Our study showed statistically significant difference between males and females for Id-Me that varied significantly between genders. The mean for Id-Me in males was 30.7±2.9, whereas for females was 28.6±2.9 respectively. Males therefore showed a longer symphysis than females in our study. Khan E *et al.*, concluded that the mean symphysis vertical dimension of participants was 49.9 ±4.7. Symphysis vertical dimension in males was 48.20 ± 6.17 and 50.78 ± 3.52 in females, which was statistically significant at p value 0.029 [8]. This was contrary with our research showing 30.7073 and 28.6327 in males and females respectively showing increased vertical dimensions for males. Notably, our findings diverge from previous research conducted by Gininda and colleagues, which demonstrated a greater lower anterior dimension in females than males among South African adults with skeletal Class I pattern [17]. Khan *et al.*, previously demonstrated that symphysis morphology is influenced by vertical facial patterns, with (↑D) subjects exhibiting narrower and more elongated symphyses, and (↓D) subjects displaying wider and shorter symphyses [23]. The authors reported that the mean vertical heights of 28.73 ± 3.88 mm, 29.13 ± 2.64 mm, and 27.87 ± 2.75 mm for (ND), (↑D), and (↓D) groups, respectively. Our study's findings support these observations, with mean vertical heights of 29.5233 mm, 30.3636 mm, and 28.9800 mm recorded for (ND), (↑D), and (↓D) groups, respectively. Orthodontists must carefully consider symphysis dimensions during treatment planning for orthodontic camouflage or surgical interventions to minimize the risk of iatrogenic complications, including fenestrations and dehiscence. This consideration is crucial due to the limited adaptive capacity of the mandibular symphysis to accommodate the lower dentition, which can compromise treatment outcomes and patient prognosis. The primary limitation of this investigation was that the measurements were based on 2-dimensional cephalometric radiographs. The study was conducted in our local hospital setup; therefore, results cannot be generalized for other populations. The inclusion criteria of skeletal class I patients eliminated the bias that could have made a difference in effect of dentoalveolar anatomy and symphysis dimensions.

CONCLUSIONS

This study revealed a statistically significant sex-related difference in the mandibular symphysis among the Pakistani population, wherein males demonstrate a significantly longer chin length compared to females. Females (↓ D) showed a short symphysis than (N D) and (↑D) subjects.

Authors Contribution

Conceptualization: SA, NAC
Methodology: SA, AA, MA
Formal analysis: AA, MA, QK, KH, SB
Writing, review and editing: SA, AA, KH, SB

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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