

The relationship between mandibular symphysis shape and lower incisor dentoalveolar compensation in Class I and Class III skeletal patterns: A CBCT study

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Abstract

Aim: The aim of this study was to examine the relationship between the lower incisor dentoalveolar compensation mechanism and the morphology of the mandibular symphysis in patients with Class I and Class III malocclusions, who have different vertical growth patterns, using cone-beam computed tomography (CBCT).

Methodology: This retrospective study analyzed the CBCT scans of 60 patients, divided into four groups based on dental and skeletal characteristics: Class I normodivergent, Class I hyperdivergent, Class III normodivergent, and Class III hyperdivergent. Measurements focused on the midsagittal section of the right lower central incisor to assess the relationship between mandibular symphysis morphology and alveolar bone thickness.

Results: There were no substantial differences observed in alveolar bone thickness or linear mandibular symphysis measures between the groups. However, significant differences were found in symphysis concavity, basal and dentoalveolar inclination, and Incisor Mandibular Plane Angle (IMPA) values ($p=0.036$, $p=0.001$, $p=0.003$, and $p=0.001$, respectively). Further analysis revealed strong correlations between symphyseal thickness, total symphysis height, dentoalveolar inclination, and convexity angle with mandibular symphysis-related alveolar bone thickness ($p<0.05$).

Conclusion: A positive correlation was observed between the dentoalveolar symphysis and alveolar bone thickness in all groups. In Class I patients, symphysis height was negatively correlated with alveolar bone thickness, whereas no correlation was found for symphysis thickness or inclination. In Class III patients, the symphysis shape provided some insight, but could not reliably estimate the alveolar bone thickness.

Keywords: alveolar bone thickness, Class I malocclusion, Class III malocclusion, normodivergent, hyperdivergent, cone-beam computed tomography, mandibular symphysis, symphysis inclination

Introduction

The dentoalveolar compensation mechanism in orthodontics has evolved to ensure functional occlusion and maintain stability during growth and development. This mechanism actively works to mask mismatches in the craniofacial structure, balancing the skeletal discrepancies of the maxilla and mandible in all three dimensions of space through adjustments of the dentoalveolar structures (1).

The primary goal of the maxillomandibular complex's dentoalveolar compensation in the vertical dimension is to achieve sufficient overbite. This compensation involves a variety of parameters, such as the vertical growth of the dentoalveolar height, the angle between the front and back parts of the maxilla, the positions and angles of the lower and upper incisors, the type of mandibular rotation, the angles of the occlusal plane, and the shape of the mandibular symphysis (2).

The mandibular symphysis region is an anatomical area that restricts the movement of the lower incisor teeth (3). Awareness of the morphology of the mandibular symphysis at the beginning of orthodontic treatment is important to avoid damaging the roots and alveolar bone during orthodontic tooth movement (4).

Wehrbein et al. (5) reported that when the mandibular symphysis is narrow and long, there is a reduction in the width of the lower anterior bone; therefore, protrusive movements should be limited. They stated that exceeding the boundary in protrusive movements could lead to bone resorption in the labial and lingual cortices.

The anterior parts of the mandible house the lower incisors in compact bone (6). During the movement of teeth root apices, they may encounter resistance by getting stuck in the mandibular symphysis or alveolar cortical plate (7). Additionally, alveolar remodeling is less prominent at the root apex compared to the alveolar crest and the middle third of the root (8). Therefore, in Class III patients, it is crucial to use cone-beam computed tomography (CBCT) to evaluate the relationship between the lower incisor bone support and mandibular symphysis when correcting a crossbite (9).

Many previous studies have evaluated the mandibular symphysis in individuals with Class I, Class II, and Class III malocclusions using two-dimensional (2D) lateral films (9-12). Research focusing on the impact of mandibular symphysis morphology on lower incisor alveolar bone support has often relied on linear measurements obtained from three-dimensional (3D) radiological imaging techniques (13, 14). However, this study contributes to the existing literature by incorporating both angular and linear measurements of the mandibular symphysis using CBCT imaging for a comprehensive and detailed analysis.

CBCT provides accurate and reliable measurement capabilities without causing image overlap, distortion, or magnification errors, which are typically observed in 2D images (15). By evaluating three-dimensional changes in

CBCT sections that closely reflect actual dimensions, we can better understand how compensation mechanisms affect the morphology of the mandibular symphysis (14). Although previous studies have explored this topic, some were conducted using 2D images, while others involved different populations (9-11). This underscores the need to investigate the compensation mechanisms in different populations. This study aimed to investigate the relationship between the lower incisors dentoalveolar compensation mechanism and the shape of the mandibular symphysis in the Turkish population with Class I and Class III malocclusions exhibiting different vertical growth patterns.

Materials and Methods

This study was approved by the Non-Interventional Clinical Research Ethics Committee of the Health Sciences Institute at İnönü University (approval date: January 24, 2023; decision number: 2023/4435).

Sample size calculation

Power analysis was performed using G*Power 3.1 software (Heinrich Heine University, Düsseldorf, Germany) to determine the sample size. For the correlation between mandibular symphysis dentoalveolar measurements and alveolar bone linear measurements, an effect size (d) of 0.3647 was applied. With a power (Power) of 0.80 and an alpha (α) level of 0.05, the minimum sample size required was determined to be n=56 individuals.

Sample selection

CBCT images of patients who visited the Department of Oral and Maxillofacial Radiology at the Faculty of Dentistry, İnönü University, between 2019 and 2022 and had not undergone orthodontic treatment were retrospectively reviewed. Of the 450 records examined, they were first classified into the following groups: Class I normodivergent, Class I hyperdivergent, Class III normodivergent, and Class III hyperdivergent. Fifteen patients were randomly selected from each group.

Group Formation

The classification of the patient groups' malocclusion was based on lateral cephalometric radiographs obtained from CBCT images (Table 1).

This study included patients aged 18-29 years with specific sagittal and vertical classifications. Sagittal classification was performed according to the ANB angles and supported by the Wits appraisal. Class I included patients with ANB angles between 0° and 4°, while Class III included patients with ANB angles less than 0°. Vertical growth patterns were normodivergent, with a

GoGn-SN angle of 32°-38° or FMA of 25°-29°, and hyperdivergent, with a GoGn-SN angle greater than 38° or FMA greater than 29°.

Exclusion criteria were that Patients who had undergone or were undergoing orthodontic treatment, those who had undergone maxillofacial surgery, patients with syndromic or craniofacial malformations, a history of craniofacial trauma, root resorption, prosthetic restorations on the lower incisors, facial asymmetry greater than 2 mm, periapical lesions or cystic formations at the apices of the lower incisors, and missing lower incisors were excluded.

Radiographic images were obtained using Newtom 5G. (NewTom QR DVT 9000. Quantitative Radiology, Verona, Italy) flat panel-based CBCT (Flat Panel Based CBCT) device. The device operates at 1-20 mA and a standard value of 110 kVp using the cone beam technique. The voxel size was 0.25 mm, with a scanning time of 18 s. CBCT data were transferred to the NNT (New New Tom version 8.0) software program. An experienced radiologist in oral and maxillofacial radiology conducted all measurements on midsagittal sections taken from CBCT images of the lower right central tooth at 1 mm thickness and 1 mm intervals.

Table 1. Cephalometric parameters in the sagittal and vertical directions.

Groups	ANB (Mean ± SD)	Wits (Mean ± SD)	FMA (Mean ± SD)	SN-GoGn (Mean ± SD)
Class I Normodivergent (N=15)	2.47 ± 0.95	0.37 ± 1.37	22.29 ± 1.69	31.85 ± 2.53
Class I Hyperdivergent (N=15)	2.73 ± 1.52	0.11 ± 1.88	30.31 ± 4.39	39.69 ± 3.20
Class III Normodivergent (N=15)	-1.51 ± 2.21	-6.97 ± 4.79	24.42 ± 2.75	32.83 ± 2.50
Class III Hyperdivergent (N=15)	-2.03 ± 2.76	-8.65 ± 3.07	31.31 ± 3.42	39.31 ± 2.17

SD: Standard Deviation.

Linear dimensions of the mandibular symphysis

Linear measurements of the mandibular symphysis were performed in the midsagittal section by creating planes from pre-marked points. Three lines were drawn.

Total symphysis height: The Infradentale medium (Idm) point, which passes through the exact midpoint between the Infradentale (Id and Idl) points marked at the most coronal part of the alveolar crests on the buccal and lingual sides of the lower right central tooth, was marked with a red marker. The distance measurement between the Idm points and the Menton (Me) point, which is the lowest point of the chin, provided the value for the total symphysis height.

Dentoalveolar symphysis thickness: The B point on the buccal side, which is the deepest point of the alveolar bone concavity near the root apex of the lower right central tooth, and the Bl point directly lingual to it were marked with a red marker. The distance between these two points provided the value for the dentoalveolar (middle) symphysis thickness.

Basal symphysis thickness: The Pogonion (Pg) point, which is the most protruding point of the mandibular symphysis, and the corresponding points on the lingual side (Pgl) were marked with a red marker. The distance between these two points was measured to obtain the basal (lower) symphysis thickness (Fig. 1).

Six linear measurements were performed between the cemento-enamel junctions (CEJ) and the root apex (ra) to determine the alveolar bone thickness of the lower right central tooth. The thickness of the buccal and lingual alveolar bones was measured by drawing

horizontal planes from the cement to the outer cortical plate at 3 mm and 6 mm apical levels from the CEJ. Finally, the amount of bone on the buccal and lingual sides of the root apex was measured (Fig. 2).

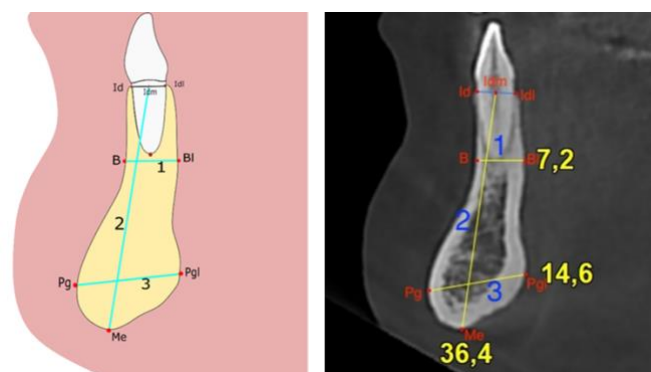


Figure 1. Linear measurements on the diagram and CBCT section: (1) Dentoalveolar symphysis thickness, (2) Total symphysis height, (3) Basal symphysis thickness.

Angular evaluation of the mandibular symphysis

Five angular measurements were performed to assess the mandibular symphysis. These include:

Symphysis Concavity (Id-B-Pg): This angle measures the concavity of the mandibular symphysis formed between the infradentale (Id), B point (B), and pogonion (Pg).

Symphysis Convexity (B-Pg-Me): This angle reflects the convexity of the symphysis, formed between the B point (B), pogonion (Pg), and menton (Me).

Basal Symphysis Inclination (B-Pg/MP): This angle evaluates the inclinations of the basal portion of the symphysis in relation to the mandibular plane (MP), formed by the B point (B) and pogonion (Pg) in relation to the mandibular plane.

Dentoalveolar Symphysis Inclination (Id-B/MP): This angle measures the inclination of the dentoalveolar region of the symphysis in relation to the mandibular plane (MP), formed between the infradentale (Id) and B-point (B).

Incisor Mandibular Plane Angle (IMPA): This angle is formed between the long axis of the lower incisors and the mandibular plane (MP), assessing the inclination of the lower incisor (Fig. 3).

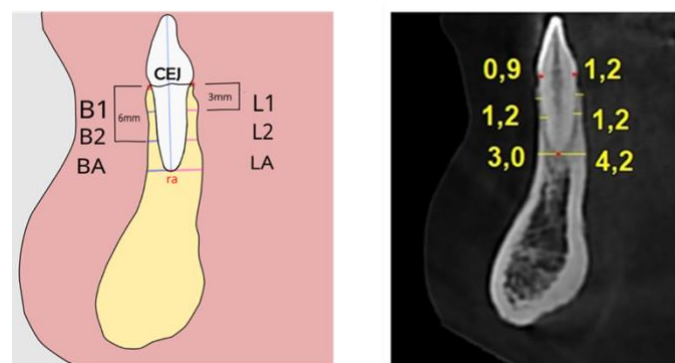


Figure 2. The measurement of alveolar bone thicknesses on both the buccal and lingual sides, as seen in the diagram and CBCT section, includes the following parameters: CEJ (Cemento-Enamel Junction), RA (Root Apex), B1 (Buccal bone thickness 3 mm apical to the CEJ), L1 (Lingual bone thickness 3 mm apical to the CEJ), B2 (Buccal bone thickness 6 mm apical to the CEJ), L2 (Lingual bone thickness 6 mm apical to the CEJ), BA (Buccal bone thickness at the root apex), and LA (Lingual bone thickness at the root apex).

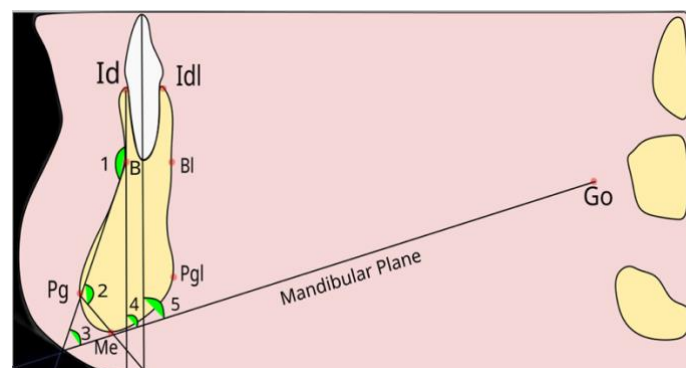


Figure 3. Angular measurements on the diagram: (1) Symphysis concavity (Id-B-Pg), (2) Symphysis convexity (B-Pg-Me), (3)

Basal symphysis inclination (B-Pg/Md), (4) Dentoalveolar symphysis inclination (Id-B/MP), (5) Incisor Mandibular Plane Angle -Lower incisor angle- (IMPA). Mandibular plane (Go-Me).

Statistical Analysis

SPSS software (version 22.0; IBM Corp., Armonk, NY, USA) was used for statistical analysis. The normality of the parameter distributions was assessed using the Shapiro-Wilk test. For all groups, we calculated descriptive statistics, such as the mean, standard deviation, and median. For normally distributed parameters, group comparisons were performed using one-way ANOVA.

Significant differences were found in some parameters, and further analysis was performed using the Tukey HSD test for homogeneous variances and Tamhane's T2 test for non-homogeneous variances.

For parameters that did not follow a normal distribution, the Kruskal-Wallis test was used to compare the groups. Pearson's correlation analysis was used to examine relationships among normally distributed parameters. The significance level was set at $p < 0.05$ for statistical analyses.

The measurements in our study were conducted at a single center by a single operator. All measurements and tracings were repeated 15 days after initial data collection. Measurement errors between the initial and repeated measurements were also evaluated.

The intra-class correlation coefficient (ICC) was calculated to assess method error and the measurements, with ICC values ranging from 0.966 to 0.999 and p -values all at 0.001 ($p < 0.05$).

Results

Evaluation of alveolar bone linear measurements

No statistically significant differences were observed among the groups in terms of alveolar bone linear measurements (Table 2).

Evaluation of mandibular symphysis dentoalveolar measurements

There were no statistically significant differences among the groups for Idm-Me, B-Bl, B-Pg-Me, and Pg-Pgl ($p > 0.05$) (Table 2). However, there were statistically significant differences among the groups for Id-B-Pg, Id-B/MP, B-Pg/MP, and IMPA ($p < 0.05$) (Table 3).

Table 2. Evaluation of alveolar bone linear measurements among groups.

Measurement	Class I Normodivergent	Class I Hyperdivergent	Class III Normodivergent	Class III Hyperdivergent	p-value
	Mean ± SD (M)	Mean ± SD (M)	Mean ± SD (M)	Mean ± SD (M)	
B1	0.34±0.38 (0.3)	0.39±0.34 (0.3)	0.63±0.4 (0.6)	0.53±0.32 (0.7)	0.173
B2	0.37±0.38 (0.3)	0.31±0.36 (0.3)	0.35±0.35 (0.3)	0.41±0.37 (0.3)	0.888
BA	3.72±0.82 (3.9)	3.29±1.26 (2.6)	3.56±1.04 (3.5)	3.11±1.16 (3.3)	0.409
L1	0.63±0.29 (0.7)	0.39±0.35 (0.5)	0.54±0.35 (0.6)	0.69±0.5 (0.8)	0.196
L2	0.91±0.49 (1)	0.72±0.45 (0.7)	0.71±0.69 (0.6)	0.97±0.57 (0.8)	0.457
LA	4.15±0.69 (4.1)	3.6±1.13 (3.5)	4.07±1.41 (3.5)	3.64±0.86 (3.5)	0.316

Kruskal-Wallis Test: No statistically significant differences were observed among the groups ($p>0.05$).
M: Median, SD: Standard Deviation.

Table 3. Evaluation of mandibular symphysis dentoalveolar measurements among groups.

Measurement	Class I Normodivergent	Class I Hyperdivergent	Class III Normodivergent	Class III Hyperdivergent	p-value
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Idm-Me	29.77±1.98	30.8±3.72	32.06±3.66	31.37±2.87	0.242
B-BI	7.99±1.09	6.95±2.06	7.65±1.65	6.71±1.55	0.121
Pg-Pgl	14.61±1.91	14.33±2.16	16.01±2.8	15.08±2.08	0.198
Id-B-Pg	153.48±5.68	148.81±6.86	152.97±7.35	156.06±6.61	0.036*
B-Pg-Me	123.29±7.19	125.62±8.74	119.08±10.07	125.27±8.56	0.160
Id-B/MP	91.26±7.15	90.04±8.38	82.07±4.95	79.72±8.82	0.001*
B-Pg/MP	63.47±7.46	58.59±5.03	55.19±4.45	54.66±9.42	0.003*
IMPA	95.17±6.21	91.11±8.44	84.97±6.42	80.27±7.97	0.001*

* One-way ANOVA ($p<0.05$) indicates statistically significant differences.
SD: Standard Deviation.

Post-hoc analysis revealed significant differences in the measurements between the Class III and Class I groups. Specifically, the Class III Hyperdivergent group showed higher Id-B-Pg measurements than the Class I Hyperdivergent group ($p=0.021$). For Dentoalveolar Symphysis Inclination, the Class III Hyperdivergent and Normodivergent groups had lower Id-B/MP measurements than both the Class I Normodivergent ($p=0.001$, $p=0.007$) and hyperdivergent groups ($p=0.002$, $p=0.025$). Regarding Basal Symphysis Inclination, the Class I normodivergent group had higher B-Pg/MP measurements than the Class III normodivergent ($p=0.007$) and hyperdivergent groups ($p=0.048$). Additionally, both Class III groups had significantly IMPA

measurements than the Class I normodivergent ($p=0.001$, $p=0.002$) and hyperdivergent groups ($p=0.001$) (Table 4).

Correlation analysis revealed significant relationships among various measurement pairs across the groups. In the Class I normodivergent group, B2 vs. B-BI ($r=0.763$), B2 vs. Id-B/MP ($r=-0.632$), and LA vs. B-BI ($r=0.738$) showed strong correlations. For Class I Hyperdivergent, BA vs. B-BI ($r=0.858$) and LA vs. B-BI ($r=0.841$) were strongly correlated. In the Class III Normodivergent group, B1 vs. Id-B/MP ($r=0.528$) and LA vs. B-BI ($r=0.795$) were significant. Finally, Class III hyperdivergent groups also showed a strong correlation between BA and B-BI ($r=0.840$) (Table 5).

Table 4. Pairwise comparison between different vertical groups and skeletal classes.

Group Comparison	Id-B-Pg	Id-B/MP	B-Pg/MP	IMPA
Class I Normodivergent				
vs. Class I Hyperdivergent	0.231	0.970	0.245	0.434
vs. Class III Normodivergent	0.997	0.007*	0.007*	0.002*
vs. Class III Hyperdivergent	0.714	0.001*	0.048*	0.001*
Class I Hyperdivergent				
vs. Class III Normodivergent	0.328	0.025*	0.312	0.111
vs. Class III Hyperdivergent	0.021*	0.002*	0.670	0.001*
Class III Normodivergent				
vs. Class III Hyperdivergent	0.583	0.824	1.000	0.306

* Tukey's HSD test was used for pairwise comparisons, and Tamhane's T2 test was used for B-Pg/Md. $p < 0.05$ indicates statistical significance. All p -values are included in the table.

Table 5. Correlation analysis for different vertical groups and skeletal classes.

Measurement Pair	Class I Normodivergent (r, p -value)	Class I Hyperdivergent (r, p -value)	Class III Normodivergent (r, (p -value)	Class III Hyperdivergent (r, p -value)
B1 vs. Id-B/MP	-0.500, 0.058	-	(0.528), 0.043*	-
B2 vs. B-BI	0.763, 0.001*	-	-	-
B2 vs. Id-B/MP	-0.632, 0.011*	-	-	-
BA vs. B-BI	0.604, 0.017*	0.858, 0.001*	0.538, 0.039*	0.840, 0.001*
L1 vs. Pg-Pgl	-0.569, 0.027*	-	-	-
L1 vs. B-Pg-Me	0.567, 0.027*	-	-	-
L2 vs. Idm-Me	-0.565, 0.028*	-	-	-
L2 vs. Pg-Pgl	-0.592, 0.020*	-	-	-
LA vs. B-BI	0.738, 0.002*	0.841, 0.001*	0.795, 0.001*	0.728, 0.002*
LA vs. Id-B/MP	-0.530, 0.042*	-	-	-
B1 vs. B-Pg-Me	-	-0.592, 0.020*	-	-
BA vs. Idm-Me	-	-0.572, 0.026*	-	-
BA vs. B-BI	-	0.858, 0.001*	0.538, 0.039*	0.840, 0.001*
LA vs. B-BI	-	0.841, 0.001*	0.795, 0.001*	0.728, 0.002*

* $p < 0.05$ indicates statistical significance. r: Correlation coefficient, representing the strength and direction of the linear relationship between two variables. The values range from -1 (perfect negative correlation) to 1 (perfect positive correlation), with 0 indicating no linear correlation.

Discussion

The mandibular symphysis region influences the movement of the lower incisor teeth owing to its direct contact with the root apex, potentially leading to slower tooth movement and root resorption (16).

In Class III patients, it is crucial to determine the limits of protrusion and retrusion of the lower incisors when deciding on orthodontic camouflage or orthognathic surgery. Failure to do so may result in surgical decompensation or orthodontic compensation, causing damage to both the teeth and alveolar bone (11). Thus, a 3D evaluation of the alveolar bones around the lower incisors is essential to define safe limits for orthodontic tooth movement prior to treatment (17).

The average distance from the CEJ to the alveolar crest in healthy teeth is 2.04 mm (18); therefore, we defined the crest as 2 mm apical to the CEJ. Using this as a reference, we measured alveolar bone thickness at 3 mm, 6 mm, and at the root apex on both the buccal and lingual sides. Similarly, Lee et al. (19) used 2 mm apical to the CEJ as the alveolar crest, but they measured at 3 mm, 6 mm, and 9 mm, whereas we focused on the root apex instead of the 9 mm level.

Our study showed no statistically significant differences in alveolar bone thickness across the four groups, irrespective of the measurement points: 3 and 6 mm apical to the CEJ, as well as at the root apex on both the buccal and lingual surfaces. In contrast, Lee et al. (19) found significant differences, likely due to differences in the sample size and population. Bo et al. (20) also reported thinner bone at the root apex of lower incisors in Class III compared to Class I patients.

In a CBCT study performed by Al-Masri et al. (6) the buccal bone thickness of the lower central incisors varied from 0.07 to 0.17 mm at the cervical level, 0.48 to 0.64 mm at the mid-root, and 2.37 to 3.71 mm at the apex. Our study showed a greater overall alveolar bone thickness; nevertheless, the buccal bone was thinner than the lingual bone.

The absence of significant differences suggests that neither the skeletal class (Class I vs. Class III) nor the divergence type (normodivergent vs. hyperdivergent) substantially affects the alveolar bone thickness at these specific measurement points. This implies that alveolar bone thickness is relatively stable across different skeletal patterns, at least in the regions and parameters studied.

The present study examined the 3D relationships between lower incisors' alveolar bone support and mandibular symphysis morphology in patients with Skeletal Class III malocclusion, considering both linear and angular dimensions. In contrast to previous studies (13, 14), which primarily used linear measurements, our analysis incorporated angular dimensions to provide a more comprehensive evaluation. We also compared the natural compensation differences in the mandibular symphysis between Skeletal Class III and Class I patients, excluding those with Skeletal Class II malocclusion.

The most pronounced differences were observed in the Class III hyperdivergent group, which often showed more extreme values, such as lower IMPA and steeper Id-B/MP angles. Our findings align with those of some studies that have explored the relationship between mandibular symphysis morphology and alveolar bone thickness using linear measurements. Specifically, the lower IMPA values in the Class III group reflected a compensatory retroclination of the mandibular incisors, likely in response to the underlying skeletal discrepancy. The more pronounced Id-B/MP and B-Pg/MP angles in Class III hyperdivergent patients indicate a steeper and more anteriorly positioned mandibular symphysis.

Our study exhibited substantial relationships between the length of the mandibular symphysis and the thickness of the alveolar bone. A positive correlation was observed in all groups between the thickness of the dentoalveolar symphysis and alveolar bone thickness at the buccal and lingual root apex. Additionally, we found a strong positive correlation between dentoalveolar symphysis thickness and buccal alveolar bone thickness in the Class I group and with lingual alveolar bone thickness in the Class III group, particularly in the middle third of the root in normodivergent patients.

A common finding across all groups was that the wider the middle section of the mandibular symphysis, the thicker the apical alveolar bone.

Foosiri et al. (13) found that a wider and shorter symphysis was associated with thicker apical and lingual alveolar bone. However, in Class III subjects, the alveolar part of the mandibular symphysis was observed to have a greater inclination and less pronounced anterior concavity compared to Class I, and Class II subjects (12).

Furthermore, studies have shown variations in alveolar bone thickness according to different skeletal patterns. Lee et al. (19) reported no significant difference in alveolar bone thickness between Class III high-angle subjects with open bite and those with normal overbite, except for the buccal alveolar bones at the 6 mm apical level. Kwon et al. (21) noted differences in buccal and lingual alveolar bone thickness based on skeletal type, with low-angle patients exhibiting a thicker buccal alveolar bone.

The morphology of the mandibular symphysis plays a crucial role in dental treatment. Sendyk et al. (22) found no significant correlation between symphysis thickness and incisor inclination after orthodontic treatment. In contrast, Lu et al. (23) reported a positive correlation between the total alveolar bone thickness at the mandibular central incisors and the degree of labial inclination of the tooth in patients with Class III malocclusion.

The total symphysis height showed a statistically significant negative correlation with lingual middle alveolar bone thickness only in Class I patients, whereas no significant correlation was observed in Class III patients. These findings are partially consistent with a few studies that have examined the correlation between linear measurements of mandibular symphysis morphology and alveolar bone thickness (13, 19).

In the present study, significant correlations between dentoalveolar symphysis inclination and alveolar bone thickness were identified, specifically in normodivergent patients. In Class I normodivergent patients, we observed a statistically significant negative correlation between dentoalveolar symphysis inclination and both buccal mid-alveolar bone thickness and alveolar bone at the lingual apex level. This suggests that as the dentoalveolar symphysis inclination increases, alveolar bone support in these regions may be reduced. In Class III normodivergent patients, we identified statistically significant positive correlations between the inclinations of the dentoalveolar symphysis and buccal marginal alveolar bone thickness. This finding can be attributed to the statistically significant lower dentoalveolar symphysis inclination observed in Class III patients compared to Class I patients. The lower inclination in Class III patients may result in a more favorable distribution of alveolar bone thickness at the buccal margin, thereby enhancing support in this region.

Class III patients represent a distinct group of orthodontic treatments compared to Class I and Class II patients; the alveolar bone surrounding the incisors is thinner (24, 25). Before orthognathic surgery, the decompensation phase involves substantial protrusion and proclination of the lower incisors. Reduction in alveolar bone height and thickness is not limited to the pre-surgical phase (26, 27). This process continues until orthodontic treatment is completed post-surgery. Contrary to these studies, a CBCT study by Lee et al. (28) found that the buccal bone thickness of the lower incisors did not change after orthodontic treatment.

Limitations

Our study was limited by the small sample size and available data, which required numerous CBCT images for comprehensive linear and angular evaluations. Although 3D data were used, the measurements were limited to midsagittal sections, with primary focus on identifying cephalometric points in 2D. Consequently, the remaining analysis was treated as 2D, which restricted the full potential of the 3D data. Future studies should utilize volumetric assessments with CBCT and AI-driven bone-tooth segmentation to fully leverage the advantages of 3D analysis.

Conclusion

The morphology of the mandibular symphysis, particularly its basal portion, does not provide a definitive indication of alveolar bone thickness in Class III patients based on both linear and angular measurements. However, the dentoalveolar part of the mandibular symphysis demonstrated a significant correlation with alveolar bone thickness in these patients. As the thickness and inclination of the

dentoalveolar symphysis increase, the alveolar bone thickness also increases. This relationship suggests that the dentoalveolar symphysis compensates and adapts with the inclination of the lower incisors. Evaluating the inclination of the dentoalveolar symphysis prior to orthodontic treatment can be considered a supportive parameter, though it is not solely sufficient for determining alveolar bone thickness.

Disclosures

Ethical Approval: Ethics committee approval for this study was obtained from the Non-Interventional Clinical Research Ethics Committee of the Health Sciences Institute at İnönü University, in accordance with the World Medical Association Declaration of Helsinki, with approval number 2023/4435.

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