Original Article

Assessment of Mandibular Posterior Available Space in Skeletal Class I and Class III Malocclusion Patients

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Abstract

Objectives: This study aimed to compare the mandibular posterior available space between patients with skeletal Class I and skeletal Class III malocclusion.

Methods: The retrospectively analyzed cone-beam computed tomography (CBCT) scans from 60 Thai orthodontic patients with normodivergent patterns. Patients were allocated to skeletal Class I or Class III; Class III severity was stratified by Wits appraisal. Mandibular posterior available space (MPAS) was measured on axial slice of CBCTs at the crown level and at root levels 3, 6 and 9 mm (RL_3, RL_6 and RL_9) apical to the cementoenamel junction. Comparisons of the mandibular posterior available space between skeletal Class I and Class III groups were performed using the Mann-Whitney U test. The value of $p<0.05$ was considered statistically significant for differences.

Results: No statistically significant differences in MPAS were detected between the skeletal Class I and Class III groups. Within the Class III group, MPAS did not differ significantly between non-severe and severe subgroups. Regarding mandibular third-molar status, Class III subjects with a mandibular third molar exhibited significantly greater MPAS at RL_6 and RL_9 compared with those without a third molar. In the Class I group, MPAS values did not differ significantly between the third-molar and non-third-molar subgroups.

Conclusions: The MPAS did not differ significantly between skeletal Class I and Class III patients. Clinically, these findings highlight the importance of individualized, CBCT-based evaluation rather than reliance on generalized characteristics such as skeletal classification.

Keywords: cone-beam computed tomography, mandibular posterior available space, orthodontics, retromolar space

Introduction

Molar distalization is a non-extraction treatment modality to correct molar relationships and alleviate dental crowding. The advent of temporary anchorage devices (TADs) enables predictable molar distalization with minimal patient compliance.(1-4) The success of molar distalization depends on the identification of the mandibular posterior available space (MPAS; also known as the retromolar space), which refers to the retromolar space located posterior to the mandibular dentition , typically distal to the mandibular second molar, that is available for distal movement of the mandibular molars. MPAS represents the anatomical limit for distal tooth movement. Evaluation of the posterior available space in both the mandibular retromolar and maxillary tuberosity regions is essential prior to treatment, as inadequate assessment may lead to periodontal complications and orthodontically induced root resorption.(5-7)

Previous studies have identified limitations in MPAS using panoramic radiographs and lateral cephalograms, revealing that the mandibular distal space is confined to the anterior border of the ramus.(8,9) However, the inherent two-dimensional (2D) nature of panoramic radiographs and lateral cephalograms limits these imaging modalities, leading to potential confusion in anatomical landmark identification due to superimposition, differential magnification, and radiographic distortion. With the introduction of cone-beam computed tomography (CBCT), three-dimensional (3D) evaluation of MPAS has become possible. CBCT provides high-resolution 3D volumetric images of the craniofacial complex, allowing clear multiplanar and cross-sectional visualization of dentoalveolar and skeletal structures without superimposition seen in conventional 2D radiographs. Therefore, CBCT allows a more accurate 3D assessment of MPAS by visualizing the posterior available space along the root length, rather than relying on projected 2D landmarks.(10) Recent findings suggest that the lingual cortical plate of the mandible, rather than the anterior border of the ramus, serves as the true posterior anatomical limit for molar distalization, as the MPAS decreases apically.(5,7,10-13) Both sagittal and vertical skeletal relationships influence the MPAS, which is the largest in patients with skeletal Class III and hypodivergent vertical discrepancies, while it is the smallest in patients with skeletal Class II and hyperdivergent vertical discrepancies.(5,7,11,12) Nevertheless, previous research has mainly focused on mild-to-moderate skeletal discrepancies, and data on patients with severe skeletal Class III malocclusion remain limited. Despite undergoing orthognathic surgery, cases involving severe skeletal discrepancies sometimes require molar distalization to alleviate crowding.

Therefore, the present study aimed to compare the MPAS between patients with skeletal Class I and skeletal Class III malocclusion. The null hypothesis was that no significant differences exist in the MPAS between patients with skeletal Class I and III malocclusion.

Materials and Methods

The inclusion criteria were (1) adult patients aged 18 to 30 years; (2) patients with a normodivergent facial profile, defined as a sella-nasion to mandibular plane angle (SN-GoGn) between 30° and 38°; (3) acceptable skeletal symmetry (Menton deviation < 4 mm, assessed on a frontal CBCT view using a midsagittal reference plane); and (4) intact roots without anomalies such as idiopathic root resorption or severe dilacerations. The exclusion criteria included (1) the presence of prostheses or missing teeth except for third molars in the mandibular arch; (2) pathological periodontal conditions with alveolar bone loss with a CEJ to alveolar bone crest distance > 2 mm; (3) history of previous orthodontic treatment, and (4) congenital craniofacial anomalies.

The sample comprised 60 Thai orthodontic patients who required CBCT images for diagnosis and treatment planning. This retrospective study was approved by the Human Experimentation Committee of the Faculty of Dentistry, Chiang Mai University, Thailand (No. 31/2024). All patients provided written informed consent before participation in the study.

To calculate the required minimum sample size, a pilot study was performed. The sample size calculation was done using the G*Power software (version 3.1.9.4, University of Kiel, Germany). Considering an effect size set of 0.755, power of 85%, and a significance level of 5%, the final sample required 28 subjects per group. However, to allow for possible exclusions, incomplete records, or unusable data, 60 participants were included to ensure that the final sample size remained sufficient for statistical analysis.

Patients who met the inclusion criteria were assigned to two groups based on a combined assessment of the

ANB angle and Wits appraisal: Patients with a skeletal Class I relationship (n=30) was defined as an ANB angle of 2º±2º and a Wits appraisal between −3 and +3 mm, and patients with a skeletal Class III relationship (n=30) was defined as an ANB angle <0º and a Wits appraisal < −3 mm. Within the Class III group, severity was further stratified using the Wits appraisal into mild-to-moderate discrepancy (Wits ≥ −9.5 mm; n=15) and severe discrepancy (Wits < −9.5 mm; n=15).

Pretreatment lateral cephalograms were obtained with the participants in maximum intercuspation, with the lips at rest, and with the Frankfort horizontal plane maintained parallel to the ground while the patients were seated in a standardized natural head position. The lateral cephalograms were generated from CBCT images and digitally traced using Dolphin Imaging Software version 11.9 (Dolphin Imaging & Management Solutions. Chatsworth, CA, USA). All measurements were performed by a single operator. To assess intra-operator reliability, lateral cephalograms of 10 subjects were traced and measured twice, with a two-week interval between the two sessions. The pretreatment CBCT images were obtained from three-dimensional imaging Cone-beam computed tomography using a NewTom Giano (Verona, Italy) CBCT unit at 90 kV, an 8 cm×8 cm field of view, and a voxel size of 0.16 mm. The Digital Imaging and Communications in Medicine (DICOM) files from CBCT were acquired and imported into Dolphin Imaging software to determine the MPAS. The 3D images were reoriented using specific reference planes to facilitate accurate analysis and interpretation. The horizontal reference plane was established by connecting the midpoint of the mandibular incisor tip and the mesiobuccal cusps of the mandibular first molars, effectively representing the mandibular occlusal plane. The midsagittal plane was constructed using anatomical landmarks, including the crista galli, anterior nasal spine (ANS), and the midpoint of the maxillary incisor tip. Using these reference planes, the CBCT images were reoriented to ensure standardized and reproducible orientations for accurate analysis (Figure 1).

The MPAS at the crown level (CL) and root level (RL) were measured on the axial slice of the CBCT image. The shortest distance between the mandibular second molar crown and the inner cortex of the ramus was measured parallel to the posterior cuspal line, which connects the buccal cusps of the mandibular first and second molars at a level 2 mm below the mandibular occlusal plane at the CL (Figure 2). At the RL, the shortest distances between the mandibular second molar root and the inner lingual cortex of the mandibular body were measured parallel to the posterior cuspal line at depths of 3 mm, 6 mm, and 9 mm (RL_3, RL_6, RL_9) on the axial slices with the distal cementoenamel junction (CEJ) of the second mandibular molar as the reference level (RL_0; Figure 3).

All measurements were performed by one investigator. Intra-examiner measurement error was assessed by remeasurement of CBCT images after a two-week interval. Intraclass correlation coefficient (ICC) analysis for the two measurements was carried out to investigate intra-examiner reliability. The intraclass correlation in the present study showed good agreement between measurements, with the ICC ranging from 0.991 to 0.997.

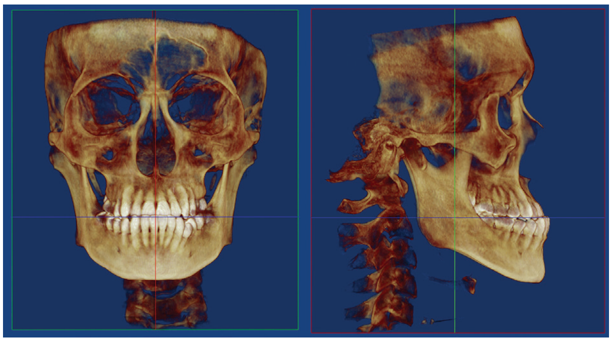

Figure 1: Reference used for this study. The mandibular occlusal plane (blue line): connection of the mesiobuccal cusps of the mandibular first molars and the mandibular central incisor tip. The midsagittal plane (Red line): passing through anterior nasal spine (ANS), crista galli and midpoint of the maxillary incisor tip.

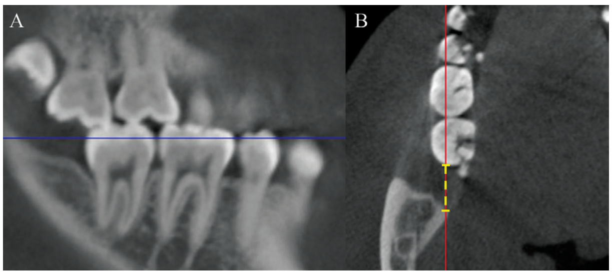

Figure 2: Mandibular posterior available space (MPAS) measured at crown level (CL). (A) Sagittal view at crown level; (B) Axial view at crown level; yellow line is MPAS, red line is posterior cuspal line which connects the buccal cusps of the mandibular first and second molars.

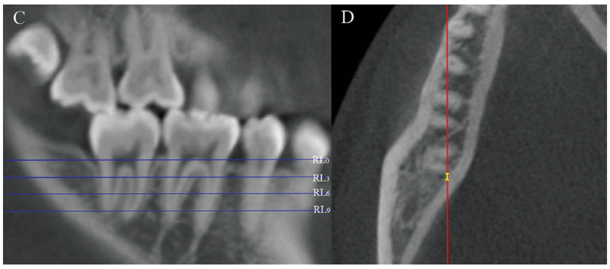

Figure 3: Mandibular posterior available space (MPAS) measured at cementoenamel junction (CEJ), 3 mm, 6 mm and 9 mm apical to CEJ level (RL_0, RL_3, RL_6 and RL_9). (C) Sagittal view; (D) Axial view; yellow line is MPAS, red line is posterior cuspal line.

Statistical analysis

Data analysis was performed using SPSS (Statistical Package for the Social Sciences, Chicago, IL, USA) version 25.0.1.0 for Windows. Descriptive statistics were used to summarize the baseline characteristics of participants.

Data distribution was assessed with the Shapiro–Wilk test and found to be non-normal. Side-to-side comparisons using the Wilcoxon signed-rank test revealed a significant difference between right and left measurements; therefore, the two sides were analyzed separately.

Comparisons of the MPAS between skeletal Class I and skeletal Class III groups were performed using the Mann–Whitney U test. $p<0.05$ was considered statistically significant.

To evaluate the effect of the mandibular third molar on MPAS, both sides of 60 patients were classified into two subgroups: third-molar present and third-molar absent (extracted or congenitally absent). The Mann–Whitney U test was used to compare MPAS values between these two groups. Chi-square tests were applied to examine differences in baseline characteristics and categorical variables related to MPAS between the sample groups.

Results

The final sample included 60 sides for each skeletal group (Class I and Class III). The mean ages of patients in the Class I and Class III groups were 25.3±4.0 years and 24.8±4.9 years, respectively (Table 1). The distribution of male and female participants did not differ significantly between the two groups by the Pearson's chi-square test (p=0.598). Patient demographic and skeletal characteristics are summarized in Table 1.

Across all measurement levels, the left and right MPAS values showed no significant differences, except within the Class III group at 6 mm (p=0.014) and 9 mm (p=0.006) below the CEJ, where statistically significant side-to-side differences were observed (Table 2). When comparing skeletal classifications, no statistically significant differences in MPAS were observed between the Class I and Class III groups at any measurement level (Table 3). However, a trend toward slightly larger MPAS measurements in the Class III group was noted across most planes, although it did not reach statistical significance (p>0.05). There were no statistically significant differences in MPAS when comparing the skeletal Class III non-severe and severe groups (Table 3).

Regarding mandibular third-molar presence, a mandibular third molar in the Class III group was associated with significantly greater MPAS distances at RL_6 (p=0.045) and RL_9 (p=0.029), with the non-third-molar group exhibiting smaller MPAS values at these levels. However, no significant differences were observed at the remaining measurement levels. Within the Class I group, MPAS distances were significantly greater at RL_0 (p=0.045) while no significant differences were observed at the remaining measurement levels between the third-molar and non-third-molar groups (Table 4). Additionally, MPAS differed significantly between males and females only in the Class I group at the crown level (CL) and at the RL_0 level, whereas no significant sex-related differences in MPAS were found at the remaining levels in Class I or at any level in Class III (Table 5).

Discussion

As a non-extraction modality, molar distalization offers an attractive option for correcting molar relationships and managing dental crowding. However, its success depends on the space available posterior to the mandibular dentition. Clinically, skeletal Class III patients are usually expected to have a larger MPAS than Class I patients, implying a potentially more favorable environment for distalization. Multiple variables may affect the MPAS[5,7,11,12], underscoring the need for accurate MPAS evaluation because the effective distalization space could be modified by factors beyond sagittal skeletal pattern. This study compared the MPAS between patients with skeletal Class I and III malocclusions using CBCT imaging to provide a 3D understanding of posterior anatomical limitations.

Table 1: Patient characteristics[a].

	Number	Age[b]	ANB[b]	SN-MP[b]	Mandibular length (Co-Gn)[b]	Gender[c]	
						Male (%)	Female (%)
Class I	30	25.3±4.0	2.6±1.1	29.1±2.9	127.1±9.5	N=13 (43.33%)	N=17 (56.67%)
Class III	30	24.8±4.9	-2.6±1.7	28.8 ±2.0	135.0±10.8	N=11 (36.67%)	N=19 (63.33%)
p	-	0.561	0.000*	0.579	0.002*	0.598	

[a]Values are presented as mean±standard deviation.
[b]Independent sample t-test.
[c]Chi-square test.
*Statistically significant at $p<0.05$

Table 2: Comparison of the mandibular posterior available space (MPAS) between the left and right side between Class I and Class III group[a].

Depth	Class I			Class III		
	Right[b] (n=30)	Left[b] (n=30)	*p*	Right[b] (n=30)	Left[b] (n=30)	*p*
CL	10.9	11.9	0.174	11.3	11.3	0.504
RL_0	10.7	11.3	0.465	11.2	11.2	0.984
RL_3	3.8	4.0	0.509	4.4	3.7	0.086
RL_6	2.3	2.4	0.992	3.5	2.3	0.014*
RL_9	1.1	1.1	0.964	2.2	1.3	0.006*

[a]All data is presented as median.
[b]Data analyzed with Wilcoxon Signed rank test.
"Depth" is the depth at which the mandibular posterior available space (MPAS) was measured; "CL" is the depth at the level of 2 mm below mandibular plane; "RL_0" is the depth at the level of cementoenamel junction (CEJ), "RL_3", "RL_9" and "RL_6" are the depth at the levels 3 mm, 6 mm, and 9 mm apical to CEJ.
*Statistically significant at $p<0.05$

Table 3: Comparison of the mandibular posterior available space (MPAS) between Skeletal Class I and Skeletal Class III patient among different planes[a].

Depth	Skeletal pattern					*p*
	Class I[b] (n=60)	Class III[b] (n=60)	*p*	Class III[b] (n=60)		
				Non-severe[b] (n=30)	Severe[b] (n=30)	
CL	11.0	11.3	0.212	11.2	11.7	0.403
RL_0	10.8	11.2	0.317	10.9	11.5	0.492
RL_3	3.9	3.9	0.259	4.0	3.8	0.813
RL_6	2.6	2.8	0.198	2.6	3.0	0.976
RL_9	1.1	1.7	0.107	1.8	1.7	0.959

[a]All data is presented as median.
[b]Data analyzed with Mann-Whitney U test.
*Statistically significant at $p<0.05$

Table 4: Comparison of the mandibular posterior available space (MPAS) between mandibular third-molar present group and third-molar absent group[a].

		Present[b]	Absent[b]	*p*
Class I		n=37	n=23	
	CL	10.7	11.1	0.082
	RL_0	10.4	11.7	0.045*
	RL_3	4.0	3.9	0.456
	RL_6	2.6	2.1	0.166
	RL_9	1.2	1.0	0.244
Class III		n=26	n=34	
	CL	11.4	11.3	0.210
	RL_0	11.3	10.9	0.296
	RL_3	4.0	3.8	0.257
	RL_6	3.5	2.3	0.045*
	RL_9	2.2	1.4	0.029*

[a]All data is presented as median.
[b]Data analyzed with Mann-Whitney U test.
*Statistically significant at $p<0.05$

Table 5: Comparison of the mandibular posterior available space (MPAS) between Skeletal Class I and Skeletal Class III patient between female and male patients[a].

Depth	Skeletal pattern					*p*
	Class I[b] (n=60)		*p*	Class III[b] (n=60)		
	Male (n=26)	Female (n=34)		Male[b] (n=22)	Female[b] (n=38)	
CL	12.1	10.2	0.010*	11.3	11.4	0.824
RL_0	12.2	10.4	0.015*	11.3	11.1	0.753
RL_3	4.1	3.5	0.189	4.5	3.8	0.060
RL_6	2.4	2.2	0.864	3.5	2.5	0.958
RL_9	1.1	1.2	0.911	2.1	1.4	0.253

[a]All data is presented as median.
[b]Data analyzed with Mann-Whitney U test.
*Statistically significant at $p<0.05$

There were no significant between-group differences in age or sex distribution between the skeletal Class I and III groups; however, mandibular length differed significantly, with the Class III group exhibiting a greater mandibular length than the Class I group. With respect to sex, significant differences were observed only at CL and RL_0 in the Class I group, whereas no significant sex-related differences were detected at the remaining root levels in either group. Because the clinically MPAS is generally evaluated at the root level rather than at the crown level, these findings suggest that any potential sex effect on MPAS may be limited. Notably, the sagittal comparison of MPAS between these skeletal patterns showed that the MPAS of Class III patients was not significantly greater than that of Class I patients at any measurement level, although a tendency toward larger values in the Class III group was noted. This overall pattern was consistent with the findings of Kim *et al.*,[16] who reported no significant differences in MPAS among different skeletal patterns, although some studies have described larger MPAS values in Class III patients compared with Class I subjects in some measurement levels.[11,13,14] The explanation for the larger MPAS in Class III patients lies in skeletal morphology and dental characteristics. Class III individuals generally present with a greater mandibular body length and lower molars that are relatively upright or lingually inclined compared with Class I patients, contributing to an increased MPAS for distalization.[17,18]

Although a trend toward a larger MPAS in Class III patients was observed, the lack of statistical significance in our data underscores the multifactorial nature of posterior anatomic limitation and the need for population-specific normative values in future research. This finding also highlights the importance of individualized assessment of distalization potential rather than relying solely on skeletal classification. Regardless of the overall sagittal skeletal dimension, previous anatomical and CBCT-based studies have consistently demonstrated that the MPAS gradually decreases as measurements approach the root apex.(5,10-14) This progressive reduction reflects the V-shaped anatomy of the mandibular basal bone, where the available space becomes narrower at the apical level compared with the crown or CEJ level. Consequently, the true anatomical limitation for molar distalization lies closer to the apical level rather than the coronal region.(5,10-14)

In the current investigation, the median MPAS at the occlusal level was 11.0 mm in Class I patients and 11.3 mm in Class III patients, which corresponds with the previous study of Kim *et al*.,(10) who reported a mean retromolar space at the CL of 9.88 mm. The minimum MPAS values were observed near the root apex level (specifically, 9 mm apical from the CEJ), where the median distances were approximately 1.1 mm in the Class I group and 1.7 mm in the Class III group. In comparison, a previous study that assessed MPAS at 6 mm apical to the furcation level reported mean values of 3.78 mm for Class I and 4.43 mm for Class III.(18) Given an average root trunk length of 3.0 mm, these measurements are considered comparable to those at the 9.0 mm level in the present study.(12) These findings suggest that the MPAS values in the present study were smaller than those reported previously. This discrepancy could be explained by differences in ethnicity between study populations and methodological variations, including differing horizontal reference levels and measurement planes used to determine the minimum distance available for molar distalization. In this study, MPAS measurements were performed along the cuspal line, which was considered a reliable reference for estimating the axis of distalization. The validity of using the cuspal line as a reference is supported by studies indicating that the angle between the cuspal line and the sagittal line remains relatively constant across individuals.(7,14) This geometric consistency reinforces its suitability as a stable and reproducible reference for MPAS assessment.

This study also compared the MPAS between skeletal Class III non-severe and severe cases and found no significant differences between these two subgroups. This suggests that, among patients with Class III malocclusion, the MPAS may not vary according to the severity of the sagittal discrepancy. Within the current study, the Wits appraisal was selected to stratify Class III severity because, although the ANB angle was the most commonly used cephalometric indicator of maxillomandibular anteroposterior discrepancy, its validity as a true measure of jaw relationships has been questioned. The ANB angle was influenced by the position of the nasion, and the rotation of the jaws could affect the ANB angle.(19) However, the Wits appraisal uses the functional occlusal plane as a reference and, therefore, jaw rotation relative to cranial reference planes had less influence on the severity of jaw disharmony.(20) Mandibular length has been considered a marker of Class III severity. Although mandibular length was greater in the Class III group than in the Class I group in this study, the MPAS did not differ significantly, suggesting that mandibular length might not be directly associated with the MPAS.

Although this study controlled vertical skeletal patterns by including only normodivergent patients, the influence of vertical divergence on MPAS is clinically relevant and should be considered in treatment planning. Previous literature consistently demonstrates a strong association between vertical facial pattern and the space available for molar distalization, and hyperdivergent patients typically exhibit the smallest MPAS and the highest risk of cortical contact, whereas hypodivergent patients present the largest MPAS.(5,7,12) By standardizing vertical skeletal characteristics, this study aimed to isolate the effect of sagittal discrepancy and minimize confounding from vertical morphological variations.

Similarly, the presence or absence of the mandibular third molar was not consistently associated with MPAS across the measured levels. Although significant differences were observed only at a few reference levels, while most measured levels showed no significant differences. Therefore, any influence of the mandibular third molar on MPAS appears to be level-specific rather than being consistent across all measurements, and should be interpreted with caution when compared with prior studies reporting no overall effect of third-molar status on MPAS.(7,10,11,15) However, when the mandibular third molar status was further classified according to the eruption or impaction type, discrepancies among studies were observed. For example, patients with normally erupted or vertically impacted mandibular third molars exhibited larger MPAS compared with those with missing, horizontally impacted, or mesially inclined third molars.(13) These findings suggest that while the presence or absence of a third molar may not be a determinant, its specific eruption status and angulation could influence the extent of MPAS.

A primary limitation of this study was its exclusive focus on hard tissue morphology, without consideration of soft tissue structures. The thickness of soft tissue in the retromolar area is a clinically relevant factor that may restrict distal tooth movement and predispose patients to complications such as pericoronitis or mucosal impingement.(10,21) In addition, mandibular third molars were not categorized separately as congenitally absent or previously extracted, although these conditions may influence posterior bone morphology. Therefore, potential confounding from pooling them should be considered when interpreting the results. Moreover, sagittal morphology indicators, such as ANB angle, mandibular length, and the degree of Class III discrepancy, were not reliable predictors of greater MPAS in our study. This finding suggests that skeletal classification and conventional sagittal cephalometric parameters alone should not be used as indicators of posterior clearance or distalization feasibility. For vertical skeletal evaluation, the SN-MP angle was used to define the vertical skeletal pattern in this investigation. To enhance the robustness of future studies focusing on vertical control, incorporating additional conventional cephalometric indicators, such as the Frankfort mandibular plane angle or facial height index, is warranted to provide a more comprehensive characterization of the vertical dimension. Although transverse skeletal discrepancy was minimized by including only subjects with acceptable skeletal symmetry (Menton deviation<4 mm), its potential influence on MPAS could not be evaluated and warrants further investigation.

Clinically, this research implies that safe and effective molar distalization requires individualized assessment rather than reliance on generalized data or standard cephalometric norms. Treatment decisions should not depend solely on factors such as sex, third-molar presence, or skeletal classification, but should include the direct measurement of each patient’s local anatomy and vertical pattern. Accordingly, individualized CBCT-guided planning is strongly recommended, utilizing measurements parallel to the cuspal line to accurately quantify the minimum MPAS and implement conservative safety margins that ensure predictable and biologically safe molar distalization. The results also highlight the need to integrate anatomical limitations with biomechanical considerations when planning mandibular molar distalization. Because the MPAS narrowed substantially toward the apex, force systems that generated uncontrolled tipping or excessive distal root movement were more likely to encounter cortical boundaries. Clinicians may need to modify mechanics, such as using TAD-supported bodily movement, segmented arch techniques, or incorporating controlled crown tipping to minimize apical displacement and maintain the root within the biologically safe zone. Future work combining MPAS quantification with 3D finite element analysis may provide deeper insight into stress distribution patterns and help refine safer, more efficient distalization protocols.

Conclusions

The MPAS did not differ significantly between skeletal Class I and Class III patients at any measurement level, although there was a tendency toward larger MPAS in the Class III group. The MPAS progressively decreased toward the root apex, with the minimum distance observed at 9 mm apical to the CEJ, emphasizing the apical region as the anatomical limit for mandibular molar distalization. In contrast, no conclusive association was identified between MPAS and either sex or the presence/absence of the mandibular third molar in this study. Clinically, these findings highlight the importance of individualized, CBCT-based evaluation rather than reliance on generalized characteristics such as skeletal classification or third-molar status. Applying conservative safety margins based on apical MPAS values is essential to avoid complications such as cortical interference, dehiscence, or root resorption.

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Conflict of Interest

The authors declare no conflict of interest.

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