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Morphometric assessment of the mandibular fossa and articular eminence at the craniomandibular level in dry human skulls

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Abstract

The temporomandibular joint (TMJ) is a complex anatomical structure whose functional integrity depends on the morphology of its osseous components. This study aimed to perform a detailed morphometric evaluation of the mandibular fossa and articular eminence using adult dry human skulls to better understand anatomical variability and its potential clinical relevance. A total of 18 TMJ regions from 9 adult dry skulls were analyzed bilaterally. Measurements included anteroposterior length, depth, and inclination angle of the articular eminence, as well as multiple inter-landmark linear distances between the mandibular fossa, eminence, porion, and postglenoid process. All measurements were performed using calibrated digital images via caliper and ImageJ software, and analyzed using descriptive and correlation statistics (SPSS 25.0). No statistically significant differences were observed between the right and left sides in any of the parameters examined ($p > 0.05$), supporting bilateral anatomical symmetry. The mean inclination angles of the articular eminence were 41.91° ± 1.10° (right) and 41.71° ± 2.64° (left), indicating a relatively steep eminence profile. Strong positive correlations were identified among several linear measurements, particularly those involving the articular eminence and its surrounding landmarks. This morphometric study underscores consistent anatomical relationships within the TMJ that can support surgical planning and prosthetic reconstruction. Moreover, the results highlight the value of individualized assessment in clinical practice. However, given the limited sample size, these findings should be regarded as preliminary and confirmed by future studies with larger datasets.

Keywords: Temporomandibular joint, mandibular fossa, articular eminence morphology, temporomandibular joint biomechanics, morphometry

Introduction

The temporomandibular joints (TMJs) are among the most complex joints in the human body. Each joint comprises the mandibular fossa, articular eminence, and the condylar process of the mandible, separated by an interposed articular disc [1]. This composite structure of bone and soft tissue operates in concert with the masticatory muscles and dentition; ligaments and muscles ensure joint stability and functional mandibular movement [2]. The morphometric attributes of the mandibular fossa and articular eminence-shape, depth, and inclination-govern the trajectory and range of condylar motion, thereby influencing masticatory biomechanics and occlusal dynamics [3,4]. Structural variations or degenerative changes in these components can disrupt condylar kinematics, manifesting clinically as pain, joint sounds, limited mandibular motion, or internal derangements. TMJ morphology is modulated by intrinsic and extrinsic factors, including age, sex, occlusal forces, tooth loss, parafunctional habits, altered muscle activity, and trauma, all of which may induce adaptive or pathological remodeling of the articular surfaces and increase the risk of dysfunction [5].

The anterosuperior surface of the mandibular condyle, which articulates with the articular eminence, is recognized as the primary load-bearing region of the TMJ [3]. Variability in the morphology of the articular eminence and mandibular fossa—including differences in shape, size, depth, and inclination—has been widely documented across individuals and populations. Cone Beam Computed Tomography (CBCT) studies indicate that males often present with higher and steeper eminences, potentially increasing susceptibility to dysfunction [6,7], while

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brachycephalic individuals similarly tend to exhibit steeper eminence angles that may influence mandibular motion patterns [8]. Dry skull investigations have reported broad ranges of inclination and height, with significant correlations between these parameters but no consistent sex- or side-related trends [9]. Age-related factors, such as tooth loss, may further contribute to remodeling by producing shallower and flattened fossae, particularly in edentulous individuals [10]. Collectively, these findings underscore the multifactorial influences—demographic, craniofacial, and functional—that shape TMJ morphology and impact joint biomechanics.

Beyond structural diversity, these variations may compromise the functional integrity of the temporomandibular joint. Because the shape of the mandibular fossa and the height and inclination of the articular eminence directly influence the path and range of condylar movement, anatomical differences in these regions can contribute to temporomandibular disorders such as disc displacement, joint pain, and restricted mandibular mobility. From a clinical perspective, recognizing and evaluating these bony variations is crucial for accurate radiological interpretation and for guiding procedures such as implant placement, prosthetic reconstruction, and orthodontic interventions. Moreover, the morphometric characteristics of the mandibular fossa and articular eminence are critical for diagnosing TMJ disorders such as disc displacement and degenerative disease, and for guiding treatment planning, including orthognathic surgery and prosthetic reconstruction [11-14].

In this context, the present study aims to perform a detailed morphometric analysis of the shape and inclination of the mandibular fossa and articular eminence using dry human skulls to clarify the anatomical basis of potential functional variations associated with morphological differences. It is hypothesized that these structures exhibit notable inter-individual variability, which may influence mandibular kinematics and temporomandibular joint stability. These findings may contribute to a better understanding of cranio-mandibular relationships and offer reference data for clinical considerations.

Material and Methods

Ethical approval for the study was obtained from the Non-Interventional Clinical Research Ethics Committee of the Faculty of Medicine, Bilecik Seyh Edebali University (Meeting No: 2025/7). This descriptive morphometric study was conducted on a total of 18 temporomandibular joint regions derived from 9 dry adult human skulls belonging to the collection of the Department of Anatomy, Faculty of Medicine, Bilecik Seyh Edebali University. Skulls with anatomical deformities, fractures, or missing landmarks that could interfere with measurement accuracy were excluded. Age and sex information for the specimens was not available.

Standardized photographs of each skull's inferior and lateral surfaces were taken using a stable camera setup positioned perpendicular to the plane of interest, with consistent lighting conditions and an included metric scale for calibration. All morphometric analyses were performed using a digital caliper and ImageJ software (National Institutes of Health, Bethesda, MD, USA).

Morphometric assessments were carried out bilaterally, allowing for separate evaluation of the right and left temporomandibular joint regions, including the mandibular fossa and articular eminence. As illustrated in Figure 1–3, a total of 15 morphometric parameters were assessed to evaluate the anatomical characteristics of these structures. The anatomical landmarks used as reference points in the measurements were defined as follows:

- **Porion (Po):** The most superior point on the external margin of the external acoustic meatus.
- **Fossa midpoint (F):** The geometric center of the mandibular fossa.
- **Medial peak of the articular eminence (EA mp):** The most elevated medial point of the articular eminence ridge.
- **Apex of the articular eminence (EA top):** The most prominent point along the superior curvature of the articular eminence.
- **Postglenoid process (Ppg):** The most prominent point of the postglenoid process.

The specific parameters evaluated were as follows:

Mandibular Fossa Parameters (Figure 1)

1. Anteroposterior length (mm)
2. Mediolateral width (mm)
3. Maximum depth (mm)

Articular Eminence Parameters (Figure 2)

4. Eminence height (mm)
5. Eminence inclination angle (°), relative to the Frankfort horizontal plane

Inter-anatomical Landmark Distances (mm) (Figure 3)

6. Po–F: Porion to fossa midpoint
7. Po–EA mp: Porion to medial peak of the articular eminence
8. Po–EA top: Porion to apex of the eminence
9. Po–Ppg: Porion to postglenoid process
10. F–EA mp: Fossa midpoint to medial peak
11. F–EA top: Fossa midpoint to apex
12. F–Ppg: Fossa midpoint to postglenoid process
13. EA mp–EA top: Medial peak to apex of the eminence
14. EA mp–Ppg: Medial peak to postglenoid process
15. EA top–Ppg: Apex to postglenoid process

All measurements were recorded for both the right and left sides where anatomical preservation permitted, yielding 18 joint regions in total.

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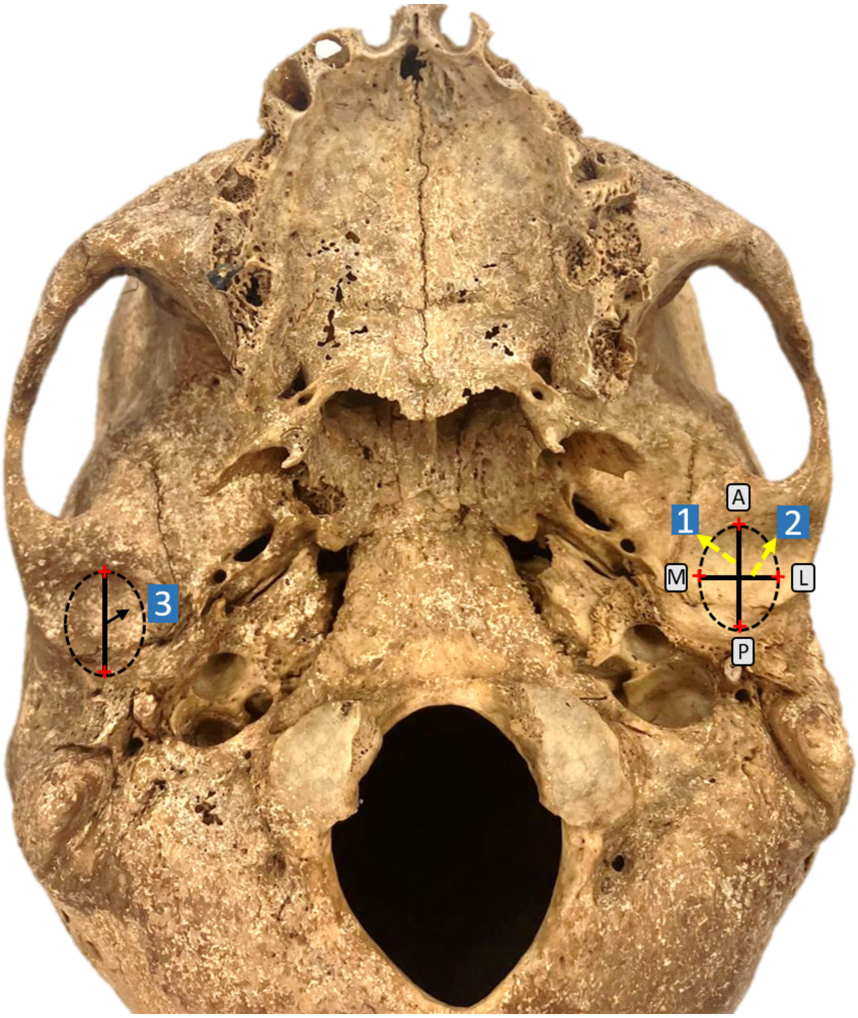

Figure 1. Inferior view of a dry human skull illustrating the morphometric parameters of the mandibular fossa. (1) Anteroposterior (AP) length, (2) Mediolateral (ML) width, (3) Maximum depth: determined by the vertical distance from the deepest point of the fossa to a line connecting its medial and lateral margins. Directional references: A = anterior, P = posterior, M = medial, L = lateral. The black dashed ellipse outlines the approximate contour of the mandibular fossa

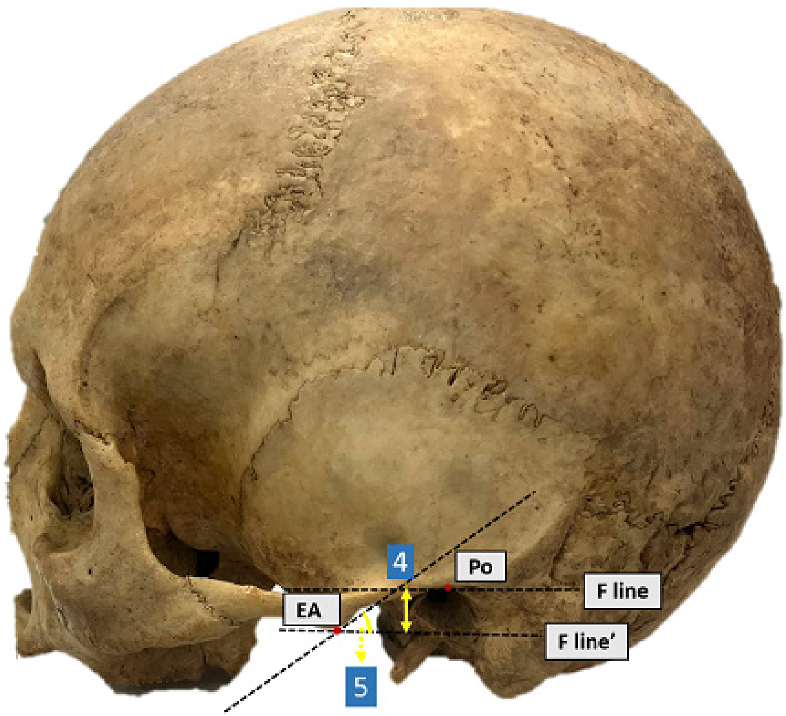

Figure 2. Lateral view of a dry human skull demonstrating the morphometric parameters related to the articular eminence and its inclination. (4) Eminence height: measured as the vertical distance from the apex of the articular eminence (EA) to its base (yellow double-headed arrow). (5) Defined as the angle between the tangent line drawn along the posterior slope of the articular eminence and the F line′, which is parallel to the Frankfort horizontal plane. Landmarks: Po = porion, EA = apex of the articular eminence. F line and F line′ represent the Frankfort horizontal plane and its parallel extension, respectively

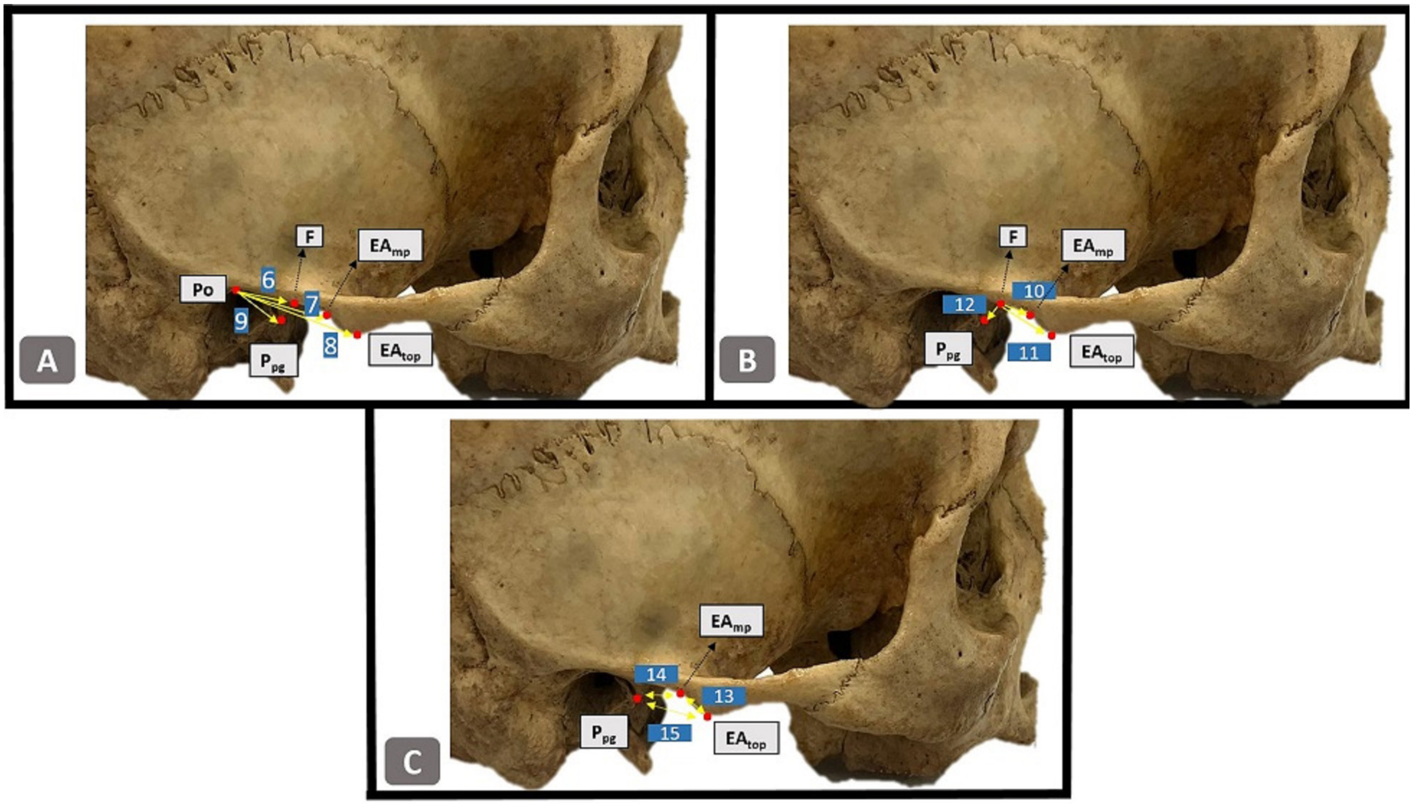

Figure 3. Spatial relationships between key anatomical landmarks of the TMJ. A: Lateral view of a dry human skull demonstrating the linear distances from the porion (Po) to several anatomical landmarks: (6) midpoint of the mandibular fossa (F), (7) medial peak of the articular eminence (EAmp), (8) apex of the articular eminence (EAtop), and (9) postglenoid process (Ppg). B: Linear distances from the midpoint of the mandibular fossa (F) to adjacent structures: (10) EAmp, (11) EAtop, and (12) Ppg. C: Intrinsic measurements among the eminential and postglenoid landmarks: (13) EAmp to EAtop, (14) EAmp to Ppg, and (15) EAtop to Ppg. Landmarks: Po = porion; F = midpoint of the mandibular fossa; EAmp = medial peak of the articular eminence; EAtop = apex of the articular eminence; Ppg = postglenoid process

Statistical Analysis

SPSS 25.0 (IBM) software was used for the statistics of the parameters included in the study. Descriptive statistical values of the data were given as mean±standard deviation for parametric data and as median (minimum-maximum) for non-parametric data in Table 1. The Shapiro-Wilk test was used to test the normality of the variables. To determine the side differences of the variables measured separately on the right and left sides, Student's T-test was applied for parametric variables, and Mann-Whitney U tests were used for non-parametric variables ($p<0.05$). Since no right and left side differences were observed in any parameter, correlation analyses were performed without considering the side differences and Spearman's correlation analysis was used for this purpose ($p<0.01$).

Results

In total, 18 temporomandibular joint regions obtained from 9 adult dry skulls were morphometrically assessed. All parameters were measured bilaterally, and descriptive statistics for each variable are summarized in Table 1. The anteroposterior length (AP) of the mandibular fossa was found to be slightly greater on the left side (20.24 ± 2.10 mm) than on the right side (19.32 ± 1.35 mm), although this difference did not reach statistical significance ($p>0.05$). Mediolateral length of the mandibular fossa was also 18.92±2.65 mm for the right side and 18.23±1.58 mm for the left side. Although this distance seems to have a higher value on the right side, no significant statistical difference was observed ($p>0.05$). Similarly, the depth of the fossa showed comparable values between sides, averaging 6.91 ± 0.66 mm on the right and 7.26 ± 0.82 mm on the left. The inclination angle of the articular eminence, measured relative to the Frankfort horizontal plane, exhibited close values between the right (41.91° ± 1.10°) and left (41.71° ± 2.64°) sides, with no significant asymmetry detected ($p>0.05$). Other linear distances measured between anatomical landmarks—including Po–F, Po–EA mp, Po–EA top, Po–Ppg, F–EA mp, F–EA top, F–Ppg, EA mp–EA top, EA mp–Ppg, and EA top–Ppg—demonstrated also no statistically significant differences between the right and left joint regions ($p>0.05$).
According to Spearman correlation analysis, strong positive relationships were observed between various anatomical landmarks of the temporomandibular joint (Table 2). Notably, the distance from the porion to the midpoint of the mandibular fossa (Po–F) showed high correlations with both the medial peak (EA mp) ($r = 0.742$) and the apex (EA top) ($r = 0.732$) of the

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articular eminence. Similarly, the Po–F to postglenoid process (P pg) distance also demonstrated notable correlations with EA mp (r = 0.624) and EA top (r = 0.678).

Strong correlations were observed between Po–EA mp and Po–EA top (r = 0.769), Po–EA mp and F–EA top (r = 0.777), and Po–EA mp and EA mp–P pg (r = 0.707). In particular, a very strong correlation was observed between Po–EA top and EA mp–P pg (r = 0.829). Additional significant correlations were identified between Po–EA top and F–EA top (r = 0.746), Po–EA top and EA top–P pg (r = 0.777), F–EA mp and EA top–P pg (r = 0.649), and F–EA top and EA top–P pg (r = 0.794). Moreover, EA mp–P pg and EA top–P pg were also highly correlated (r = 0.783). These findings indicate coordinated spatial relationships between anatomical components of the temporomandibular joint, suggesting that such structural associations may contribute to maintaining functional joint stability.

Table 1. Descriptive statistics of variables and comparative statistics for side differences

Parameter	Side	Median (Min.-Max.) Mean±S.D	p-value	95% CI Lower Bound	95% CI Upper Bound
1. AP Lenght of the MF	Right	19.20 (17.10-21.30)	0.222*	18.28	20.36
	Left	20.24±2.10		18.63	21.86
2. Mediolateral Lenght of the MF	Right	17.50 (16.10-23.00)	0.863*	16.89	20.96
	Left	18.23±1.58		19.45	18.19
3. Depth of the MF	Right	6.91±0.66	0.342*	6.40	7.42
	Left	7.26±0.82		6.63	7.89
4. Height of the EM	Right	6.90±0.23	0.087*	6.72	7.08
	Left	6.59±0.45		6.25	6.93
5. Inclination angle of the EM	Right	41.50° (41.10°-44.20°)	0.258*	41.06	42.76
	Left	41.71°±2.64°		39.68	43.74
6. Po-F	Right	8.71±1.07	0.971*	7.89	9.54
	Left	8.73±1.46		7.61	9.85
7. Po- EA mp	Right	14.06±1.68	0.879*	12.76	15.35
	Left	14.17±1.34		13.14	15.20
8. Po- EA top	Right	18.07±2.14	0.963*	16.41	19.71
	Left	18.11±1.89		16.66	19.57
9. Po- P pg	Right	9.00 (7.70-16.20)	0.796*	7.85	11.68
	Left	9.61±2.67		7.56	11.66
10. F- EA mp	Right	6.53±1.09	0.275*	5.69	7.37
	Left	6.03±0.75		5.45	6.61
11. F- EA top	Right	10.80±1.68	0.638*	9.51	12.09
	Left	10.46±1.36		9.41	11.50
12. F-P pg	Right	6.80 (6.20-10.90)	0.546*	6.38	8.69
	Left	7.86±1.69		6.56	9.16
13. EA mp- EA top	Right	5.52±0.95	0.516*	4.79	6.26
	Left	5.77±0.55		5.34	6.19
14. EA mp- P pg	Right	9.31±1.80	0.731*	7.93	10.69
	Left	9.01±1.85		7.59	10.43
15. EA top- P pg	Right	11.74±1.76	0.956*	10.39	13.10
	Left	11.70±1.61		10.47	12.93

*: No statistically significant difference

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Table 2. Highly correlated parameters and correlation coefficients

Parameter	R	p value
Po-F and Po- EA mp	0.742	<0.001
Po-F and Po- EA top	0.732	0.001
Po-F and EA mp- P pg	0.624	0.006
Po-F and EA top- P pg	0.678	0.002
Po- EA mp and Po- EA top	0.769	<0.001
Po- EA mp and F- EA top	0.777	<0.001
Po- EA mp and EA mp- P pg	0.707	0.001
Po- EA mp and EA top- P pg	0.829	<0.001
Po- EA top and F- EA top	0.746	<0.001
Po- EA top and EA top- P pg	0.777	<0.001
F- EA mp and EA top- P pg	0.649	0.004
F- EA top and EA top- P pg	0.794	<0.001
EA mp- P pg and EA top- P pg	0.783	<0.001

Discussion

The articular eminence and mandibular fossa are critical components of the TMJ, playing essential roles in its dynamic function. Previous studies have shown that the morphology of the articular eminence evolves in response to functional loading—starting as a relatively flat structure at birth and gradually developing a steeper posterior wall due to masticatory forces [9,15-17]. In this context, the present study aims to provide a detailed morphometric evaluation of these load-bearing structures using adult dry skulls, offering insight into anatomical variations that may influence TMJ biomechanics.

In this study, the AP length of the mandibular fossa was measured as 19.32 ± 1.35 mm on the right and 20.24 ± 2.10 mm on the left (p=0.222, non-significant), while the mediolateral (ML) width averaged 23.86 ± 2.63 mm on the right and 24.47 ± 3.06 mm on the left (p=0.863, non-significant). These findings indicate that the fossa is a broad, transversely oriented structure and support bilateral symmetry in TMJ morphology. The lack of statistically significant differences between the right and left sides reinforces the concept of bilateral symmetry in TMJ morphology and suggests consistent functional loading across both joints in anatomically normal individuals. In the current literature, studies reporting direct morphometric measurements of the AP and ML dimensions of the mandibular fossa are scarce [9,12]. Most CBCT-based investigations tend to focus on condylar morphology or intra-articular joint space measurements [18]. This scarcity highlights the originality and academic contribution of the present dry skull-based morphometric analysis. Moreover, the obtained AP and ML values can be indirectly compared to condylar dimensions occasionally reported in the literature. For instance, the average condylar width in asymptomatic individuals without TMJ clicking was reported as 19.0 ± 2.1 mm (range: 13.4–23.9 mm), suggesting a proportional compatibility with the observed mediolateral dimensions of the mandibular fossa in the present study [18]. These values suggest that harmony between the condyle and fossa is essential for TMJ stability and function.

According to Uçar et al. (2016), the mean depth of the mandibular fossa in healthy adolescents was 6.68 mm on the right and 6.59 mm on the left, with no statistically significant side differences [19]. These values are comparable to those observed in the current study, which revealed mean depths of 6.91 mm and 7.26 mm on the right and left sides, respectively, in adult dry skulls. Although slightly higher, the values obtained in the present study may reflect age-related anatomical remodeling or skeletal maturity, yet still support the general notion of bilateral morphological symmetry. Beyond their morphometric relevance, mandibular fossa depth measurements hold considerable clinical value [5]. In total joint replacement surgeries, standard prostheses are commonly used; however, increased fossa depth necessitates greater bone correction to ensure proper prosthetic fit, which may in turn elevate the risk of skull base perforation [14]. Therefore, mandibular fossa depth is a critical parameter in the design and stabilization of fossa prostheses. Previous CBCT-based research has demonstrated that patients with temporomandibular disorders often present with reduced mediolateral width and mandibular fossa depth values compared to control groups [20], whereas individuals with osseous abnormalities may show a lower width of the mandibular fossa and higher mandibular fossa depth measurements [21]. These findings underscore the dual anatomical and clinical significance of fossa depth and support the integration of morphometric data into personalized TMJ treatment planning.

In this study, the mean height of the articular eminence was 6.90 ± 0.23 mm on the right and 6.59 ± 0.45 mm on the left (p = 0.087), which is in close agreement with the CBCT findings of Elgüy et al. (2014) [6]. The slightly lower values observed in dry skulls compared to radiological studies likely reflect methodological differences between direct measurements and in vivo imaging, as well as natural variation related to skeletal maturation and population characteristics. Beyond these basic variations, facial type has also been shown to influence TMJ morphology. Da Costa et al. (2019) reported that brachycephalic individuals display the greatest eminence heights, followed by mesocephalic and dolichocephalic types [8], a pattern that reflects the influence of craniofacial architecture on joint loading and adaptation. Although facial type could not be assessed in the present sample, the range of eminence heights recorded here is consistent with values reported in facial type–based studies. Collectively, these findings underscore the importance of morphometric variability in understanding TMJ structure and its relevance for individualized surgical and prosthetic planning.

In the present study, the inclination of the articular eminence was assessed by measuring the angle formed between the Frankfort horizontal plane and a line extending from the roof

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of the mandibular fossa to the lowest point of the articular eminence. This widely accepted method, which reflects the influence of eminence height on its slope, enables the evaluation of morphological changes associated with functional loading [16,17,22]. The mean inclination angle was found to be approximately 41.91° ± 1.10° on the right and 41.71° ± 2.64° on the left, indicating a relatively steep eminence profile. Although the inclination angle was slightly higher on the right, the difference was not statistically significant ($p = 0.258$). These values are consistent with those reported in previous studies and may reflect an anatomical configuration that promotes joint stability during mandibular movement [6,9]

There is ongoing debate in the literature regarding the age-related trajectory of articular eminence inclination. While Angel et al. [23] reported that the inclination increases with age-possibly due to cumulative masticatory stress-Moffett et al. [24] suggested a decrease in inclination as a result of attrition and bone remodeling. These contrasting findings imply that individual variability, occlusal dynamics, and craniofacial morphology may all modulate the developmental course of the eminence slope. Furthermore, previous research has shown that individuals with brachycephalic cranial types tend to exhibit steeper and more prominent articular eminences [8]. This structural predisposition may increase mechanical interference during condylar excursion and elevate the risk of disc displacement. In addition, recent CBCT-based research has highlighted sex-specific patterns in TMJ morphology: while overall degenerative changes appear more prevalent in females, erosions are more frequent in younger males and flattening more common in middle-aged men [25]. Taken together, these findings emphasize the functional and clinical relevance of evaluating eminence inclination in relation to skeletal maturity, craniofacial type, and demographic variability.

The correlation analysis revealed a series of strong relationships between anatomical landmarks associated with the articular eminence and adjacent cranial structures. Notably, the high correlation between Po–EA mp and Po–EA top ($r = 0.769$) and between Po–EA mp and F–EA top ($r = 0.777$) suggests a stable spatial relationship between the porion and various points along the eminence and fossa. These findings imply that the relative positions of these landmarks are not random but follow a coordinated anatomical pattern.

The very strong correlation observed between Po–EA top and EA mp–P pg ($r = 0.829$) is particularly noteworthy, as it may reflect the integrated morphological development of the eminence's apex and its articulation with posterior elements such as the postglenoid process. Likewise, consistent associations between F–EA top and EA top–P pg ($r = 0.794$) and between EA mp–P pg and EA top–P pg ($r = 0.783$) further support the notion that these components function as a unified architectural unit within the TMJ complex.

These findings confirm that the shape and alignment of the articular eminence are structurally interdependent and biomechanically relevant. Clinically, changes in one landmark may alter the entire TMJ compartment, underscoring the importance of morphometric evaluation in diagnosis and treatment planning [18]. Therefore, understanding these correlations can aid in more precise anatomical modeling, surgical planning, and the interpretation of imaging in patients with suspected temporomandibular disorders.

The strong correlations observed between anatomical landmarks of the temporomandibular joint—particularly those involving the articular eminence and its surrounding structures—hold significant clinical relevance. In procedures such as orthognathic surgery, TMJ arthroplasty, and prosthetic joint reconstruction, surgeons often encounter challenges due to asymmetry, bone loss, or obscured landmarks resulting from trauma, congenital anomalies, or degenerative disease.

The consistent spatial relationships identified in this study provide a valuable anatomical framework for reconstructive and prosthetic planning, particularly when key landmarks are obscured, damaged, or absent. Correlated measurements from stable cranial points such as the porion or postglenoid process may guide the restoration of joint morphology, supporting both functional and esthetic outcomes while preserving natural anatomical proportions in total joint replacements or customized condylar components. This, in turn, may help reduce the risk of misalignment, disc displacement, and mechanical failure. In implantology, such knowledge can also minimize the risk of iatrogenic injury and enhance the precision of implant placement near the TMJ. Collectively, these insights highlight the importance of integrating detailed morphometric data into clinical workflows, reinforcing the role of individualized anatomical assessment and informing the development of template-based surgical protocols. However, it should be noted that due to the small sample size used in the study, the data obtained are statistical data analysis. To fully adapt the data to clinical practice and provide a clear interpretation, studies with a larger number of bones are necessary.

Limitations

This study has several limitations that should be acknowledged. First, the sample size was relatively small and limited to 18 temporomandibular joint regions derived from 9 dry adult human skulls, which may affect the generalizability of the findings. Moreover, the age and sex of the specimens were unknown, precluding any analysis of potential demographic influences on TMJ morphology. Since only osseous structures were examined, soft tissue components such as the articular disc, ligaments, and masticatory muscles could not be evaluated. Additionally, measurements were based on two-dimensional standardized photographs rather than direct three-dimensional imaging, which may introduce minor deviations despite calibration efforts. Finally, although dry skull analysis provides valuable baseline data, clinical correlation with in vivo studies is necessary to fully understand the functional implications of the observed anatomical variations.

Given these limitations, the present study should be regarded as preliminary, and further validation through larger, demographically characterized samples and advanced 3D imaging techniques, including CBCT and micro-CT, is warranted.

Conclusion

This study provides a detailed morphometric analysis of the mandibular fossa and articular eminence, revealing consistent anatomical symmetry and a relatively steep eminence inclination—features that may contribute to temporomandibular joint stability. The strong correlations identified between key anatomical landmarks reflect a coordinated spatial organization, which may assist clinicians in reconstructive and prosthetic procedures when direct anatomical references are compromised. These findings support the integration of morphometric data into clinical practice and highlight the importance of individualized anatomical evaluation in TMJ-related interventions.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
The Non-Interventional Clinical Research Ethics Committee of the Faculty of Medicine, Bilecik Seyh Edebali University (Meeting No: 2025/7).

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