European Journal of Therapeutics
pISSN: 2564-7784
eISSN: 2564-7040

Eur J Ther. 2025.
https://doi.org/10.58600/eurjther2896

Original Research

Investigation of the Effect of Unilateral Maxillary Sinus Hypoplasia on Temporomandibular Joint Morphology

Begüm Özemre [1], Şuayip Burak Duman [1,2], Duygu Çelik Özen [1], Oğuzhan Altun [1]

[1] Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, İnönü University, Malatya, Türkiye
[2] Department of Diagnostic Sciences, Texas A&M College of Dentistry, Dallas, Texas, USA

Received: 2025-10-13 **Accepted:** 2025-12-23 **Published Online:** 2026-01-02

Corresponding Author
Duygu Çelik Özen, Assist. Prof.
Address: Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, İnönü University, Malatya, Türkiye
E-mail: duygu.celik@inonu.edu.tr

© 2026. The copyright of this article is retained by the author(s).

OPEN ACCESS

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.
This license permits the free sharing and adaptation of the work for non-commercial purposes, provided that appropriate attribution is given to the original author(s) and to its initial publication in this journal.

ABSTRACT
Objective: Maxillary sinus hypoplasia is frequently discovered by accident and is typically asymptomatic. This study aims to assess how temporomandibular joint (TMJ) morphology is affected by unilateral maxillary sinus hypoplasia.
Methods: For this study, cone beam computed tomography (CBCT) images in the radiology archive of the Department of Oral, Dental, and Maxillofacial Radiology, Faculty of Dentistry, İnönü University, were retrospectively reviewed. The study included 77 patients (51 female, 26 male) aged 18-73 years with unilateral maxillary sinus hypoplasia. The patients' articular eminence angles, glenoid fossa root thickness, joint spaces, ramus lengths, condyle sizes, and condyle shapes were evaluated and compared bilaterally.
Results: Condylar dimensions, joint spaces, articular eminence inclinations, glenoid fossa roof thickness, ramus length, and condyle shape did not significantly differ ($p>0.05$) between the hypoplastic and normal maxillary sinus sides.
Conclusion: The study's findings show that maxillary sinus hypoplasia has no discernible impact on TMJ morphology; hence, this anatomical variation does not result in appreciable morphological alterations in the joint structure.

Keywords: cone beam computed tomography, maxillary sinus hypoplasia, temporomandibular joint

INTRODUCTION

The maxillary sinuses occupy a significant portion of the maxilla's interior and are pyramid-shaped air cavities found inside the maxilla bone [1]. These anatomical features have a major impact on the weight and volume of the craniofacial structure in addition to aiding in the respiratory system's air circulation. Maxillary sinus hypoplasia, which is typically asymptomatic and unintentionally discovered during radiological tests, is defined by these sinuses being smaller than normal, undeveloped, or unilaterally asymmetric in structure [2]. According to reports, the frequency of maxillary sinus hypoplasia ranges from 1.7% to 3.6% [3]. About 1.7% of people have unilateral maxillary sinus hypoplasia, while 7.2% have bilateral hypoplasia [4]. Although nasal congestion and head and face pain are possible indicators, the majority of individuals have no symptoms and are only discovered by chance [2]. It might present as cleft-like sinuses or as minor sinus hypoplasia.

Situated between the jaw and the temporal bone, the temporomandibular joint (TMJ) is one of the body's most intricate and commonly used joints. It is essential for carrying out daily tasks such chewing, speaking, swallowing, and yawning [5]. The TMJ's morphological structure can change according on a person's age, gender, functional habits, and surroundings. However, it is still unclear how developmental abnormalities in craniofacial tissues affect the morphology of the TMJ. More scientific research is required in this area because the literature has not adequately examined the potential implications of maxillary sinus hypoplasia on temporomandibular joint morphology.

This study aims to assess and compare the morphological features of the TMJ on CBCT pictures of people who have unilateral maxillary sinus hypoplasia on both sides. The goal is to add to the body of knowledge regarding the connection between craniofacial developmental abnormalities and joint structure by revealing the possible morphological effects of maxillary sinus hypoplasia on the TMJ.

Cone-beam computed tomography (CBCT) is highly effective in assessing bone disorders such erosion, flattening, osteophyte, hypoplasia, subchondral cyst, and sclerosis, despite its limitations in imaging the soft tissues and joint spaces. Furthermore, CBCT is a popular imaging method that enables low-radiation-dose, high-resolution analysis of the three-dimensional anatomical components of the temporomandibular joint and the maxillary sinuses [6].

Main Points

- Unilateral maxillary sinus hypoplasia is clinically important in evaluating anatomical asymmetries of the maxillofacial region.
- Examination of temporomandibular joint morphology contributes to understanding functional balance and occlusal relationships.
- Cone beam computed tomography (CBCT) provides high-accuracy assessment of sinus and joint structures.
- Such studies help clarify the possible effects of maxillary sinus hypoplasia on the temporomandibular joint and increase diagnostic awareness.

MATERIALS AND METHODS

This study protocol was established in accordance with all principles of the Helsinki Declaration, and access to the data used was limited solely to the responsible researchers. The study was approved by the İnönü University Health Sciences Non-Interventional Clinical Research Ethics Committee on July 16, 2024, with decision number 2024/6121.

Patient Selection

The power analysis was performed using G*Power software, version 3.1.9.7 (Franz Faul, University of Kiel, Germany; copyright 1992–2012). Based on an assumed effect size of d = 0.50 (medium effect), a type I error rate (α) of 0.05, and a type II error rate (β) of 0.10, the sample size calculation indicated that 70 CBCT scans were required for each group. To detect statistically meaningful differences between the evaluated conditions, account for potential data loss during the study process, and achieve a statistical power of 90%, the total sample size was determined as 140 CBCT scans. Accordingly, a total of 70 patients were included in the study, and measurements were obtained from both the hypoplastic maxillary sinus side and the normal maxillary sinus side for each patient.

Within the scope of this study, CBCT images obtained for various indications (presence of lesions in the maxillofacial region, impacted or supernumerary teeth, temporomandibular joint disorders, dental implant planning, orthognathic surgery preparation, etc.) between January 2022 and April 2024 were retrospectively scanned from the radiology archive of xxxx University Faculty of Dentistry, Department of Oral, Dental, and Maxillofacial Radiology. For all archived images, the NewTom 5G (Verona, Italy) CBCT device located at the Department of Oral, Dental, and Maxillofacial Radiology of İnönü University Faculty of Dentistry was used (Figure 3.1). The scanning time of the images taken while patients were in a standard supine position was 18 seconds, with an imaging field of 15×12 cm; exposure time = 3.6 seconds, kVp = 110, mA = 1–20; voxel size was 0.2 mm³. The patient's head was positioned inside the gantry so that the Frankfurt plane was perpendicular to the floor, with the mouth closed and the head stabilized during imaging.

As a result of the radiographic evaluation, CBCT images of 77 patients diagnosed with unilateral maxillary sinus hypoplasia were included in the study.

Of the patients included, 66.2% were female and 33.8% male. The age range was between 18 and 73, with a mean age calculated as 40.05 ± 14.12.

Inclusion Criteria

1. Individuals aged 18 years and older,
2. Patients diagnosed with unilateral maxillary sinus hypoplasia,
3. Individuals with occlusion in the posterior region,
4. Individuals with CBCT images taken with the same device and protocol, having sufficient technical quality.

Exclusion Criteria

1. Patients with a history of previous surgical intervention in the study area (maxillary sinus or TMJ region),
2. CBCT scans presenting maxillary sinus pathology (e.g., mucosal thickening, retention cysts, sinusitis or other inflammatory or obstructive conditions),
3. Cases with foreign bodies (e.g., metallic implants, screws, etc.) in the examined region,
4. Individuals with craniofacial syndromes or congenital anomalies,
5. Total edentulism or absence of occlusion in the posterior region,
6. Patients with a history of fracture or trauma findings in the examined region,
7. Cases with inadequate image quality for evaluation (metal artifacts, image distortions due to patient movement or positioning errors, etc.).

Image Evaluation

1. The sinus is smaller and oval-shaped compared to normal
2. The orbit appears larger and oval-shaped
3. The medial sinus wall is located lateral to the medial border of the orbit
4. The lateral sinus wall is located medial to the center of the orbit at the infundibulum level
5. The sinus floor is positioned superiorly compared to the nasal cavity floor

Patients meeting at least four of these criteria were evaluated as having unilateral maxillary sinus hypoplasia [7] (Figure 1).

In these patients, TMJ measurements were performed separately for the side with the hypoplastic maxillary sinus and the side with the normal maxillary sinus.

Condylar Dimensions

From axial section images showing the maximum mediolateral dimension of the condyle, the mediolateral and anteroposterior lengths of the condyle were calculated [8] (Figure 2).

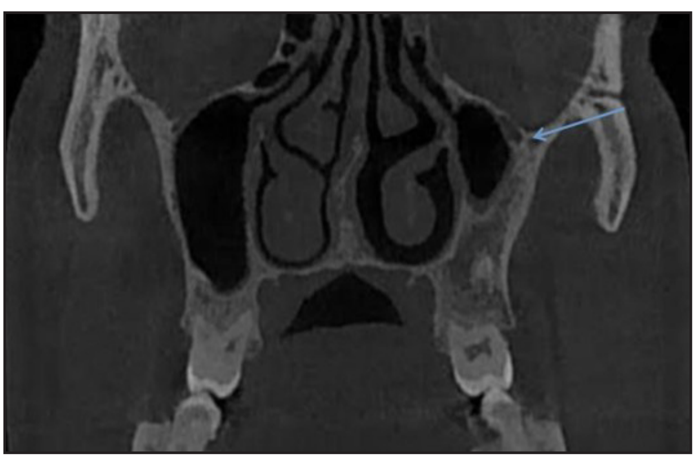

Figure 1. CBCT coronal section image showing unilateral maxillary sinus hypoplasia, indicated by a blue arrow.

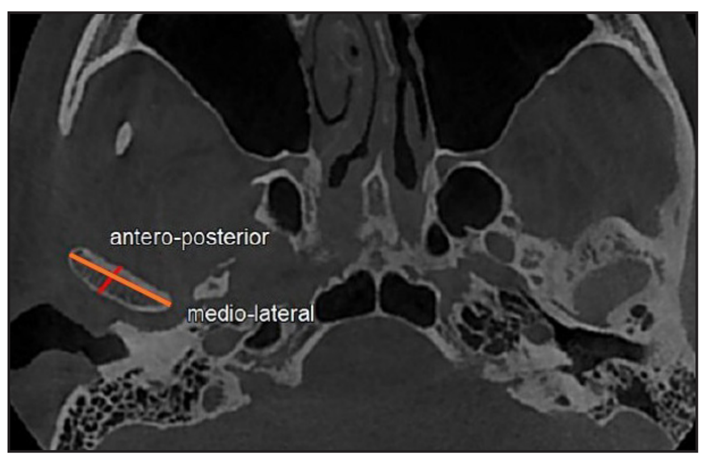

Figure 2. CBCT axial section showing the mediolateral (orange line) and anteroposterior (red line) dimensions of the condyle.

Joint Spaces

For TMJ joint space measurement, the most central oblique sagittal section taken from 1 mm-thick slices at the axial image showing the maximum mediolateral dimension of the condyle was selected (Figure 3A). The highest point in the mandibular fossa was identified and named MF. The most prominent points on the anterior and posterior surfaces of the condyle were marked as A (anterior) and P (posterior), respectively. The MF point was connected with tangents to points A and P.

- Anterior joint space: The perpendicular distance from point A to the glenoid fossa,
- Posterior joint space: The perpendicular distance from point P to the glenoid fossa,
- Superior joint space: The perpendicular distance from the most protruding point on the superior aspect of the condyle head to point MF [8] (Figure 3B).

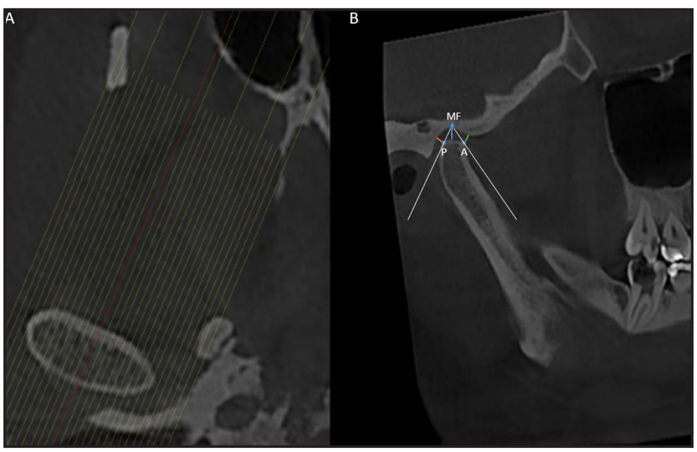

Figure 3. CBCT axial section showing the maximum mediolateral dimension of the condyle (A). CBCT oblique sagittal section corresponding to the red line (B). The blue line represents the superior joint space, the green line represents the anterior joint space, and the orange line represents the posterior joint space. A: The most anterior point of the condyle, P: The most posterior point of the condyle, MF: The highest point in the mandibular fossa

Articular Eminence Inclinations

The inclination of the articular eminence was evaluated using two separate angles. Measurements were taken from the most central oblique sagittal section of 1 mm thickness in the axial image showing the condyle's maximum mediolateral dimension, the same used for joint space measurement. Before measurement, certain points and lines were identified in addition to the MF point.

- AE: The lowest point on the articular eminence image,
- a: A line parallel to the Frankfurt plane passing through point AE,
- b: A line parallel to the Frankfurt plane passing through point MF,
- c: A tangent line to the largest possible posterior inclination surface of the articular eminence,
- d: A line passing through points MF and AE,
- α angle: The angle formed at the intersection of lines a and c,
- β angle: The angle formed at the intersection of lines a and d [8,9] (Figure 4).

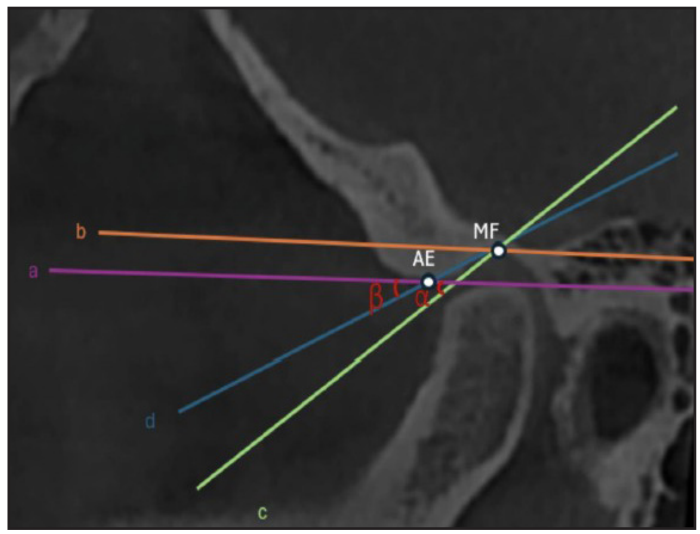

Figure 4. CBCT oblique sagittal section showing the inclination angles of the articular eminence (α angle: between the a and c lines; β angle: between the d and a lines). a line: A line parallel to the Frankfurt plane passing through point AE, b line: A line parallel to the Frankfurt plane passing through point MF, c line: A tangent line to the largest possible posterior inclination surface of the articular eminence, d line: A line passing through points MF and AE. MF: The highest point in the mandibular fossa, AE: The lowest point on the articular eminence image

Glenoid Fossa Roof Thickness

For measuring the roof thickness of the glenoid fossa, the slice with the thinnest roof thickness was selected from 1 mm oblique sagittal sections taken from the axial image showing the maximum mediolateral dimension of the condyle. The perpendicular distance between the MF point and the intracranial fossa was measured. In patients with continuity loss in the glenoid fossa roof, the measurement was recorded as zero [8,10] (Figure 5A).

Ramus Length

Ramus length measurements were also taken from the same section used for joint space and articular eminence inclination measurements. The distance between the most posterior and superior point of the condyle, called Co, and the gonial point, called Go, was measured [8,11] (Figure 5B).

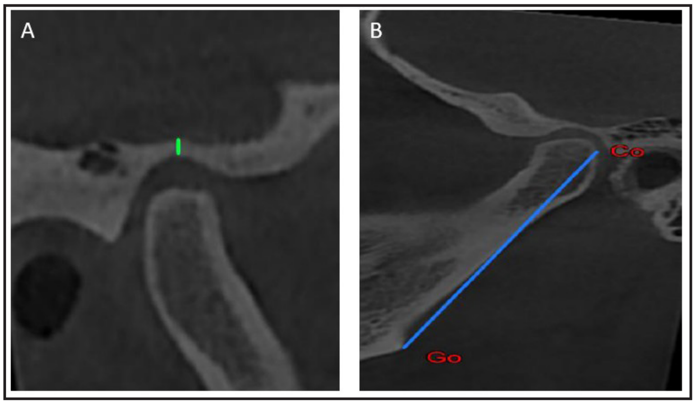

Figure 5. CBCT oblique sagittal section showing the thickness of the glenoid fossa roof, indicated by the green line (A) and the ramus length, indicated by the red line (B). Co:Condylon, Go: Gonion

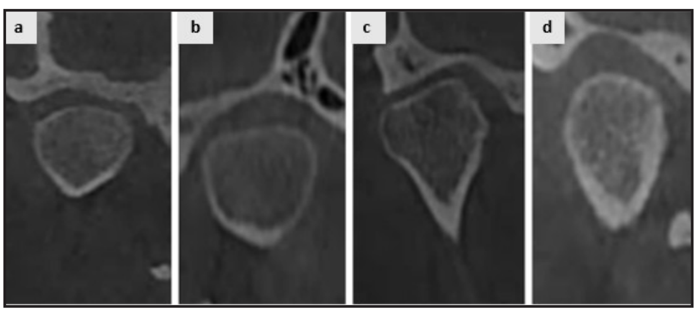

Figure 6. CBCT coronal section images showing condylar shapes: round (a), flat (b), angled (c), and convex (d).

Condylar Shape

The condylar shape was evaluated on the coronal section, where the mandibular condyle was most clearly visible. The condylar shape was classified into four types: round, flat, angled, and convex [8] (Figure 6).

Statistical Method

Data were analyzed using version 4.4.1 of the R programming language. The normality of the distribution was examined using the Kolmogorov-Smirnov test. For variables that conformed to a normal distribution, an independent two-sample t-test was used for comparisons. For variables that did not conform to a normal distribution, the Mann-Whitney U test was applied. The chi-square test was used to compare condylar shape between groups. Quantitative data were presented as mean ± standard deviation and median (minimum–maximum). The significance level was set at $p < 0.05$.

RESULTS

The gender distribution showed that 66.2% of the participants were female, while 33.8% were male. The mean age was calculated as 40.05 based on 77 observations (Table 1).

The mean alpha angle in normal sinuses was 56.47, while it was 55.32 in hypoplastic sinuses. The mean alpha values did not significantly differ between normal and hypoplastic sinuses ($p = 0.571$). The median beta angle was 42.3 in normal sinuses and 39.9 in hypoplastic sinuses, with no significant difference between groups ($p = 0.192$). The median roof thickness was 0.6 mm in both normal and hypoplastic sinuses, showing no significant difference according to group ($p = 0.174$).

No statistically significant difference was found in the mean anteroposterior length values between groups ($p = 0.757$). The mean anteroposterior length was 7.09 mm in normal sinuses and 7.02 mm in hypoplastic sinuses. The mean mediolateral length was 18.32 mm in normal sinuses and 18.41 mm in hypoplastic sinuses, with no significant difference observed ($p = 0.789$).

The median anterior joint space was 1.9 mm in both normal and hypoplastic sinuses, with no statistical difference ($p = 0.902$). The median posterior joint space was 2 mm in normal sinuses and 1.9 mm in hypoplastic sinuses, showing no significant difference ($p = 0.624$). The median superior joint space was 3.4 mm in both groups, with no significant difference ($p = 0.928$). The median ramus length was 49.2 mm in normal sinuses and 48.8 mm in hypoplastic sinuses, with no significant difference according to group ($p = 0.881$) (Table 2).

When the distribution of condyle shapes in the normal maxillary sinus group was examined, 26.3% were round, 38.2% flat, 23.7% angled, and 11.8% convex. In the hypoplastic maxillary sinus group, 27.3% were round, 36.4% flat, 31.2% angled, and 5.2% convex. No statistically significant association was found between condyle shape and the groups ($p = 0.421$) (Table 3).

Table 1. Descriptive characteristics of the sample

Gender	Frequency	Percent (%)
Female	51	66.2
Male	26	33.8
	mean ± SD	**median (min-max)**
Age (years)	40.05 ± 14.04	40 (18 - 73)

Table 2. Comparison of parameters by groups

	Normal Maxillary Sinuses	Hypoplastic Maxillary Sinus	Test Statistic	p
α Angle (°)	56.47 ± 13.13	55.32 ± 12.07	0.567	0.571[x]
β Angle (°)	42.3 (19- 435)	39.9 (21 – 61.9)	3326.000	0.192[y]
Roof thickness (mm)	0.6 (0 – 2.1)	0.6 (0 – 2.8)	2604.500	0.174[y]
Anteroposterior length (mm)	7.09 ± 1.48	7.02 ± 1.38	0.310	0.757[x]
Mediolateral length (mm)	18.32 ± 2.21	18.41 ± 2	-0.268	0.789[x]
Anterior joint spaces (mm)	1.9 (0.4 – 4.5)	1.9 (0.4 – 4.5)	2930.000	0.902[y]
Posterior Joint Space (mm)	2 (0.7 – 8.2)	1.9 (0.4 – 12.1)	3100.500	0.624[y]
Superior Joint Space (mm)	3.4 (0.6 – 8.2)	3.4 (0.6 – 9.5)	2990.000	0.928[y]
Ramus Length (mm)	49.2 (4.8 – 65.4)	48.8 (38.5 – 64.1)	2922.500	0.881[y]

[x] Independent samples t-test; [y] Mann Whitney U test, Mean ± standard deviation (Mean ± SD), Median (minimum – maximum)

Table 3. Comparison of condyle shapes between groups

Condyle Shape	Normal Maxillary Sinus n (%)	Hypoplastic Maxillary Sinus n (%)	Test Statistic	p
Round	20 (26.3)	21 (27.3)	2.816	0.421[x]
Flattened	29 (38.2)	28 (36.4)		
Angled	18 (23.7)	24 (31.2)		
Convex	9 (11.8)	4 (5.2)		

[x] Pearson's Chi Squared Test ;

DISCUSSION

In our study, the effect of unilateral maxillary sinus hypoplasia on TMJ morphology was examined. Parameters such as condyle dimensions, joint spaces, articular eminence inclinations, glenoid fossa roof thickness, ramus length, and condyle shape were evaluated. As is known, there is no study examining the effects of unilateral maxillary sinus hypoplasia on the TME. Understanding the possible effects of maxillary sinus hypoplasia detected on CBCT examinations on the morphology of adjacent anatomical structures such as the temporomandibular joint may contribute to a more accurate interpretation of radiological findings. In addition, this knowledge may support a more careful and balanced approach in clinical evaluation by improving the understanding of the relationship between anatomical variations and morphological changes.

The glenoid fossa roof is a thin layer of temporal bone that separates the TMJ from the middle cranial fossa [12]. Many studies have evaluated the thickness of the glenoid fossa roof of the TMJ [13-17].Ejima et al. [13] investigated the effect of different condylar morphologies on the thickness of the glenoid fossa roof in CBCT coronal sections and reported no significant differences related to condylar morphology. In the same study, osteoarthritic changes such as osteophyte formation, erosion, and flattening were reported to increase the roof thickness in sagittal sections. Khojastepour et al., using CBCT, compared the glenoid fossa roof thickness between individuals with and without TMJ disorders; the average thickness was 1.91 mm in the TMJ disorder group and 1.12 mm in the control group, indicating a significant increase in TMJ disorders [14]. Soydan and colleagues investigated the effect of degenerative changes in the joint on minimum glenoid fossa roof thickness and found that osteophytes, sclerosis, flattening, and pseudocysts were associated with thickness. The osteoarthritis group had an average thickness of 0.91 mm, while the control group had 0.69 mm [15]. In our study, the median value of glenoid fossa roof thickness was found to be 0.6 mm on both the hypoplastic maxillary sinus and normal maxillary sinus sides. This result indicates that the hypoplastic maxillary sinus does not significantly affect the glenoid fossa roof thickness and supports that there is no direct impact of hypoplastic maxillary sinus on the glenoid fossa roof.

There is no quantitative standard for the ideal position of the mandibular condyle within the glenoid fossa in the general population [18]. Dalili and colleagues evaluated joint spaces using CBCT in individuals without TMJ disorders through coronal and sagittal sections [19]. They found that the central positioning of the condyle was more common than anterior or posterior positioning. Ikeda et al. examined asymptomatic individuals with no disk displacement excluded by MRI using CBCT sagittal sections. They reported anterior, posterior, and superior joint spaces as 1.3 mm, 2.1 mm, and 2.5 mm, respectively [20]. In our study, these values on the hypoplastic and normal sinus sides were 1.9, 1.9, 3.4 mm and 1.9, 2.0, 3.4 mm, respectively, with no significant difference between the groups. In one study, no difference was found in posterior and superior joint spaces between individuals with and without TMJ disorders. In contrast, the anterior joint space was reported to be wider in individuals with TMJ disorders [21]. Yildizer et al. found anterior and superior joint spaces to be higher in patients with anterior dislocation compared to the control group, while no significant difference was observed in the posterior joint space; condyle position did not differ between groups [22]. Overall, joint spaces can be affected by pathologies such as osteoarthritis or anterior dislocation, but in our study, maxillary sinus hypoplasia showed no significant effect on joint spaces. TMJ disorders can cause pain that radiates to the head and face [21]. Maxillary sinus hypoplasia is generally asymptomatic, but it has been reported that this condition can cause head and facial pain [23]. In this context, evaluating the relationship between both anatomical structures and head and facial pain may contribute to a better understanding of possible etiological factors.

In the literature, it has been reported that various clinical conditions can affect condyle dimensions. In a study conducted by Paknahad et al., it was found that patients with osteoarthritis had a significantly reduced maximum anteroposterior dimension, while the mediolateral dimension did not change [24]. Derwich et al. also reported a decrease in anteroposterior dimensions along with osteoarthritic changes [25]. Another study showed that on the chewing side, the mediolateral dimension was larger, while the anteroposterior dimension was smaller [26]. Wang et al. compared patients with unilateral scissor bite in the second molars and a control group using CBCT axial sections and found no significant difference in the maximum mediolateral and anteroposterior condyle dimensions [27]. Similarly, in our study, no statistical difference was observed between the condyle dimensions on the hypoplastic and normal sinus sides. This finding suggests that unilateral maxillary sinus hypoplasia does not have a significant effect on TMJ morphology, unlike unilateral scissor bite. When the literature data are evaluated, changes in condyle dimensions are more closely associated with TMJ dysfunction, osteoarthritis, vertical skeletal patterns, and malocclusions.

Mandibular ramus length can also be affected by different growth patterns and malocclusion conditions, similar to condyle dimension. Lemes examined the ramus length from CBCT sagittal sections in individuals with hyperdivergent, normodivergent, and hypodivergent facial types and found that the ramus length was shorter in the hyperdivergent group [28]. Another study evaluated ramus length in Class III patients according to menton deviation and found that in the asymmetry group, the non-deviated side was longer [29]. It has been reported that ramus lengths decrease in patients with unilateral and bilateral cleft lip and palate compared to normal groups [11, 30], and in Lin's study, the ramus on the cleft side was found to be shorter in patients with unilateral clefts [31].

In light of these studies, while malocclusions, facial growth patterns, and cleft lip and palate affect ramus length, maxillary sinus hypoplasia was found to have no significant effect on ramus length. This leads to the conclusion that sinus hypoplasia, as a local difference, does not directly affect the development of critical mandibular regions.

Since the morphology of the articular eminence influences the rotational movements of the mandible, its variations have been suggested to cause biomechanical changes in the TMJ [9]. In this context, it has been shown in the literature that dental arch shape, cleft lip and palate, TMJ dysfunction, and degenerative changes can affect the inclination of the articular eminence. Verner examined the relationship between dental arch morphology and articular eminence inclination in individuals with normal occlusion using CBCT sagittal sections and found that oval arches had higher and square arches had lower inclination angles [9]. Abdelkarim measured the inclination in patients with cleft lip and palate and demonstrated that in unilateral cleft individuals with ongoing growth and development, the cleft side inclination was greater [32]. Studies measuring the inclination angles in individuals with TMJ dysfunction reported that the inclination angles in the dysfunction group were lower than those in the control group [8,33,34]. In our study, articular eminence inclinations were measured using two angles based on the Frankfurt plane, and it was found that maxillary sinus hypoplasia had no significant effect on the inclination. This approach increases comparability with different methods in the literature and allows a comprehensive evaluation of different regions of the articular eminence.

Mandibular condyle shape can vary depending on TMJ dysfunction, age, gender, and dentition status. Yasa compared groups with TMJ dysfunction and asymptomatic individuals and found that the most common shape in both groups was convex [8]. Ma investigated the relationship between condyle cortical development and condyle shape and showed that the prevalence of flat condyle morphology increased after cortical bone completion [35]. In studies classifying condyle shape on coronal sections as convex, angled, flat, and round, the most frequently observed variants were usually convex or angled [36-38]. Çağlayan found significant differences between groups with and without TMJ dysfunction, reporting that round-shaped condyles were more common in the dysfunction group [34]. These findings supports, in line with the functional matrix theory, that environmental factors and muscle activities play a more decisive role in TMJ development [39,40].

Limitations

There are several limitations on this study. The study's retrospective approach and small sample size limit how far the results may be applied. TMJ soft tissue components could not be assessed since CBCT pictures were utilized. Furthermore, this study was unable to evaluate the correlation between radiological and clinical findings. Prospective studies that combine functional and clinical evaluations are advised in order to get more reliable results in this area.

CONCLUSION

In this cohort undergoing CBCT evaluation, TMJ morphology did not differ significantly between the hypoplastic maxillary sinus side and the contralateral normal side. Larger-scale, functionally oriented prospective studies assessing maxillary sinus hypoplasia are necessary to completely comprehend the long-term implications on TMJ function.

Acknowledgments: Not applicable

Funding: No funding

Informed Consent: Informed consent form was not obtained because the study was retrospective.

Conflict of Interest: The authors declare that they have no confict ofinterest.

Ethical Approval Statement This study was carried out with the approval (Desicion number: 2024/6121, Date: 16.07.2024) from the İnönü University Health Sciences Non-Interventional Clinical Research Ethics Committee.

Author Contributions: Conception: D, ŞB - Design: D, ŞB, Ö, B – Supervision: A, O - Materials:B,Ö– Data Collection and/or Processing: B,Ö – Analysis and/or Interpretation: D, ŞB, ÇÖ, D - Literature Review: Ö,B– Writing: Ö,B – Critical Review: D, ŞB

Author Statement Regarding the Use of Artificial Intelligence-Enhanced Tools: Artificial intelligence tools, such as OpenAI's ChatGPT, have only been used to enhance expressiveness and alter text. The authors are solely responsible for the integrity and uniqueness of the work since they created all scientific information, interpretations, and conclusions.

REFERENCES

[1] Harorlı A, Akgül HM, Yılmaz AB, Bilge OM, Dağıstan S, Çakur B, et al. (2014) Paranazal Sinüs Radyolojisi. In: Harolı A, editor. Ağız, Diş ve Çene Radyolojisi. İstanbul: Nobel Tıp Kitabevleri p. 523–529.

[2] Alsufyani N, El-Hakim H, Major P (2021) Prevalence of maxillary sinus hypoplasia and association with variations in the sinonasal complex: a cone beam CT study. Clin Oral Investig. 25:5463-5471. https://doi.org/10.1007/s00784-021-03854-3

[3] Bolger WE, Woodruff Jr WW, Morehead J, Parsons DS (1990) Maxillary sinus hypoplasia: classification and description of associated uncinate process hypoplasia. Otolaryngol Head Neck Surg. 103:759-765. https://doi.org/10.1177/019459989010300516

[4] White SC, Pharoah MJ (2018) Oral Radyoloji İlkeler ve Yorumlama. 7. baskıdan çeviri. Palme Yayınevi, Ankara, pp 472-491.

[5] Harorlı A, Akgül HM, Yılmaz AB, Bilge OM, Dağıstan S, et al. (2014) Temporomandibular Eklem Radyolojisi. In: Harorlı A, editor. Ağız, Diş ve Çene Radyolojisi. Nobel Tıp Kitabevleri, İstanbul, pp 503–522.

[6] Wang YH, Ma RH, Li JJ, Mu CC, Zhao YP, et al. (2022) Diagnostic efficacy of CBCT, MRI and CBCT–MRI fused images in determining anterior disc displacement and bone changes of temporomandibular joint. Dentomaxillofac Radiol. 51:20210286. https://doi.org/10.1259/dmfr.20210286

[7] Koenig LJ, Tamimi D, Petrikowski CG (2017) Maxillary sinus and nasal cavity. In: Diagnostic Imaging: Oral and Maxillofacial. 2nd ed. Elsevier, Philadelphia, pp. 650-721.

[8] Yasa Y, Akgül HM (2018) Comparative cone-beam computed tomography evaluation of the osseous morphology of the temporomandibular joint in temporomandibular dysfunction patients and asymptomatic individuals. Oral Radiol. 34:31-39. https://doi.org/10.1007/s11282-018-0323-2

[9] Verner FS, Roque-Torres GD, Ramírez-Sotello LR, Devito KL, Almeida SM (2017) Analysis of the correlation between dental arch and articular eminence morphology: a cone beam computed tomography study. Oral Surg Oral Med Oral Pathol Oral Radiol. 124(4):420-431. https://doi.org/10.1016/j.oooo.2017.07.004

[10] Rosado LPL, Barbosa IS, Junqueira RB, Martins APVB, Verner FS (2021) Morphometric analysis of the mandibular fossa in dentate and edentulous patients: A cone beam computed tomography study. J Prosthet Dent. 125(5):758.e1-758.e7. https://doi.org/10.1016/j.prosdent.2021.01.014

[11] Golshah A, Hajiazizi R, Azizi B, Nikkerdar N (2022) Assessment of the asymmetry of the lower jaw, face, and palate in patients with unilateral cleft lip and palate. Contemp Clin Dent. 13(1):40-49. https://doi.org/10.4103/ccd.ccd_652_20

[12] Al-Ekrish AaA, Alorainy IA (2016) Apparent discontinuity of the roof of the glenoid fossa on cone-beam computed tomography images of an asymptomatic temporomandibular joint. Oral Radiol. 32:61-65. https://doi.org/10.1007/s11282-015-0207-7

[13] Ejima K, Schulze D, Stippig A, Matsumoto K, Rottke D, Honda K (2013) Relationship between the thickness of the roof of glenoid fossa, condyle morphology and remaining teeth in asymptomatic European patients based on cone beam CT data sets. Dentomaxillofac Radiol. 42(3):90929410. https://doi.org/10.1259/dmfr/90929410

[14] Khojastepour L, Haghnegahdar A, Eisazadeh M, Bahreini M (2019) Comparison between glenoid fossa roof thickness in TMD and non-TMD patients, a CBCT study. J Dent. 20(3):165-170. https://doi.org/10.30476/DENTJODS.2019.44906

[15] Soydan D, Doğan S, Canger EM, Coşgunarslan A, Akgün IE, Kış HC (2020) Effect of internal derangements and degenerative bone changes on the minimum thickness of the roof of the glenoid fossa in temporomandibular joint. Oral Radiol. 36:25-31. https://doi.org/10.1007/s11282-019-00373-6

[16] İlgüy D, İlgüy M, Fişekçioğlu E, Dölekoğlu S, Ersan N (2014) Articular eminence inclination, height, and condyle morphology on cone beam computed tomography. The ScientificWorldJournal. 2014(1):761714. https://doi.org/10.1155/2014/761714

[17] Matsumoto K, Honda K, Sawada K, Tomita T, Araki M, Kakehashi Y (2006) The thickness of the roof of the glenoid fossa in the temporomandibular joint: relationship to the MRI findings. Dentomaxillofac Radiol. 35(5):357-364. https://doi.org/10.1259/dmfr/30011413

[18] Panchbhai A. Temporomandibular joint space. (2017) Indian J Oral Health Res. 3(2). https://doi.org/10.4103/ijohr.

ijohr_37_17

[19] Dalili Z, Khaki N, Kia SJ, Salamat F (2012) Assessing joint space and condylar position in the people with normal function of temporomandibular joint with cone-beam computed tomography. Dental Res J. 9(5):607. https://doi.org/10.4103/1735-3327.104881

[20] Ikeda K, Kawamura A (2019) Assessment of optimal condylar position with limited cone-beam computed tomography. Am J Orthod Dentofacial Orthop. 135(4):495-501. https://doi.org/10.1016/j.ajodo.2007.05.021

[21] Park HJ, Seo YS, Kim JW, Yu SK, Ryu JW (2023) Joint Space Analysis Using Cone-beam Computed Tomography Imaging in Patients Diagnosed with Temporomandibular Joint Osteoarthritis and Occlusal Changes. J Oral Med Pain. 48(4):152- 158. https://doi.org/10.14476/jomp.2023.48.4.152

[21] Imanimoghaddam M, Madani AS, Mahdavi P, Bagherpour A, Darijani M, Ebrahimnejad H (2016) Evaluation of condylar positions in patients with temporomandibular disorders: A cone-beam computed tomographic study. Imaging Sci Dent. 46(2):127-131. https://doi.org/10.5624/isd.2016.46.2.127

[22] Yildizer E, Odabaşı O, Erbaşar NH (2023) Evaluation of congruency of condyle convexity and fossa concavity and interrelationship bony components in temporomandibular joint anterior dislocation. Oral Radiol. 39(3):588-597. https://doi.org/10.1007/s11282-023-00676-9

[24] Paknahad M, Shahidi S, Iranpour S, Mirhadi S, Paknahad M (2015) Cone-beam computed tomographic assessment of mandibular condylar position in patients with temporomandibular joint dysfunction and in healthy subjects. Int J Dent. 2015(1):301796.

[25] Okur A, Ozkiris M, Kapusuz Z, Karaçavus S, Saydam L (2012) Characteristics of articular fossa and condyle in patients with temporomandibular joint complaint. Eur Rev Med Pharmacol Sci. 16(15):2131-2135.

[23]. Alsufyani N, El-Hakim H, Major P (2021) Prevalence of maxillary sinus hypoplasia and association with variations in the sinonasal complex: a cone beam CT study. Clin Oral Investig. 25(9):5463-5471. https://doi.org/10.1007/s00784-021-03854-3

[24] Paknahad M, Mazarei F, Mohaghegh M (2024) Evaluation of the Relationship Between Osteoarthritis and Morphological Changes in the Joint Structures in Temporomandibular Disorders By Cone Beam Computed Tomography. J Maxillofac Oral Surg. 24:1954-1961. https://doi.org/10.1007/s12663-024-02277-3

[25] Derwich M, Mitus-Kenig M, Pawlowska E (2020) Morphology of the temporomandibular joints regarding the presence of osteoarthritic changes. Int J Environ Res Public Health. 17(8):2923. https://doi.org/10.3390/ijerph17082923

[26] Zhai X, Huang D, Hu Y, Li X, Wang J, et al. (2023) Cone-beam computed tomographic characteristics in degenerative temporomandibular joint disease patients with chewing side preference. Clin Oral Investig. 27(5):2267-2276. https://doi.org/10.1007/s00784-023-04961-z

[27] Wang G, Feng Y, Tang JQ, Zhang JJ, Wang XQ (2024) Measurement and analysis of condylar morphology and thickness of the roof of the glenoid fossa in patients with unilateral second molar scissor bite. Sci Rep. 14(1):24747. https://doi.org/10.1038/s41598-024-76216-0

[28] Lemes CR, Tozzi CF, Gribel S, Gribel BF, Venezian GC, et al. (2021) Mandibular ramus height and condyle distance asymmetries in individuals with different facial growth patterns: a cone-beam computed tomography study. Surg Radiol Anat. 43:267-274. https://doi.org/10.1007/s00276-020-02577-6

[29] You KH, Lee KJ, Lee SH, Baik HS (2010) Three-dimensional computed tomography analysis of mandibular morphology in patients with facial asymmetry and mandibular prognathism. Am J Orthod Dentofacial Orthop.138(5):540. https://doi.org/10.1016/j.ajodo.2010.04.025

[30] Celikoglu M, Halicioglu K, Buyuk SK, Sekerci AE, Ucar FI (2013) Condylar and ramal vertical asymmetry in adolescent patients with cleft lip and palate evaluated with cone-beam computed tomography. Am J Orthod Dentofacial Orthop. 144(5):691-697. https://doi.org/10.1016/j.ajodo.2013.07.009

[31] Lin Y, Chen G, Fu Z, Ma L, Li W (2015) Cone-beam computed tomography assessment of lower facial asymmetry in unilateral cleft lip and palate and non-cleft patients with class III skeletal relationship. PLoS One. 10(8):e0130235. https://doi.org/10.1371/journal.pone.0130235

[32] Abdelkarim AZ, Almeshari AA, Ozen DC, Khalifa AR, Rezallah NN, et al. (2024) Comparative Evaluation of Temporomandibular Joint Parameters in Unilateral and

Bilateral Cleft Lip and Palate Patients Using Cone-Beam CT: Focus on Growing vs. Non- Growing Subjects. Healthcare. MDPI. 1563. https://doi.org/10.3390/healthcare12161563

[33] Sümbüllü M, Çağlayan F, Akgül H, Yilmaz A (2012) Radiological examination of the articular eminence morphology using cone beam CT. Dentomaxillofac Radiol. 41(3):234-240. https://doi.org/10.1259/dmfr/24780643

[34] Çağlayan F, Sümbüllü MA, Akgül HM (2014) Associations between the articular eminence inclination and condylar bone changes, condylar movements, and condyle and fossa shapes. Oral Radiol. 30:84-91. https://doi.org/10.1007/s11282-013-0149-x

[35] Ma RH, Feng JL, Bornstein MM, Li G (2023) Relationship between development of the condylar cortex and the changes in condyle morphology: a cone-beam computed tomography (CBCT) observational study. Quant Imaging Med Surg. 13(4):2388. https://doi.org/10.21037/qims-22-891

[36] Yalcin ED, Ararat E (2019) Cone-beam computed tomography study of mandibular condylar morphology. J Craniofac Surg. 30(8):2621-24. https://doi.org/10.1097/SCS.0000000000005699

[37] Shubhasini A, Birur P, Shubha G, Keerthi G, Sunny SP, Nayak DS (2016) Study of three dimensional morphology of mandibular condyle using cone beam computed tomography. MJDS 1:7-12.

[38] Tassoker M, Kabakci ADA, Akin D, Sener S (2017) Evaluation of mandibular notch, coronoid process, and mandibular condyle configurations with cone beam computed tomography. Biomed Res. 28(19):8327-8335.

[39] White SC, Pharoah MJ (2018) Konik Işınlı Bilgisayarlı Tomografi:Anatomi. In: Oral Radyoloji İlkeler ve Yorumlama. 7. baskıdan çeviri. Palme Yayınevi, Ankara, pp. 214-228.

[40] Alsufyani NA, Major MP, Major PW (2022) Relationship between maxillary sinus hypoplasia and maxillary occlusal cant: a cone beam CT study. BioMed Res Int. 4651514. https://doi.org/10.1155/2022/4651514

How to Cite;

Ozemre B, Duman SB, Celik Ozen D, Altun O (2025) Investigation of the Effect of Unilateral Maxillary Sinus Hypoplasia on Temporomandibular Joint Morphology. Eur J Ther. https://doi.org/10.58600/eurjther2896