MÆDICA - a Journal of Clinical Medicine

ORIGINAL PAPER

MAEDICA – a Journal of Clinical Medicine
2025; 20(4): 802-807
https://doi.org/10.26574/maedica.2025.20.4.802

Comparison of Morphological Patterns and Location of Maxillary Sinus Septa in Dentate and Edentulous Patients Using Cone-Beam Computed Tomography

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ABSTRACT

Background and objective: *Evaluation of anatomical structures, such as the maxillary sinus septa, is critical for the success of sinus surgeries. This study compared the morphological patterns and locations of maxillary sinus septa in dentate and edentulous patients using cone-beam computed tomography (CBCT).*

Methods: *This retrospective descriptive-analytical study included 164 patients (327 maxillary sinuses) who were referred to a private radiology clinic in Ahvaz during 1399–1400. Cone-beam computed tomography images were obtained using a NewTom VGi unit and evaluated with NNT Viewer software. Data were analyzed using SPSS software version 26 and the chi-square test and analysis of variance.*

Results: *Of the 327 sinuses examined by us, 135 septa (41.2%) were identified. The prevalence of septa in the complete dentition (32.8%), complete edentulism (27.8%) and partial dentition (34.1%) groups did not differ significantly. Septa were most frequently located on the lateral wall (48.1%) and the distribution of septal location among the different groups was statistically significant (P = 0.042). The vertical morphological pattern was the most commonly found one (53.3%) and the molar region showed the highest frequency of septa (58.8%). The mean septal length was 8.23 mm.*

Conclusion: *The findings indicated that maxillary sinus septa are common structures, predominantly with a vertical pattern and located on the lateral wall and in the molar region.*

Keywords: morphological patterns, septa, maxillary sinus, cone-beam computed tomography.

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Article received on the 18th of November 2025 and accepted for publication on the 10th of December 2025

INTRODUCTION

The maxillary sinuses are the first sinuses to develop in the second month of fetal life and are considered the largest paranasal sinuses (1). These sinuses are divided into two or more compartments by septa. Maxillary sinus septa, first described by Underwood in 1910, are plates of cortical bone that originate from the inferior and lateral walls of the sinus (2). Developmentally, septa are classified as primary (embryonic in origin) and secondary (resulting from irregular pneumatization of the sinus floor after tooth loss) (3). The prevalence of maxillary sinus septa has been reported to range from 16% to 58% in different studies (4).

Accurate evaluation of the maxillary sinus anatomy, particularly the presence of septa, is of special importance for the success of implantology and sinus lift surgeries (5). The presence of these anatomical structures can increase the risk of perforation of the Schneiderian membrane during sinus floor elevation procedures (6). In addition, septa may sometimes mimic the appearance of periapical disease and complicate differential diagnosis (7). Cone-beam computed tomography (CBCT), as an advanced imaging technique, provides precise three-dimensional visualization of bony structures and dental hard tissues (8). According to the guidelines of the European Association for Osseointegration and the International Team for Implantology, CBCT is considered an appropriate technique for detecting anatomical details of the maxillary sinus (6).

Numerous studies have investigated the characteristics of maxillary sinus septa in different populations. For example, in Germany, Hungerbühler *et al* reported a prevalence of 33% (9), whereas Bornstein *et al* in Switzerland observed a prevalence of 56.5% (9). In Iran, studies by Fazeli *et al* (10) and Rezaei *et al* (11) have also been conducted, each reporting different findings.

Given the discrepancies among previous studies and the importance of this issue in the planning of dental treatments, the present study was designed and conducted to compare the morphological patterns and location of maxillary sinus septa in dentate and edentulous patients using CBCT in a population referred to radiology centers in Ahvaz. ❑

MATERIALS AND METHODS

This research was conducted as a retrospective descriptive-analytical study between mid-February 2021 and mid-March 2022. The study population comprised all patients who were referred to a specialized oral and maxillofacial radiology clinic in Ahvaz and whose maxillary CBCT images were available in the clinic's archive. A census sampling method was used to determine the sample size, resulting in the evaluation of 164 patients and 327 maxillary sinuses.

Inclusion criteria were the availability of CBCT images of acceptable quality, complete demographic information, including the patient's age and sex and complete coverage of the posterior maxillary region. Exclusion criteria included a history of maxillary sinus surgery, the presence of sinonasal tumors or polyps, midfacial trauma, age under 15 years and the presence of septa with a soap-bubble appearance. After obtaining the necessary approvals from the university ethics committee (ethics code IR.AJUMS.REC.1400.640) and coordinating with the radiology clinic management, the CBCT images of eligible patients were retrieved from the archive. All photos were acquired using a NewTom VGi unit (Italy) with standard parameters: FOV = 11 × 8 cm, high resolution, Kvp = 90 and a scan time of nine seconds. The image evaluation process was performed using NNT Viewer software version 10 on a 15.6-inch ASUS monitor, in a room with controlled lighting conditions, under the direct supervision of an oral and maxillofacial radiologist. In this study, the minimum acceptable prominence for a septum was set at 2 mm.

The independent variable in this study was the patients' dentition status, categorized into three groups: complete dentition, complete edentulism and partial dentition. The dependent variables included the presence and number of septa; the location of septa on the medial, lateral, or inferior walls; the anatomical region of the septa in the premolar or molar areas; the morphological pattern of the septa, including vertical, medio-lateral and antero-posterior types; and the length of the septa in millimeters. Operationally, a maxillary sinus septum was defined as a cortical bony structure with a minimum height of 2 mm. The premolar region was defined as extending from the distal surface of the canine to the distal surface of the second premolar, and the molar region as extend-

ing from the mesial surface of the first molar to the maxillary tuberosity.

Data analysis

The collected data were analyzed using SPSS statistical software version 26. Descriptive statistics, including mean, standard deviation, frequency, and percentage, were used to describe the data. In the inferential statistics section, the chi-square test was used to compare qualitative variables, and one-way analysis of variance was used to compare quantitative variables. The level of significance for all tests was set at 0.05. ❑

RESULTS

In this study, which evaluated the characteristics of maxillary sinus septa, a total of 327 maxillary sinuses from 164 patients were thoroughly assessed. Of these, 180 sinuses (55%) were in patients with complete dentition, 18 sinuses (5.5%) were in patients with complete edentulism, and 129 sinuses (39.5%) were in patients with partial dentition (Table 1).

Of all sinuses evaluated by us, at least one septum was identified in 108 sinuses (33%) and a total of 135 septa were observed, indicating an overall prevalence of 41.2% for septa in the study population. Among the sinuses with septa, the highest frequency was related to sinuses with a single septum (90 sinuses, 27.5%).

With respect to the relationship between dentition status and the presence of septa, 59 sinuses (32.8%) in the complete dentition group had septa. In the complete edentulism group, five sinuses (27.8%) had septa and in the partial dentition group, 44 sinuses (34.1%) had septa. The chi-square test showed no statistically significant difference in the presence or absence of septa among the three dentition groups ($P = 0.862$).

Regarding the anatomical regions of the septa, the molar region, with 79 septa (58.5%), had the highest frequency, followed by the premolar region, with 56 septa (41.5%). No significant difference was observed in the distribution of the anatomical areas of septa among the three dentition groups ($P = 0.169$) (Table 2).

Dentition status \ Frequency		No septum	One septum	Two septa	Three septa	Four septa	Total	Significance level
Complete dentition	Number	121	48	6	3	2	180	0.859
	% within dentition status	67.2%	26.7%	3.3%	1.7%	1.1%	100%	
	% within frequency	55.3%	53.3%	50%	100%	66.7%	55%	
Complete edentulism	Number	13	5	0	0	0	18	
	% within dentition status	72.2%	27.8%	0%	0%	0%	100%	
	% within frequency	5.9%	5.6%	0%	0%	0%	5.5%	
Partial dentition	Number	85	37	6	0	1	129	
	% within dentition status	65.9%	28.7%	4.7%	0%	0.8%	100%	
	% within frequency	38.8%	41.1%	50%	0%	33.3%	39.5%	
Total	Number	219	90	12	3	3	327	
	% within dentition status	67%	27.5%	3.7%	0.9%	0.9%	100%	
	% within frequency	100%	100%	100 %	100%	100%	100%	

TABLE 1. Frequency distribution of septa in maxillary sinuses according to dentition status

Dentition status \ Location (wall)		Medial wall	Lateral wall	Inferior wall	Total	Significance level
Complete dentition	Number	7	43	27	77	0.042
	% within dentition status	9.1%	55.8%	35.1%	100%	
	% within wall location	30.4%	66.2%	57.4%	57%	
Complete edentulism	Number	1	3	1	5	
	% within dentition status	20%	60%	20%	100%	
	% within wall location	4.3%	4.6%	2.1%	3.7%	
Partial dentition	Number	15	19	19	53	
	% within dentition status	28.4%	35.8%	35.8%	100%	
	% within wall location	65.2%	29.2%	40.4%	39.3%	
Total	Number	23	65	47	135	
	% within dentition status	17%	48.1%	34.8%	100%	
	% within wall location	100%	100%	100%	100%	

TABLE 2. Distribution of the location of the maxillary sinus septa

Data analysis showed that, among the 135 identified septa, the highest frequency was observed in those located on the lateral wall, with 65 cases (48.1%), followed by the inferior wall with 47 septa (34.8%) and the medial wall with 23 septa (17%). The chi-square test revealed a statistically significant difference in the distribution of septal location among the three dentition groups (P = 0.042) (Table 3).

TABLE 3. Comparison of the length of maxillary sinus septa according to dentition status

Variable	Length of maxillary sinus septa			
	Complete dentition	Complete edentulism	Partial dentition	Total
Mean	8.12	8.26	8.39	8.23
Standard deviation	3.836	2.335	3.707	3.704
Minimum	2.40	4.70	3.42	2.40
Maximum	26	11	23	26
Significance level				0.936

In terms of morphological pattern, the vertical pattern, with 72 septa (53.3%), was the most commonly encountered. The medio-lateral pattern, with 43 septa (31.9%), ranked second and the antero-posterior pattern, with 20 septa (14.8%), ranked third. No statistically significant difference was observed in the distribution of morphological patterns among the three dentition groups (P = 0.425).

The mean septal length in the entire sample was 8.23 mm, with a standard deviation (SD) of 3.704. The minimum measured length was 2.40 mm, and the maximum length was 26 mm. One-way analysis of variance showed no statistically significant difference in septal length among the three dentition groups (P = 0.936). ❑

DISCUSSION

The findings of this study showed that the overall prevalence of maxillary sinus septa in the study population was 41.2%, which lies

within the range reported in other studies (16–58%) (12-16). This variability in prevalence may be attributed to racial differences, imaging techniques and measurement criteria (12).

Regarding the relationship between dentition status and the presence and number of septa, the present study found no significant differences in the presence or number of septa among the complete dentition, complete edentulism and partial dentition groups. This finding is consistent with the study conducted by Jang *et al* (5), which also found no significant difference in septal prevalence between dentate and edentulous patients. However, some studies, such as that of Shibli *et al* (4), have reported that septa are more likely to form in edentulous individuals, which may be due to irregular pneumatization of the sinus floor following tooth loss (2).

Regarding septal location, our study found that the highest frequency was in the lateral wall (48.1%) and the distribution across groups was statistically significant. This finding is in agreement with the study carried out by Bornstein *et al* (6), who reported that septa mainly originated from the lateral and inferior walls. From a clinical perspective, this is important because septa located on the lateral wall may complicate access to the sinus during sinus lift procedures (6).

The vertical morphological pattern, with a frequency of 53.3%, was the most common in the present study. This result is consistent with the findings of Hungerbühler *et al* (10), who reported a vertical pattern in 53.2% of cases. However, in the United States, Tadinada *et al* (13) reported the horizontal pattern as the most common, and this discrepancy may be due to racial differences or variations in classification methods.

In the anatomical region, the molar region (58.8%) had the highest frequency of septa. This finding is in line with several studies, including those conducted by Sigaroudi *et al* (14) in Rasht and Bornstein *et al* (6) in Switzerland, which found that septa were more frequently located in the molar region. From a clinical standpoint, this is important because most implants are placed in the molar area and the presence of septa in this region can influence treatment planning (17).

The mean septal length in this study was measured as 8.23 mm, which is greater than in some studies, such as that of Fazeli *et al* (10), who reported a mean length of 9.5 mm. This difference may arise from variations in measurement criteria or differences in the characteristics of the study populations. Clinically, longer septa may pose greater challenges during surgery (15).

The present study is among the relatively few large-sample studies in the Khuzestan region and was conducted using standard CBCT methodology. However, there are limitations, including the study's retrospective design and the COVID-19 pandemic's impact on patient referrals. Furthermore, the lack of evaluation of other potential factors influencing septum formation, such as sinus pathologies, is another limitation of the present study. ❑

CONCLUSION

The findings of this study indicate that maxillary sinus septa, with a prevalence of 41.2%, are common structures in the studied population. These septa are predominantly located on the lateral wall and in the molar region, and the vertical morphological pattern is the most frequent. No significant association was observed between patients' dentition status and septal characteristics, except for septal location. This anatomical information can be helpful to dentists and maxillofacial surgeons in planning implant and sinus-lift surgeries and may help reduce potential complications. Prospective studies with larger sample sizes and broader geographic distribution are recommended. ❑

Patient informed consent: obtained.

Conflicts of interest: none declared.

Financial support: This study was financially supported by the Deputy of Research and Technology Development of Ahvaz Jundishapur University of Medical Sciences (project number U-00285).

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