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Applying Cone Beam Computed Tomography to Examine Maxillary Sinus Septa and Figuring Out the Occurrence of Morphological Patterns

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ABSTRACT

Introduction and objective: *A comprehensive examination of anatomical characteristics, particularly the maxillary sinus septa, is crucial for the efficacy of sinus interventions. The current research employed cone beam computed tomography (CBCT) to figure out the position of the maxillary sinus septa and the prevalence of particular morphological patterns.*

Materials and methods: *This descriptive-analytical retrospective study was conducted in 2020. The sample size (n=108 samples) was determined by a census method, where all CBCT images of the maxillary arches of patients visiting the Radiology Department of the Faculty of Dentistry, Ahvaz University of Medical Sciences, Iran, during the years 2018–2019, were included in the present study. All images were obtained and stored using the NewTom VGi (QR, Verona, Italy) system under automatic exposure conditions. Data were collected by the researcher using a checklist and then analyzed using SPSS version 22 at a significance level of 0.05.*

Results: *The results indicated that the prevalence of septa was 21.3%, with the majority (8.3%) on the inferior wall. The distribution of septa was similar between genders and across the molar and premolar regions. The direction of septa was vertical in 60% of cases, with no significant difference between genders (P>0.05). Vascular structures were present in 40% of cases, with no significant gender-related differences (P>0.05). The maxillary sinus septa were 5.51±9.34 mm long and 4.94±1.09 mm apart from the vascular structures.*

Conclusion: *It is hoped that the results of this study may help reduce the risk of complications during sinus lift surgeries, particularly in terms of minimizing the occurrence of severe bleeding.*

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

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BACKGROUND

The maxillary sinus develops into an air-filled canal (1). Septa normally split the maxillary sinus cavity into several pieces (2). Teeth fall out, the vertical bone dimension of the maxilla decreases because the posterior alveolar process resorbs (3).

Implant placement in the posterior maxilla can be difficult due to the pneumatization of the maxillary sinus, which decreases the vertical bone dimension; therefore, the only way to fix it and get implants in the right places is to do sinus floor elevation surgery (4). Issues that occur during sinus lift surgery may impact implant performance. The presence of septa has been linked to complications such as sinus membrane perforation (2, 5), which occurs in 4-7% of cases during sinus lift surgery (5). Avoiding bleeding and membrane rupture requires an understanding of the maxillary sinus vascular architecture (6).

Cone beam computed tomography (CBCT) is widely used for a precise anatomical evaluation of the maxillary sinus. Studies have shown variations in septa prevalence and orientation, with reports indicating that one-third of maxillary sinuses contain septa, and their presence is more frequent in edentulous patients. Additionally, pathological conditions such as mucosal thickening and sinus opacification have been observed in CBCT analyses, emphasizing the need for preoperative imaging (4, 7-9).

Given these considerations, the present study aims to assess the frequency and morphological patterns of maxillary sinus septa as well as their relationship with the posterior alveolar artery in the Ahvaz population. Understanding these anatomical variations can aid in improving surgical planning and minimizing complications in implant dentistry (3). ❑

MATERIALS AND METHODS

This was a descriptive-analytical retrospective study conducted in 2020. The sample size was determined using a census method. In this approach, all CBCT images (totaling 108 samples) of the maxillary arches from patients visiting the Oral and Maxillofacial Radiology Department in the Dentistry Faculty, Ahvaz University of Medical Sciences, Iran, during the years 2018–2019, were included in our study. The inclusion criteria for the present study were high-quality images with information on patient's age, gender and coverage of the posterior maxillary region. Exclusion criteria were patients with a history of sinus surgery, sinus tumors, sinonasal polyps, or midfacial trauma.

Methods

With an exposure setting of (Kvp=90, 9-second duration), all photographs were captured and saved using the NewTom VGi gadget (QR, Verona, Italy) with a FOV of 11 x 8 cm. On a 15.6-inch Asus monitor (Korea), an oral and maxillofacial radiologist examined the pictures with NNT Viewer software (version 3.00, QR, Verona, Italy). Cone beam computed tomography scan volumetric data was used to build multi-planar reconstructed coronal images, which were then used to assess the maxillary sinus septa. Patients' sex and the degree to which their upper jaws were fully or partially dented, or completely missing teeth, were also documented in this investigation following the methodology proposed by Hangerbohler *et al* (7).

We used the software's ruler tool to take all measurements in a dark room on a monitor that met all the requirements. Two millimeters was the lowest threshold for septal prominence. The premolar (including the gap between the distal canine and the distal second premolar) and molar (including the mesial first molar and the maxillary tuberosity) areas were used to classify the septa. Sigaroudi (10) investigation used axial images to assess the presence of septa in the left and right maxillary sinuses. Slice thickness was fixed at one millimeter and the sinuses were scanned sequentially at one millimeter intervals. As stated by Danesh (11), coronal sections were taken at the second molar, first molar, second premolar and first premolar sites in order to evaluate the presence of the anterior-posterior alveolar artery in the lateral wall of the sinus and its relationship to the septa. A digital caliper was also used to measure the length of the septa and the distance between it and the vessels.

Data analysis

Quantitative variables were reported as means (standard deviations) and qualitative variables as frequencies (percentages). The normality of quantitative variables was confirmed using the Kolmogorov-Smirnov test. For data analysis, SPSS

version 22 was used, with a significance level being set at 0.05. ❑

RESULTS

Results showed that out of 108 participants (43.5%males and 56.5% females), 85 (78.7%) subjects did not have any septa in their maxillary sinus, nine (8.3%) had one septum in their inferior wall and nine (8.3%) in their lateral wall, while five (4.7%) subjects had one septum in their posterior wall. Among participants with maxillary sinus septa, 12 (52.2%) were females and 11 (47.8%) males. The prevalence of maxillary sinus septa in males and females did not differ statistically significantly (P>0.05). The vertical morphological pattern was observed in 13 (56.5%) of participants with maxillary sinus septa. In addition, among the males and females with maxillary sinus septa, five (45.4%) and nine (75%), respectively, showed the vertical pattern. The morphological pattern of maxillary sinus septa did not differ substantially (P>0.05) between males and females. Furthermore, 11 (10.2%) out of all participants had vessels detected close to the septa. Although 11 (47.8%) subjects had arteries close to the maxillary sinus septa. Among the male subjects of our study, 15 (21.7%) had blood vessels close to the septa. Regarding the existence or lack of vessels near the septa, there was no statistically significant difference (P>0.05) between male and female participants. Table 1 shows the results according to location and Table 2 according to gender, for the distribution (%) of the frequency of maxillary sinus septa.

According to Table 3, females' distance to the maxillary sinus septum was 3.77 mm, which was significantly greater than men'. However, the distance to the maxillary sinus septum did not differ significantly by gender (P = 0.607).

The length of the maxillary sinus septum in males was 10.65 mm, which was more significant than in females. However, there was no significant difference between gender and the length of the maxillary sinus septum (Table 4, P = 0.438). ❑

TABLE 1. Distribution (percent) of maxillary sinus septa frequency based on location

Variable	Maxillary sinus septa				Total
	Present		Absent		
	n	Percent	n	Percent	
No septa	0	0	85	100	85
Premolar	12	52.2%	0	0	12
Molar	11	47.8%	0	0	11
Total	23	21.3%	85	78.7%	108

TABLE 2. Distribution (percentage) of maxillary sinus septa frequency based on gender

Variable	Maxillary sinus septa				Significance level
	Male		Female		
	n	Percent	n	Percent	
Premolar	6	54.5			P > 0.05
Molar	5	45.5			
Total	11	100	12	100	

TABLE 3. Distance to the maxillary sinus septum based on gender

Variable	Distance to maxillary sinus septum	
	Male	Female
Mean	2.55 mm	3.77
Standard deviation	5.24 mm	
Minimum	0	
Maximum	17	
Significance level	0.607	

TABLE 4. Length of the maxillary sinus septum based on gender

Variable	Length of maxillary sinus septum	
	Male	Female
Mean	10.65 mm	
Standard deviation	6.04 mm	
Minimum	3.40 mm	
Maximum	21.10 mm	
Significance level	0.438	

DISCUSSION

The findings of this study demonstrate the occurrence of maxillary sinus septa in 21.3% of participants, which falls within the lower range reported in previous studies. According to the literature, the prevalence of maxillary sinus septa varies significantly, with rates ranging from 20% to 69%, depending on the population and imaging techniques used (12, 13). The prevalence observed in our study is consistent with the 20% to 36% reported in studies using CBCT imaging (14, 15), further confirming the value of CBCT as a reliable tool for identifying sinus septa. Possible explanations for the disparities include racial inequalities and geographical variances in the populations' living conditions.

Regarding the location of the septa, we found that inferior and lateral wall septa were the most common, which was in accordance with previous

findings indicating that septa were frequently located in the posterior and lateral sinus walls due to bone resorption following tooth loss (16, 17). However, our results differ from some studies that have reported a higher prevalence of septa in the anterior maxillary sinus (18). This discrepancy may be attributed to population differences and variations in edentulism among study participants.

The morphological pattern of the maxillary sinus septa was predominantly vertical (56.5%), which was consistent with previous reports identifying vertical septa as the most frequent configuration (19). Interestingly, while our study observed a higher proportion of vertical septa in females (75%) compared to males (45.4%), this difference was not statistically significant ($P > 0.05$). Similarly, previous studies have reported that gender has no significant impact on septa prevalence, morphology, or location, reinforcing the notion that these anatomical variations were not sex-dependent (20).

A clinically relevant finding was the presence of blood vessels near the septa in 47.8% of cases and in 10.2% of the total study population. This observation is particularly important, as the proximity of vascular structures to the septa may increase the risk of intraoperative bleeding during sinus augmentation procedures. Previous studies have also emphasized the importance of vascular anatomy in sinus surgery, with reports suggesting that vessels located near septa may contribute to complications such as membrane perforation (21). Our study further supports the need for detailed preoperative CBCT assessments to identify vascular risks, which could significantly enhance surgical safety.

While no statistically significant gender-based differences were observed in the distance of septa from adjacent structures or the length of the septa, our findings indicate that males had slightly longer septa (mean 10.65 mm) than females. This aligns with previous research showing a tendency for greater sinus dimensions in males, though the differences often remain insignificant (22). These variations reinforce the importance of individualized imaging and surgical planning rather than relying on generalized anatomical assumptions based on gender.

This study contributes to the existing body of knowledge by providing population-specific data on the prevalence, morphology and vascular associations of maxillary sinus septa. While previous studies have established the clinical significance of septa in sinus augmentation, our research adds to the literature by emphasizing a detailed analysis of septa location and morphology in a specific population (Ahvaz), which is valuable for regional implantology and surgical planning. The high prevalence of vascular structures near septa (47.8%) reinforces the importance of using preoperative imaging to minimize intraoperative complications. Confirmation that gender does not significantly affect septa prevalence or morphology supports the use of CBCT imaging for personalized treatment planning rather than relying on demographic predictors. Given the clinical implications of these findings, future research should focus on evaluating the impact of septa on implant success rates and surgical outcomes in different populations to further refine treatment protocols. ❑

CONCLUSION

It was concluded that 21.3% of participants in the present study exhibited maxillary sinus septa, with no significant difference in prevalence between male and female subjects. The vertical morphological pattern was the most common, particularly among female participants, though this difference was not statistically significant. Additionally, 10.2% of participants had vessels near the septa, but no significant gender differences were observed in vascular proximity. While females had a greater average distance to the maxillary sinus septum and males had longer septa, these variations were not statistically significant. These results contribute to the anatomical understanding of maxillary sinus septa, which may be relevant for surgical and clinical applications. Further studies with larger sample sizes are recommended to explore potential clinical implications. ❑

Conflicts of interest: none declared.

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Informed patient consent: The authors confirm that written informed consent has been obtained from all patients involved in the present study.

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