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ORIGINAL RESEARCH

Prevalence, Location, and Size of Maxillary Sinus Septa: Computed Tomography Scan Analysis

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ABSTRACT

Introduction: The present study was undertaken to evaluate the anatomy of the maxillary sinus in relation to its position and the height of its septa, using cone beam computed tomography (CBCT).

Materials and methods: In this descriptive retrospective study, 300 CBCT images of maxillary sinuses of patients with posterior maxillary edentulism were evaluated. The maxillary sinus septa were evaluated in relation to their prevalence, height, and position; t-test and Mann–Whitney tests were used for the analysis of data.

Results: Sinus septa were detected in 44% of the subjects, with equal frequencies in the anterior, middle, and posterior positions. The mean height of the septa was 3.6 ± 1.56 mm.

Conclusion: In a population of Iranian subjects, in half of the cases, the sinus septa might be present in the anterior, middle, and posterior positions.

Clinical significance: In order to avoid intraoperative problems during sinus lift procedures, it is necessary to accurately evaluate the sinus, preferably with the use of CBCT.

Keywords: Cone beam computed tomography, Dental implant, Maxillary sinus septa.

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INTRODUCTION

Currently, sinus lift procedures using the lateral window technique are a safe and predictable method for the reconstruction of atrophic posterior maxilla for placing implants; however, it is a sensitive technique and requires surgical expertise of the surgeons.[1] A lack of accurate knowledge about the anatomy of the maxillary sinus before the sinus lift procedure might result in intraoperative problems.[2] Perforation of the Schneiderian membrane is the chief intraoperative complication, occurring in 11 to 56% of sinus lift procedures.[3] The presence of septa increases the risk of perforation of the membrane. The maxillary sinus septa were first described by Underwood in 1910.[4] Septa are partitions of the cortical bone and are found in the form of an inverted gothic arch, originating from the inferior or lateral walls of the sinus[5] (Fig. 1).

Maxillary sinus septa are varied in size and position, and different prevalence rates have been reported in various studies.[6-8] Septa might be detected in 9 to 70% (a mean of 36%) of patients.[9] Panoramic radiographs are not reliable in this context because they yield false-positive

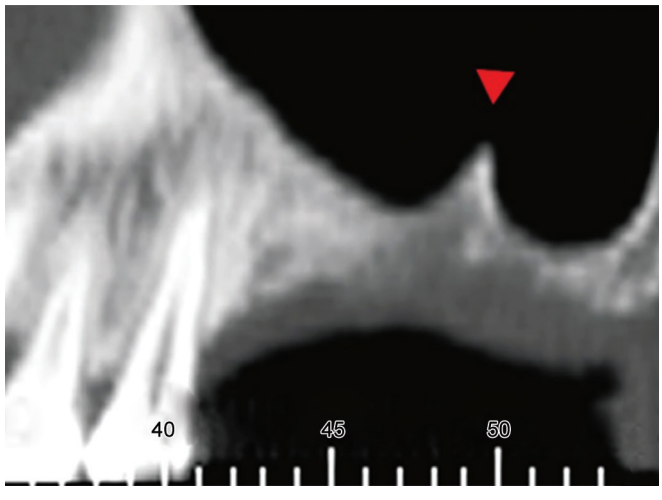

Fig. 1: Septa originating from the inferior wall of sinus

results of the presence of septa in 11.8 to 52.68% of the cases.[10] Based on the latest guidelines of the European Association of Osseointegration and the International Team for Implantology, three-dimensional (3D) imaging techniques, such as computed tomography (CT) and cone beam computed tomography (CBCT) are preferable for such evaluations.[11] In this context, an accurate imaging technique, i.e., able to provide a 3D view of the anatomy of the maxillary sinus will be very useful.[11] The CBCT is a medical imaging technique that uses X-rays to provide images.[12] During the imaging procedure, the scanner of the machine revolves around the patient's head and provides approximately 600 diagnostic images, which are reconstructed by the software program of the machine. These images can be used to evaluate each area from different and unique angles.[13,14] The CBCT technique was introduced to the dental field in the late 1990s.[15,16] One of the most important advantages of CBCT is a decrease in the patient radiation dose.[17-19]

It is very important to observe and identify septa before sinus lift procedures because designing of the lateral window during the sinus lift procedure depends on the presence and height of these septa. Therefore, the aim of the present study was to determine the prevalence, position, and size of maxillary sinus septa, using the CBCT imaging technique, in a population of Iranian subjects for the placement of implants in the posterior maxilla.

MATERIALS AND METHODS

The present descriptive retrospective study was carried out in the Department of Periodontics, Shahed University, during 2014–2015. The protocol of the study was approved by the Ethics Committee of Shahed University. The digital images were taken by a CBCT unit (Newtom VG, Verona, Italy) using the following exposure conditions: kVp = 110, mA = 4.08–6.09, *t* = 3.6 seconds, field of view = 160 × 110 cm, voxel size of 0.3 mm for full and 0.25 mm for zoom, and slice thickness = 1 mm.

A total of 300 CBCT images of 138 females and 162 males, with an age range of 33 to 86 years, were retrieved from the archives of a specialty radiology center; they had been referred to the clinic in 2014–2015. All the CBCT images had been taken in order to place dental implants. The images were selected randomly based on inclusion criteria, which consisted of the following: (1) CBCT images of posterior maxilla when upper molars and premolars are absent at least on one side; (2) visibility of at least 2 cm above the sinus floor; and (3) no motion or scattering artifacts. Images exhibiting changes in the morphology of sinus walls due to trauma or pathologic conditions were excluded from the study.

The maxillary sinus septa were evaluated on the coronal cross-sections with the use of the quantitative radiology software program (NNT Workstation, Version 4.5, Verona, Italy). Data were recorded in special forms for each patient.

The maxillary sinus septa were evaluated in relation to the following variables:

Prevalence (in Terms of Gender, Age, and the Type of the Residual Ridge)

The type of the residual ridge was evaluated based on a classification introduced by Lekhom and Zarb[32] in terms of the amount of resorption in the edentulous area: (A) Ridges with no signs of atrophy; (B) ridges with some atrophy, with adequate ridge width and a small amount of decrease in ridge height; (C) advanced ridge atrophy, with decreases in both the width and height of the ridge; (D) severe atrophy of the ridge with severe decreases in the height and width of the ridge; and (E) complete atrophy of the ridge.

Position

In order to evaluate the position of the septa, the sinus floor was divided into three segments: Anterior, middle, and posterior. In the present study, since all the patients were edentulous, the positions of the teeth were estimated by a software program.

In order to classify septa location, the antral cavity was divided into three regions according to the protocol by Kim et al: Anterior (mesial to the distal aspect of the 2nd premolar), middle (distal to the 2nd premolar to distal of the 2nd molar), and posterior (mesial to the distal aspect of the 3rd molar).[20]

Height

The height of the sinus was also evaluated. In addition, the patients were divided into two groups – partially and completely edentulous. The images were evaluated by a trained observer.

All measurements were taken twice by the same observer at an interval of 2 weeks.

Statistical Analysis

Statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS) software program (Version 22.0, Armonk, NV:IBM Cor, USA). Significance was accepted at $p < 0.05$.

Descriptive statistics (means, variance, standard deviations, and change ranges) were used for the analysis of data. The t-test was u sed to compare the means between the two groups with the use of quantitative data

and the relative measurement scale; Mann–Whitney and Kruskal–Wallis nonparametric tests were used to compare the means between the two groups with the use of qualitative data and ordinal measurement scale.

RESULTS

The mean age of the subjects was 62.4 ± 10.6 years, with a range of 33 to 86 years. The results of the study showed that septa were present in 44% of the sinuses, with no significant differences in the presence and observance of septa between males and females ($p > 0.05$) (Table 1).

In subjects exhibiting septa, the septa were detected in the posterior, middle, and anterior areas of maxillary sinuses in 32.6, 34.8, and 52.6% of the cases respectively, with no significant difference between males and females ($p > 0.05$) (Table 2).

The mean height of the septa was 3.67 ± 1.56 mm in males and females. Based on the results of the t-test, there was a significant difference in the mean heights of septa between males and females ($p = 0.006$). The mean heights of septa were 4.08 ± 1.64 and 3.33 ± 1.42 mm in males and females respectively ($p < 0.01$) (Table 3).

Based on the classification given by Zarb and Lekhom, the majority of the subjects in the present study had ridges in the C (53%) and D (335%) categories (Table 4).

The results of Kruskal–Wallis test did not show any relationship between the type of the edentulous ridge and the prevalence of septa ($p > 0.05$).

In addition, the results of the Mann–Whitney test showed no relationship between the type of edentulism (complete or partial) and the prevalence of septa ($p > 0.05$).

Table 1: The prevalence of septa in terms of gender

		Absence of septa	*Presence of septa*	*p-value*
Gender	Male	78 (56.5%)	60 (43.5%)	0.867
	Female	90 (55.5%)	72 (44.5%)	

Table 2: The position of septa in terms of gender

		Posterior	*Middle*	*Anterior*	*p-value*
Gender	Male	24 (41.3%)	16 (27.6%)	18 (31.3%)	0.189
	Female	19 (25.7%)	30 (40.5%)	25 (33.8%)	

Table 3: The descriptive data of the heights of septa in terms of gender

Gender	*Min*	*Max*	*Mean*	*SD*	*SEM*
Male	2.7	8.8	4.08	1.64	0.21
Female	1.5	7.6	3.33	1.42	0.17

SD: Standard deviation; SEM: Standard error of the mean

Table 4: Evaluation of different types of residual ridges based on the classification of Zarb and Lekhom

	A	*B*	*C*	*D*	*E*
Frequency (%)	1.5	8	53	33.5	4

Pearson's correlation coefficient showed a correlation between age and the prevalence of septa ($p = 0.001$), with a decrease in their prevalence with aging.

DISCUSSION

Considering the changes in the volume and size of bone in the edentulous posterior maxilla due to the expansion of the maxillary sinus in association with the resorption of the alveolar bone, it is necessary to increase the volume and size of the bone in this area in order to place implants.[21] The sinus lift procedure in this area is one of the best and safest methods to solve such a problem.[1] Therefore, it is necessary for the surgeon to acquire proper knowledge about this area. The prevalence of septa can be calculated based on either the number of sinuses that have septa or the number of patients who have septa.

In the present study, almost half of the sinuses exhibited septa (44%). Based on a systematic review in 2001 by Maestre-Ferrín et al,[22] in studies in which the prevalence of septa was expressed in terms of the number of sinuses, the prevalence of septa was 13 to 35.3%, and in studies in which the prevalence of septa was reported in terms of the number of patients, the prevalence of septa was 21.6 to 66.7%. Based on a systematic review by Malec et al in 2014,[9] septa were detected in 9 to 70% of the subjects in all the age groups, with a mean prevalence rate of 36%. The prevalence rates of septa have been reported differently in different studies, depending on the type of edentulism (partial or complete), the patients being dentate, and the imaging technique used (CBCT, CT, or panoramic). Ilguly et al,[33] Maestre-Ferrín et al,[7] Malec et al,[23] Qian et al,[24] and Sakhdari et al[25] reported rates of 55.2, 53.2, 49, 48.2 and 44.8% respectively, for the prevalence of sinus septa, almost consistent with the results of the present study. Based on a study by Faramarzie et al,[26] the sequence of tooth extraction might affect the position of septa in the maxillary sinus.

Septa were detected in the three posterior (32.6%), middle (34.8%), and anterior (32.6%) segments of the sinuses almost equally. In the study by Maestre-Ferrín et al,[7] septa were present in the middle, posterior, and anterior segments of the sinus in 60, 22.5, and 17.5% of the cases respectively. In a study by Kim et al,[20] septa were found in 50.8 and 23.7% of the sinuses in the middle and posterior segments respectively. In studies by Pommer et al[27] and Bornstein et al,[28] the most frequent positions of the septa were above the 1st and 2nd maxillary molars. In a study by Shahidi et al,[29] septa were present in the anterior, middle, and posterior segments of the sinuses in 58.9, 21.1, and 20% of the cases respectively. Such a discrepancy between the results might be attributed to individual differences and minor differences in dividing the sinuses into

anterior, middle, and posterior segments. In relation to the position of septa, there were no significant differences between males and females in the present study, consistent with the results reported by Maestre-Ferrín et al.[7]

In the present study, the mean height of septa was 3.67 ± 1.56 mm (with a range of 1.5-8.8 mm). Different studies have reported different heights for septa.[9] Qian et al[24] reported mean heights of 6.44, 5.56, and 4.39 mm in the medial, middle, and lateral areas of the sinuses respectively. In a study by Sakhdari et al,[25] the mean height of septa on the right side was 6.3 mm, with 7.1 mm on the left side. In a study by Naitoh et al[30] too, the mean height of septa was reported to be 3 mm, almost consistent with the present study.

The results of the present study showed no relationship between the type of edentulism (complete and partial) and the prevalence of septa, consistent with the results of a study by Qian et al.[24] Some studies have reported a higher prevalence of septa in totally edentulous subjects compared with partially edentulous subjects, which was attributed by Kim et al[20] to the fact that atrophic edentulous maxilla generally contains secondary septa.[31]

CONCLUSION

Based on the results of the present study, 44% of the maxillary sinuses had septa. In order to avoid intraoperative problems during sinus lift procedures, it is necessary to accurately evaluate the sinus, preferably with the use of CBCT.

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