

Maxillary Sinus Septa Prevalence and Morphology-Computed Tomography Based Analysis

Prevalencia y Morfología del Septo del Seno Maxilar.
Análisis Basado en Estudios de Tomografía Computadorizada

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MALEC, M.; SMEKTALA, T.; TUTAK, M.; TRYBEK, G. & SPORNIAC-TUTAK, K. Maxillary sinus septa prevalence and morphology - computed tomography based analysis. *Int. J. Morphol.*, 33(1):144-148, 2015.

SUMMARY: The aim of this study was to examine the prevalence, location and morphology of maxillary sinus septa, and in particular sagittally orientated forms, which cannot be visualized by classic 2D x-rays. Thereby authors would like to provide information about the potential patient group, to be referred for the computed tomography scan before sinus lift procedure. The analysis was based on 216 computed tomography archival images. The exclusion criterion was occurrence of any suspected pathology in the maxillary region. The septa prevalence that was investigated in computed tomography was high (49%) with the mean height of 5.44 mm. The incidence of sagittally orientated septa as a challenge in 2D x-rays was 10%, with the second molar region as the most frequent location. Based on the obtained results and radiation safety principles, the authors suggest that orthopantomogram x-ray may be a sufficient ancillary radiological examination before beginning preimplant surgical procedure in the area of the maxillary sinus.

KEY WORDS: Dental Implants; Sinus Floor Augmentation; Maxillary Sinus.

INTRODUCTION

Since the maxillary sinus lift procedure has become routine in oral rehabilitation, detailed knowledge related to maxillary sinus anatomy and its variations is indispensable. One of the most common morphological variations was described by Underwood as sinus septa (Underwood, 1909). Septa prevalence should be considered on each occasion prior to sinus lift surgery, as its presence may lead to perforation or tearing of the Schneiderian membrane or a reduction in the capability of augmentation steps and may force the surgeon to enlarge the operation to an extent that it may result in a decrease in treatment success rate (Underwood, 1909; van den Bergh *et al.*, 2000; Chanavaz, 1990; ten Bruggenkate *et al.*, 1998; Ulm *et al.*, 1995; Ella *et al.*, 2008).

Standard diagnostic technique in oral implantology is an orthopantomogram (OPG). However in OPG, the septa cannot be decisively excluded or detected due to the difficulty in clearly differentiating it from other anatomic structures, perhaps resulting in a false diagnosis in 11.8–

52.68% compared to computed tomography (CT) (Ulm *et al.*; Ella *et al.*). This makes the computed tomography scan obligatory before sinus floor elevation (Kasabah *et al.*, 2002; Koymen *et al.*, 2009; Krennmair *et al.*, 1997; Pommer *et al.*, 2012). Nevertheless, the radiation dose means that there has to be a policy regarding the careful use of this method.

Consequently, the aim of this study was to examine the prevalence, location and morphology of maxillary sinus septa, especially those sagittally orientated which cannot be visualized in OPG. A correlation between the anatomic variation and age, sex or side of localization was also investigated. The authors would also like to provide information about the potential number of septa that cannot be diagnosed in OPG (the standard method), leading to examples of diagnostic mistakes and failure during later surgical procedures. This data is aimed to assist in the establishment of clear guideline for CT scan patient screening prior to sinus lift procedure.

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MATERIAL AND METHOD

This retrospective study was based on an analysis of 216 computed tomography archival images obtained from the Private Unit of Maxillofacial Radiology. The selection criteria was that only scans performed for reasons other than the visualization of suspected pathology in maxillary region could be included in the analysis. Cone beam computed tomography (CBCT) scans were obtained from an I-CAT device (Imaging Sciences International, Hatfield, UK). Images were recorded at 120 kVP and 3–5 mA using a 160 mm field of view, an axial slice thickness of 0.2 mm with isotropic voxels. Image analysis was performed via RadiAnt software, v1.8 (Medixant, Poznań, Poland).

Each patient signed consent forms prepared in accordance with the principles of the Helsinki Declaration, including all amendments and revisions.

All examinations and measurements were carried out by a PhD fellow in oral surgery with at least 3 years experience (M.M.). The septa were diagnosed and measured in three orthogonal slice views: transverse, coronal and sagittal. All measurements were taken twice by the same observer at an interval of 2 weeks (M.M.).

Patients were divided into groups depending on age and sex. The septa were divided according to location, orientation and type (partial, complete). The mean height of the septa was measured. In order to classify septa location, the antral cavity was divided into three regions: anterior (above the premolars), middle (from the first molar to the second) and posterior: (mesial to the distal aspect of the third

molar). The Pearson X^2 test was performed for statistical analysis with regard to sex, age and localization ($p < 0.05$). The prevalence of exostoses was also checked. All records were made in Microsoft Excel 2003 (Microsoft Office, Redmond, WA, United States). If the vertical dimension of the septa was over 2.5 mm it was included in the study, otherwise it was classified as exostosis (Ulm *et al.*). Statistical analyses were carried out using SPSS version 12.0.1 software program (SPSS, Chicago, Ill., USA).

RESULTS

The analysis of the CBCT scans revealed that septa occurred in 106 of 216 patients (49%). One hundred and sixty three septa were present in 432 sinuses. Patient age ranged from 23 to 92. The average number of septa was 1.52 ± 0.7 ; in most cases one septa occurred (60%) with an average height of 5.44 mm. The location of the septa was, in most cases, the middle region: 90 septa (66%) were above the roots of the second molar (Table I). Next in order of prevalence was the anterior region where were 30 septa (18%) were noted. In the posterior region 21 septa (13%) were found. The most frequent orientation was the coronal plane (59%). Data in regard to sex are listed in Table II and III.

In this study the prevalence of exostoses was also performed and reached 16%, with a higher prevalence on the left side. No statistically significant differences were observed with regard to sex or localization. The only significant relationship was septa occurrence in the 50-59 age group ($p > 0.05$) (Table IV).

Table I. Brief characteristics of the study group and the main results of the analysis.

	Men	Women
Number of examined objects (%)	112 (52%)	104 (48%)
Mean age	56±15	56±13
Septa prevalence (%)	50 (47%)	56 (54%)
Mean septa prevalence	1.51±0.74	1.54±0.65
Most prevalent location	Region of 2 nd molar	Region of 2 nd molar
Mean height (mm)	6.13	4.88
Type (partially/complete)	Partially	Partially
Most prevalent orientation	Frontal	Frontal
Side of incidence	49% right	51% right

Table II. Septa orientation and location in females. Women (56- number of patients where septa occurred).

Regio 4	Regio 5	Regio 6	Regio 7	Regio 8	Orientation
3%	3%	3%	7%	2%	Sagittal
6%	10%	16%	36%	12%	Frontal
---	7%	10%	14%	5%	Transversal

Table III. Septa orientation and location in males. Men (50- number of patients where septa occurred).

Regio 4	Regio 5	Regio 6	Regio 7	Regio 8	Orientation
2%	6%	4%	---	---	Sagittal
9%	6%	26%	32%	20%	Frontal
4%	6%	6%	4%	4%	Transversal

Table IV. Septa number and occurrence according to age group.

Age	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	Total
Prevalence	0,00%	0,93%	0,93%	4,63%	12,04%*	6,94%	2,78%	0,46%	0,00%	1 septa
	0,00%	1,39%	1,85%	2,31%	5,09%	3,24%	0,93%	0,00%	0,46%	2 septa
	0,00%	0,93%	0,46%	0,93%	2,31%	0,00%	0,46%	0,00%	0,00%	3 septa
	0,00%	0,00%	0,00%	0,46%	0,00%	0,00%	0,00%	0,00%	0,00%	4 septa

*Significant relationship between septa occurrence and age group.

DISCUSSION

The presented study revealed that the prevalence of sinus septa is 49%, relatively high in regard to other reports which were in the range of 25–35.5% (Ulm *et al.*; Kasabah *et al.*; Gonzáles-Santana *et al.*, 1997; Kim *et al.*, 2006; Underwood, 1910). Nonetheless it should be reiterated that the most reliable method of measurement is only obtained through the use of CT scans.

The average septal height was found to be 5.5 mm, a similar figure reported by other researchers who reported mean heights of 5.9±3 mm, 5.4 mm and 4.9 mm, respectively (Velásquez-Plata *et al.*, 2002; Gosau *et al.*, 2009; Maestre-Ferrin *et al.*, 2011). The height of the septa may have an influence on sinus lift procedures used in maxillary bone compromised patients before dental implant treatment (Neugebauer *et al.*, 2010). The septa can limit the view of the sinus floor or placement of grafts, and therefore the proper filling of the sinus floor (Ulm *et al.*, 1995). A modification of conventional surgical procedure might be required where a complete septa at the frontal plane occurred, in this case a double window technique would be necessary (van den Bergh *et al.*; Betts & Miloro, 1994). Another interesting alternative is the possibility of using the septa as an implant field to avoid a sinus lift procedure completely (Fortin *et al.*, 2013). If the septa (exostosis) is lower than 2.5 mm or situated in a position which would not disturb any procedures, other treatments are not required. However a medium sized, sagittal or horizontal septa can limit access to the maxillary sinus and required more advanced procedures through a modification of the opening window shape (van den Bergh *et al.*; Fortin *et al.*).

Regarding location, our study presented a greater incidence in the middle region (66%) as the majority of other authors (Koymen *et al.*; Kim *et al.*; Velásquez-Plata *et al.*),

64%, 41.1%, 51%, although two observers did find more in the anterior region (Ulm *et al.*; Krennmair *et al.*).

Panoramic radiograph are the most commonly used diagnostic methods for planning dental implant treatment, but two-dimensional imaging may provide 11.8–52.68% of false-negative results (Kasabah *et al.*; Koymen *et al.*; Krennmair *et al.*; Pommer *et al.*). This may occur in situations especially if the septa is sagittally orientated. Our research revealed that summary sagittally orientated septa prevalence was 10%, especially above the area of the second molar. In recent years the CBCT technique has become more popular for maxillocraniofacial imaging (Mozzo *et al.*, 1998). It has the advantage that CT imaging and dose absorption is similar to dental panoramic radiology (Ludlow *et al.*, 2006). It is also important to note that beam-hardening artefacts, due to metallic materials, are weaker at CBCT than at multi slice CT (Carrafiello *et al.*, 2010). From a radiation point of view, CBCT examinations can be used in the place of CT in order to evaluate anatomical structures such as the maxillary sinus. However our study has shown a low incidence of potentially problematically orientated Septa - 10%. Its most frequent localization, above the area of the second molar, was also clinically negligible following guidelines for the amount of limited dental implants for fixed dental arch reconstruction (Heydecke *et al.*, 2012). This result may suggest that OPG will be sufficient in most cases. The greater availability of panthomogram in dental practices also is beneficial regarding their use, in contrast to CT or CBCT.

Septa incidence in relation to age, shows that the highest rate was found in age group from 50-59, which was also the most numerous, with the lowest number of septa being seen in the 10-19 and 80-89 age groups. Patients who make up the 50–59 age group are the most frequently referred for implantation procedures and as a result these are the individuals who should be most accurately diagnosed (Lee *et al.*, 2013; Di *et al.*, 2013).

CONCLUSION

Septa prevalence investigated in CBCT is high (49%) especially in the area above the second molar and frontal orientation. The mean height of septa is 5.44 mm. The only significant correlation of septa was noted between the incidence in the 50–59 age groups. The incidence of septa that could be problematic in OPG (sagittally orientated) was

10% with the second molar region as the most frequent localization. This result, together with the ALARA (As Low As Reasonably Achievable) radiation safety principles, have led the authors to suggest that OPG may be a sufficient ancillary diagnostic tool and test before any sinus lift procedures take place.

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RESUMEN: El objetivo de este estudio fue determinar la prevalencia, ubicación y morfología del septo del seno maxilar, y en particular de las formas orientadas sagitalmente, que no pueden ser visualizadas con el uso de equipos convencionales de Rayos X en dos dimensiones. De esta manera, se busca ofrecer información sobre el grupo potencial de pacientes, que serán sometidos a estudios de tomografía computadorizada antes de la elevación del seno maxilar. El análisis se basó en 216 imágenes de archivo de tomografía computadorizada. El criterio de exclusión fue la presencia de cualquier sospecha de patología en la región maxilar. La prevalencia de septos hallados en tomografía computadorizada fue alta (49%) con una altura media de 5,44 mm. La incidencia de septos orientados sagitalmente, encontrados en estudios de Rayos X 2D fue del 10%, siendo la localización más frecuente la región del segundo molar. De acuerdo a los resultados obtenidos y respetando los principios de seguridad radiológica, los autores sugieren que la ortopantomografía de rayos X puede ser un examen radiológico suficiente antes de comenzar el procedimiento quirúrgico de implante en el área del seno maxilar.

PALABRAS CLAVE: Implantes dentales; Elevación del piso del seno maxilar; Seno maxilar.

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Received: 22-06-2014
Accepted: 24-10-2014