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Anatomical characteristics of maxillary sinus septa visualized by cone beam computed tomography

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Abstract. Proper implant positioning in the posterior region of the edentulous maxilla commonly requires sinus floor elevation. Maxillary sinus septa increase the risk of membrane perforation during sinus floor elevation. The purpose of this retrospective, cone beam computed tomography (CBCT)-based study was to examine the frequency, number, location, and orientation of antral septa in the maxillary sinus. Further, possible associated factors were assessed. Measurements were performed on CBCT scans of 301 patients (602 sinuses). The data were analysed statistically with respect to patient age, sex, and dentition type. One or more septa were detected in 117 patients (38.9%). A total of 188 septa were found in the 602 sinuses (31.2%). Septa were most often coronally oriented (53.2%), followed by sagittal (24.5%) and transverse (22.3%) orientations. Septa were most often found in the region of the first and second molar (37.2%), followed by the posterior region of the third molar (33.0%) and the anterior region of the premolars and canines (29.8%). A significant association was found between edentulism and the presence of septa. For edentulous patients, the septa were most often transversally oriented. Maxillary sinus septa are encountered in every third patient. This may have an influence on the performance of sinus floor elevation.

Key words: oral surgery; pre-implant surgery; cone beam computed tomography; maxillary sinus; sinus septum.

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The cavity of the maxillary sinus is commonly subdivided by septa. Maxillary sinus septa are thin structures of cortical bone. These septa may divide the sinus into two or more compartments[1,2]. In 1910, the anatomist Arthur S. Underwood described the sinus septa as thin, fragile, and sickle-shaped walls[3]. Thus the maxillary sinus septa are often called Underwood's septa. The morphology of the maxillary sinus is influenced by the person's age and tooth loss. Edentulous and elderly patients show a decreasing dimension of the maxillary sinus[4]. With regard to the development of septa, there are two types of septa: primary septa originate from congenital diversity and secondary septa may develop after tooth loss and irregular pneumatization of the maxillary sinus floor[1,2,5].

Implant planning in the maxilla is often complicated by bone atrophy of the alveolar process, which mostly happens in the distal region of the alveolar ridge. With lower vertical bone height induced by resorption after tooth loss, the necessity for maxillary sinus floor elevation increases[6,7]. The need for sinus floor elevation procedures is also influenced by prosthetically driven implant planning, augmenting bone where it is needed. The presence of maxillary sinus septa influences any sinus floor elevation procedure, as the adhesive strength of the Schneiderian membrane is higher in the area of a maxillary septum[8,9]. Several studies have shown an association between the presence of maxillary septa and perforation of the membrane during sinus floor elevation[10–12]. With digital implant planning software based on cone beam computed tomography (CBCT), possible risks such as interfering maxillary sinus septa can be detected. These risks can be taken into account during implant planning and later implant placement[13,14].

The purpose of this study was to examine the frequency, number, location, and orientation of septa in the maxillary sinus based on CBCT imaging. Further, associations between sinus septa and individual patient-related factors (age, sex, and dentition type) were investigated.

Materials and methods

Study design

This retrospective study was based on CBCT scans that were performed consecutively at the Clinic of Cranio-Maxillofacial and Oral Surgery (CMFO-S), Centre of Dental Medicine of the University of Zurich, Switzerland. The CBCT scans were screened for the following inclusion criteria: (1) both maxillary sinuses were entirely depicted, (2) no detectable pathologies were present, (3) no foreign bodies or biomaterial were present, and (4) no surgical procedures had been performed according to the X-ray. The study protocol was approved by the Cantonal Ethics Committee of Zurich. The study was conducted in accordance with the World Medical Association Declaration of Helsinki.

Imaging and analysis

The CBCT scans examined in this study had a voxel size varying between 0.125 mm and 0.4 mm. The scans were generated by a KaVo CBCT scanner (KaVo 3D eXam; KaVo Dental, Biberach, Germany) with a field of view varying from 8 cm × 16 cm diameter to 13 cm × 16 cm diameter (operating parameters: 120 kV, 5 mA, 4 seconds of exposure time). Images were analysed using eXam Vision software (KaVo Dental).

The following patient-related parameters were recorded: sex (male, female), age (at the time of CBCT), and status of the upper jaw dentition (full dentition, partial dentition, or edentulous). The software measurement tool was used to measure the septa. The septa were recorded from a minimal expansion of 2 mm and categorized into sagittal, coronal, and transverse (axial) orientation (Fig. 1).

The septa were further spatially divided into anterior (distal canine to second premolar distal), middle (first molar mesial to second molar distal), and posterior (second molar distal to maxillary tuberosity region) sinus (Fig. 2). All measurements were performed by two independent raters (AH, CR). Initially both raters evaluated the same 15 patients and then re-evaluated these cases after a period of 3 months to obtain data on the inter-rater and intra-rater reliability.

Statistics

A descriptive analysis of the dataset was first performed. The χ^2 test was used to determine differences between patient age, sex, and dentition type and the occurrence of septa. Furthermore, the difference between the orientation of the septa and the dentition type was calculated using the same test. Cohen's kappa test was used to evaluate inter- and intra-rater reliability[15,16]. All statistical tests were performed using R software[17]. A P-value of less than 0.05 was considered as significant.

Results

Investigation of the general population

A total of 560 CBCT scans were performed at the CMFO-S clinic during the study period. Three hundred and one CBCT scans fulfilled the inclusion criteria and were included in the study. Thus, a total 602 maxillary sinuses were observed. Septa were detected in 117 patients.

Of the patients examined, 138 (45.8%) were male and 163 (54.2%) were female. The mean age of the patients was 44 years (median 43 years, range 18–87 years). With regard to the type of dentition, 173 (57.5%) patients had a full dentition, 106 (35.2%) had a partial dentition, and 22 (7.3%) were edentulous. Age was classified into the following groups: 18–20 years ($n = 31$), 20–30 years ($n = 81$), 30–40 years ($n = 33$), 40–50 years ($n = 35$), 50–60 years ($n = 47$), 60–70 years ($n = 38$), $\geq$ 70 years ($n = 36$).

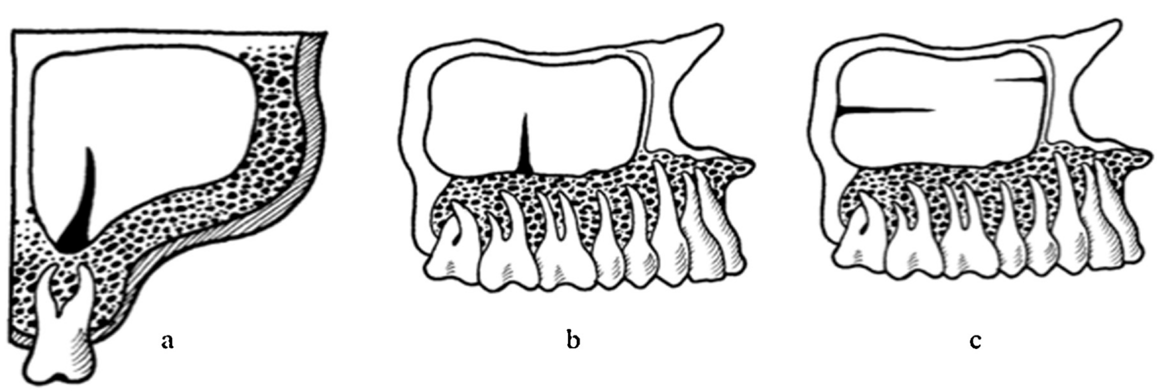

Fig. 1. Septa orientation: (a) sagittal septum shown in a coronal cut of the maxillary sinus; (b) coronal septum shown in a sagittal cut of the maxillary sinus, (c) transverse septa shown in a sagittal cut of the maxillary sinus. © Sandro Sieber/Alex Hungerbühler.

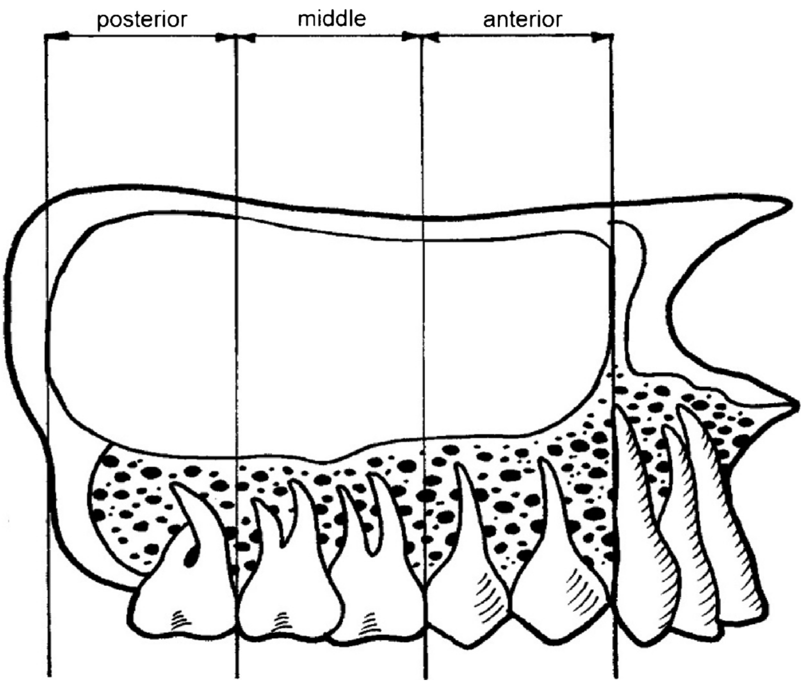

Fig. 2. Spatial division of the maxillary sinus. © Sandro Sieber/Alex Hungerbühler.

Detection of maxillary sinus septa

At least one septum was detected in 117 patients. Of these patients, 102 (87.2%) showed only one septum and 15 (12.8%) showed more than one septum. With regard to male patients, 80 (58.0%) showed no septum and 58 (42.0%) showed one or more septa in the CBCT. For female patients, 104 (63.8%) showed no septum and 59 (36.2%) showed one or more maxillary septa.

The distribution of patients according to dentition type and the presence or absence of septa is shown in Table 1.

In 301 CBCT scans, representing 602 single sinuses, 188 septa were measured. One septum was found in 142 sinuses (23.6%), two septa were found in 17 sinuses (2.8%), and three septa were found in four sinuses (0.7%). Thus, 163 (27.1%) sinuses in total showed one or more septa.

Out of the 188 septa, 100 (53.2%) were coronally oriented (20.0% in the anterior third, 44.0% in the middle third, and 36.0% in the posterior third), 46 (24.5%) were sagittally oriented (50.0% anterior third, 23.9% middle third, 26.1% posterior third), and 42 (22.3%) were transversally oriented (31.0% anterior third, 35.7% middle third, 33.3% posterior third). The orientation of the septa according to their location is shown in Table 2 and Fig. 3.

Associations between septa characteristics and other variables

The presence of septa was found not to be associated with age or sex (Table 3). However, a significant association was observed between the absence/presence of septa and the dentition type: patients with a full dentition more often showed no septa and edentulous patients more often had septa present.

When looking at the orientation of the septa, there was a significant association between the number of transverse septa and the edentulous dentition type. This was not the case for coronally or sagittally oriented septa. Thus, edentulous patients more often had septa present compared to fully and partially dentate patients, and these were often of the transverse type. The exact *P*-values for the associations are shown in Table 3.

Table 1. Descriptive statistics of patients according to dentition type and prevalence of septa.

Dentition type	Number of patients with recorded septa		Number of patients with unilateral or bilateral septa	
	0 (%)	≥1 (%)	Unilateral septa (%)	Bilateral septa (%)
Full dentition	116 (67.1%)	57 (32.9%)	35 (61.4%)	22 (38.6%)
Partial dentition	60 (56.6%)	46 (43.4%)	28 (60.9%)	18 (39.1%)
Edentulous	8 (36.4%)	14 (63.6%)	9 (64.3%)	5 (35.7%)

Inter- and intra-rater reliability

Cohen's kappa test for inter-rater reliability was 0.92, showing very good agreement. The intra-rater reliability was also high (AH: 1; CR: 0.92).

Discussion

The aim of this study was to examine the anatomical structure of antral septa in the maxillary sinus and their possible association with patient-specific factors such as age, sex, and dentition type. The results showed that edentulous patients had a significantly higher prevalence of sinus septa than partially and fully dentate patients. The most common septum orientation in edentulous patients was transverse. The highest prevalence of septa was found in the middle region of the maxillary sinus. In total, 39% of all patients showed septa.

In a similar analysis, Tadinada et al. found a higher number of septa. They analysed 36 randomly selected preoperative implant planning CBCT scans of posteriorly dentate and edentulous patients. Sinus septa were found in 60% of 72 sinuses, with 28% of the sinuses showing only one septum and 24% showing two septa. The septa were most commonly transverse in orientation[18]. These results were based on a relatively small number of patients and differ from those found in the present study. This study results showed a lower frequency of septa and a mostly coronal septum orientation, with only edentulous patients showing a mostly transverse septum orientation. In a radiographic study, Bornstein et al. analysed unilateral and bilateral CBCT scans of 212 patients and found septa in 67% of 212 patients and 57% of 294 maxillary sinuses. These numbers are higher than those found in the present study. The differences might be explained by the higher mean age of the patients, being associated with a higher proportion of edentulous patients. The most common septum orientation was coronal, which is in agreement with the present study, and the septa were found in the region of the first and second molar (representing the middle region in this study)[19].

As sinus floor elevations are performed in the posterior maxilla, the possible presence of septa in the molar area is of special interest. Taleghani et al. examined 300

Table 2. Number of septa categorized according to different orientations.

Septum orientation	Distribution of septa in the maxillary sinus, *n* (%)		
	Anterior third	Middle third	Posterior third
Coronal	20 (20.0)	44 (44.0)	36 (36.0)
Sagittal	23 (50.0)	11 (23.9)	12 (26.1)
Transverse	13 (31.0)	15 (35.7)	14 (33.3)
Total septa in A/M/P	56 (29.8)	70 (37.2)	62 (33.0)

CBCT scans of maxillary sinuses from patients with posterior edentulism. They detected septa in 44% of all patients and the spatial distribution was equal across the anterior, middle, and posterior positions[20]. Dragan et al. found an even higher prevalence of septa in the posterior region. Analyzing CBCT scans of 100 edentulous patients and 100 dentate patients, they showed septa in 96% and 98% of patients, respectively[21]. In that study, the maxillary sinus was subdivided into three equal units that were not defined by the position of the teeth. Thus the spatial division differed from that used in the present study. Further, they observed an oblique orientation for most septa[21], which is comparable to the coronal orientation of the present study. The only significant difference was shown in the comparison between the two dentition types, in which it was observed that edentulous patients had a lower height of septa compared to dentate patients[21].

Krennmair et al. examined 194 posterior maxillary regions of dentate and edentulous patients subdivided into four groups: (1) clinically and radiographically (panoramic radiography) verified atrophic alveolar processes, (2) cadaveric edentulous maxillae, (3) CT-verified atrophic alveolar processes, and (4) partially and completely dentate patients with non-atrophic maxillary ridges examined by CT. They found a significantly higher incidence of septa in edentulous ridges[22]. This is also in agreement with the present study results; however, a limitation was that only 22 edentulous patients were included.

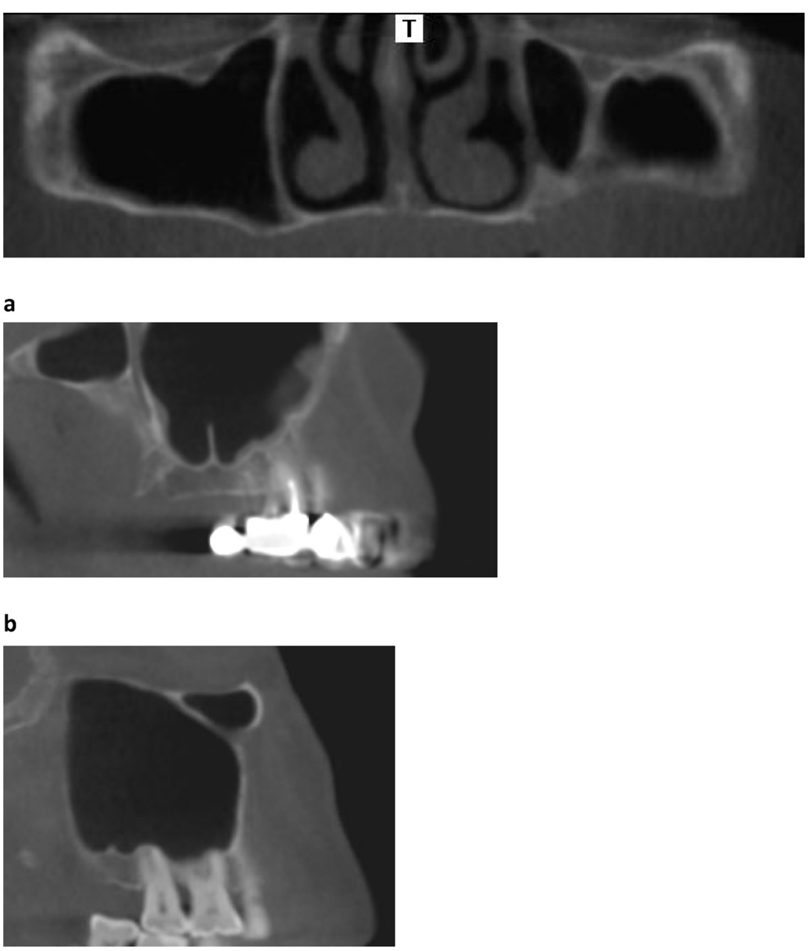

Fig. 3. Septa orientation on CBCT: (a) sagittal, (b) coronal, (c) transverse.

The clinical importance of maxillary septa is the possible interference with sinus floor elevation surgery. Irinakis et al. analysed the correlation between septa and surgical interventions, observing a significant association between interfering septa (found in CBCT scans) and complications in sinus floor augmentation. They described a significant correlation between interfering septa and sinus membrane perforations, identifying interfering septa in 48% of all sinuses. Seventy-one percent of the septa had a bucco-palatal orientation (corresponding to the coronal septa in the present study)[23].

Next to radiological studies, human cadaver studies are of interest. The main difference is the bias of a threshold in radiological studies in contrast to the direct inspection of cadavers. In a human cadaver study, Rosano et al. described sinus septa in 33% of 60 sinuses in 30 cadavers, most of them in the middle region[24]. Gosau et al. examined 130 sinuses in 65 cadavers, observing a prevalence of septa of 27% in all sinuses. Most of these septa were found in the region of the first molar (29%) and the second molar (23%)[25]. These two cadaver studies showed a lower number of septa than in many of the radiological studies, but a percentage of septa comparable to that observed in the present study.

The different percentages of septa reported in the different studies might be explained by the sample collection in each study. A systematic review by Maestre-Ferrin et al. showed a prevalence of 13–35% of septa in maxillary sinuses[2]. Calculated according to the number of patients, the prevalence of septa varied from 22% to 67%[2]. Another systematic review and meta-analysis by Pommer et al. included studies published between 1995 and 2011 and found a prevalence of septa in 28% of 8923 sinuses; there was a significantly higher prevalence of septa in edentulous maxillae than in dentate maxillae[26]. A systematic review of CBCT scans by Ata-Ali et al. analysed the frequency of anatomical variations and pathologies in maxillary sinuses. The frequency of septa was between 33% and 58%, with the highest prevalence being in the region of the first and second molars[27].

Table 3. Associations between septa characteristics and other variables.

Associations between septa characteristics and other variables	P-value[a]
Prevalence of septa and age	0.460
Prevalence of septa and sex	0.411
Prevalence of septa and dentition type	0.010*
Dentition type and coronal orientation	0.114
Dentition type and sagittal orientation	0.379
Dentition type and transverse orientation	0.013*

[a] Chi-square test.
* Significant, $P < 0.05$.

In general, multiple studies have assessed the prevalence of maxillary septa. The majority of the studies discussed corroborate the findings of the present study. The results of this study showed significantly more septa in edentulous patients than in partially or fully dentate patients. The septa in edentulous patients mostly showed a transverse orientation. The most frequent orientation of septa was coronal (53.2%), followed by sagittal (24.5%) and transverse (22.3%). No correlation was found between the prevalence of maxillary sinus septa and patient age or sex.

Edentulous patients in particular suffer from bone atrophy, often requiring sinus floor elevation prior to implant placement. It has been shown that the frequency of membrane perforations increases with the presence of septa[7,10,12,28,29]. Membrane perforations were described by von Arx et al. in the presence of septa with a septum height of >5 mm[29]. As the presence of septa can have an influence on sinus floor elevation[7,10], most guidelines strongly recommend three-dimensional imaging prior to these procedures[30,31]. In contrast to CBCT, false results in the detection of septa using panoramic X-rays has been reported to occur in almost 50% of cases[32].

The clinical importance of the present study findings lies in the provision of anatomical information that is helpful during implant planning and prior to performing sinus floor elevations. This anatomical information can be integrated into the decision-making process for guided implant placement in the posterior maxilla. In clinics, there is currently a choice between long and short implants. The choice between these two options should be based on the desired implant position with regard to the prosthodontic situation and sinus-related factors like possible septa in the area of a future sinus floor elevation[33,34]. A septum in the area of the desired implant position may speak in favour of a short implant[35], and the lack of a septum may speak in favour of a long implant. In the future, such information could also be integrated into decision-making algorithms using machine learning or artificial intelligence[36]. This would also allow a preoperative risk analysis, taking the presence of septa and the desired implant position into account.

In conclusion, the results of this study show that the frequency of septa in the maxillary sinus requires preoperative three-dimensional imaging to minimize risk. This is of high relevance for maxillofacial surgeons, dentists, and insurance providers. Furthermore, this three-dimensional information could influence decision-making during implant planning and also reduce the number of membrane perforations during sinus floor elevation, as the position of the septa can already be taken into account during implant planning. However, this should be investigated in another, ideally prospective study.

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Competing interests. The authors confirm that there is no known conflict of interest in relation to this study.

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Patient consent. Not required.

References

1. Rancitelli D, Borgonovo AE, Cicciu M, Re D, Rizza F, Frigo AC, Maiorana C. Maxillary sinus septa and anatomic correlation with the Schneiderian membrane. *J Craniofac Surg* 2015;**26**:1394–8.
2. Maestre-Ferrin L, Galan-Gil S, Rubio-Serrano M, Penarrocha-Diago M, Penarrocha-Oltra D. Maxillary sinus septa: a systematic review. *Med Oral Patol Oral Cir Bucal* 2010;**15**:e383–6.
3. Underwood AS. An inquiry into the anatomy and pathology of the maxillary sinus. *J Anat Physiol* 1910;**44**(Pt 4):354–69.
4. Velasco-Torres M, Padial-Molina M, Avila-Ortiz G, Garcia-Delgado R, O'Valle F, Catena A, Galindo-Moreno P. Maxillary sinus dimensions decrease as age and tooth loss increase. *Implant Dent* 2017;**26**:288–95.
5. Vinter I, Krmpotic-Nemanic J, Hat J, Jalsovec D. Does the alveolar process of the maxilla always disappear after tooth loss? *Laryngorhinootologie* 1993;**72**:605–7.
6. Al-Dajani M. Recent trends in sinus lift surgery and their clinical implications. *Clin Implant Dent Relat Res* 2016;**18**:204–12.
7. Schwarz L, Schiebel V, Hof M, Ulm C, Watzek G, Pommer B. Risk factors of membrane perforation and postoperative complications in sinus floor elevation surgery: review of 407 augmentation procedures. *J Oral Maxillofac Surg* 2015;**73**:1275–82.
8. Sakhdari S, Panjnoush M, Eyvazlou A, Niktash A. Determination of the prevalence, height, and location of the maxillary sinus septa using cone beam computed tomography. *Implant Dent* 2016;**25**:335–40.
9. Park YB, Jeon HS, Shim JS, Lee KW, Moon HS. Analysis of the anatomy of the maxillary sinus septum using 3-dimensional computed tomography. *J Oral Maxillofac Surg* 2011;**69**:1070–8.
10. Al-Dajani M. Incidence, risk factors, and complications of Schneiderian membrane perforation in sinus lift surgery: a meta-analysis. *Implant Dent* 2016;**25**:409–15.
11. Toscano NJ, Holtzclaw D, Rosen PS. The effect of piezoelectric use on open sinus lift perforation: a retrospective evaluation of 56 consecutively treated cases from private practices. *J Periodontol* 2010;**81**:167–71.
12. Becker ST, Terheyden H, Steinriede A, Behrens E, Springer I, Wiltfang J. Prospective observation of 41 perforations of the Schneiderian membrane during sinus floor elevation. *Clin Oral Implants Res* 2008;**19**:1285–9.
13. Greenberg AM. Digital technologies for dental implant treatment planning and guided surgery. *Oral Maxillofac Surg Clin North Am* 2015;**27**:319–40.
14. Tyndall DA, Price JB, Tetradis S, Ganz SD, Hildebolt C, Scarfe WC. Position statement of the American Academy of Oral and Maxillofacial Radiology on selection criteria for the use of radiology in dental implantology with emphasis on cone beam computed tomography. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2012;**113**:817–26.
15. Gamer M, Lemon J, Fellows I, Singh P. *irr: Various coefficients of interrater reliability and agreement. R package version 0.84*. R Foundation; 2012.
16. McHugh ML. Interrater reliability: the kappa statistic. *Biochem Med (Zagreb)* 2012;**22**:276–82.

17. R Core Team. *R: a language and environment for statistical computing*. R Foundation; 2015.
18. Tadinada A, Jalali E, Al-Salman W, Jambhekar S, Katechia B, Almas K. Prevalence of bony septa, antral pathology, and dimensions of the maxillary sinus from a sinus augmentation perspective: a retrospective cone-beam computed tomography study. *Imaging Sci Dent* 2016;**46**:109–15.
19. Bornstein MM, Seiffert C, Maestre-Ferrin L, Fodich I, Jacobs R, Buser D, von Arx T. An analysis of frequency, morphology, and locations of maxillary sinus septa using cone beam computed tomography. *Int J Oral Maxillofac Implants* 2016;**31**:280–7.
20. Taleghani F, Tehranchi M, Shahab S, Zohri Z. Prevalence, location, and size of maxillary sinus septa: computed tomography scan analysis. *J Contemp Dent Pract* 2017;**18**:11–5.
21. Dragan E, Odri GA, Melian G, Haba D, Olszewski R. Three-dimensional evaluation of maxillary sinus septa for implant placement. *Med Sci Monit* 2017;**23**:1394–400.
22. Krennmair G, Ulm CW, Lugmayr H, Solar P. The incidence, location, and height of maxillary sinus septa in the edentulous and dentate maxilla. *J Oral Maxillofac Surg* 1999;**57**:667–71. discussion 671-672.
23. Irinakis T, Dabuleanu V, Aldahlawi S. Complications during maxillary sinus augmentation associated with interfering septa: a new classification of septa. *Open Dent J* 2017;**11**:140–50.
24. Rosano G, Taschieri S, Gaudy JF, Lesmes D, Del Fabbro M. Maxillary sinus septa: a cadaveric study. *J Oral Maxillofac Surg* 2010;**68**:1360–4.
25. Gosau M, Rink D, Driemel O, Draenert FG. Maxillary sinus anatomy: a cadaveric study with clinical implications. *Anat Rec (Hoboken)* 2009;**292**:352–4.
26. Pommer B, Ulm C, Lorenzoni M, Palmer R, Watzek G, Zechner W. Prevalence, location and morphology of maxillary sinus septa: systematic review and meta-analysis. *J Clin Periodontol* 2012;**39**:769–73.
27. Ata-Ali J, Diago-Vilalta JV, Melo M, Bagan L, Soldini MC, Di-Nardo C, Ata-Ali F, Mañes-Ferrer JF. What is the frequency of anatomical variations and pathological findings in maxillary sinuses among patients subjected to maxillofacial cone beam computed tomography? A systematic review. *Med Oral Patol Oral Cir Bucal* 2017;**22**:e400–9.
28. Zijderveld SA, van den Bergh JP, Schulten EA, ten Bruggenkate CM. Anatomical and surgical findings and complications in 100 consecutive maxillary sinus floor elevation procedures. *J Oral Maxillofac Surg* 2008;**66**:1426–38.
29. von Arx T, Fodich I, Bornstein MM, Jensen SS. Perforation of the sinus membrane during sinus floor elevation: a retrospective study of frequency and possible risk factors. *Int J Oral Maxillofac Implants* 2014;**29**:718–26.
30. Dula K, Bornstein MM, Buser D, Dagassan-Berndt D, Ettlin DA, Filippi A, Gabioud F, Katsaros C, Krastl G, Lambrecht JT, Lauber R, Luebbers HT, Pazera P, Türp JC. SADMFR guidelines for the use of cone-beam computed tomography/digital volume tomography. *Swiss Dent J* 2014;**124**:1169–83.
31. Malina-Altzinger J, Damerau G, Gratz KW, Stadlinger PD. Evaluation of the maxillary sinus in panoramic radiography—a comparative study. *Int J Implant Dent* 2015;**1**:17.
32. Maestre-Ferrin L, Carrillo-Garcia C, Galan-Gil S, Penarrocha-Diago M, Penarrocha-Diago M. Prevalence, location, and size of maxillary sinus septa: panoramic radiograph versus computed tomography scan. *J Oral Maxillofac Surg* 2011;**69**:507–11.
33. Naenni N, Sahrmann P, Schmidlin PR, Attin T, Wiedemeier DB, Sapata V, Hämmerle CHF, Jung RE. Five-year survival of short single-tooth implants (6 mm): a randomized controlled clinical trial. *J Dent Res* 2018;**97**:887–92.
34. Naziri E, Schramm A, Wilde F. Accuracy of computer-assisted implant placement with insertion templates. *GMS Interdiscip Plast Reconstr Surg DGPW* 2016;**5**. Doc15.
35. Dragan E, Guillaume OA, Haba D, Olszewski R. Three-dimensional evaluation of implant positioning in the maxillary sinus septum: a retrospective study. *Med Sci Monit* 2015;**21**:2666–71.
36. Mehl A, Blanz V, Hickel R. Biogeneric tooth: a new mathematical representation for tooth morphology in lower first molars. *Eur J Oral Sci* 2005;**113**:333–40.

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