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Original Research

Cone beam computed tomographic evaluation of the maxillary sinus septa and location of blood vessels at the lateral maxillary sinus wall in a sample of the Singaporean population

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ABSTRACT

Objectives: The purpose of the study was to retrospectively investigate the prevalence, location, orientation, origin and height of the maxillary sinus septa as well as the location of anastomosis (of the infra-orbital artery and posterior superior alveolar artery) from the alveolar crest in a sample population of Singapore.

Methods: The study was done through the retrospective analysis of cone beam computed tomography (CBCT) images of 224 maxillary sinuses in 139 patients.

Results: The prevalence of septa was 38.3% in this study. Septa formation was most commonly seen at the anterior region (i.e. first and second premolar), followed by the posterior (third molar) and middle region (first and second molar). 93% of the septa demonstrated a bucco-lingual orientation. 61.6% of septa were found to be primary septa i.e. located above root apices of maxillary teeth whereas 38.4% of septa were secondary septa i.e. located above an edentulous span. The mean height of the septa was 5.95 mm.

The intra-osseous anastomosis between the infra-orbital artery and posterior superior alveolar artery was visible on the coronal view of 100 (45%) maxillary sinuses and the mean height of the intra-osseous anastomosis from the alveolar crest was 17.8 mm.

Conclusion: To prevent the occurrence of complications, it is vital to have sufficient pre-operative knowledge of the possible anatomic structures present in the maxillary sinus. Having pre-operative CBCT imaging prior to sinus augmentation is advantageous as it allows for accurate assessment for the presence of septa or other anatomic irregularities that may complicate the surgery.

1. Introduction

The maxillary sinus floor elevation with placement of autogenous or synthetic grafting materials (sinus lift bone graft) has enabled endosseous implants to be placed in severely resorbed posterior maxillas and is seen as a predictable treatment modality today. It was first verbally presented by Tatum at the Alabama Implant Congress in 1976 and published for the first time in 1980 by Boyne and James [1]. The most frequent complication of sinus floor elevation is perforation of the Schneiderian membrane [2–6]. Prevalence of sinus perforations from the literature ranges from 11% to 44% [4,6–11]. A systematic review of 48 studies by Pjetursson et al. found that the average perforation rate was 19.5% [5]. Perforation usually happens as the lateral wall is being in-fractured or when the membrane is being lifted off the sinus wall and floor. The risk of membrane perforation increases in presence of anatomical variations such as presence of septa or irregular sinus floor [2,12–14].

Maxillary sinus septa are bone ridges inside the sinus. The clinical significance of pre-existing septa during sinus floor elevation procedures is that access from the lateral window is affected. The sinus membrane is adherent to the wall of the septa and this increases the difficulty of membrane elevation as the

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surgeon would need to take into account the altered anatomy. It is also challenging to insert the graft material into both parts of the sinus cavity, anterior and posterior to the septa [2,13]. The prevalence of septa within maxillary sinuses ranges from 16% to 67% whereas prevalence of septa within patients ranges from 22% to 69% (Table 1). In the absence of additional imaging, such septa may not be picked up on a panoramic or intraoral radiograph. Attempts at sinus augmentation without checking the existence of such septa can lead to increased risk of membrane perforation.

Besides perforation of the maxillary sinus membrane, another possible complication is profuse bleeding that occurs during osteotomy of the lateral sinus wall, coming from anastomoses between the infra-orbital artery and posterior superior alveolar artery [33]. These anastomoses can give rise to both intra and extra-osseous branches, supplying the lateral sinus wall and overlying membranes, with the intra-osseous branches found in all cases about 19 mm from the alveolar ridge crest and the extra-osseous branches found in 50% of all specimens about 23–26 mm from the alveolar ridge crest, according to Solar et al. [33].

These anatomical variations can pose a challenge to clinicians and it is critical to access and know the variations before surgery is attempted. There have been studies on these variations in an ethnic Chinese population in Taiwan. The population of Singapore is much more heterogeneous, with a majority race 70% of Chinese mainly descendants of immigrants from southern China, 25% Malays, 3% Indians, mainly descendants of immigrants from southern India and the rest made up of mixed races and other races. It is unknown what variation exists in the Singapore population. The National University Hospital Singapore serves as one of two tertiary referral hospitals in Singapore. The purpose of this study was to retrospectively investigate the prevalence and location of maxillary sinus septa and arterial anastomoses of a sample of the Singapore population by analyzing cone beam computed tomography images of patients taken in the National University Hospital, Singapore.

2. Materials and methods

2.1. Scan and image collection

All cone beam computed tomography (CBCT) scans, performed at the University Dental Cluster, National University Hospital, Singapore, of patients showing at least one full maxillary sinus, were collected. These patients had undergone scans for implant planning purposes, impacted teeth, orthognathic surgery or pathology. Permission was sought and granted for access to these records from the Institutional Review Board of the hospital.

2.2. Scanner

The CBCT scans were taken using the Vatech Pax-Reve3D CBCT machine (Vatech Co Ltd, Korea). Field of view (FOV) chosen ranged from 5 cm × 5 cm, 8 cm × 6 cm, 12 cm × 8 cm, 15 cm × 15 cm depending on requirements of the ordering clinician. Voxel size ranges from 0.12 to 0.2 mm. Slice thickness is 0.1–0.4 mm. Maxillary sinuses with gross pathology were excluded from the study.

2.3. Image analysis

The image analysis program – EZ3D Plus (QST Group, Singapore) was used to reconstruct the maxillary sinus into axial, coronal, sagittal planes and reformatted panoramic images. The images were referenced to the occlusal plane.

2.4. Sinus septa

The presence of maxillary sinus septa was initially evaluated using axial images and further defined by the sagittal and coronal images. Presence of septa was indicated by bony structures that divide the maxillary sinus cavity into separate compartments.

The locations of septa were divided into anterior, middle and posterior regions. The anterior region was defined as the first and second premolar region. The middle region was defined as the first and second molar region. The posterior region was defined as the third molar region [18,28,29,31]. In edentulous areas, the anterior-posterior width was divided into thirds for the purpose of classifying location.

Orientation of the septa was evaluated using axial, coronal and sagittal views. Orientation was classified as bucco-lingual, sagittal or transverse [14]. Origin of septa was classified as primary or secondary. When a septum is located superior to roots of maxillary teeth, it is classified as a primary septum. When located above an edentulous span, the septum is termed secondary septum [14,20].

Table 1
Prevalence of septa [9,11,14–32].

Type of study	No. of subjects	Ethnicity	No. of sinuses	Prevalence among subjects (%)	Prevalence among sinuses (%)	Author	Year
In-vivo	41	Austrian	–	31.7	–	Ulm et al. [15]	1995
MSCT	–	Austrian	200	–	16	Krennmair et al. [14]	1997
MSCT	156	USA	312	32.7	24	Velasquez-Plata et al. [16]	2002
MSCT	–	Czech	68	–	36	Kasabah et al. [17]	2002
MSCT	100	Korean	200	38	26.5	Kim et al. [18]	2006
DPT	1024	Brazilian	–	21.6	–	Shibli et al. [19]	2007
MSCT	30	Spanish	60	–	25	Gonzalez-Santana et al. [20]	2007
MSCT	–	Turkish	330	–	23	Selcuk et al. [21]	2008
Cadaveric/MSCT	75	French	150	39	–	Ella et al. [22]	2008
Cadaveric	65	German	130	–	27	Gosau et al. [23]	2009
CBCT	15	Japanese	30	–	37	Naitoh et al. [24]	2009
MSCT	111	Polish	222	–	26	Rysz et al. [34]	2009
MSCT	45	Canadian	52	–	40	Malkinson et al. [9]	2009
MSCT	200	S. African	400	69	56	Van Zyl et al. [25]	2009
Cadaveric	30	Italian	60	–	33	Rosano et al. [26]	2010
CBCT	1029	German	–	47	33	Neugebauer et al. [27]	2010
MSCT	204	Korean	236	27	24.6	Lee et al. [28]	2010
MSCT	200	Korean	400	37	27.7	Park et al. [29]	2011
MSCT	30	Spanish	60	–	66.7	Maestre-Ferrin et al. [30]	2011
MSCT	423	Taiwanese	846	30	20.5	Shen et al. [31]	2012
CBCT	500	Brazilian	–	44	–	Lana et al. [32]	2012
CBCT	–	Korean	150	–	44	Kang et al. [11]	2013

DPT: dental panoramic tomography; MSCT: multislice computed tomography; CBCT: cone beam computed tomography.

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