



Comprehensive CBCT - Evaluation of Facial Anatomic Variations as a Critical Factor in Implant Treatment Planning

Thomas G Wiedemann^{1*}, Schablowski Isabel² and Herrera Antonio Miguel³

¹Clinical Associate Professor, Department of Oral and Maxillofacial Surgery, New York University, College of Dentistry, New York, United States

²Zahnarztzentrum.ch, Switzerland

³Private Practice, Philippines

***Corresponding Author:** Thomas G Wiedemann, Clinical Associate Professor, Department of Oral and Maxillofacial Surgery, New York University, College of Dentistry, New York, United States.

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Abstract

Anatomic variations affecting the maxillary sinus and the mandibular canal are relevant findings in CBCT imaging for dental implant planning. An awareness of these alterations is important for implant surgery since some of them might require treatment or cause complications or even make modifications in surgical and prosthetic treatment planning necessary. Localisation of sinus septa, patency of the osteomeatal complex, endosseous vascular anastomoses, variation of course of the IAN and its anterior loop, accessory foramina and lingual undercuts in the mandible are critical and must be properly taken into consideration in the course of surgical and prosthetic implant treatment planning. Inadequate preoperative CBCT evaluation of these individual variations leads to unnecessary surgical complications and even to unfavorable implant outcomes.

Conclusion: Various parameters should be checked in CBCT images of paranasal sinuses and course of the mandibular canal other than the width and height of the residual ridge. Each of them may have a significant impact on the results of implant placements, bone graft harvesting and open sinus lift surgery and can lead to intra-/postoperative complications or even implant failure.

Keywords: CBCT Evaluation; Anatomical Variations; Sinuslift; Implant Treatment Planning

Introduction

Implant planning includes a thorough radiographic evaluation by the treating dentist. The widespread availability of cone beam computed tomography (CBCT) in dental offices allows a detailed three-dimensional evaluation of the surgical site. Besides the primary assessment, anatomic variations of the maxillary sinus and the mandibular canal are frequent secondary findings. Careful identification and evaluation of potential variations is important for implant surgery as some require pre-surgical treatment or modification of the surgical approach.

Objective of the Study

To improve CBCT assessment, this review provides an overview of anatomic variations of the maxillary sinus and the mandible. This article discusses clinically significant variations that must be

considered prior to implant placement or sinus augmentation to avoid complications.

Materials and Methods

A PubMed and Google Scholar search was conducted to identify relevant articles. 13 articles were included in this review based on their clinical significance.

Results and Discussion

Nine categories of anatomic variations that must be taken into consideration for surgical implant treatment planning have been identified (Table 1):

- Osteometal complex/Haller cells
- Alveolar antral artery
- Type and thickness of the Schneiderian membrane

Maxilla	
Ostium patency	Blockage: Refer to ENT prior to sinus augmentation
Haller Cells	Refer to ENT if history of sinusitis present
Sinus membrane thickness (MT)	If > 5 mm/irregular type and history of sinusitis Refer to ENT prior to sinus augmentation referral prior surgery MT of < 1 mm and > 2 mm are more prone to perforation → Proceed with caution when elevation membrane
Alveolar antral artery	Visibility on CBCT depends on diameter and voxel size Diameter is associated with extend of hemorrhage → Design window to spare the artery → If not visible prepare for hemostatic measurements
Palatonasal recess	An acute angle complicates lifting of the membrane and increases perforation risk → Proceed with caution or alter prosthodontic plan
Presence of sinus septa	Presence of septa aggravates membrane lifting. → Cautious elevation → Piezoremoval of septum base → Modification of surgical approach → Can be used as distal wall if in posterior department
Mandible	
Accessory Mental Foramen/Incisive Branch of Mental Foramen/anterior loop	Presence aggravates the risk of paresthesia by implant placement → Consider implant position
Lingual/Lateral Lingual Foramen	Accessory arteries increase risk of perforation and hemorrhage → Consider implant position
Accessory Mandibular Canal (Bifid Canal)	Can lead to paresthesia if damaged. → If suspected modify implant position
Anatomical Undercuts in the Mandible	Risk of perforation of the lingual plate → Consider implant length and angulation/position

Table 1: Checklist for CBCT-evaluation in implant treatment planning.

- Palatonasal recess and sinus septa
- Accessory mental foramen
- Incisive branch of the mandibular canal
- Lingual and lateral lingual foramen
- Accessory mandibular canal (Bifid canal)
- Variations of the mandibular contour.

Osteomeatal complex/Haller cells

Description: Prior to a sinus floor elevation (SFE) attention should be paid to the patency of the osteomeatal complex (OMC) (Figure 1) and the presence of Haller Cells (infraorbital ethmoid cells) [4].

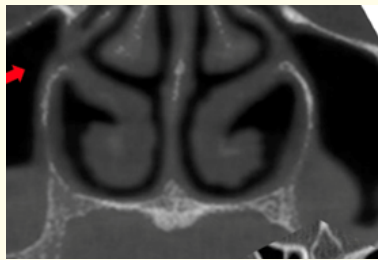


Figure 1: Obstructed osteomeatal complex.

Clinical implication: A non patent OMC impairs the sinus clearance. Obstruction of the ostium and/or the presence of Haller Cells may cause postoperative sinus infections. A preoperative ENT evaluation and even a surgical intervention has to be considered prior to sinus augmentation [4].

Alveolar antral artery

Description: The posterior superior alveolar artery (PSAA) and the infra-orbital artery (IA) form an anastomosis in the lateral sinus wall. The artery is present in 100% of cases but not always visible on CBCT [2,3] (Figure 2).

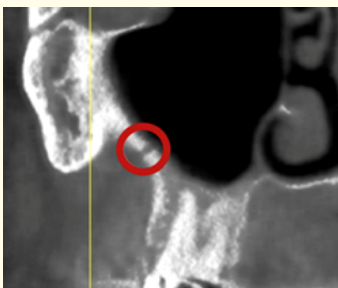


Figure 2: Intraosseous alveolar antral artery.

Clinical implication: Significant intraoperative hemorrhage can occur if the alveolar antral artery is severed during the lateral window approach. The lateral window approach should be planned accordingly to avoid injury of this artery [2,3].

Type and thickness of the Schneiderian membrane

Description: The Schneiderian membrane lines the maxillary sinus and is responsible for the mucociliary clearance of the sinus. Sinus augmentation requires carefully lifting of the membrane to avoid perforation [3].

Clinical implication: Membrane perforation is more likely in the polyp/irregular type. A thickness of 1 - 2 mm is associated with a lower perforation risk compared to < 1 mm or > 2 mm. Consider ENT evaluation if membrane thickness is above 5 mm, since this condition is highly correlated with the risk of inflammatory pathologies, such as sinusitis or obstruction of sinus ostium [5,6].

Palatoglossal recess and underwood sinus septa

Description: The presence of a septum and an acute palatonasal-recess angle increases the complexity of detaching the Schneiderian membrane without perforation. A wide angle is more favorable and decreases the risk of perforation [1,3].

Clinical implication: A septum, depending on its position, may lead to an altered surgical approach while attention should be paid to careful elevation and avoidance of underfilling if an acute angle is present in a palatonasal recess [1].

Accessory mental foramen

Description: The mandibular canal usually forms an anterior loop before opening into one mental foramen. Accessory foramen are present in 8 - 10% of patients [13].

Clinical implication: Surgical Implant placement impacting an accessory canal may result in a partial loss of sensation and the possibility of neuropathic pain.

Incisive branch of mental foramen and anterior loop

Description: The incisive branch of the mandibular canal (IBMC) is a ramification of the anterior loop of the mandibular canal [9,13]. This canal contains a neurovascular bundle that supplies the anterior portion of the mandible.

Clinical implication: Complications may occur as a result of injury to the IBMC and the anterior loop. Patients may complain about neuropathic pain and altered sensation [8,9,13].

Lingual and lateral lingual foramen

Description: Various vessels may run through these widely unknown foramina: branches of the sublingual artery, submental artery or anastomoses of branches of these arteries. The lateral lingual foramen is usually located in the premolar region and its associated canals proceed towards the midline.

Clinical implication: Acute hemorrhage in the floor of the mouth during implant procedures due to injury of these arteries with consecutive airway obstruction can occur during the osteotomy [7,9,10,13].

Accessory mandibular canals

Description: Bifid mandibular canals (BMC) and trifid mandibular canals (TMC) are variations of the normal anatomy with incidences ranging from 0.08% to 65.0% [8,11,13].

Clinical implication: An additional mandibular canal may explain inadequate anesthesia. During mandibular surgery or implant placement a second neurovascular bundle may be damaged causing paresthesia, neuroma formation or bleeding [8,11,13].

Mandibular undercuts

Description: The lingual cortical plate especially in the molar region can be convergent, parallel or show significant undercuts (Figure 3).

Clinical Implication: Perforation of the lingual plate in the submandibular fossa may be asymptomatic but can also result in damage of the sublingual arteries, leading to life-threatening hemorrhage causing an obstruction of the upper airway [12].

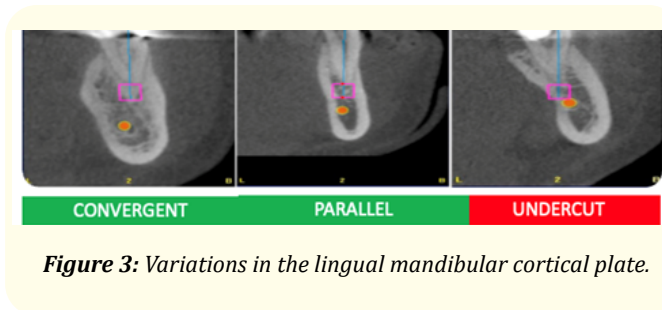


Figure 3: Variations in the lingual mandibular cortical plate.

Conclusion

There is a high variability of anatomical structures identified on CBCT. Each of them may have the potential to significantly impact the result of implant placements, bone graft harvesting and open sinus lift surgery and may lead to intra-/postoperative complications. Identifying these structures help to facilitate dental implant placement surgery by accommodating the individual need and allowing to take the full scope of CBCT imaging, thus leading to precise treatment planning and a more predictable outcome.

Conflict of Interest

The authors of this study declare that there is no conflict of interest.

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