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ROLE OF CONE BEAM COMPUTED TOMOGRAPHY IN DIAGNOSING MAXILLARY SINUS PATHOLOGIES - A REVIEW

RUNNING TITLE- MAXILLARY SINUS AND CBCT

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ABSTRACT

The most common disease affecting the maxillary sinus is of odontogenic origin. Dental practitioners should be aware about the pathologies related to maxillary sinus and its relationship to maxillary dentition and supporting structures. After the introduction of Cone Beam Computed Tomography (CBCT), it has become the imaging modality of choice for clinicians in evaluating maxillary sinuses and maxillofacial structures. Three-dimensional (3D) imaging can be achieved by CBCT, which offers volumetric data about sinus pathologies and relationship between the maxillary teeth roots and the antrum with relatively low radiation doses and costs. CBCT is also capable of guiding the clinicians in final diagnosis, treatment planning and follow up. This review aims to emphasize the role of CBCT in the detection of maxillary sinus pathologies in day to day dental practice. Further studies using 3-D visualization in sinus pathologies will yield a fundamental data & guidelines for future research. However, more research is required to authenticate its use in odontogenic maxillary sinusitis.

KEYWORDS:

Cone beam computed tomography, maxillary antrum, maxillary sinus, paranasal sinus, Schneiderian membrane, sinus pathologies.

INTRODUCTION

The CBCT has become a vital diagnostic aid in dentistry due to its possibility to limit imaging to specific areas of interest, thus reducing the radiation exposure to the patient and also because of higher image resolution. Various dental specialties like oral and maxillofacial surgery, orthodontics, implantology and endodontics increasingly utilize CBCT imaging[1]. The maxillary antrum or the maxillary sinuses are the largest of the four paranasal sinuses. It is a 4-sided pyramid with apex pointing laterally towards the zygoma and the base facing the nasal cavity. The maxillary antrum open into the nasal cavity through the ostium, located within the hiatus semilunaris in the middle meatus of the nasal cavity and is lined by a thin mucous membrane known as the Schneiderian membrane[2,3,4]. This membrane is about 1 mm thick and it adheres to the periosteum. The normal sinus mucosa is not visualized on a radiograph, but in conditions where the sinus mucosa gets irritated from either an infectious or allergic process, its thickness increases and can be visualized on a radiograph. If the mucosal thickness is greater than 3 mm then it is considered as pathological. The thickened sinus mucosa is seen on the radiograph as a non-corticated radiopaque band, paralleling the bony wall of the sinus[2].

Maxillary sinus is in close proximity to the alveolar crest and in certain cases the floor can be perforated by the root apices. This close anatomic proximity of tooth apices to the maxillary antrum makes odontogenic infection, especially periapical lesion, a potential source for the spread of the infection into the sinuses[5]. In addition to the spread of infection, the close association between the floor of the maxillary sinus and the roots of maxillary posteriors can lead to accidental formation of oroantral communication during extraction of these teeth[6]. Hence it is essential for

clinicians to be aware of the precise relationship between the apical roots of the maxillary teeth and the maxillary sinus floor.

An exact evaluation of the maxillary sinus is important in dentistry. After the introduction of cone-beam computed tomography (CBCT) in dentistry, it has become an important diagnostic tool due to its higher resolution and due to its possibility to limit imaging to specific areas of interest. CBCT has increased the interest in revisiting the anatomical features of the jaws. Various specialties in dentistry like oral and maxillofacial surgery, periodontics, orthodontics, endodontics and implant dentistry utilize CBCT imaging. The advantages of CBCT include accurate evaluation of jaw bone quality and quantity, no geometric magnification or distortion, and there is no superimposition of surrounding anatomical structures[1,2]. CBCT is capable of producing three-dimensional (3D) images that can guide the clinician in final diagnosis, treatment, and follow-up.

ROLE OF CBCT IN DIAGNOSING MAXILLARY SINUS PATHOLOGY

Maxillary sinus pathologies may be of rhinogenic, odontogenic, allergic, traumatic, bone-related and neoplastic origin[7]. Pathologies of the sinus are common in patients with dental problems like periodontal or periapical lesions, odontogenic cysts or tumors. Radiographs are frequently used in diagnosing the sinus pathologies. Maxillary sinus can be visualized on the periapical radiograph, panoramic radiograph (OPG), Water's (occipitomental) view, computed tomography (CT), magnetic resonance imaging (MRI) and cone-beam computed tomography (CBCT). CT is considered as the “gold standard” for imaging the maxillary antrum. However, in dentistry CT’s are not often used because of greater radiation exposure and their high cost[8].

CBCT addresses the limitation of CT and provides various advantages. In dentistry no other imaging modality has made as great an impact on dental procedures in a short span as CBCT. Even though CBCT has limitations in differentiation of soft-tissue, it easily identifies maxillary sinus opacification (OPA) and without additional exposure can provide valuable information on sinus inflammation[8].

The region of the maxillary antrum is within the imaging field when the CBCT is taken for various dental purpose such as implant site assessment, sinus augmentation, evaluation of periapical and periodontal lesions, endodontic lesions, bony and inflammatory pathologies, orthodontics, impacted and supernumerary teeth. The increased use of CBCT by dental professionals in various specialty opens up a chance for assessment of the prevalence of incidental findings with in the maxillary sinus. These findings would be relevant for further evaluation or of direct significance during treatment planning[9].

The close anatomical relationship between the maxillary posterior teeth and the maxillary sinus floor results in variations of the sinus mucosa secondary to dental pathologies. The maxillary molars and premolars lie close to the floor of the sinus.

The closest lying tooth is the maxillary second molar, followed by the first molar[10]. In addition to the close proximity to the antrum, the prevalence of periapical lesions in these teeth are higher compared with other teeth, specifically on endodontic treated teeth as well as greater susceptibility to periodontal disease due to furcation involvement[11,12]. Under normal conditions the maxillary posterior teeth are separated from the maxillary sinus by a dense layer of cortical bone of variable thickness where as in some cases these structures are separated only by the mucoperiosteum[13]. Such close proximity between the teeth and the antrum results in anatomical changes of the sinus membrane and to develop sinus radio-opacities such as odontogenic maxillary sinusitis (OMS) and other disorders such as mucous retention cysts (MRCs) or retention cysts (RCs)[14]. Thickening of the maxillary sinus membrane (TSM) is reportedly the most frequent alteration of the maxillary sinus, followed by MRCs and radio-opacities[15]. MRCs or RCs or antral pseudocysts (different pathological conditions but radiographically indistinguishable) has a controversial etiology because they may or may not be associated with odontogenic infections[16].

Previous literature has stated that the sinus is considered to be normal in the absence of TSM, or when there is a uniform thickening of less than 2 mm. But there is no clear cut evidence regarding the threshold limit for which the thickness of the sinus membrane should be considered as pathological[17]. CBCT has been recommended for preoperative assessment of alveolar bone in the maxillary posteriors and to evaluate the maxillary sinus health or pathologies and it provides three-dimensional view of the maxillofacial structures, with insignificant radiation doses when compared to medical CT[18].

Maxillary sinusitis of odontogenic origin comprises for about $1/10^{th}$ of all cases of maxillary sinusitis [19,20]. The close relationship of the sinus to the maxillary posterior teeth makes dental pathologies an etiological factor for maxillary sinusitis[21]. Previous literature have stated that the violation of the Schneiderian membrane due to bacterial invasion from periapical infections, periodontal disease or iatrogenic factors significantly rises the risk of sinusitis[22,23,24]. CBCT imaging helps in 3D observation and clear cut visualization of the inflammatory changes in the nasal and paranasal sinus mucosa.

Three-dimensional images with high spatial resolution can help in identifying odontogenic cause of maxillary sinusitis. Even though numerous studies are done on this imaging technique and its various applications in the field ofdentistry, there is relatively very little data focused on odontogenic maxillary sinusitis.

CONCLUSION

Recent developments in 3D imaging modalities have introduced many potential benefits to dentistry. These imaging systems provide cross-sectional images and multiple sections through the sinuses at various planes, which may help in final diagnosis. For the diagnosis of challenging cases, CBCT may be considered a more suitable diagnostic option. A complete medical and dental clinical assessment of the

patients with symptoms of maxillary sinusitis is important to identify the underlying etiologic factors. Various researches have shown that with 2D imaging modalities the origin of odontogenic sinusitis may be masked, especially in the posterior maxilla, where the 3D imaging seems to be utmost helpful. CBCT examination is the best and accurate imaging tool in the dental practice that can detect maxillary sinus pathologies and helps the dentist in preoperative treatment planning, guide the clinician during surgical procedure as well as help in post-operative assessment and follow-up. The advent of CBCT machines capable of producing low-dose radiation in dental practice may be particularly useful when odontogenic maxillary sinusitis is not responsive to therapy. Yet, it seems that more research is needed to validate its use in odontogenic maxillary sinusitis.

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