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Review Article

A cone beam computed tomography and oral-maxillofacial pathology: A review

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ABSTRACT

The use of Cone Beam Computed Tomography has significantly increased in the last decade. The goal is to provide images of oro-facial problems in all three planes, with additional features of three-dimensional reconstruction. Compared to Orthopantomograph, Cone Beam Computed Tomography offers greater accuracy in measurement and lesser image distortion. It can be used as an important tool for assessing the cortical perforation of aggressive benign cysts or tumors. Cone Beam Computed Tomography sialography can serve as a supplementary noninvasive diagnostic tool for imaging the intraglandular ductal system of the major human salivary glands. The ease of use, smaller physical dimensions, lower radiation dose, and lower costs are key factors driving the acceptance of Cone Beam Computed Tomography. However, the major drawbacks for installing Cone Beam Computed Tomography in dental offices are the cost and size of the machines. Therefore, many young dentists currently consider Cone Beam Computed Tomography as a supplementary diagnostic tool rather than a primary one.

1. Introduction

Orthopantomograph (OPG) is commonly used for the radiographic analysis of large lesions in the maxillofacial region. Despite the utilities, OPG has notable limitations, including magnification issues, distortion, superimposition of structures, and a focal trough that records only specific structures. As a result, the use of Cone Beam Computed Tomography (CBCT) has seen a significant rise over the past decade for diagnosing orofacial conditions. CBCT aims to provide comprehensive imaging in all three planes and offers additional features such as reconstruction.[1] Oral and maxillofacial lesions (OMFL) encompass a broad range of conditions affecting the oral cavity, including benign and malignant lesions, diseases of the para-nasal sinuses, inflammatory bone changes, salivary gland disorders, defects in the maxillary sinuses and soft tissue calcification. A multi planar view of CBCT can answer questions that arise during the radiographic investigation of a bony lesion: whether or not the lesion involves the cortex, if it is unilocular or multilocular, what the characteristics of the border are, if any teeth are involved, whether or not they are impacted or have been displaced or not, and if the roots have been resorbed.[2] This review article explores the connection between maxillofacial lesions and CBCT, highlighting the advantages and limitations of this imaging technique.

2. CBCT for Benign Lesions and Cysts

Clinicians rely on 2D information for well-defined cystic or benign lesion margins. While, CBCT is the best option when the margins are ill-defined. As compared to OPG, CBCT provides greater accuracy in measurement and lesser image distortion. Compared to a gold standard dry skull, the

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measurements on CBCT images are accurate, with an error rate of less than 1%.[3] According to Kaneda et al.,[4] if the lesion is small (< 2 cm in diameter), OPG and intra oral periapical radiograph (IOPAR) are suitable for detecting abnormal maxillo-mandibular lesions and relationships between the lesions and the teeth. But when the lesion is ≥ 3 cm in diameter, the multiplanar CBCT images play a key role in recording all three dimensions and provide important information on the presence and extent of bone resorption, sclerosis of adjacent bones, cortical expansion and internal or external calcification.[4] Yuan Xiao-ping et al.,[5] have pointed out that 3D reconstruction is a highly valuable tool for analyzing growth and developmental disturbances, tumor incidence, and fracture displacement. It also aids in analyzing the morphological and spatial relationships of lesions with adjacent structures.CBCT can be used as an important tool for assessing the cortical perforation of aggressive benign cysts or tumours (e.g., Odontogenic keratocysts (OKCs) or ameloblastomas). Spatial relation, the size and extent of the lesion with respect to the internal and adjacent structures are much better observed in multiplanar view.[6] Kawai et al.,[7] have shown that the exact dimensions of a maxillary ameloblastoma and its invasion into critical structures may be better viewed on Magnetic resonance imaging (MRI).[7]

3. CBCT for Malignant Lesions

Detecting a malignant lesion by an ordinary IOPAR or OPG is a hard job for a clinician. For malignant lesions, early detection is very crucial. Small lesions often remain 'hidden' by superimposed dense tooth structure, which can be easily identified on a CBCT scan.[8] If clinicians suspect bony involvement of a malignant lesion, a multiplanar view CBCT scan must be done. When soft tissue is involved, MRI is the first choice, because CBCT can only identify the bony erosion.

4. CBCT for Inflammatory Changes in the Bone

Irregular margins are a key radiographic feature of both malignancy and osteomyelitis, which can thus look similar in a plain radiograph. Ida et al.,[9] concluded that periosteal reactions and cortical destructions are better viewed on multiplanar images.

An aggressive infection of about two or more weeks old resembles a lytic lesion with irregular margins in any radiograph. And a bone with moderate to low-grade infection appears to be of mixed density in radiograph. Periosteal reaction due to osteomyelitis can be properly observed by changing image orientation and adjusting density and contrast in CBCT.

5. CBCT for Diseases of Paranasal Sinuses

Maxillary sinus plays crucial role in implant planning, endodontic therapy and orofacial pain. Sinusitis, a common inflammatory condition, involves the maxillofacial skeleton and often has an odontogenic origin.[10] CBCT provides diagnostic information about the extension of the periapical lesion in the maxillary sinus, the presence of exostoses and the septa. These are important for sinus floor augmentation during implant placement.[11] CBCT gives superior information about the size and margin of the sinus mass, status of the sinus wall, and blockage of the ostium.[12]

6. CBCT for Digitally Guided Biopsy

For a precise and minimally invasive trephine biopsy of a complex anatomical region a three dimensionally printed tooth supported drilling template is a key tool. Valdec et al.,[13] have shown that a CBCT scan is uploaded as a Dicom file on the planning software for making this template. It reduces the risk of devitalizing a neighbouring teeth or possible damage to a nerve structure.[13]

CBCT is the best choice for imaging craniofacial area, especially the bony part, because it can capture images of small areas of interest or the ones beyond the limits of OPG. CBCT slices can be reformatted and viewed in multiple possible orientations without superimposition.[14] Easier function, smaller physical dimensions, lower radiation doses and lower costs for patients are the leading causes for the acceptance of CBCT in dental offices. It contains a software to reconstruct a 3D model of a skull, which can depict the maxillofacial structure and its relation with dental arches. The artifacts arising from metal restorations are lower in the CBCT compared to the multidetector computed tomography (MDCT). Therefore, CBCT is a better imaging technique to assess metal fragments in the face.[15]

Bianchi et al.,[16] have shown that bisphosphonate-related osteonecrosis of the jaw (ONJ) is evaluated more quickly in CT and MRI than panoramic radiograph (OPG).[16] Konen et al.,[17] have explained that altering scan time doesn't affect the diagnostic value of a CBCT image. Low dose and high-resolution multiplanar CBCT scan can replace the traditional water's sinus view for examining the maxillary sinus with better accuracy.[17] Kroll et al.,[18] have shown that CBCT sialography can be used as a supplementary noninvasive diagnostic tool for imaging the intraglandular ductal system of the major human salivary glands.[18]

CBCT has its own limitations nonetheless. Quality of the image depends on scanning protocols and reconstruction settings of the equipment. CBCT offers better visualization of details of the small bony structures and spiral tomography offers better visualization of the cortical bone and the gingiva.[18,19] However, since an acute infection does not create enough bony changes, neither the plain film radiography nor CBCT is reliable. Also, CBCT can't

replace MRI where soft tissue is the primary concern and higher cost of CBCT machine prevents young dentists from installing it in the dental offices.

7. Conclusion

Cone Beam Computed Tomography (CBCT) has become a crucial diagnostic tool in the last decade, particularly for evaluating oral and maxillofacial pathology of osseous structures. Its capability to capture information in all three planes and provide detailed three-dimensional images makes it invaluable for diagnosing and assessing a wide range of conditions. Compared to traditional OPG, CBCT offers enhanced accuracy, reduced image distortion, and superior measurement capabilities, which are essential for evaluating complex lesions, assessing cortical perforation, and identifying the extent of bone resorption. Despite many advantages, CBCT too is not without limitations. The quality of CBCT images depends on scanning protocols and reconstruction settings, and it cannot replace MRI when soft tissue assessment is required. Furthermore, the high cost and size of CBCT machines pose significant barriers, particularly for young dentists and smaller practitioners, leading to its current status as a supplementary rather than the primary diagnostic tool. A thorough and clear interpretation of CBCT data is essential to fully leverage its capabilities and address its limitations effectively.

8. Source of Funding

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9. Conflict of Interest

None.

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