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REVIEW ARTICLE

CONE BEAM COMPUTED TOMOGRAPHY: A REVOLUTION IN DENTISTRY

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ABSTRACT:
Cone Beam Computed Tomography (CBCT) is an extra-oral imaging system specifically designed for three dimensional imaging of the oral and maxillofacial structures at a lower cost and absorbed dose compared with conventional computed tomography (CT). CBCT is a type of computed tomography that uses a cone shaped x-ray beam for image exposure. The use of a cone shaped primary x-ray beam to expose the patient results in raw images. There are several uses of CBCT. Amongst all are- implant radiology, in endodontics, maxillofacial trauma, fracture assessment, root canal morphology, in forensic sciences, TMJ disorders etc. this article demonstrate various applications of CBCT in dentistry.
Key words:- Forensic sciences, Maxillofacial, Tomography

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INTRODUCTION

Cone Beam Computed Tomography (CBCT) is an extra-oral imaging system specifically designed for three dimensional imaging of the oral and maxillofacial structures at a lower cost and absorbed dose compared with conventional computed tomography (CT).[1] CBCT is a type of computed tomography that uses a cone shaped x-ray beam for image exposure. The use of a cone shaped primary x-ray beam to expose the patient results in raw images. Also, in CBCT imaging, the x-ray source and receptor rotate an arc between 180° and 360° around the patient. Signal to noise ratio (SNR) for CBCT is approximately 15 to 20%. The result is that CBCT provides excellent images of dense objects such as teeth and bone[2]. At first glance, this lack of soft tissue detail may seem to be a disadvantage for CBCT; however, in dentistry most of our diagnostic tasks are focused on teeth and bone planning for implants, localizing impacted maxillary canines and mandibular third molars etc.; and as mentioned, CBCT imaging is an excellent choice for imaging these high density anatomic features.[2] In addition, CBCT provides images with soft tissue outlines from which we can determine orthodontic and airway landmarks providing assistance with 3D diagnosis and planning. In actuality, most diagnostic problems do not require the additional information of soft tissue details that MDCT can offer.[3]
CBCT viewing software generally provides us with two types of images — multiplanar reconstructed images (MPR) or 3D volumetric reconstructions. Once the volumetric image is obtained, the computer processes this volume into axial, coronal and sagittal slices which the user can then scroll through, slice by slice. Many volumes are approximately 512 x 512 x 512 slices; the actual number of slices is dependent on the scanning and reconstruction resolutions. Different types of 3D volumes are obtained depending on the diagnostic task.[4]

APPLICATION OF CBCT

There are numerous uses of CBCT. It can be useful in TMJ disorders, in endodontics, in implant surgery etc.

TEMPOROMANDIBULAR JOINT DISORDER

CBCT is the imaging device of choice in cases of trauma, pain, dysfunction, fibro-osseous ankylosis and in detecting condylar cortical erosion and cysts. Because of the use of the 3-D features, the image guided puncture technique, which is a treatment modality for TMJ disk adhesion, can safely be performed. CBCT helps in defining the true position of the condyle in the fossa, which often reveals possible dislocation of the disk in the joint, and the extent of translation of the condyle in the fossa. With its accuracy, measurements of the roof of the glenoid fossa can be done easily. Soft tissues around the TMJ can also be visualized.[5]

FORENSIC DENTISTRY

Many dental age estimation methods, which are a key element in forensic science, are described in the literature. CBCT was established as a non-invasive method to estimate the age of a person based on the pulp–tooth ratio. Thus its role in forensic dentistry is very useful in detecting victim of crime.[6]

ENDODONTICS

CBCT is very useful in endodontics. Various applications are fracture assessment,detection of apical periodontitis, assessment of root and canal anatomy.

IN ASSESSING FRACTURES

CBCT can be used to determine root morphology, the number of roots, canals and accessory canals, as well as to establishing the working length and angulations of roots and canals. It also is accurate in assessing root-canal fillings. It is very helpful in detecting the pulpal extensions in talon cusps and the position of fractured instruments. It is also a reliable tool tool for presurgical assessment of the proximity of the tooth to adjacent vital structures, size and extent of lesions, as well as the anatomy and morphology of roots with very accurate measurements.[7]

CBCT demonstrated superiority to 2-D radiographs in detecting fractured roots. Vertical and horizontal root fracture detection is described in several clinical cases. It is also agreed that CBCT is superior to peri-apical radiographs in detecting these fractures, whether they are bucco lingual or mesiodistal.[8]

DETECTION OF APICAL PERIODONTITIS

Conventional radiography results in an under-estimation of the incidence of apical periodontitis. Lesion confined within the cancellous bone cannot be detected by conventional radiographs, whereas they are easily detected in CBCT which captures images in slices thereby avoiding anatomic superimposition. Thus, apical Periodontitis can be detected at an early stage using CBCT when compared to conventional radiographs. It is a very useful tool in diagnosing apical lesions. It can be helpful in differential diagnosis of apical lesions by measuring the density from the contrasted images of these lesions, in whether the lesion is an apical granuloma or an apical cyst. CBCT acts as a tool to assess whether the lesion is of endodontic or non-endodontic origin.[9]

ASSESSMENT OF ROOT AND CANAL ANATOMY

CBCT has been proved beneficial in assessing the exact anatomy and morphology of root canals. Increased number of MB2 canal can be identified with CBCT when compared to conventional radiographs. CBCT imaging has also been reported to characterize the high prevalence of the distolingual canal, highlight anomalies in the root canal system of mandibular premolars, and assist in the determination of root curvature. In a study that evaluated 608 permanent mandibular second molars using CBCT a higher prevalence of “C” shaped canals was noticed CBCT is an effective tool for the detection of additional distolingual roots and C-shaped canals.[10]

ORAL AND MAXILLOFACIAL SURGERY

Jaw pathologies

CBCT have been used to investigate the exact location and extent of jaw pathologies and assess impacted or supernumerary teeth and the relationship of these teeth to vital structures. CBCT images are used for pre- and postsurgical assessment of bone graft recipient sites and to evaluate osteonecrosis changes of the jaws and paranasal sinus pathology and/ or defect. CBCT technology has also been used for thorough pretreatment evaluations of patients with obstructive sleep apnea, to determine an appropriate surgical approach.[11]

FRACTURES

It has been proved useful in detecting fractures. CBCT the technique of choice for investigating and managing midfacial and orbital fractures, postfracture assessment, interoperative visualization of the maxillofacial bones, and intraoperative navigation during procedures involving gunshot wounds. CBCT is used widely for planning orthognathic and facial orthomorphic surgeries, where detailed visualization of the interocclusal relationship and representation of the dental surfaces to augment the 3D virtual skull model is vital. By utilizing advanced software, CBCT allows for minimum visualization of soft tissue, allowing dentists to control post treatment esthetics and evaluate the outline of the lip and bony regions of the palate in cases of cleft palate.[12]

IMPLANT DENTISTRY

CBCT is the preferred option for implant dentistry, providing greater accuracy in measuring compared to 2D imaging, while utilizing lower doses of radiation. New software has reduced the possibility of malpositioned fixtures and damaged anatomical structures. CBCT has reduced implant failures by providing information about bone density, the shape of the alveolus, and the height and width of the proposed implant site for each patient. CBCT is commonly utilized in postsurgical evaluations to assess bone grafts and the implant’s position in the alveolus.[13]

ORTHODONTICS

CBCT is a reliable tool in the assessment of the proximity to vital structures that may interfere with orthodontic treatment. Orthodontists can use CBCT images in orthodontic assessment and cephalometric analysis. Today, CBCT is already the tool of choice in the assessment of facial growth, age, airway function and disturbances in tooth eruption. In cases in which mini-screw implants are placed to serve as a temporary anchorage, CBCT is useful for ensuring a safe insertion and to assess the bone density before, during and after treatment.[14]

PERIODONTICS

The first reported applications of CBCT in periodontology were for diagnostic and treatment outcome evaluations of periodontitis. It has ability to accurately reconstruct periodontal intrabony and fenestration defects, dehiscences, and root furcation. CBCT 3D geometric accuracy has been suggested to be equal to radiography and MDCT but with

better observer-rated image quality than MDCT as well as superior periodontal-defect detection than radiography. It also provides accurate measurement of intrabony defects and allows clinicians to assess dehiscence, fenestration defects, and periodontal cysts. 3D imaging such as CBCT can visualize buccal and lingual defects. CBCT has been used to obtain detailed morphologic descriptions of bone as accurately as direct measurement with a periodontal probe. CBCT can also be used to assess furcation involvement of periodontal defects and allow clinicians to evaluate postsurgical results of regenerative periodontal therapy.[15]

CONCLUSION

Author concluded that when 3D image is necessary, CBCT should be the method of choice. The dental profession now has the ability to generate full 3D images of our patients' dental and maxillofacial complex. These images are reliably accurate with no magnification and unfettered by superimposition from other anatomic structures. CBCT is an excellent diagnosis tool, offering significant advantages regarding to the quality and quantity of anatomic information.

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