CBCT AND ENDODONTICS: A REVIEW

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ABSTRACT : The need for three-dimensional imaging in endodontics is increasing from last several decades. Computed tomography (CT) allows conditions to be diagnosed with 3D images but it is relatively expensive and exposes patient to high doses of radiation.In the late 90’s, a new technology using a cone-shaped beam, called the cone beam computerized tomography (CBCT), made the perception of three-dimensional imaging easy to dentists. Cone beam computerized tomography (CBCT) has evolved as an adjunct to other radiographic imaging techniques in endodontics and is useful in many aspects in endodontics. This article will provide a brief review of CBCT in endodontics covering all aspects.

KEYWORDS : Cone beam computed tomography (CBCT), endodontics, guidelines.

INTRODUCTION

Computed tomography developed in 1972, which was reported in 1973, enabled conditions to be diagnosed with 3-dimensional (3D) images. These devices were used in different fields, and their use in dentistry increased with the advent of implant surgery. CT devices continue to be relatively large, expensive, and expose patients to relatively high doses of radiation [1]. Arai and colleagues started developing a compact CT apparatus specifically for use in dentistry. In 1997, they created a prototype-limited cone beam CT (CBCT) device for dental use and about 2 years after that achievement, the device was used in approximately 2000 cases to evaluate conditions, such as impacted teeth, apical lesions, and mandibular and maxillary diseases, both before and after surgery proving highly successful [2,3].

FUNDAMENTALS OF CONE BEAM COMPUTED TOMOGRAPHY

CBCT uses an extraoral imaging scanner which is specifically designed for head and neck imaging that produces 3D scans of the maxillofacial skeleton. Cone beam machines use x-rays in the form of a large cone covering the head surface to be examined while in CT a linear array of detectors is used which is a 2-dimensional (2D) planar detector. Because the cone beam irradiates a large volume area instead of a thin slice, the machine does not need to rotate as many times as CT. It gives all the required information of the region of interest in one rotation. This technique allows clinicians to obtain 2D reconstructed images in all planes, and reconstructions in 3 dimensions with very much low-level exposure to x-radiation [4].

SUPINE VERSUS SEATED POSITIONING

There are different types of CBCT machines with many characteristics. One of the main differences is the position of patients in the machine: standing, sitting, or lying on a table. Clinicians are used to sitting or standing positioning for 2D imaging. For 3D cone beam imaging, minimizing patient motion is critical to reduce blur and motion artifacts [5].

IMAGE INTENSIFIER VERSUS FLAT PANEL EFFICIENCY OVER TIME

Image intensifiers were commonly used in the early CBCT machines. Currently, different types of flat panel detectors (FPDs) are used as these detectors are distortion free, have a higher dose efficiency and a wider dynamic range, and can be produced with either a smaller or larger field of view (FOV) [6,7,8].

FIELD OF VIEW

The size of the FOV describes the scan volume of a particular CBCT machine and depends on the detector's size and shape, the beam projection geometry, and the ability to collimate the beam, which is different from one manufacturer to other. Beam collimation decreases the patients' ionizing radiation exposure to the region of interest and ensures that an appropriate FOV can be selected based on the specific case. Limiting the scan volume should be based on the clinician's judgment for the situation. For most dental implant applications, a small or medium FOV is sufficient to see the region of interest in detail. Small-volume CBCT machines are more popular in endodontic cases because they provide the following advantages over larger-volume CBCT:

1) Increased spatial resolution [6,7]

2) Decreased radiation exposure to patients [6,7]

3) Smaller volume to be interpreted [6,7]

4) Less expensive machines [6,7]

APPLICATIONS IN ENDODONTICS

1) Evaluation of root canal morphology [9-12].
2) 3D representation of periapical pathology [13].
3) Assessment of pathosis of endodontic and non-endodontic origin [14].
4) Identifying an untreated or missed canal [15,16].
5) Visualizing over-extended root canal obturation material [17].
6) Analysis of external and internal resorption [18,19]
7) Evaluation of vertical and horizontal root fractures [20].
8) Traumatic dental injuries [21].
9) Guided endodontics [22].

SPECIFIC REQUIREMENTS FOR ENDODONTICS

Cone beam computed tomography imaging in Endodontics requires extremely high detail and resolution to appreciate the complexities of the root canal system and periodontium. High image resolution comes at the cost of higher patient radiation exposure. Only small field of view cone beam computed tomography scans are recommended for the diagnosis and management of endodontic problems. A small field of view reduces scatter which in turn improves image quality. The generated imagegets easily degraded by subtle patient movement.The most suitable machines for maintaining patient stability are where the patient sits, or even lies down, rather than stands. This is an important feature in cone beam computed tomography machines as most of the hybrid panoramic/CBCT machines keep the patient in standing position [23]. The American Association of Endodontists and the AAOMR published the following updated joint position statement intended to provide scientifically based guidance to clinicians regarding the use of cone beam computed tomography in endodontic treatment [24,25]. (Table No. 1)

Recommendation 1	Intraoral radiographs should be considered the imaging modality of choice in the evaluation of endodontic patients.
Recommendation 2	Limited FOV CBCT should be considered the imaging modality of choice for diagnosis in patients who present with contradictory or nonspecific clinical signs and symptoms associated with untreated or previously endodontically treated teeth.
Recommendation 3	Limited FOV CBCT should be considered the imaging modality of choice for initial treatment of teeth with the potential for extra canals and suspected complex morphology, such as mandibular anterior teeth, maxillary and mandibular premolars and molars, and dental anomalies.
Recommendation 4	If a preoperative CBCT has not been taken, limited FOV CBCT should be considered as the imaging modality of choice for intra-appointment identification and localization of calcified canals.
Recommendation 5	Intraoral radiographs should be considered the imaging modality of choice for immediate postoperative imaging.
Recommendation 6	Limited FOV CBCT should be considered the imaging modality of choice if clinical examination and 2D intraoral radiography are inconclusive in the detection of vertical root fracture.
Recommendation 7	Limited FOV CBCT should be the imaging modality of choice when evaluating the nonhealing of previous endodontic treatment to help determine the need for further treatment, such as nonsurgical, surgical, or extraction.
Recommendation 8	Limited FOV CBCT should be the imaging modality of choice for nonsurgical retreatment to assess endodontic treatment complications, such as overextended root canal obturation material, separated endodontic instruments, and localization of perforations.
Recommendation 9	Limited FOV CBCT should be considered as the imaging modality of choice for presurgical treatment planning to localize root apex/ apices and to evaluate the proximity to adjacent anatomic structures.

Recommendation 10	Limited FOV CBCT should be considered as the imaging modality of choice for surgical placement of implants.
Recommendation 11	Limited FOV CBCT should be considered the imaging modality of choice for diagnosis and management of limited dentoalveolar trauma, root fractures, luxation, and/or displacement of teeth and localized alveolar fractures, in the absence of other maxillofacial or soft tissue injury that may require other advanced imaging modalities.
Recommendation 12	Limited FOV CBCT is the imaging modality of choice in the localization and differentiation of external and internal resorptive defects and the determination of appropriate treatment and prognosis.
Recommendation 13	In the absence of clinical signs or symptoms, intraoral radiographs should be considered the imaging modality of choice for the evaluation of healing following nonsurgical and surgical endodontic treatment.
Recommendation 14	In the absence of signs and symptoms, if limited FOV CBCT was the imaging modality of choice at the time of evaluation and treatment, it may be the modality of choice for follow-up evaluation. In the presence of signs and symptoms, refer to recommendation 7.

TABLE NO. 1

LIMITATIONS

The presence of metallic restorations (e.g. amalgam restorations, metal posts and/or crowns, and implants) or even gutta-percha can cause a radiographic artefact which compromises the details of root canal anatomy and relevant pathology such as root resorption and root fractures. Metal artefact reduction algorithms (MAR) are becoming more popular in operating and viewing software in order to overcome this loophole [26].In most of the vertical root fracture cases it is almost difficult to diagnose even by cone beam computed tomography as the width of the fracture is too small in early stage. The width of the fracture must be twice the voxel size of the cone beam computed tomography machine so that it is detectable. If the voxel size of the CBCT machine is 0.3mm then it is not reliable for detection of vertical root fracture. The vertical root fracture is not diagnosed until the width of fracture is greater than 0.15mm [27]. Elsaltani in his study confirmed that voxel size of 0.35mm will not benefit the endodontist [28].

CONCLUSION

It is clear that the CBCT provides additional information that increases diagnostic accuracy and confidence in decision-making as well as have an impact of treatment planning. More clinical studies are required to assess the long-term impact of CBCT on the outcomes of endodontic treatment. CBCT should be used as an adjunct to other radiographic imaging modalities in complex endodontic cases.

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