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# CONE BEAM-COMPUTED TOMOGRAPHY IN ENDODONTICS

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**ABSTRACT**

Cone beam computed tomography (CBCT) is a contemporary, radiological imaging system designed specifically for use on the maxillo-facial skeleton. The system overcomes many of the limitations of conventional radiography by producing undistorted, three-dimensional images of the area under examination. These properties make this form of imaging particularly suitable for use in endodontics. Purpose of this paper is to review the potential applications of this newer radiographic technique in endodontics.

## I.Introduction

Radiographic imaging is essential in diagnosis, treatment planning and follow-up in endodontics. The interpretation of an image can be confounded by a number of factors including the regional anatomy as well as superimposition of both the teeth and surrounding dentoalveolar structures. As a result of superimposition, periapical radiographs reveal only limited aspects, a two-dimensional view, of the true three-dimensional anatomy.[1,2] Additionally, there is often geometric distortion of the anatomical structures being imaged with conventional radiographic methods.3 These problems can be overcome by utilizing small- or limited-volume cone beam-computed tomography imaging techniques, which produce accurate 3-D images of the teeth and surrounding dentoalveolar structures.[1,2,4]

CBCT is accomplished by using a rotating gantry to which an x-ray source and detector are fixed. A divergent pyramidalor cone-shaped source of ionizing radiation is directed through the middle of the area of interest onto an area x-ray detector on the opposite side of the patient. The x-ray source and detector rotate around a fixed fulcrum within the region of interest. During the exposure sequence, hundreds of planar projection images are acquired of the field of view (FOV) in an arc of at least 180°. In this single rotation, CBCT provides precise, essentially immediate and accurate 3-D radiographic images. As CBCT exposure incorporates the entire FOV, only one rotational sequence of the gantry is necessary to acquire enough data for image reconstruction. At the present time, CBCT is considered a complementary modality for specific applications rather than a replacement for 2-D imaging modalities.[4]

## *II.Patient Selection Criteria:*

CBCT must not be used routinely for endodontic diagnosis or for screening purposes in the absence of clinical signs and symptoms. The patient's history and clinical examination must justify the use of CBCT by demonstrating that the benefits to the patient outweigh the potential risks

## III.Endodontic applications

It is in the area of endodontic applications that the literature has proved most fruitful to date. Endodontic applications include the diagnosis of periapical lesions due to pulpal inflammation, visualization of canals, elucidation of internal and external resorption, and detection of root fractures.

- In general, the use of CBCT in endodontics should be limited to the assessment and treatment of complex endodontic conditions such as:
- Identification of root canal system anomalies and determination of root curvature.
- Diagnosis of dental periapical pathosis in patients who present with contradictory or nonspecific clinical signs and symptoms, who have poorly localized symptoms associated with an untreated or previously endodontically treated tooth with no evidence of pathosis identified by conventional imaging
- Diagnosis of pathosis of nonendodontic origin in order to determine the extent of the lesion and its effect on surrounding structures.
- Intra- or postoperative assessment of endodontic treatment complications, such as overextended root canal obturation material, separated endodontic instruments, calcified canal identification and localization of perforations.
- Diagnosis and management of dentoalveolar trauma, especially root fractures, luxation and/or displacement of teeth, and alveolar fractures.
- Localization and differentiation of external from internal root resorption or invasive cervical resorption from other conditions, and the determination of appropriate treatment and prognosis.
- Presurgical case planning to determine the exact location of root apex/apices and to evaluate the proximity of adjacent anatomical structures.

## I. Detection of Apical Periodontitis:

CBCT enables the detection of radiolucent findings before they are visualized on conventional radiographs.[7-13] Lesions in the cortical bone can only be detected radiographically when there is perforation of the bone cortex, erosion from the inner surface of the bone cortex, or extensive erosion or defects on the outer surface. It is known that periapical lesions in cancellous bone cannot be detected radiographically. [13] CBCT, however, can reveal bone defects of the cancellous bone and cortical bone separately. The prevalence of apical periodontitis was found to be significantly higher when using CBCT, in comparison with periapical radiographs.8 Moreover, the information obtained by CBCT evaluation of periapical repair following root canal treatment was comparable to histological analysis, whereas conventional radiographs underestimated the size of the periapical lesion.[12] One study showed that 34% of the radiolucencies detected with CBCT were missed with periapical

radiography in maxillary premolars and molars.[10] It was concluded that the detection of apical periodontitis was considerably higher with CBCT than with periapical radiography.[8] Thus, CBCT was found to be a more sensitive diagnostic method to identify apical periodontitis.

**ii.IPresurgical Assessment:**

Three-dimensional imaging allows the anatomical relationship of the root apices to important anatomical structures, such as the inferior dental canal, mental foramen and maxillary sinus, to be clearly identified in any plane the clinician wishes to view. [14-16] It was concluded that CBCT may play an important role in planning for periapical microsurgery on the palatal roots of maxillary first molars.15 The distance between the cortical plate and the palatal root apex could be measured, and the presence or absence of the maxillary sinus between the roots could be assessed. By selecting relevant views and slices of data, the thickness of the cortical plate, the cancellous bone pattern, fenestrations, as well as the inclination of the roots of teeth planned for surgery, can be accurately determined preoperatively.

CBCT scans from 139 patients were analyzed to evaluate the proximity of the mandibular canal to the root apices of 743 mandibular second premolar and first and second molar teeth. The results revealed that the CBCT scan was an accurate, noninvasive method to evaluate the position of the mandibular canal. The variable position of this structure between patients suggests the need for CBCT to determine the proximity of the nerve bundle before attempting invasive treatment in this area.

**iii.Assessment of Tooth Morphology and Complications:**

Root morphology and bony topography can be visualized in 3-D, as can the number of root canals and whether they converge or diverge from each other. Unidentified and untreated root canals may be identified using axial slices, which may not be readily identifiable with periapical radiographs.[14] The efficacy of CBCT as a modality to accurately identify the presence of second mesiobuccal canals in maxillary first and second molars has been evaluated.[16] The CBCT images accurately identified the presence or absence of the MB2 canal in 78.95% of samples. Statistical analysis showed that there was no significant difference in the ability of CBCT scanning to detect the MB2 canal when compared with the gold standard of clinical sectioning. Additionally, CBCT images have clearly demonstrated the presence of untreated or missed canals intraoperatively or in root-filled teeth, as well as complications (i.e., perforations).

**iv.Assessment of Traumatic Injuries and Sequelae:**

The CBCT provided valuable information that assisted in the determination of the type and severity of dental injuries. [17] Horizontal root fractures, resorptive defects (internal, external and invasive cervical) and alveolar fractures are readily observed and differentiated on CBCT images, whereas their diagnoses on periapical radiographs are often quite difficult. [18]

**v.Assessment of Vertical Root Fractures:**

Images obtained on conventional periapical radiographs and 3-D scans for the diagnosis of vertical root fractures have been compared. [19] Twenty cases with suspected vertical root fractures were subjected to radiographic imaging. They found that CBCT was significantly better than conventional radiographs in the diagnosis of vertical root fractures. However, fine vertical cracks appear to **not** be revealed on CBCT images at current CBCT resolutions. [20] What may be observed, however, is the resultant vertical bone loss in one or more of the CBCT slices.

**IV.Conclusion**

CBCT for endodontic purposes appears to be the most promising use of CBCT, in many instances instead of 2D images. Applications would include apical lesions, root fractures, canal identification, and characterization of internal and external root resorption.

Conventional intraoral radiography provides clinicians with cost-effective, high-resolution imaging that continues to be the front-line method for dental imaging. However, it is clear that there are many specific situations where the 3-D images produced by CBCT facilitates diagnosis and influences treatment. The usefulness of the CBCT cannot be disputed. It is a valuable task-specific imaging modality, producing minimal radiation exposure to the patient and providing maximal information to the clinician.

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