Application of Cone Beam Computed Tomography (CBCT) in Endodontics

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Introduction

Cone-beam computed tomography (CBCT) has existed since the last 1990s. However, recent technological advances have made cone-beam computed tomography (CBCT) a feasible option especially in the field of endodontics. Cone-beam technology “uses a cone-shaped beam of radiation to acquire volume at a single 360-degree rotation”. Thin slices in all three anatomical planes are obtained: axial, sagittal and coronal. The image data for dental CBCT unlike medical CT is reconstructed from isometric voxels which allows for the same length, width and depth in the projection. In endodontics, limited field of view (FOV) CBCT is preferred due to its reduced voxel size which leads to higher spatial resolution. Thus, CBCT has the potential to revolutionize the specialty of endodontics with its increased accuracy and resolution, low radiation dosage, and low financial burden for the patients. The following cases presented are from patients seen at the Indiana University School of Dentistry Graduate Endodontic Clinic.

CBCT and Diagnosis of Apical Periodontitis

Periapical lesions located within the cancellous bone may not be detected by conventional periapical radiography if the cortical plate remains unaffected. Thus, small periapical lesions confined within the cancellous bone can now be detected by CBCT as well as large periapical lesions which have not yet perforated the cortical bone. In addition, the ability of CBCT to view thin axial, sagittal and coronal sections has eliminated superimposition of anatomical structures such as zygomatic buttress, maxillary sinus etc on periapical lesions leading to enhanced sensitivity in contrast to conventional radiography. The isometric volume of CBCT ensures that the anatomical relationship between periapical lesions and vital structures such as mandibular canal and maxillary sinus can be measured accurately without the inherent distortion of conventional radiography. In the near future, CBCT may be considered as the ‘gold standard’ with a sensitivity and specificity value of 1.0 to detect the presence or absence of periapical disease in contrast to the sensitivity value of 0.55 with periapical radiography.

Case 1 is a good example which illustrates the value of CBCT in detecting the presence of periapical radiolucency which had not perforated the cortical plate due to which the conventional radiography was not diagnostic. 43 year old Asian patient presented to Graduate Endodontics Clinic with the chief complaint of having discolored anterior tooth. Cold, percussion and palpation for both types of #3 were negative and no #3 was performed a year ago. As shown in Figure 1, conventional radiography did not show definitive pathology associated with #3. Clinical testing of percussion and palpation #3 was negative and no radiolucency which had not perforated into the cortical plate due to which the conventional radiography was non-diagnostic. CBCT accurately depicts the internal root canal anatomies of this complex case which makes the endodontic treatment and outcome much more predictable and successful.

The clinical diagnosis of cracked teeth and root fractures is considered to be one of the most difficult diagnosis in endodontics. Although an isolated probing depth with a “J-shape” lesion may be indicative of a vertical root fracture, it is not pathognomonic. For vertical root fractures, the definitive diagnosis is only confirmed by direct visualization which typically entails invasive procedure of surgical flap. For cracked tooth fracture, line fracture is typically in a mesio-distal direction which is almost impossible to detect with conventional radiography as the x-ray beam must be within 45 degrees of the fracture plane to allow detection of the fracture. The three-dimensional nature of CBCT allows visualization of the fracture line from multiple planes at a very high contrast due to which CBCT scans are considered to be more accurate and sensitive in diagnosing root fractures in comparison to conventional radiography.

Cases 4 and 5 in which CBCT was able to show fractured mesial root and missed disto-lingual canal for #19 which had been previously endodontically treated (Figures 7 and 8). Conventional periapical film due to its inherent limitations with two-dimensional radiography failed to show whether the fractured root nor the missed canal (Figure 6). Thus, CBCT can be a valuable diagnostic tool particularly in assessing the etiology of failing endodontic therapy as shown by Case 3.

Indications of CBCT

The American Association of Endodontists (AAE) and the American Academy of Oral and Maxillofacial Radiology (AAOMR) have jointly developed the following indications for CBCT: 4

- Identification of accessory canals in teeth with suspected complex morphology as well as root canal systems (RCSs) with digital radiography as compared with 100% of RCSs with CBCT.
- Teeth with unusual anatomy such as dilacerated roots, dens in dente, C-shaped canals etc. are particularly challenging to be identified with conventional radiography.
- CBCT accurately depicts the internal root canal anatomies of this complex case which makes the endodontic treatment and outcome much more predictable and successful.
- Accurate diagnosis of root fracture,
- Diagnosis of dental periapical pathologies in patients which present with inconsistent or non-specific clinical signs and symptoms which could not be initially detected with conventional radiography.
- Diagnosis of non-endodontic origin pathologies.
- Intra- or postoperative evaluation of endodontic treatment complications.
- Identification of dental/vascular trauma injuries.
- Differentiation of various types of root resorptions in order to determine proper treatment and prognosis.
- Pre-surgical identification of the precise location of root apex and its proximity to sensitive anatomical structures.
- Dental implant case planning when 3-dimensional imaging is considered indispensable based on the clinical evaluation of the edentulous ridge.

CBCT and Assessment of Root Canal Anatomy and Root Fracture

Endodontic success hinges on the proper knowledge of the myriad root canal morphologies and its frequent variations in different teeth. Two dimensional radiography makes it difficult to discern the number of canals and their anatomical characteristics. Matherne et al.3 found that endodontists identified between 70%-80% of root canal systems (RCSs) with digital radiography as compared with 100% of RCSs with CBCT. Teeth with unusual anatomy such as dilacerated roots, dens in dente, C-shaped canals etc. are particularly challenging to be identified with conventional radiography. CBCT accurately depicts the internal root canal anatomies of this complex case which makes the endodontic treatment and outcome much more predictable and successful.

References