



Heal Talk

Cone Beam Computed Tomography In Endodontics

Talk

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Introduction

Since Kells first reported the usefulness of visualizing a lead wire in a root canal on a “radiogram” in establishing the length of a root canal in 1899, radiography has been a pivotal tool in the practice of endodontics. Almost a century later, building on the pioneering efforts of those using conventional computed tomography (CT) and micro-CT, the introduction of maxillofacial CBCT in 1996 provided the first clinically practical technology demonstrating application of 3D imaging for endodontic considerations.

Role of Imaging in Endodontics

Radiography is essential to successful diagnosis of odontogenic and nonodontogenic pathoses, treatment of the pulp chamber and canals of the root of a compromised tooth via intra-coronal access, biomechanical instrumentation, final canal obturation, and assessment of healing. Imaging serves at all stages in endodontics:

1. Preoperative Assessment

Imaging achieves visualization of dental and alveolar hard tissue morphology and pathologic alterations to assist correct diagnosis. It provides information on the morphology of the tooth including location and number of canals, pulp chamber size and degree of calcification, root structure, direction and curvature, fractures, iatrogenic defects, and the extent of dental caries. The effects of peri-radicular and periapical disease can be determined, including the degree of root resorption and characteristics of periapical osteolysis. Larger lesions, only determined by imaging, may necessitate adjunctive surgical procedures in addition to conventional intracanal therapy. Diagnostic radiographs help predict the potential for complications, permit root fracture detection, and demonstrate periapical lesions.

2. Intraoperative

During therapy two intraoral periapical images may be performed. The first is a “working” radiograph achieved by placement of a metallic file(s) into the root canal(s) to a length that approximates that of the root as radiological and anatomic root apexes are almost never coincident. This ensures that mechanical debridement of the intracanal contents extends to the apical terminus of the canal and that obturation

is dense, homogeneous, and contained within the root canal system. In addition, prior to final obturation, a “final” or pre-condensation radiograph is made to assure proper fitting of the master cone.

3. Postoperative

A “postoperative” radiograph immediately after root canal obturation is made to assess the sealing condensation and containment of the root canal filling material within the root canal system. In cases where peri-radicular healing is incomplete, it acts as a baseline for assessment of healing in the medium and potentially long term. Imaging is important in evaluating the results of previous therapy, delayed healing, evaluating potential obstacles to retreatment, as well as surgical considerations.

Radiological aspects of CBCT

The pulp of a tooth is structurally complex. The dental pulp comprises a sophisticated arrangement of hard tissues, intricate root canals, and a network of nerves and blood vessels. Precise visualization of these internal components is essential for successful root canal treatment. This requires a comprehensive understanding of tooth anatomy. To examine the dental pulp, dental professionals use various aids, including traditional diagnostic techniques and modern imaging methods such as cone-beam computed tomography (CBCT). CBCT offers a cost-effective and non-invasive approach for capturing tooth anatomy details.

The two-dimensional (2D) representation of three-dimensional (3D) objects in intraoral radiography hampers the interpretation of root morphology, which in turn, affects treatment and endodontic healing. Studies found that when using 2D periapical radiographs to evaluate the healing of a periapical lesion, only 47% agreement was achieved among six examiners. Moreover, there was only 19%–80% agreement between two evaluations of the same films. A limited understanding of 2D imaging increases the risk of errors and can lead to an underestimation of the endodontic problem compared with 3D imaging.

In dentistry, CBCT is the preferred three-dimensional imaging method. The use of CBCT in Endodontics is increasing rapidly worldwide. The three-dimensional radiographic assessment of teeth and their surrounding structures with cone beam computed tomography (CBCT) is desirable for aiding

diagnosis and/or management of complex endodontic problems.

Cone beam computed tomography is a modification of the computed tomography (CT) concept, involving the single rotation of an X-ray source around the dental subject. CBCT uses a rotating arm and a cone-shaped ionizing radiation source to capture images via an X-ray source and detector. CBCT offers rapid and precise 3D imaging by capturing multiple cross-sectional images. Currently, CBCT is being utilized as an adjunctive aid together with traditional 2D methods for specific dental applications.

The data are analysed and reconstructed using a CT-based algorithm to create a volume of data, which can be viewed in three conventional planes (axial, sagittal and coronal) and multiple alternative planes on manipulation of the data set.

Image acquisition is rapid and uses technology, which is becoming relatively affordable. A three-dimensional visualization of the region of interest is obtained in sufficient detail to localize teeth and adjacent anatomy in a manner, which is simply not achievable with conventional, 2D, plain dental film imaging.

The potential benefits of CBCT must be balanced with the comparatively higher levels of risk from radiation exposure, compared to conventional imaging.

The 3D visualization of CBCT is superior to that of traditional scans, providing inter-relational images in three planes and allowing data reorientation for accurate spatial representation in endodontics. CBCT has a lower spatial resolution than that of digital- and film-based intraoral radiography. Moreover, CBCT illuminates the entire field of view (FOV) but may struggle to detect minimal attenuation changes. Furthermore, CBCT is prone to artifacts, similar to other imaging modalities.

Specific Requirements For Endodontics

Cone beam computed tomography imaging in Endodontics requires exceptionally high detail and resolution to appreciate the intricacies of the root canal system and periodontium. High image resolution comes at the cost of higher patient radiation exposure.

Only small FOV CBCT scans are recommended for the diagnosis and management of endodontic problems. A small FOV scan reduces the volume of exposed tissue, and therefore, the effective radiation dose, but, favourably, this also reduces scatter,

which improves image quality. The generated images may be 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 consideration when using CBCT imaging, as the dedicated CBCT units are often designed for a seated or supine patient whilst hybrid panoramic/CBCT units usually have the patient standing. The trend for hybrid panoramic/CBCT units appears to be the predominant growth area in CBCT imaging currently, most probably because these units are cheaper yet multifunctional. However, it must be recognized that image quality is at risk of being lower.

Limitations

The presence of metallic restorations (e.g. amalgam restorations, metal posts and/or crowns, and implants) or even gutta-percha can cause significant radiographic artefact, sufficient to compromise details of root canal anatomy and relevant pathosis such as root resorption and root fractures. Metal artefact reduction algorithms (MAR) are becoming more common in operating and viewing software in order to overcome this disadvantage.

Concluding Remarks

- A CBCT scan should be tailored to the individual patient and their diagnostic needs;
- The potential benefits of the CBCT scan should outweigh the potential risks;
- Clinicians must regularly update their core knowledge in CBCT;
- Undergraduate curricula should include an introduction to CBCT radiology;
- Post-graduate endodontic programmes should incorporate the use of CBCT.

To be continued.....

(It's a review of literature and not an original article)

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