Joint Position Statement of the American Association of Endodontists and the American Academy of Oral and Maxillofacial Radiology

USE OF CONE-BEAM COMPUTED TOMOGRAPHY IN ENDODONTICS

INTRODUCTION

The American Association of Endodontists (AAE) and the American Academy of Oral and Maxillofacial Radiology (AAOMR) have jointly developed this position statement. It is intended to provide scientifically based guidance to clinicians regarding the use of cone beam computed tomography (CBCT) in endodontic treatment as an adjunct to planar imaging. This document will be periodically revised to reflect new evidence.

Endodontic disease adversely affects quality of life and can produce significant morbidity in afflicted patients. Radiography is essential for the successful diagnosis of odontogenic and non-odontogenic pathoses, treatment of the pulp chamber and canals of a compromised tooth, biomechanical instrumentation, evaluation of final canal obturation, and assessment of healing.

Until recently, radiographic assessments in endodontic treatment have been limited to intraoral and panoramic radiography. These radiographic technologies provide two-dimensional representations of three-dimensional tissues. If any element of the geometric configuration is compromised, the image can demonstrate errors.[1] In more complex cases, radiographic projections with different beam angulations can allow parallax localization. However, complex anatomy and surrounding structures can make interpretation of planar "shadows" difficult.

CONE BEAM COMPUTED TOMOGRAPHY

The advent of CBCT has made it possible to visualize the dentition, the maxillofacial skeleton, and the relationship of anatomic structures in three-dimensions.[2] Significantly increased use of CBCT is evidenced by a recent Web-based survey of active AAE members in the U.S. and Canada which found that 34.2% of 3,844 respondents indicated that they were utilizing CBCT. The most frequent use of CBCT among the respondents was for diagnosis of pathosis, preparation for endodontic treatment or endodontic surgery, and for assistance in the diagnosis of trauma related injuries.[3]

CBCT, as with any technology, has known limitations. There are also numerous CBCT equipment manufacturers and models available. In general, CBCT can be categorized into large, medium, and limited volume units based on the size of their "field of view."

Volume Size(s)

The size of the "field of view" or FOV describes the scan volume of CBCT machines and is dependent on the detector size and shape, beam projection geometry and the ability to collimate the beam. Beam collimation limits the x-radiation exposure to the region of interest and ensures that an optimal FOV can be selected based on disease presentation. Smaller scan volumes generally produce higher resolution images, and since endodontics relies on detecting disruptions in the periodontal ligament space measuring approximately 200µm, optimal resolution is necessary.[4]

The principal limitation of large FOV cone beam imaging is the size of the field irradiated. Unless the smallest voxel size is selected in these larger FOV machines, there is also reduced resolution compared to intraoral radiographs or limited-volume CBCT machines with inherent small voxel sizes. The limited volume CBCT imaging in endodontics is advantageous, but by irradiating only one site or area, projections acquired may not contain the entire region of interest. Reconstructed images may suffer from truncation artifacts[5] when comparing medical CT with CBCT reconstructed images; medical CT scans provide the most suitable images for tumor-derived alterations due to their capacity for soft tissue visualization.[6]

For most endodontic applications, limited volume CBCT is preferred over large volume CBCT for the following reasons:

1. Increased spatial resolution to improve the accuracy of endodontic-specific tasks such as the visualization of small features including accessory canals, root fractures, apical deltas, calcifications, etc.
2. Highest possible spatial resolution that provides a diagnostically acceptable signal-to-noise ratio for the task at hand.
3. Decreased radiation exposure to the patient.
4. Time savings due to smaller volume to be interpreted.

Dose Considerations

Every effort should be made to reduce the effective radiation dose to the patient for endodontic-specific tasks. Using the smallest possible FOV, the smallest voxel size, the lowest mA setting and the shortest exposure time in conjunction with a pulsed exposure mode of acquisition is recommended. If extension of pathology beyond the area surrounding the tooth apices or a multifocal lesion with possible systemic etiology is suspected, and/or a non-endodontic cause for devitalization of the tooth is established clinically, appropriate larger field of view protocols may be employed on a case-by-case basis. Interpretation of the entire acquired volume will be essential to justify the use of task-specific modification of acquisition protocol in such cases.

CBCT has a significant advantage over medical grade CT as radiation doses from commonly used CBCT acquisition protocols are lower by an order of magnitude.[7] Selection of the most appropriate imaging protocol for the diagnostic task at hand is paramount.

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. Clinicians should use CBCT only when the need for imaging cannot be answered adequately by lower dose conventional dental radiography or alternate imaging modalities.

Patient Consent

Significant risks, benefits and alternatives of special importance should be explained by disclosure and patient education and then documented in patient's record. The use of CBCT will expose the patient to ionizing radiation that may pose elevated risks to some patients (*e.g.*, cases of pregnancy, previous treatment with ionizing radiation and younger patients). Patients should be informed that CBCT volumes cannot be relied upon to show soft-tissue lesions unless they have caused changes in hard tissues (teeth and bone), and some of the images may contain artifacts that can make interpretation difficult.

A patient may understand the relevant facts and implications of not following a recommended diagnostic or therapeutic action and still refuse the proposed intervention. This is known as the medico-legal concept of "informed refusal" and is recognized in certain state laws and court decisions.[8] Should a patient be incapable of understanding or responding to an informed consent presentation or be a minor, the informed consent or informed refusal should be documented in the patient's record and signed by an individual legally responsible for the patient. If a legally responsible individual is not available, a witness should acknowledge in writing that the informed consent or refusal process took place.

Interpretation

Clinicians ordering a CBCT are responsible for interpreting the entire image volume, just as they are for any other radiographic image. Any radiograph may demonstrate findings that are significant to the health of the patient. There is no informed consent process that allows the clinician to interpret only a specific area of an image volume. Therefore, the clinician can be liable for a missed diagnosis, even if it is outside his/her area of practice.[9] Any questions by the practitioner regarding image data interpretation should promptly be referred to a specialist in oral and maxillofacial radiology.

Protection of Patients and Office Personnel

At this time, all CBCT equipment produce dose levels and beam energies that are higher than conventional dental radiography, requiring extra practical protection measures for office personnel. Appropriate qualified experts should be consulted prior to and after installation to meet state and federal requirements, and manufacturer's recommended calibration routines should be conducted at the recommended intervals.

RECOMMENDATIONS

The decision to order a CBCT scan must be based on the patient's history and clinical examination, and justified on an individual basis by demonstrating that the benefits to the patient outweigh the potential risks of exposure to X-rays, especially in the case of children or young adults. CBCT should only be used when the question for which imaging is required cannot be answered adequately by lower dose conventional dental radiography or alternate imaging modalities. Initial studies regarding the use of CBCT for a variety of endodontic related imaging tasks have demonstrated the effectiveness and comparability of CBCT to conventional radiography.[10-15] In general, the use of CBCT in endodontics should be limited to the assessment and treatment of complex endodontic conditions such as:

- Identification of potential accessory canals in teeth with suspected complex morphology based on conventional imaging.
- 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, and in cases where anatomic superimposition of roots or areas of the maxillofacial skeleton is required to perform task-specific procedures.
- Diagnosis of non-endodontic origin pathosis in order to determine the extent of the lesion and its effect on surrounding structures.
- Intra- or post-operative 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 dento-alveolar 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.
- Pre-surgical case planning to determine the exact location of root apex/apices and to evaluate the proximity of adjacent anatomical structures.
- Dental implant case planning when cross-sectional imaging is deemed essential based on the clinical evaluation of the edentulous ridge.

SUMMARY

All radiographic examinations must be justified on an individual needs basis whereby the benefits to the patient of each exposure must outweigh the risks. In no case may the exposure of patients to X-rays be considered "routine," and certainly CBCT examinations should not be done without initially obtaining a thorough medical history and clinical examination. CBCT should be considered an adjunct to two-dimensional imaging in dentistry. Limited field of view CBCT systems can provide images of several teeth from approximately the same radiation dose as two periapical radiographs, and they may provide a dose savings over multiple traditional images in complex cases.

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