



Impact of cone beam computed tomography (CBCT) on diagnostic thinking in endodontics of posterior teeth: A before- after study

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ABSTRACT

Objectives: The aim of this study was to evaluate the impact of limited volume CBCT upon diagnosis as part of endodontic management of posterior teeth. The null hypothesis that CBCT does not make any difference in endodontic diagnosis was tested.

Methods: A single-centre “before-after” study was conducted in a secondary healthcare establishment. Eligible patients were all adults aged 18 years or over who were referred to a specialist endodontic unit. Further inclusion criteria were that the cases were either re-treatment or *de novo* root canal treatment where the anatomy was judged to be complex. Exclusion criteria included vulnerable groups and *de novo* endodontic treatment with uncomplicated root canal anatomy. As well as a full history and clinical examination, a high quality colour photographic intraoral image, two paralleling technique periapical radiographs and limited volume CBCT examination were carried out for each patient. All components, except the CBCT dataset, were combined into a Powerpoint presentation and assessed by 4 observers. A questionnaire was designed for the observers as part of the study.

Results: CBCT information only changed the radiological findings and the final diagnosis in a minority of cases. There was no clear evidence that CBCT increases the confidence of observers or that CBCT was helpful in making a diagnosis.

Conclusions: Routine use of CBCT cannot not be justified on the basis of a change in diagnosis and carefully selected use is appropriate.

Clinical significance: CBCT is being increasingly used in the field of endodontics. The benefits gained from the use of CBCT must be carefully balanced against the increased radiation dosage. Determination of selection criteria for the use of CBCT in endodontics is, therefore, essential.

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1. Introduction

Cone beam computed tomography (CBCT) represents a major advance in the imaging of the dental and maxillofacial region. It is not surprising, therefore, that all dental specialties have explored its use for imaging dental problems, including in endodontics [1,2]. The limitations of conventional intraoral radiography in endodontic practice, relative to CBCT, have been highlighted [1]; two-dimensional images are limited in terms of diagnostic yield by anatomical superimpositions and distortions, as well as by exposure and processing errors. On the other hand, conventional intraoral radiographs are cheap, have a low radiation dose, have

higher resolution than CBCT images and may often be sufficient for diagnosis. CBCT is expensive, invariably gives a higher radiation dose than conventional radiographs and suffers from artefacts [3–5]. Furthermore, CBCT is a collective term for a large number of imaging systems [6] which differ greatly in image quality, radiation dose and diagnostic potential and generalisations about its clinical value are not valid.

There is evidence that some CBCT systems may have greater diagnostic performance than conventional intraoral radiographs for various tasks relevant to endodontics, notably identification of root canal systems, resorptions, root fracture and periapical pathosis. Much of this research can be criticised for being performed in a laboratory setting on extracted teeth, using experimental models which do not adequately reproduce the patient and which lack the artefacts that affect clinical images. The design of research carried out on patients can also be challenged

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because of risk of bias: for example, they include “diagnostic accuracy” studies without a reference standard [7]. Fryback and Thornbury [8] developed a model of diagnostic efficacy, with the objective of encompassing the whole contribution of radiology to patient management. They explained that traditional assessments of radiological systems concentrated on image quality and upon sensitivity, specificity and other parameters of diagnostic accuracy. They highlighted, however, that diagnostic radiology is just part of a wider system “whose goal is to treat patients effectively and efficiently”. For example, it is possible to have an imaging system which offers better image quality and diagnostic accuracy than another but which fails to change outcomes for patients. They addressed this by defining a six-level hierarchical model of efficacy which extended from technical measures of image quality through to societal impact (Table 1). In order to understand the value of a radiological method in clinical practice, a comprehensive understanding of the diagnostic efficacy is desirable, encompassing information at each of these levels. Clinical research related to dental CBCT at the higher levels of diagnostic efficacy is, however, extremely limited.

Guideline documents on CBCT in endodontics are in broad agreement that, on the basis of current evidence at the time they were written, CBCT should be reserved for cases where conventional intraoral radiographs fail to answer the diagnostic question for which imaging was undertaken [9–12]. The studies of Mota de Almeida et al. [13,14] found that CBCT examinations, selected on the basis of the European Commission guidelines [10], developed by the SEDENTEXCT project, had a significant impact on endodontic diagnosis and treatment planning although for a substantial number of teeth and patients there was no value. There is, however, a lack of knowledge of the impact of using CBCT in a less restricted patient sample. The European Commission document provided a guideline which suggested that localised CBCT may be indicated in selected cases in a variety of situations, but suggested that its use would be most probably applicable in multi-rooted teeth [10].

It seems reasonable to expect that the greatest chance of seeing a diagnostic benefit from using CBCT in an endodontic context would be in more complex cases, particularly in multi-rooted posterior teeth referred for specialist assessment. Consequently, the aim of this study was to measure the impact of limited volume

CBCT upon diagnostic thinking as part of endodontic management of posterior teeth (molars and premolars) referred for an opinion to hospital-based endodontic specialists.

2. Material and methods

The reporting of this study conforms as far as possible to the CONSORT statement, with suitable adjustment for the particular study design informed by Meads & Davenport [15].

2.1. Study design

This was a single-centre “before-after” study conducted in a secondary healthcare establishment (Dental Hospital) in the United Kingdom. There were no changes to the study design after commencement.

2.2. Ethics

Ethical approval was obtained from the National Research Ethics Service (North West 1 Research Ethics Committee-Cheshire, UK).

2.3. Participants

Eligible patients were all adults aged 18 years or over who were referred from general dental practices to a specialist endodontic unit for opinion and management of premolar or molar teeth. Additional inclusion criteria were that the cases were either re-treatment or were *de novo* root canal treatment where the anatomy was judged to be complex e.g. sclerotic canals. Exclusion criteria were vulnerable groups, including prisoners, mentally deficient persons and severely injured patients, pregnant patients, anterior (incisor and canine) teeth and *de novo* endodontic treatment with uncomplicated root canal anatomy. Informed consent was obtained from each patient during their initial consultation with the chief investigator (registered specialist in Restorative Dentistry). They were provided with a patient information sheet at the time of their initial consultation. Patients handed in their consent form normally within 6 weeks of their consultation.

Table 1

The hierarchical model of efficacy of diagnostic imaging, described by Fryback & Thornbury [8], with some typical measures of analysis.

Efficacy level	Measures of analysis
Level 1: Technical efficacy	Spatial resolution. Contrast detail resolution. Linear/ angular measurement accuracy Accuracy of grey scale reproduction of true density differences. Artefact severity.
Level 2: Diagnostic accuracy efficacy	Sensitivity, specificity. Positive and negative predictive values. Area under ROC curves.
Level 3: Diagnostic thinking efficacy	Proportion of cases in a series in which image judged to be “helpful”. Difference in clinicians’ subjective estimated diagnosis probabilities pre- and post- imaging in a case series.
Level 4: Therapeutic efficacy	Proportion of cases in a series for which image judged to be “helpful” in planning treatment. Proportion of cases in which pre-imaging treatment plans were changed after imaging.
Level 5: Patient outcome efficacy	Proportion of patients improved with the imaging test compared to without the imaging test. Morbidity avoided by using imaging. Change in quality of life indices resulting from using imaging.
Level 6: Societal efficacy	Benefit- cost analysis from a societal standpoint. Cost-effectiveness analysis from a societal standpoint.

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