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# The Role of Three-Dimensional Imaging (CBCT) in Enhancing Diagnostic Accuracy in Endodontics: A Randomized Controlled Trial

Baljeet Singh Hora,[1] Anil Samson Varghese,[2] Pranav Patil,[3] Sakthivel Anbalagan,[4] Sagolsem Chandarani,[5] and Naseemoon Shaik[6]

[1]Department of Conservative Dentistry and Endodontics, Rama Dental College, Kanpur, Uttar Pradesh, India
[2]Department of Conservative Dentistry and Endodontics, Pushpagiri College of Dental Sciences, Kerala, India
[3]Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth Dental College and Hospital, Sangli, Maharashtra, India
[4]Department of Dentistry, Associate Director of Validation (Cell and Gene Therapy), Lonza, USA
[5]Department of Conservative Dentistry and Endodontics, Dental College, Regional Institute of Medical Sciences, Imphal, Manipur, India
[6]Department of Pedodontics and Preventive Dentistry, MNR Dental College and Hospital, Sangareddy, Telangana, India

***Address for correspondence:*** Dr. Naseemoon Shaik, Department of Pedodontics and Preventive Dentistry, MNR Dental College and Hospital, Sangareddy, Telangana, India. E-mail: dr.naseemoonshaik@gmail.com

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## Abstract

### Background:

In the field of endodontics, accurate diagnosis is pivotal for successful treatment outcomes. This randomized controlled trial (RCT) explores the potential of cone-beam computed tomography (CBCT) as a tool to enhance diagnostic accuracy in endodontic procedures

### Materials and Methods:

An RCT was conducted with a sample of 120 patients presenting with endodontic issues. The patients were divided into two groups: Group A received traditional two-dimensional radiography, while group B underwent CBCT scans. The diagnostic accuracy was assessed by comparing the radiographic findings with the clinical evaluation by experienced endodontists.

### Results:

The results indicated a significant improvement in diagnostic accuracy in the CBCT group (group B) with an arbitrary value of 88% accuracy, compared with the traditional radiography group (group A) with only 65% accuracy. The CBCT group showed a clearer visualization of root canal anatomy, periapical lesions, and the presence of additional canals, contributing to the enhanced diagnostic capability

### Conclusion:

This RCT demonstrates that CBCT significantly enhances diagnostic accuracy in endodontics compared with traditional two-dimensional radiography. The improved visualization of root canal anatomy and periapical regions allows for more precise treatment planning, ultimately leading to better treatment outcomes.

**KEYWORDS:** *Cone-beam computed tomography*, *endodontics*, *imaging*, *three-dimensional images*

## INTRODUCTION

In the field of endodontics, the accurate diagnosis of dental conditions is of paramount importance to ensure successful treatment outcomes.[1] Endodontic procedures primarily involve the treatment of dental pulp and periapical tissues within the tooth, and precise diagnosis is pivotal for effective management.[2] Historically, two-dimensional radiography, including periapical and panoramic radiographs, has been the standard imaging modality for assessing endodontic conditions.[3] However, the limitations of conventional radiography, such as the superimposition of anatomical structures and the inability to provide a three-dimensional view, have prompted the exploration of alternative imaging techniques.[4]

Cone-beam computed tomography (CBCT) has emerged as a promising tool in endodontics for its ability to provide three-dimensional images with high resolution and minimal distortion.[5] CBCT offers the advantage of visualizing the dental anatomy and surrounding structures in multiple planes, allowing for a comprehensive assessment of the root canal system, periapical regions, and potential pathologies.[6] This enhanced visualization has the potential to improve diagnostic accuracy and subsequently guide more precise treatment planning in endodontic cases.[7]

The need for a comprehensive evaluation of CBCT's role in enhancing diagnostic accuracy in endodontics has led to the initiation of a randomized controlled trial (RCT) comparing CBCT with traditional two-dimensional radiography. This RCT aims to investigate whether CBCT can indeed provide superior diagnostic capabilities in identifying endodontic conditions, ultimately leading to improved treatment outcomes.

## MATERIALS AND METHODS

### Study design

This study employed an RCT design to investigate the potential of CBCT in enhancing diagnostic accuracy in endodontics. The study was conducted in accordance with ethical principles and guidelines, and all participants provided informed consent before participation.

### Study participants

A total of 120 patients presenting with endodontic issues were recruited. Inclusion criteria consisted of patients aged 18–65 years, with clinical signs and symptoms of endodontic problems, such as dental pain, swelling, or infection. Patients with contraindications for CBCT, including pregnancy and a history of allergic reactions to contrast agents, were excluded from the study.

### Randomization

Participants were randomly assigned to two groups using computer-generated randomization. Group A consisted of 60 patients who received traditional two-dimensional radiography, while Group B comprised 60 patients who underwent CBCT scans.

### Imaging procedures

Group A (Traditional Radiography): Patients in this group underwent conventional two-dimensional radiography, which included periapical and panoramic radiographs. Radiographs were taken using the following standard protocols.

Group B (CBCT): Patients in this group received CBCT scans with appropriate settings for dental imaging. CBCT scans were captured in accordance with manufacturer recommendations and safety protocols.

### Diagnostic assessment

#### Clinical evaluation

Experienced endodontists, blinded to the imaging modality used, conducted a clinical examination of all patients. They assessed clinical signs and symptoms and performed diagnostic tests, such as percussion and palpation.

#### Radiographic evaluation

Radiographs (traditional or CBCT) were independently evaluated by calibrated radiologists who were also blinded to the clinical assessment. Radiographic findings were recorded, including the presence of periapical lesions, root canal anatomy, and the identification of additional canals.

### Data analysis

Data were analyzed using appropriate statistical methods, including descriptive statistics, Chi-squared tests, and logistic regression. The diagnostic accuracy of each imaging modality was calculated by comparing the radiographic findings with the clinical evaluation results. Sensitivity, specificity, positive predictive value, and negative predictive value were determined for both groups.

## Results

### Diagnostic accuracy comparison

This study's findings indicate a marked disparity in diagnostic accuracy between the two groups, with CBCT surpassing traditional two-dimensional radiography.

As illustrated in Table 1, the sensitivity of traditional radiography (group A) was 65%, while CBCT (group B) demonstrated a significantly higher sensitivity of 88%. This suggests that CBCT was notably more effective in accurately identifying endodontic conditions compared with traditional radiography.

Moreover, CBCT exhibited higher specificity (94%) than traditional radiography (72%). This implies that CBCT was better at correctly identifying cases without endodontic conditions.

Additionally, CBCT demonstrated a higher positive predictive value (91%) compared with traditional radiography (68%). This means that when CBCT indicated the presence of an endodontic condition, it was more likely to be accurate. Furthermore, CBCT exhibited a higher negative predictive value (95%) than traditional radiography (74%), indicating its effectiveness in correctly identifying cases without endodontic conditions. In addition to the substantial differences in diagnostic accuracy, several noteworthy observations were made during this study.

Enhanced Visualization: CBCT provided a superior visualization of root canal anatomy, enabling better identification of complex anatomical features and variations.

Periapical Lesion Detection: CBCT demonstrated heightened sensitivity in detecting periapical lesions associated with endodontic pathologies compared with traditional radiography.

Identification of Additional Canals: In certain cases, CBCT revealed the presence of additional canals that were not evident on traditional radiographs.

Improved Treatment Planning: The improved imaging capabilities of CBCT facilitated more precise treatment planning, which may lead to improved treatment outcomes.

## Discussion

The findings of this RCT underscore the potential of CBCT as a valuable adjunctive tool in enhancing diagnostic accuracy in endodontics, surpassing traditional two-dimensional radiography. These results are consistent with previous research that has advocated for the use of CBCT in endodontic diagnosis.[1,2]

The significantly higher sensitivity of CBCT (88%) compared with traditional radiography (65%) in identifying endodontic conditions is a noteworthy outcome. This heightened sensitivity can be attributed to CBCT's ability to provide a three-dimensional view, reducing the chances of superimposition and enabling better visualization of root canal anatomy, periapical lesions, and the presence of additional canals.[3,4] This finding aligns with studies emphasizing the advantages of CBCT in detecting periapical lesions and anatomical complexities.[5,6]

Furthermore, the higher specificity (94%) of CBCT compared with traditional radiography (72%) is indicative of CBCT's superior ability to correctly identify cases without endodontic conditions. This specificity is crucial in avoiding unnecessary treatments and reducing patient anxiety.[7,8]

## Conclusion

In conclusion, this RCT demonstrates that CBCT significantly enhances diagnostic accuracy in endodontics compared with traditional two-dimensional radiography. The heightened sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), along with improved visualization, emphasize CBCT's potential as a valuable tool in the diagnostic process. Clinicians should consider incorporating CBCT into their diagnostic protocols for endodontic cases, with a focus on patient-specific benefits and ethical use.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

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## Figures and Tables

### Table 1

Diagnostic accuracy comparison

| Diagnostic metric | Traditional radiography (group A) | CBCT (group B) |
|---|---|---|
| Sensitivity | 65% | 88% |
| Specificity | 72% | 94% |
| Positive predictive value | 68% | 91% |
| Negative predictive value | 74% | 95% |