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Cone-Beam Computed Tomography in Endodontics: A Comprehensive Review

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Abstract

Cone-Beam Computed Tomography (CBCT) has revolutionized endodontic diagnostics and treatment planning by providing high-resolution, three-dimensional imaging of dental structures. This comprehensive review explores the evolution, applications, and clinical impact of CBCT in endodontics. It delves into its role in detecting complex root canal anatomies, periapical pathologies, root fractures, and resorptive lesions, highlighting its superiority over traditional two-dimensional radiography. The review also addresses the limitations of CBCT, including radiation exposure, image artifacts, and interpretation challenges, emphasizing the importance of adhering to the ALARA (As Low As Reasonably Achievable) principle. Furthermore, it examines the integration of artificial intelligence in enhancing CBCT image analysis and discusses current guidelines and future research directions. By synthesizing current evidence, this article aims to inform clinicians about the judicious use of CBCT, optimizing diagnostic accuracy and patient outcomes in endodontic practice.

Keywords: Cone-beam computed tomography; Endodontics; Periapical pathology; Root canal anatomy; Radiation dose; Three-dimensional imaging

Introduction

Cone-Beam Computed Tomography (CBCT) has revolutionized endodontic diagnostics and treatment planning by providing high-resolution, three-dimensional imaging of dental structures. This comprehensive review explores the evolution, applications, and clinical impact of CBCT in endodontics. It delves into its role in detecting complex root canal anatomies, periapical pathologies, root fractures, and resorptive lesions, highlighting its superiority over traditional two-dimensional radiography. The review also addresses the limitations of CBCT, including radiation exposure, image artifacts, and interpretation challenges, emphasizing the importance of adhering to the ALARA (As Low As Reasonably Achievable) principle. Furthermore, it examines the integration of artificial intelligence in enhancing CBCT image analysis and discusses current guidelines and future research directions. By synthesizing current evidence, this article aims to inform clinicians about the judicious use of CBCT, optimizing diagnostic accuracy and patient outcomes in endodontic practice.

Role of Imaging in Endodontics

Radiographic imaging plays a pivotal role in the success of endodontic diagnosis, treatment, and follow-up. It is indispensable not only in identifying odontogenic and non-odontogenic pathoses but also in guiding every stage of endodontic therapy—from access cavity preparation and canal instrumentation to final obturation and evaluation of healing outcomes[12].

Preoperative Assessment

Preoperative imaging provides critical information regarding the morphology of teeth and surrounding alveolar structures. It aids in determining the number and location of root canals, assessing pulp chamber dimensions, degrees of calcification, root length, direction and curvature, as well as identifying fractures, carious involvement, and iatrogenic defects[3],[4]. Furthermore, it helps in evaluating the extent of periapical and periradicular disease, including root resorption and periapical osteolysis[5]. In certain cases, the detection of extensive lesions through imaging may influence the treatment plan, requiring surgical interventions in addition to conventional intracanal therapy[6]. Thus, diagnostic radiographs serve as valuable tools for predicting potential complications, detecting root fractures, and confirming the presence of periapical pathology[7].

Intraoperative Phase

During endodontic therapy, radiographs provide real-time feedback that guides clinical procedures. A working length radiograph is typically obtained with metallic files placed in the root canal to approximate the position of the apical terminus, given that radiographic and anatomical root apices rarely coincide[8,9]. This ensures accurate canal debridement and proper cleaning and shaping of the root canal system. Additionally, before obturation, a master cone radiograph (or pre-condensation image) is taken to verify the correct positioning and adaptation of the master cone, ensuring dense and homogeneous filling of the canal system[10].

Postoperative Evaluation

Following obturation, a postoperative radiograph is essential to confirm the quality of root canal filling, including its condensation, homogeneity, and containment within the root canal system[11]. These radiographs also serve as a baseline for monitoring periradicular healing in the medium and long term[12]. In cases of incomplete healing or persistence of pathology, imaging is crucial for evaluating the success of previous treatment, identifying potential causes of failure, and planning retreatment or surgical management as necessary[13,14].

Radiological Aspects of CBCT

Cone beam computed tomography is a variation of computed tomography (CT) that uses an X-ray source that rotates once around the tooth topic. A CT-based algorithm is used to analyze and rebuild the data, producing a volume of data that may be viewed in three standard planes (axial, sagittal, and coronal) as well as several alternate planes upon data set manipulation[15].

Rapid image acquisition is made possible by technology that is getting more and more reasonably priced. In a way that is simply not possible with traditional 2D plain dental film imaging, a three-dimensional picture of the region of interest is achieved in sufficient detail to pinpoint teeth and neighbouring structures[16].

Dosages, Reduction, and Optimization

The diagnostic advantages of CBCT must always be balanced against its relatively higher radiation exposure when compared with conventional dental imaging. Reported mean effective doses for large, medium, and small field-of-view (FOV) CBCT scans are 212 μSv, 177 μSv, and 84 μSv, respectively[17]. Small FOV scans show a wide dose range (5–146 μSv), though many CBCT systems typically deliver around 30 μSv when operated using standard manufacturer settings[17]. By comparison, a routine panoramic radiograph exposes the patient to approximately 16–20 μSv[17].

Therefore, radiation dose reduction should be achieved by adjusting exposure parameters based on the individual diagnostic needs of each patient (Table 1). Imaging protocols should be customized rather than relying solely on default settings. A comprehensive understanding of the CBCT unit's technical capabilities is essential for producing diagnostically reliable images—ultimately improving accuracy in endodontic diagnosis and treatment while minimizing unnecessary radiation exposure[18].

- **Table 1. Factors that increase effective dose (μSv):**
  Inclusion of salivary glands within the FOV (e.g., posterior mandible > anterior maxilla)
- Use of larger FOVs
- Higher kilovoltage (kV)
- Higher milliamperage (mA)
- Longer exposure time (full vs. half rotation;
- increased basis images; continuous vs. pulsed beam)
  Smaller voxel size (not inherently dose-

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increasing, but often requires compensatory higher exposure)[18]

Training and Education

Despite its increasing use, CBCT remains relatively underrepresented in undergraduate dental teaching. As a result, both newly qualified graduates and experienced clinicians may require further education to ensure safe and effective utilization[19].

Article 18 of the EURATOM directive (2013) stipulates that all individuals involved in radiological imaging must receive "adequate training" for their respective responsibilities[20]. Although the directive outlines general training principles for radiation protection, it does not specify what constitutes adequate training for specialized modalities such as CBCT.

Guidelines from the European Academy of Dent maxillofacial Radiology (EADMFR) and Public Health England propose two tiers of CBCT training[19]:

• **Level 1 (Core Training):** For clinicians who prescribe CBCT examinations

• **Level 2 (Advanced Training):** For practitioners responsible for interpreting CBCT images

Brown et al.[19] further suggest that comprehensive CBCT training should encompass approximately 12 hours delivered through a combination of lectures, seminars, case-based learning, workshops, and online instruction.

Specific Requirements for Endodontics

In Endodontics, CBCT imaging demands exceptionally high spatial resolution to accurately evaluate the complex anatomy of the root canal system and surrounding periodontal structures. Achieving this level of detail, however, often results in higher radiation exposure[21].

For endodontic purposes, small field-of-view (FOV) CBCT scans are strongly recommended[22]. Using a small FOV minimizes the volume of irradiated tissue and reduces scatter radiation, thereby improving overall image clarity.

Despite these advantages, CBCT images used in endodontics are highly vulnerable to motion artefacts. Spin-Neto et al.[23] noted that CBCT units allowing patients to sit or lie supine offer greater stability and reduced movement compared with standing-position systems. Although hybrid panoramic/CBCT machines are more economical and widely adopted, they may compromise the image quality essential for precise endodontic assessment[23].

Limitations

Metallic restorations—including amalgam, crowns, implants, and gutta-percha—frequently create extensive artefacts on CBCT images, masking critical anatomical structures and pathological changes[24].

To minimize these issues, many CBCT systems employ metal artefact reduction (MAR) algorithms[25]. These post-processing tools estimate grey values within artefact-affected regions, smoothing distortions and approximating the underlying tissues[25].

However, MAR techniques are not without drawbacks. They may compromise fine anatomical detail[26], show optimal performance in full-rotation scans[27], and are more effective around metallic restorations than gutta-percha[28]. MAR also performs best when the metal object is centrally located within the FOV[29].

Development of CBCT in Dentistry

CBCT has become an indispensable imaging modality in dental specialties that require three-dimensional visualization, and for some applications it is now regarded as the standard of care[15]. The technology operates via a rotating gantry equipped with an X-ray source and detector. As the cone-shaped beam rotates through at least 180°, multiple projection images are captured and reconstructed into accurate three-dimensional radiographic datasets[2].

The first dental CBCT unit, the NewTom DVT 9000 (Quantitative Radiology, Verona, Italy), received FDA approval in 2001. This was followed by the introduction of several advanced systems in 2003, including the 3D Accuitomo (J. Morita, Japan), i-CAT (Imaging Sciences International, USA), and CB MercuRay (Hitachi, Japan). Later models, such as the Kodak 9000 3D (Carestream/Trophy, France), further enhanced image resolution and voxel precision[16].

Types of CBCT Equipment

CBCT systems differ in patient positioning, scan volume, and clinical functionality:

- **Patient positioning:** Units allow scanning in seated, standing, or supine positions. Seated

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systems generally offer more comfort and accessibility, though head stabilization is often more critical than orientation[^33].

- **Scan volume:** The field of view (FOV) may range from localized regions (<5 cm) to craniofacial imaging (>15 cm). Smaller FOVs yield higher resolution and reduced radiation exposure, making them preferable for endodontic applications. Modern small FOV systems provide voxel resolutions as fine as 0.076 mm, sufficient to detect early signs of periapical disease such as periodontal ligament space widening[34].
- **Multimodality:** Hybrid systems integrate digital panoramic radiography with small- to medium-volume CBCT. These units, such as the ProMax 3D (Planmeca, Finland) and Veraviewepocs 3D (J. Morita, Japan), offer cost efficiency and versatility while maintaining diagnostic capability in localized regions[35].

Radiation Dose Considerations

Radiation risk from CBCT is quantified as effective dose (E, in µSv or mSv), calculated by weighting absorbed doses to radiosensitive tissues as defined by the International Commission on Radiological Protection (ICRP)[36]. For comparison, digital panoramic radiographs typically deliver 5.5–22 µSv, whereas the average annual background dose is approximately 3,000 µSv (3 mSv)[37]. CBCT effective dose varies widely depending on parameters such as kVp, mAs, beam quality, filtration, rotation arc, and especially FOV size. Smaller FOV scans generally deliver lower doses by excluding radiosensitive organs such as the thyroid[38]. Reported effective doses for small FOV units like the Kodak 9000 3D range from 0.4 to 2.7 times that of a digital panoramic examination, depending on the area imaged[^39].

Advantages of CBCT in Endodontics

The principal advantage of CBCT in endodontics is its ability to provide undistorted 3D visualization of dental and maxillofacial structures. Data are reconstructed into axial, sagittal, and coronal planes, and can be reformatted into oblique or curved planar views for panoramic-like images or serial cross-sections[40]. Software tools further allow magnification, contrast adjustments, annotations, and accurate linear measurements, all free from distortion and magnification errors[41].

With isotropic voxel datasets, CBCT delivers high-resolution volumetric images that enable superior assessment of root canal anatomy, periapical lesions, root fractures, and their spatial relationship with adjacent anatomical structures such as the mandibular canal and maxillary sinus[42]. This technology therefore offers an unparalleled diagnostic advantage in complex endodontic cases, where conventional radiographs may be insufficient[43].

Limitations of CBCT in Endodontics

Although CBCT has transformed endodontic imaging by providing three-dimensional visualization, several limitations must be acknowledged.

- **Spatial Resolution:**

  The resolution of CBCT (0.4–0.076 mm, ~1.25–6.5 lp/mm) is lower than that of conventional intraoral radiography, where film achieves ~20 lp/mm and digital sensors 8–20 lp/mm[44]. Since endodontics often involves very small structures, voxel size is critical. Studies indicate that detecting external root resorption requires at least 0.3 mm voxel resolution[45], and identification of secondary canals in maxillary molars is far more reliable at 0.12 mm (over 93% accuracy) compared to 0.4 mm (~60% accuracy)[46]. Similarly, subtle conditions such as early apical periodontitis demand high-resolution imaging[47].

- **Noise and Scatter:**

  Because the entire field of view is exposed during each scan, scattered radiation is inevitably recorded, contributing to noise and image graininess[48]. While noise-reduction algorithms can improve image quality, large FOV scans or reduced exposure settings often accentuate this problem[49].

- **Contrast Resolution:**

  CBCT has limited contrast resolution, reducing its ability to differentiate soft tissue changes. This is due to scattered radiation, beam divergence effects across the detector (heel effect), and detector imperfections[50]. Consequently, current dental CBCT systems

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are most reliable for evaluating osseous structures rather than soft tissue pathology[51].

- **Artifacts:**
  CBCT images are prone to artifacts that may compromise diagnostic accuracy. Beam hardening, caused by the polychromatic nature of X-rays, can create distortion around metallic structures (cupping artifact) and streaks or dark bands between dense objects[52]. Restorations, implants, or retrograde fillings within the scan field often generate such artifacts. These effects are typically more pronounced in CBCT than in conventional CT due to lower mean photon energy[53]. Use of a limited FOV can reduce artifact expression by excluding metallic structures outside the region of interest.

Applications of CBCT in Endodontic Practice

Cone beam computed tomography (CBCT) effectively addresses the shortcomings of conventional radiography. In Endodontics, where anatomical structures are often complex, this imaging modality offers significant advantages. The combination of its diagnostic benefits with the reduced cost, smaller equipment size, and lower radiation dose compared to conventional CT has led to its widespread adoption in dental practices in recent years (31). As CBCT becomes an increasingly accessible and integral tool in the endodontist's practice, understanding its various applications in the management of endodontic conditions is essential

Assessment of Periapical Periodontitis

Detection of Apical Periodontitis

Periapical radiography (PR) has long been considered the reference standard for the radiological detection of apical periodontitis (AP) [54]. However, its diagnostic accuracy is limited by anatomical noise, which may obscure the early stages of periapical bone destruction. Consequently, identifying early periapical changes can be challenging, particularly in cases where clinical signs and symptoms suggest pulp necrosis or irreversible pulpitis [55].

- Evidence from ex vivo studies, in which periapical status was known beforehand, consistently indicates that CBCT is more accurate than PR in detecting AP [56.] Clinical research supports these findings, showing that CBCT identifies significantly more periapical lesions than PR [57]. Animal and cadaver studies further corroborate the diagnostic superiority of CBCT for detecting apical periodontitis [58,59.] Moreover, CBCT enables the visualization of small periapical lesions that may not be visible on PR, influencing treatment planning and helping to rule out non-odontogenic causes of pain [60]. However, CBCT interpretation carries a higher risk of false-positive diagnoses and requires adequate operator training to ensure diagnostic accuracy [61.]

- **Assessment of the Outcome of Root Canal Treatment**

- Teeth presenting with preoperative AP generally exhibit poorer outcomes than those without preexisting lesions [62.] Early and more precise detection of AP using CBCT can therefore facilitate timely and targeted intervention. Studies have demonstrated that CBCT is more sensitive than PR in identifying persistent or recurrent disease following root canal therapy [63].

- For instance, Paula-Silva et al. [64] reported that CBCT exhibited higher sensitivity in detecting persistent periapical disease in animal models. Clinical investigations have also confirmed that CBCT provides superior detection of voids, inadequate root fillings, and discrepancies in periapical healing when compared with PR [65.] Additionally, several studies have found that treatment success rates appear lower when outcomes are evaluated with CBCT rather than with conventional radiography—particularly in molar teeth [66,67.] Long-term follow-up studies have further identified key prognostic factors negatively affecting treatment success, including canal curvature, missed canals, and inadequate coronal restoration quality [68].

- **Assessment of Potential Surgical Sites**

- Cone beam computed tomography has proven to be an invaluable aid in the planning of surgical endodontic procedures [69,70.] It provides detailed visualization of the spatial relationships between the affected root(s) and adjacent anatomical structures such as the maxillary sinus, inferior alveolar nerve canal,

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and mental foramen [71,72.] This comprehensive anatomical understanding allows clinicians to assess case suitability for surgical intervention, thereby minimizing morbidity by identifying and excluding high-risk cases.

- For suitable cases, CBCT delivers accurate preoperative measurements—such as root length and angulation, cortical plate thickness, and the distance between the root apex and critical anatomical landmarks like the mental foramen—which can be directly applied during surgery. These measurements enhance surgical precision and significantly reduce the likelihood of iatrogenic damage [73].

Assessment and Management of Dental Trauma

The advantages of CBCT in evaluating and managing dentoalveolar trauma are well documented in the literature [54,55]. By eliminating anatomical noise and image distortion, CBCT enables precise assessment of the nature and extent of injuries to both teeth and the alveolar bone, allowing clinicians to plan and implement appropriate treatment with greater confidence. It also facilitates accurate evaluation of the degree and direction of displacement in luxation injuries [56]Fig. 4). Moreover, CBCT has been demonstrated to be significantly more sensitive than multiple periapical radiographs in detecting horizontal root fractures [57] (Fig. 5). Failure to identify such fractures after dental trauma can result in incorrect treatment decisions and a poorer prognosis for the affected teeth. Traumatic injuries to the dentition seldom involve a single tooth in isolation. Small-volume CBCT units, which are most suitable for endodontic assessments, provide detailed imaging of all teeth and surrounding structures within a 4 cm × 4 cm field of view (FOV). This allows multiple teeth to be evaluated accurately in a single scan without geometric distortion. Additionally, since CBCT is an extraoral imaging modality, it enhances patient comfort during imaging—a significant advantage when assessing dental trauma cases where conventional intraoral radiographs may be difficult due to mobile teeth, painful tissues, or patient discomfort. Considering that the peak incidence of traumatic dental injuries (TDI) occurs around the ages of three and nine [58], ensuring patient comfort during imaging is also important from an emotional standpoint.

External root resorption (ERR) is a frequent complication following dental luxation [59,60] and avulsion [61–63]injuries. Among the three types of ERR described by Andreasen, external inflammatory root resorption (EIRR) is the only form that responds to endodontic therapy. The reported prevalence of EIRR after luxation injuries ranges from approximately 5% [60] to 18% ,and it affects nearly 30% of replanted avulsed teeth [63]. EIRR is the most common type of root resorption following both luxation and avulsion trauma [64].

Diagnosis of EIRR relies entirely on radiographic evidence . Because the process can begin rapidly and progress aggressively—sometimes resulting in complete root resorption within three months—early detection after a TDI is critical for tooth survival. In an ex vivo human model, Durack et al. [3]demonstrated that CBCT offers significantly greater sensitivity and specificity than periapical radiographs for detecting simulated, early-stage EIRR lesions. Importantly, reducing the X-ray source rotation from 360° to 180°—thereby halving the patient's effective radiation dose—did not compromise diagnostic accuracy.

Early diagnosis and timely intervention markedly improve prognosis. Conversely, if resorption progresses undetected until it becomes visible on conventional radiographs, irreversible damage may already have occurred. Traumatic dental injuries remain the only clinical situations in which the use of CBCT might be justified for detecting early external resorption—before it becomes radiographically apparent—as part of a comprehensive assessment of trauma-related damage.

Currently, CBCT is commonly used to evaluate the extent of specific types of ERR (such as pressure-related surface resorption and external cervical resorption) and to assess the prognosis of affected teeth. However, these scans are typically prescribed only after conventional radiographs indicate resorptive changes, which often occurs at a relatively advanced stage of the process.

Assessment of Root Canal Anatomy and Morphology

Conventional radiographs often fail to reveal the full number of root canals in teeth undergoing non-surgical endodontic treatment [65,66]. Missing accessory or additional canals can adversely affect treatment

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success [67]. In an ex vivo study, Matherne et al. [68]demonstrated that CBCT is significantly more effective than conventional radiography in identifying extra canals (Figs. 2 and 6). In fact, traditional radiographs failed to detect at least one canal in 40% of the teeth examined. Similarly, Tu et al. [65] reported that CBCT detected a higher prevalence of distolingual roots in mandibular first molars among a Taiwanese population—33% compared to 21% using conventional radiographs. Awareness of additional canals or roots before starting treatment allows clinicians to locate them more effectively and to design access cavities that are both conservative and strategically guided.

Unidentified or complex canal morphology increases the likelihood of procedural errors such as ledge formation, canal transportation, or perforation [69–71], which can compromise treatment outcomes [72]. CBCT has proven to be a dependable tool for accurately evaluating the degree and configuration of root curvatures, even in teeth with normal anatomical variations [73]. Having this information preoperatively helps minimize the risk of such complications. Furthermore, CBCT is particularly valuable in assessing and planning endodontic treatment for teeth presenting with developmental anomalies like dens invaginatus and fused roots [74,75].

Diagnosis, Assessment, and Management of Root Resorption

The clinical diagnosis of root resorption primarily depends on radiographic evidence [18,61,76]. Conventional radiography, however, has markedly lower sensitivity than CBCT for detecting external root resorption (ERR) in its early stages . As a result, significant hard tissue loss may occur before the condition becomes visible on standard radiographs. Additionally, ERR superimposed over the root canal space on two-dimensional images can mimic internal resorption, leading to potential diagnostic errors [77]. Differentiating between external cervical resorption (ECR) and internal resorption is particularly challenging on conventional radiographs [77,78](Fig. 7).

Although clinical studies directly comparing intraoral radiographs and CBCT in diagnosing root resorption are limited, available evidence supports the superior performance of CBCT. One clinical investigation reported that CBCT outperformed conventional radiography in detecting and evaluating non-specific inflammatory resorption affecting root surfaces [79]. In another study, Patel et al. [80]compared the diagnostic accuracy of intraoral radiography and CBCT for external cervical and internal resorption lesions. They found that CBCT achieved 100% accuracy in determining both the presence and type of resorption, whereas intraoral radiographs demonstrated significantly lower sensitivity.

These findings have been confirmed by ex vivo research. Kamburoğlu et al.[81] evaluated the ability of examiners to identify and distinguish between simulated ECR and internal root resorption (IRR) at the cervical region using CBCT and conventional periapical radiography. CBCT performed significantly better than periapical radiographs in both detection and localization of the simulated lesions. The study concluded that CBCT is an effective and reliable tool for identifying and differentiating early-stage ECR and IRR, whereas conventional radiography lacks sufficient diagnostic accuracy for this purpose.

Diagnosis of Vertical Root Fractures

Detecting vertical root fractures (VRF) presents a major diagnostic challenge in endodontics ([82]). Clinical and radiographic indicators of VRF often appear only after the fracture has been present for an extended period. Even in chronic cases, clinical manifestations may be limited to a draining buccal sinus , which is not pathognomonic for VRF. Although a deep, narrow, isolated periodontal pocket can be a suggestive sign , improper probe alignment along the defect may result in it being overlooked. Radiographically, VRF may appear as J-shaped or halo-like radiolucencies ([83]), but these features typically emerge only after substantial bone loss has occurred—and similar patterns may also be observed in apical periodontitis unrelated to fractures.

Ex vivo studies have shown that CBCT is more sensitive than conventional radiography in detecting vertical root fractures [84]. However, caution is advised when interpreting CBCT scans of root-filled teeth, as image artifacts caused by radiopaque filling materials or other high-density substances can create false-positive appearances suggestive of fractures 84.

Assessment of the Outcome of Endodontic Treatment

CBCT has demonstrated the ability to detect periapical bone destruction associated with apical periodontitis

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before it becomes visible on conventional radiographs—an encouraging advancement in endodontic diagnostics. Since treatment initiated before radiographic evidence of disease typically yields better outcomes , the use of CBCT may allow for more timely intervention. However, this assumption is based on treatment outcomes being assessed using conventional radiographs. When CBCT is used for diagnosis but conventional imaging is used for follow-up, the true success of treatment may be underestimated or misinterpreted.

For an accurate evaluation of endodontic treatment outcomes with CBCT, preoperative and postoperative scans should be compared. Although data on CBCT-based outcome assessment are limited, existing studies suggest that success rates may appear lower when CBCT is used compared to traditional radiographs, likely due to the higher sensitivity of CBCT in detecting residual periapical pathology.

In an experimental study, Paula-Silva et al. [45]compared CBCT and periapical radiography in assessing treatment outcomes in dogs. After six months, the success rate was reported as 79% using conventional radiographs, but only 35% when evaluated with CBCT. Similarly, in a clinical study involving human subjects, Liang et al. [85] found success rates of 87% when assessed with periapical radiographs and 74% when CBCT was used, after a two-year follow-up.

These findings suggest that many cases previously considered healed on conventional radiographs may, in fact, exhibit residual pathology when evaluated with CBCT. This insight could lead to reconsideration of the strict criteria currently used to define radiographic success in endodontics, which have been established primarily through conventional imaging ([86]).

Concluding Remarks

This review underscores the wide-ranging applications of CBCT in the diagnosis, assessment, and management of endodontic conditions. As a three-dimensional imaging modality, CBCT effectively overcomes many limitations of conventional radiography and serves as a valuable adjunct in endodontic practice.

However, it is important to recognize that the radiation dose associated with CBCT is higher than that of conventional intraoral radiographs. Therefore, its use must be justified by ensuring that the diagnostic benefits outweigh the potential risks to the patient [87]. The principle of **ALARA**—"As Low As Reasonably Achievable"—should always be applied when determining the need for CBCT imaging. Ultimately, the decision to prescribe CBCT should be made on a case-by-case basis and only when sufficient diagnostic information cannot be obtained through conventional clinical or radiographic methods.

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