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A utilização da tomografia computadorizada de feixe cônico altera o diagnóstico e plano de tratamento em Endodontia em comparação à radiografia periapical? Uma revisão sistemática

Governador Valadares
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Orientadora: Profa. Dra. Francielle Silvestre Verner
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RESUMO

O objetivo do estudo foi avaliar o impacto da Tomografia Computadorizada de Feixe Cônico (TCFC) no diagnóstico e plano de tratamento em endodontia, comparando-os à radiografia periapical. A metodologia envolveu a formulação da pergunta do estudo com base em PECOS (População, Exposição, Comparação, Resultado, Desenho do Estudo). Descritores relevantes foram selecionados, incluindo termos indexados das bases de dados MeSH, Emtree e DeCS, bem como descritores de texto livre, para garantir cobertura abrangente. Operadores booleanos (OR e AND) foram utilizados para combinar os descritores e criar a consulta de pesquisa. As bases de dados pesquisadas foram MEDLINE via PubMed, SciELO, Scopus, Biblioteca Cochrane, Web of Science e EMBASE. Além disso, uma busca manual nas listas de referências dos estudos elegíveis foi realizada. Após a busca, os estudos foram avaliados quanto aos critérios de elegibilidade, sendo incluídos nesta revisão 24 artigos. Os resultados mostraram que, exceto por 8% dos artigos, todos os outros 92% relataram mudanças no diagnóstico ou plano de tratamento quando a TCFC foi utilizada, em comparação à radiografia periapical. Mesmo avaliadores com menos conhecimento e experiência em tratamentos endodônticos conseguem obter melhores resultados utilizando a TCFC para a avaliação de casos complexos. Pode-se concluir que o uso da TCFC realmente leva a mudanças no diagnóstico e no plano de tratamento em casos de endodontia, especialmente em cenários mais desafiadores e pode melhorar os resultados mesmo para avaliadores menos experientes.

Palavras-chave: Diagnóstico; Endodontia; Estudos observacionais; Plano de tratamento; Radiografia Periapical; Tomografia Computadorizada de Feixe Cônico.

ABSTRACT

The aim of the study was to evaluate the impact of Cone Beam Computed Tomography (CBCT) on the diagnosis and treatment plan in endodontics, comparing it to Periapical Radiography. The methodology involved formulating the study question based on PECOS (Population, Exposure, Comparison, Outcome, Study design). Relevant descriptors were selected, including indexed terms from MeSH, Emtree, and DeCS databases and free-text descriptors, to ensure comprehensive coverage. Boolean operators (OR and AND) were used to combine the descriptors and create the search query. Multiple databases were searched, including MEDLINE via PubMed, SciELO, Scopus, Cochrane Library, Web of Science, and EMBASE. In addition, a manual search of the reference lists of eligible studies was conducted. After the search, the studies were evaluated for eligibility criteria, and 24 articles were included in this review. The results showed that, except for 8% of the studies, all the other 92% reported changes in diagnosis or treatment plan when CBCT was used compared to periapical radiography. Even evaluators with less knowledge and experience in endodontic treatments can achieve better results using CBCT for the assessment of complex cases. It can be concluded that the use of CBCT does lead to changes in the diagnosis and treatment plan in endodontic cases, especially in more challenging scenarios, and it can improve outcomes even for less experienced evaluators.

Keywords: Cone beam computed tomography; Diagnosis; Endodontics; Observational studies.; Periapical X-ray; Treatment plan.

SUMÁRIO

1 INTRODUÇÃO

Nos tratamentos endodônticos, assim como em outras áreas da odontologia, as radiografias intraorais são de grande importância para um diagnóstico preciso e planejamento do tratamento.[1] Desde seu início, as radiografias convencionais fornecem aos dentistas o maior suporte de imagem. Entretanto, com o avanço tecnológico, novos métodos de obtenção de imagens radiográficas têm sido adotados em diversas áreas odontológicas, com variados graus de sucesso.[2] Dentre todas as novas técnicas, a Tomografia Computadorizada de Feixe Cônico (TCFC) foi selecionada como a de maior potencial para auxiliar no diagnóstico por imagem em Endodontia, em comparação com radiografias periapicais.[1] No entanto, essas técnicas digitais demoraram a ganhar aceitação em Endodontia.[2]

As radiografias periapicais são normalmente a modalidade de imagem inicial de escolha em tratamentos endodônticos devido ao seu fácil acesso, baixo custo para o paciente e baixa dose de radiação.[3] A principal limitação dessa técnica reside em sua representação bidimensional de uma estrutura tridimensional , levando à sobreposição de estruturas anatômicas e reduzindo a eficácia diagnóstica.[1-3] No entanto, está bem estabelecido que a radiografia periapical convencional não é tão precisa quanto a TCFC na avaliação de detalhes anatômicos e lesões apicais, por exemplo.[4]

A TCFC projeta raios X na região de interesse enquanto um detector gira em torno da cabeça do paciente. Múltiplas imagens são obtidas e formatadas digitalmente, resultando em uma imagem tridimensional imediata.[1] Além disso, a TCFC fornece uma dose de radiação efetiva significativamente menor em comparação com alguns equipamentos de tomografia computadorizada multislice,[1,5] mas tem uma dose maior do que a radiografia periapical.[5] A escolha de qual modalidade de imagem usar deve seguir o princípio de "Tão baixo quanto diagnosticado Aceitável sendo orientado para a indicação e específico do paciente" (ALADAIP), onde o método de imagem selecionado deve fornecer a menor exposição possível enquanto alcança um diagnóstico aceitável.[36] Em consenso, a Associação Americana de Endodontistas e a Academia Americana de Radiologia Oral e Maxilofacial definiram que a radiografia periapical deve ser a técnica inicial de escolha para casos endodônticos. No entanto, a TCFC pode ser usada quando imagens radiográficas anteriores levam a

diagnósticos contraditórios ou quando o paciente apresenta sinais e sintomas clínicos inespecíficos associados a dentes tratados ou não tratados.[7]

Estudos recentes têm mostrado a superioridade da TCFC em comparação com as radiografias periapicais no diagnóstico de várias condições em Endodontia.[8,9] No entanto, a literatura carece de estudos que suportem o real impacto das informações adicionais obtidas através da TCFC no diagnóstico e plano de tratamento. Rosen[10] et al. (2015) realizaram uma revisão sistemática e análise de eficácia utilizando um modelo hierárquico de evidência com seis níveis, onde o nível 1 representa o nível mais baixo de evidência e o nível 6 o mais alto, em relação à eficácia diagnóstica da TCFC em Endodontia. De acordo com os artigos que atenderam aos critérios dos autores (n=58), apenas três artigos foram classificados como nível 3 de evidência (alterações no diagnóstico ou prognóstico antes e após a avaliação da CBCT) e apenas dois como nível 4 de evidência (alterações no plano de tratamento, como a introdução de uma nova terapia ou evitar tratamentos desnecessários). [10] Apesar de novos estudos sobre o tema terem sido publicados nos últimos cinco anos,[1,3,11,12] os dados ainda parecem controversos, e a literatura ainda carece de uma avaliação mais robusta. Portanto, o objetivo do presente estudo foi realizar uma revisão sistemática para avaliar se o uso da TCFC altera o diagnóstico e o plano de tratamento em Endodontia em comparação com a radiografia periapical. Embora Tay[13] et al., 2022 tenham realizado uma pesquisa inovadora recentemente, o presente estudo dá um passo adiante ao selecionar meticulosamente a literatura disponível. A intenção por trás dessa abordagem era acumular um conjunto abrangente de dados que respondesse de forma decisiva ao cerne de nossa questão de pesquisa, não deixando espaço para dúvidas ou incertezas.

2 ARTIGO CIENTÍFICO

Artigo científico a ser enviado para publicação no periódico *International Endodontic Journal*. A estruturação do artigo baseou-se nas instruções aos autores preconizadas pelo periódico (Apêndice A).

Can the use of cone-beam computed tomography change the diagnosis and treatment plan in Endodontics compared to periapical radiography? A Systematic Review

Short title: CBCT compared to PR in Endodontics

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Abstract

Background: Conventional periapical radiography is a 2D technique that represents a 3D structure. This can lead to the superimposition of anatomical structures and reduce diagnostic effectiveness. CBCT is an imaging technology that allows for the acquisition of 3D images of the area of interest. This can aid in endodontic diagnosis and treatment planning.

Objectives: The aim of this study is to evaluate whether cone beam computed tomography (CBCT) changes the diagnosis and treatment plan in endodontics, compared to periapical radiography.

Method: The development of this research followed the PRISMA 2020 criteria, and the PRISMA-DTA extension and respected all the issues listed in the documents. The study question was formulated based on the PECOS, being P: Endodontics; E: cone beam computed tomography; C: Periapical X-ray; O: Diagnosis (major outcome) and treatment plan (minor outcome); and S: Observational studies. Initially, relevant descriptors were chosen for the study, including indexed terms from MeSH, Emtree, and DeCS databases, and free-text descriptors, to ensure comprehensive coverage. Boolean operators (OR and AND) were used to combine the descriptors and create the search query. The search was conducted across MEDLINE via PubMed, SciELO, Scopus, Cochrane Library, Web of Science, and EMBASE. A manual search of the

reference lists of eligible studies was also performed and considered articles published up to May 2022.

Results: 24 observational studies were included, and all of them evaluated the impact of diagnostic changes and treatment plan modifications. Except for two studies, all of the other 22 studies reported changes in diagnosis or treatment plan when CBCT was used compared with periapical radiography.

Conclusion: The use of CBCT indeed leads to a change in the diagnosis and treatment plan in endodontic cases, particularly in more challenging scenarios. Even evaluators with less knowledge and experience in endodontic treatments are able to achieve better results using this imaging modality for the assessment of complex cases.

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Keywords: Endodontics; Cone beam computed tomography; Periapical X-ray; Diagnosis; treatment plan; Observational studies.

Introduction

In endodontic treatments, as well as in other areas of dentistry, intraoral radiographs are of substantial importance for accurate diagnosis and treatment planning.[1] Since their inception, conventional radiographs have provided dentists with the greatest imaging support. However, with technological advancements, new methods of obtaining radiographic images have been adopted in various dental areas, with varying degrees of success.[2] Among all the new techniques, Cone Beam Computed Tomography (CBCT) has been selected as having the highest potential for assisting in diagnostic imaging in Endodontics, compared to periapical radiographs.[1] However, these digital techniques have been slow to gain acceptance in Endodontics.[2]

Periapical radiographs are typically the initial imaging modality of choice in endodontic treatments due to their easy accessibility, low cost to the patient, and low radiation dose.[3] The main limitation of this technique lies in its two-dimensional representation of a three-dimensional structure, leading to the superimposition of anatomical structures and reducing diagnostic effectiveness.[1-3] However, it is well-

established that conventional periapical radiography is not as accurate as CBCT in assessing anatomical details and apical lesions, for exemple.[4]

CBCT projects X-rays onto the region of interest while a detector rotates around the patient's head. Multiple images are obtained and digitally formatted, resulting in an immediate three-dimensional image.[1] Furthermore, CBCT provides a significantly lower effective radiation dose compared to some multislice computed tomography,[1,5] but has a higher dose than periapical radiography.[5] The choice of which imaging modality to use should follow the principle of "As Low As Diagnostically Acceptable being Indication-oriented and Patient-specific" (ALADAIP), where the selected imaging method should provide the lowest possible exposure while achieving an acceptable diagnosis.[36] In consensus, the American Association of Endodontists and the American Academy of Oral and Maxillofacial Radiology have defined that periapical radiography should be the initial technique of choice for endodontic cases. However, CBCT can be used when previous radiographic images lead to contradictory diagnoses or when the patient presents nonspecific clinical signs and symptoms associated with treated or untreated teeth.[7]

Recent studies have shown the superiority of CBCT compared to periapical radiographs in diagnosing various conditions in Endodontics.[8,9] However, the literature lacks studies that support the actual impact of the additional information obtained through CBCT on diagnosis and treatment planning. Rosen et al. conducted a systematic review and efficacy analysis using a hierarchical model of evidence with six levels, where level 1 represents the lowest level of evidence and level 6 the highest, regarding the diagnostic efficacy of CBCT in Endodontics. According to the articles that met the authors' criteria (n=58), only three articles were classified as level 3 evidence (changes in diagnosis or prognosis before and after CBCT evaluation) and only two as level 4 evidence (changes in the treatment plan, such as the introduction of a new therapy or avoidance of unnecessary treatment). [10] Despite new studies on the topic being published in the past five years,[1,3,11,12] the data still appear to be controversial, and the literature remains in need of a more robust evaluation. Therefore, the objective of the present study was to conduct a systematic review to assess whether the use of CBCT changes the diagnosis and treatment plan in Endodontics compared to periapical radiography. Although Tay[13] et al., 2022 have conducted a groundbreaking research recently, the present study takes a step further by meticulously selecting the available literature. The intention behind this approach was to amass a comprehensive

pool of data that decisively answers the very core of our research question, leaving no room for doubt or uncertainty.

Materials and Methods

The development of this research followed the PRISMA 2020 criteria (The Preferred Reporting Items for Systematic Reviews and Meta-Analyses)[14], and the PRISMA-DTA extension will respect all the issues listed in the documents.[15]

This research was registered in the PROSPERO database (https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=320057) to ensure transparency throughout the study process.

Type of study and ethical aspects

This study is a systematic review; therefore, it was not necessary to be evaluated by the ethics committee on human beings and/or animal experimentation.

Elaboration of the study question

The study question was formulated based on the PECOS strategy (Population; Exposure; Comparison; Outcome; Type of study), and was set as “Can the use of cone-beam computed tomography change the diagnosis and treatment plan in Endodontics compared to periapical radiography?”, being: P: Endodontics; E: Cone beam computed tomography; C: Periapical X-ray; O: Diagnosis (major outcome) and treatment plan (minor outcome); and S: Observational studies.

Eligibility Criteria

Inclusion criteria were: 1) studies using periapical radiography and CBCT for endodontic treatment planning; 2) studies comparing changes in clinicians’ treatment plans with and without the use of CBCT; 3) Articles written in English. And exclusion criteria were: 1) in vitro studies; 2) animal studies; 3) case reports; 4) literature reviews; 5) studies reporting the effect of CBCT on endodontic diagnosis and/or changes in confidence only, without consideration for changes in the treatment plan.

Search Strategy

Initially, all descriptors related to the purpose of the study were selected, considering both those indexed in the MeSH, Emtree, and DeCS databases and free descriptors, for a broader reach. Boolean operators (OR and AND) were combined with descriptors to form the search key (*supplementary file*).

Searches were carried out in MEDLINE databases via PubMed, SciELO, Scopus, Cochrane Library, Web of Science, and EMBASE. A manual search of the reference list of eligible studies was also performed. The searches were carried out specifically and advanced according to each of the platforms, and considered articles published up to May 2022. The search was performed in May 2022.

Data extraction

Data extraction was performed in an ordered and standardized manner, containing the following items: Author; publication year; country of origin of the study; kind of study; sample size; data regarding the evaluated endodontic conditions; data referring to the periapical radiography examination (technique used, device, and acquisition protocol); data regarding the diagnosis and/or treatment plan based on the periapical radiography; data regarding the CBCT examination (device and acquisition protocol); data regarding diagnosis and/or treatment plan based on CBCT; data referring to the comparison of modalities in relation to outcomes diagnosis and/or treatment plan comparing (Table 1).

Results

Articles Selection

A total of 980 articles were identified through the literature search. Following the removal of 364 duplicates, 616 articles underwent initial screening based on their title and abstract. From this pool, 20 articles were selected for full-text review. In addition, other four studies were discovered through a manual search of the references of the relevant articles. These studies were evaluated for eligibility and subsequently included in the final review (Figure 1).

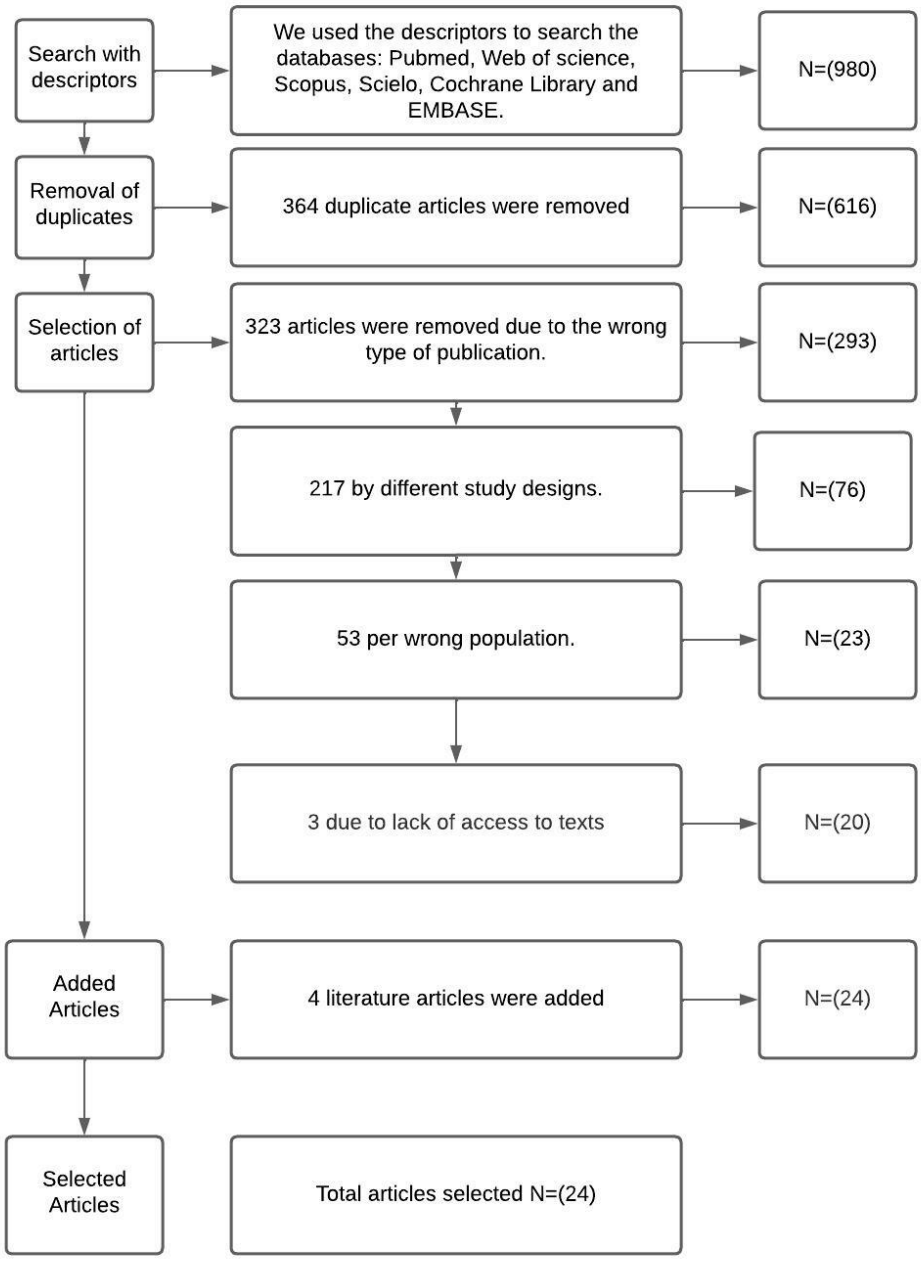

Figure 1 – Flow diagram of articles selection.

Studies Characteristics

For the purpose of analysis, a total of 24 articles published from 2008 to 2021 were selected. Out of these, in 22 studies, the number of examiners was explicitly mentioned. The majority of examiners in these studies were identified as endodontists and endodontic residents. Notably, two studies (Rodríguez[17,33] et. al., 2017a, 2017b) included a larger number of examiners from various dental disciplines, ranging from 120-140 individuals, while the in remaining studies it ranged from 2-15 examiners.

All studies in this review, except for 8% (Balasundaram[16] et al., 2012; Roríguez[17] et. al., 2017a), adhered to the guidelines outlined in the AAE/AAOMR 2015 Joint Position Statement or employed the AAE Endodontic Case Difficulty Assessment Form and Guidelines to determine the need for CBCT imaging. Specifically, CBCT imaging was indicated for moderate and high-difficulty cases.[16] Notably, one study included cases of minimal difficulty in addition to more complex cases.[17] Five studies utilized CBCT imaging to assess periapical healing following surgical endodontic retreatment. [18,19,20,21,22] Two studies employed CBCT imaging to evaluate the proximity of periapical lesions to anatomical structures. [23,24] Additionally, three studies evaluate external cervical resorption.[25-27] Nineteen studies reported the treatment options available to examiners; [1,3,8,12,16,17,19-21,25,26,28-35] and five studies did not report those options.[18,22,23,24,27] Study characteristics were summarized in Table 2.

Results of included studies

All the included studies evaluated both diagnosis (major outcome) and treatment plan (minor outcome). Except for Balasundaram[16] et al., 2012 and Jorge[18] et al., 2015, all of the other 22 studies reported changes in diagnosis or treatment plan when CBCT was used compared with PR.

Recommendation for further intervention post-CBCT

Regarding studies, most of them (79%) reported an increase in recommendations for further interventions, such as non-surgical and surgical endodontic treatment, and extractions, following CBCT imaging. [1,3,8,12,16,17,19-21,25,26,28-35] The majority of the analyzed samples revealed a statistically significant difference between PR and CBCT imaging.

Studies that do not follow all AAE/AAOMR parameters

Balasundaram[16] et al., 2012, selected teeth with periapical lesions that are at least 3mm wide or larger as observed on periapical radiographs, which may differ from the AAE endodontic case difficulty criteria. All of the studies included cases of moderate to high difficulty, except for one (Rodriguez[17] et al., 2017a), which also

included an additional 10 cases of the minimum difficulty. When comparing cases of low difficulty with high difficulty, significant differences in treatment plan changes were found in the high-difficulty cases.

Recommendation for extraction post-CBCT

An increase in the recommendation for extraction post-CBCT was reported in 9 studies [1,12,17,25,26,29,30,33,34] and the difference was statistically significant in 3 studies.[17,30,33] Goodell[26] et al, 2018, did not provide a separate report on the option of extraction, instead only reporting the option of "no external cervical resorption repair" as an alternative to surgical or nonsurgical treatment.

Discussion

As previously mentioned, this systematic review aims to evaluate the available literature data related to the comparison of CBCT with PR in the diagnosis and treatment plan in endodontic treatments. This study evaluated a total of 20 articles, which were selected from major available databases, and also, 4 articles were selected from a manual search in the references of the previously mentioned articles, all in English.

In recent years, Cone-beam Computed Tomography (CBCT) imaging has gained widespread use as a diagnostic tool in endodontics. However, if radiographic imaging is deemed necessary, it should be conducted while adhering to the principle of radiation protection is known as "As Low as Reasonably Achievable" (ALARA) [1,5,6]. It is important to note that the effective dose of CBCT scans is generally higher than that of periapical radiography. It is noteworthy that the effective dose of CBCT scans is not fixed, but rather it varies depending on multiple factors, such as the type of CBCT scanner used, the specific region of the jaw that is scanned, exposure settings of the scanner, the size of the field of view (FOV), exposure time in seconds (s), tube current in milliamperes (mA), and the energy potential in kilovolts (kV).[10] The decision to use CBCT imaging should be based on individual patient factors and clinical needs. This ensures that the benefits of the imaging outweigh the potential risks associated with increased radiation exposure. Patient safety and well-being should always be prioritized when considering the use of CBCT. [1,5,6]

Among the 24 studies reviewed, 17 reported a significant impact of CBCT imaging on the diagnosis or treatment plan compared to PR.[12,17,19,21-34] Specifically, CBCT imaging was found to provide additional diagnostic information such as the detection of extra canals, root fractures, root resorption, and apical periodontitis, which are often missed with PR. This additional information led to changes in treatment plans, such as the adjustment of the root canal filling, retreatment, apical surgery, or extraction.

In their study, Giudice[28] et al., 2018 described that the utilization of CBCT is indispensable in cases where a discrepancy between clinical examinations and the evidence demonstrated by intraoral radiographic examination is observed. This information is further supported by the findings of other authors [3,34], who concluded in their study that CBCT enhances the diagnostic confidence of the clinicians and endodontists and treatment planning, particularly in complex cases when compared to conventional periapical radiography. Other authors have also affirmed that preoperative CBCT image change significantly the treatment plan or decision-making.[12,17,24,25,31,32]

Additionally, several studies have demonstrated that CBCT alters the diagnosis and treatment plan for highly difficult cases compared to PR. Jonathan[31] et al., 2019, reported that there was a statistically significant change in the treatment plan when comparing periapical radiographs and CBCT for three endodontist examiners.[31] They have rejected the null hypothesis, indicating that preoperative CBCT images do indeed result in a significant alteration of the proposed treatment plan when compared to periapical radiographs alone. When Rodríguez[17] et al., 2017 assessed the influence of CBCT on clinical decision-making among specialists, they concluded that a significant difference existed in the treatment plan between the two imaging modalities (CBCT and PR) as observed in each specialist group. CBCT imaging exerted a substantial influence on the treatment plan of all specialist groups when the endodontic cases were classified as high difficulty. This difference was evident in all specialist groups, with the exception of endodontists, who did not modify their self-reported level of difficulty when selecting a treatment. According to the findings (Bornstein[24] et al., 2011) 15 out of the total periapical lesions (25.86%) detected using sagittal CBCT reconstructions were not identified with PR in mandibular molars. These results highlight the significance of limited CBCT imaging as a valuable diagnostic tool for

assessing anatomically challenging regions, particularly the posterior mandible, prior to apical surgery.[24]

In their study, Almeida[12] et al., 2015 reported that CBCT imaging, when used in accordance with the current European Commission guidelines, is recommended for a small group of patients with complex endodontic cases. This imaging modality has a significant impact on treatment planning decisions in endodontic cases and contributes to enhancing the precision of the performed therapy. By providing detailed and three-dimensional images, CBCT enables clinicians to assess the anatomy more accurately, identify pathological conditions, and plan appropriate treatment strategies. The findings suggest that CBCT plays a valuable role in improving the overall quality and effectiveness of endodontic care. This other study conducted by Patel[25] et. al., 2016, demonstrated that CBCT imaging had higher sensitivity and specificity in detecting external cervical resorption (ECR) lesions. Furthermore, CBCT allowed for a more precise assessment of the size and location of the lesions, which is crucial in determining the appropriate treatment plan. Based on the findings, a higher percentage of teeth were deemed unrestorable when assessed using CBCT imaging, indicating its effectiveness in identifying extensive or difficult-to-access ECR lesions that may not be treatable and may require extraction or close monitoring. Therefore, CBCT imaging plays a pivotal role in facilitating improved treatment planning for ECR cases, ensuring better clinical outcomes and prognosis.

Two studies reported no significant differences in diagnosis or treatment plan when comparing CBCT and PR imaging.[16,18] These authors compared conventional PR and CBCT images for determining the size of periapical bone lesions. These studies found that there were no significant differences between the two diagnostic techniques when measurements were made using appropriately calibrated evaluators and standardized methods. CBCT imaging provides additional diagnostic information beyond periapical bone lesions, although both PR and CBCT are accurate for measuring lesion size. Balasundaram[16] et. al., 2012, described several risk factors that could have influenced the outcome of their study. The research sample (n=24) is relatively small, and it is unknown whether a larger sample size could yield different results. Furthermore, the patient's medical history and clinical information were not assessed. Therefore, the absence of this information may or may not result in a significant difference in treatment selection between the two imaging modalities. From the same perspective, Jorge[18] et. al., 2015 reported that the similar results found

between PR and CBCT could be attributed to the removal of the cortical bone plate of the alveolar ridge during surgery, thereby eliminating one of the factors that push down the quality of PR. This removal of the cortical bone may have favored the PR in the evaluation compared to CBCT in the assessment of periapical bone repair.[18] Guidelines recommend high-resolution CBCT for detecting periapical bone lesions, but results should be interpreted with caution and clinical signs and symptoms considered. Radiological evidence should not be the sole factor in treatment decisions, and patient preferences and medical history should also be considered.

Wanzeler[3] et al., 2020, demonstrated in their research that the use of CBCT images had a significant impact on confidence in diagnosis and treatment planning for complex endodontic cases. In both moderate and complex cases, there was a considerable shift in the planned treatment after the use of CBCT. Interestingly, the level of case complexity did not affect the decision of participants to request additional information through CBCT.[3] Cheung[35] et al., 2013, evaluated PR and CBCT assessments of molar teeth and showed substantial disagreements in the number of canals, the number and size of lesions, and the number of J-shaped lesions. This discrepancy was more evident in maxillary molars, particularly in the presence and size of lesions, compared to mandibular molars. The results suggest that using periapical radiography alone for evaluating the outcome of endodontic treatment may result in underestimating the number of lesions associated with root-filled teeth, particularly in the maxillary posterior segment.[35]

Still, other results affirm the importance of CBCT in the evaluation of periapical lesions. CBCT promoted a better visualization of the number of teeth involved in the lesion and helps in accurate treatment planning and providing safer treatment by presenting the clinician with relevant information.[23] According to a study conducted by Goodell[26] et al., 2018, there was a notable disparity between treatment plans developed using CBCT images and those developed using PR radiographs in the majority of cases. Periapical radiography consistently underestimates the size and extent of classification of ECR lesions when compared to CBCT imaging.[26] Moreover, in the current investigation conducted by Low[22] et al., 2008, it was found that lesions in close proximity to the sinus floor had a higher probability of being overlooked when using PA, compared to lesions located away from or overlapping the sinus floor. Similarly, lesions associated with molars, particularly second molars, were more prone to being missed with PR compared to lesions related to premolars. Furthermore,

supplementary findings including maxillary sinus expansion, thickening of the sinus membrane, undetected canals, and the presence of apicomarginal communications were more frequently identified using CBCT rather than PR. Davies[8] et. al., 2015, conducted a study evaluating the diagnosis of primary root canal treatment. The study revealed that CBCT scans demonstrated a lower rate of healing and recovery compared to periapical radiographs. Molar teeth without pre-operative periapical radiolucency showed a fourteenfold higher failure rate when assessed through CBCT (17.6%) in contrast to periapical radiographs (1.3%).[8]

A histological study conducted by Kruse[19] et al., 2017 aimed to evaluate periapical lesions that underwent surgical endodontic retreatment (SER). All cases were diagnosed with chronic periapical periodontitis. The study's results indicated that the correct radiographic diagnosis was achieved in 63% and 58% of cases using periapical radiographs PR and CBCT, respectively. Interestingly, more than 40% of the SER cases diagnosed as unsuccessfully healed during a 7-year follow-up after SER-R showed no signs of periapical inflammation upon histopathological examination of the periapical soft tissues. These findings highlight that these patients did not benefit from the SER-R procedure. Therefore, it can be concluded that caution should be exercised when using CBCT for assessing periapical healing after SER.[19]

Based on the recent studies evaluated in this work, in agreement with Bhatt[29] et al., 2020 it has been observed that in the majority of cases where CBCT was prescribed, it served to confirm suspected pathosis or aid in treatment planning. CBCT scans have been shown to be more effective in revealing periapical lesions, identifying missed canals, detecting root fractures, and visualizing complex anatomical structures when compared to periapical radiographs.[29] However, it is important to note that the treatment plan is not solely dependent on the additional information obtained the from CBCT examination. It also takes into consideration the patient's signs and symptoms, individual needs, and financial circumstances. By considering all these factors, a more comprehensive and tailored treatment plan can be developed, potentially leading to an improved prognosis for the tooth. Therefore, it is essential to not only rely on the radiographic data provided by CBCT but also consider the patient's clinical condition and other relevant factors in order to make informed and personalized decisions regarding endodontic treatment.

Conclusion

The CBCT image indeed promotes a change in the diagnosis and treatment plan in endodontic cases, being particularly impactful in more challenging scenarios. Even evaluators with lesser knowledge and experience in endodontic treatments are able to achieve better results using this imaging modality for the assessment of complex cases.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary file – Search key

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#1	TITLE-ABS-KEY ("Endodontics") OR TITLE-ABS-KEY ("Endodontology") OR TITLE-ABS-KEY ("Endodontists") OR TITLE-ABS-KEY ("Endodontist") OR TITLE-ABS-KEY ("Endodontic") OR TITLE-ABS-KEY ("Endodontic cases") OR TITLE-ABS-KEY ("Endodontic treatment") OR TITLE-ABS-KEY ("Endodontic intervention") OR TITLE-ABS-KEY ("Endodontic therapeutic") OR TITLE-ABS-KEY ("Endodontic retreatment") OR TITLE-ABS-KEY ("Surgical endodontic retreatment") OR TITLE-ABS-KEY ("Retreatment")
#2	TITLE-ABS-KEY (Cone-beam computed tomography*) OR TITLE-ABS-KEY (Cone Beam Computed Tomography) OR TITLE-ABS-KEY (Cone-Beam CT Scan) OR TITLE-ABS-KEY (Cone-Beam CT Scans) OR TITLE-ABS-KEY (Cone Beam CT Scan) OR TITLE-ABS-KEY (Cone Beam CT Scans) OR TITLE-ABS-KEY (Volume Computed Tomography) OR TITLE-ABS-KEY (Volumetric CT) OR TITLE-ABS-KEY (Volumetric Computed Tomography) OR TITLE-ABS-KEY (Cone-Beam CAT Scan) OR TITLE-ABS-KEY (Cone-Beam CAT Scans) OR TITLE-ABS-KEY (Cone Beam CAT Scan) OR TITLE-ABS-KEY (Cone Beam CAT Scans) OR TITLE-ABS-KEY (Cone-Beam Computer-Assisted Tomography) OR TITLE-ABS-KEY (Cone Beam Computer Assisted Tomography) OR TITLE-ABS-KEY (Cone-Beam Computer-Assisted Tomography) OR TITLE-ABS-KEY (Cone-Beam CT) OR TITLE-ABS-KEY (Cone Beam CT) OR TITLE-ABS-KEY (Volume CT) OR TITLE-ABS-KEY (CBCT) OR TITLE-ABS-KEY (CB computed tomography) OR TITLE-ABS-KEY (Cone beam CT) OR TITLE-ABS-KEY (Cone-beam CT)
#3	OR TITLE-ABS-KEY (Radiography, Dental, Digital) OR TITLE-ABS-KEY (Dental Digital Radiography) OR TITLE-ABS-KEY (Digital Dental Radiography, Direct) OR TITLE-ABS-KEY (Radiography, Dental) OR TITLE-ABS-KEY (Dental Radiography) OR TITLE-ABS-KEY (X-Ray Film) OR TITLE-ABS-KEY (X Ray Film) OR TITLE-ABS-KEY (Radiographic Film) OR TITLE-ABS-KEY (Xray Film) OR TITLE-ABS-KEY (Film, Xray) OR TITLE-ABS-KEY (Films, Xray) OR TITLE-ABS-KEY (Xray Films) OR TITLE-ABS-KEY (Film, Radiographic) OR TITLE-ABS-KEY (Films, Radiographic) OR TITLE-ABS-KEY (Radiographic Films) OR TITLE-ABS-KEY (Film, X-Ray) OR TITLE-ABS-KEY (Film, X Ray) OR TITLE-ABS-KEY (Films, X-Ray) OR TITLE-ABS-KEY (X-Ray Films) OR TITLE-ABS-KEY (Periapical radiograph) OR TITLE-ABS-KEY (Periapical radiography) OR TITLE-ABS-KEY (Periapical radiographs) OR TITLE-ABS-KEY (Intraoral radiograph) OR TITLE-ABS-KEY (Intraoral radiography) OR TITLE-ABS-KEY (Intraoral radiographic)
#4	OR TITLE-ABS-KEY (Decision making) OR TITLE-ABS-KEY (Clinical Decision-making) OR TITLE-ABS-KEY (Clinical Decision Making) OR TITLE-ABS-KEY (Decision-Making, Clinical) OR TITLE-ABS-KEY (Medical Decision-Making) OR TITLE-ABS-KEY (Decision-Making, Medical) OR TITLE-ABS-KEY (Medical Decision Making) OR TITLE-ABS-KEY (Treatment outcome) OR TITLE-ABS-KEY (Treatment Effectiveness) OR TITLE-ABS-KEY (Treatment Efficacy) OR TITLE-ABS-KEY (Clinical Efficacy) OR TITLE-ABS-KEY (Clinical protocols) OR TITLE-ABS-KEY ((Treatment protocols) OR TITLE-ABS-KEY (Treatment plan) OR TITLE-ABS-KEY (Treatment planning) OR TITLE-ABS-KEY (Endodontic Diagnosis) OR TITLE-ABS-KEY (Endodontic outcome) OR TITLE-ABS-KEY (Decision treatment planning) OR TITLE-ABS-KEY (Decision-making)
#5	#1 AND #2 AND #3 AND #4

DeCS

#1	(Endodontics) OR (Endodontists)
#2	(Cone beam computed tomography) OR (Cone-beam computed tomography) OR (Cone beam volumetric tomography) OR (Cone-beam volumetric tomography) OR (CBCT) OR (cone beam CT) OR (cone-beam CT) OR (cone-beam CT scan) OR (volume computed tomography)
#3	(Dental digital radiography) OR (Dental radiography) OR (Film)
#4	(Diagnosis) OR (Decision making) OR (Decision-making) OR (Clinical decision making) OR (Oral diagnosis) OR (Treatment outcome)
#5	#1 AND #2 AND #3 AND #4

Entree

#1	(Endodontics) OR (Endodontist) OR (Retreatment)	
#2	(Cone beam computed tomography) OR (Cone beam volumetric tomography) OR (CBCT) OR (Cone-beam computed tomographic imaging) OR (cone beam CT) OR (cone-beam CT)	
#3	(Periapical radiography) OR (Dental digital radiography) OR (Dental radiography) OR (Film) OR (Intraoral periapical radiography) OR (dental x ray system) OR (tooth radiography) OR (X ray film)	
#4	(Diagnosis) OR (Decision making) OR (Clinical decision making) OR (Treatment planning) OR (Oral diagnosis) OR (Treatment outcome) OR (radiodiagnosis) OR (mouth disease)	
#5	#1 AND #2 AND #3 AND #4	

Table 1 – Search data extraction

Study	Outcome	Study Objectives	Indications for CBCT	Sample / Case selection	Number of examiners	Patient history	Treatment options
A. Davies, 2016	Diagnosis using CBCT revealed a significantly lower number of favourable outcomes than periapicals in root canal retreatment. This significantly affected the future management of cases attending for a review.	Compare the 1-year outcome of root canal retreatments, when individual roots and teeth were assessed by periapical radiographs and cone beam computed tomography (CBCT).	Subjects participating in this study had been referred to Guy's and St Thomas' NHS foundation trust, London, UK, for management of an endodontic problem associated with one or more root filled teeth.	98 teeth from 84 patients.	Two Endodontist.	Patients who had teeth with signs and symptoms of endodontic post-treatment disease were considered for inclusion.	1. New periapical radiolucency 2. Enlarged periapical radiolucency 3. Unchanged periapical radiolucency 4. Reduced periapical radiolucency 5. Resolved periapical radiolucency 6. Unchanged healthy periapical status (no radiolucency before or after treatment).
Almeida F.J.M, 2021	CBCT influences endodontic therapeutic decision-making regarding immature traumatised teeth with suspected pulp necrosis.	To evaluate the impact of cone-beam computed tomography (CBCT) in endodontic therapeutic decision-making of immature traumatized teeth with suspected pulp necrosis	Patients recruited from an ongoing study investigating regenera tive treatments in immature traumatized necrotic teeth assessed by CBCT.	18 Teeth from 15 patients, all central incisors.	Three experienced clinical endodontists (between 10 and 20 years of experience) and two first-year endodontic residents.	Patients were consecutively included if they presented untreated and traumatized immature front teeth with suspicion of pulp necrosis and with no restoration or an adequate coronal restoration without signs of caries.	A) no treat ment; B) watchful waiting; C) endodontic orthograde treatment; and D) extraction
Almeida, 2014	CBCT has a significant impact on therapeutic decision efficacy in endodontics when used in concordance with the current European Commission guidelines.	What extent cone beam CT (CBCT) used in accordance with current European Commission guidelines in a normal clinical setting has an impact on therapeutic decisions in a population referred for endodontic problems.	The population was selected from consecutively exam ined patients recruited from two endodontic specialist clinics in Sweden (situated in Lulea and Uppsala) between October 2011 and December 2012.	81 Teeth from 53 patients	Three specialists in endodontics and four post-graduate residents took part as examiners in the study.	The inclusion criteria for referring patients to CBCT examination were in accordance with current European guidelines.	1.No treatment 2.Watchful waiting 3.Orthograde endodontics 4.Retrograde endodontics 5.Explorative surgery 6.Extration 7.Referral to other 8.specialist 9.Other
Ashok Balasundaram, 2012	No difference in treatment plan was noticed between the two imaging modalities.	To compare the ability of endodontists to determine the size of apical pathological lesions and select the most appropriate choice of treatment based on lesions' projected image characteristics using 2D and 3D images.	All subjects reported to the Endodontic Division of the University of Detroit Mercy School of Dentistry with symptoms suggestive of a periapical lesion.	24 teeths, 11 women and 13 men, with an average age of 53 years (range 18–88 years).	Six endodontists.	Both single rooted and multirooted teeth with periapical lesion size equal to or greater than 3 mm on intraoral periapical radiography.	1.Root canal 2.Periapical surgery 3.Root canal + Periapical surgery 4.No treatment
Bornstein, 2011	CBCT has advantages for treatment planning.	Evaluate the detectability and dimensions of periapical lesions, the relationship of the mandibular canal to the roots of the respective teeth, and the dimension of the buccal bone by using limited CBCT in comparison to conventional PA radiographs for evaluation of mandibular molars before apical surgery.	Patients were consecutively enrolled in the present study from June 2007–February 2008. The patients were all referred to the Department of Oral Surgery and Stomatology at the University of Bern, Bern, Switzerland for further evaluation of possible apical	38 Teeth and 75 roots	-	(1) there were clinical signs or symptoms and/or radiographic findings of apical periodontitis in at least 1 mandibular molar, (2) teeth had been previously endodontically treated, and (3) teeth involved were	nonspecific
Buchheister, 2019	The main utility of CBCT was increasing the confidence of the clinicians in the initial treatment plans (50%), followed by the drastic change or variation in the therapeutic approach adopted prior to	The aim of this study was to evaluate the clinical utility of Cone Beam Computed Tomography (CBCT) in cases of medium and high endodontic complexity.	Patients with endodontic pathology that required endodontic treatment or retreatment, and patients who presented an endodontic case considered of medium or high	40 patients, with a mean of 41 years of age.	12 specialty interns.	Regarding complexity, 20 cases were of median complexity, and 20 cases of high complexity.	No treatment, further check-up, conventional endodontic treatment, microsurgery, extraction, or other.

C. Kruse, 2018	The radiographic assessment was changed as a result of the CBCT in 51% of cases. The treatment plan was changed in 24.3%.	Evaluate how additional information fron CBCT impacts on periapical acessement and treatment planning based on clinical examination and periapical radiographs.	Patients, who had underwent SER within the period January 2004 to December 2010.	74 teeth from 66 patients.	Two endodontists and one oral radiologist evaluated all information.	Patients receiving SER during 2004– 2010 were reinvited for follow-up examination including clinical examination.	1) complete healing; 2) incomplete healing; 3) uncertain healing; or 4) unsatisfactory healing.
Casper Kruse, 2017	Caution should be exercised when using CBCT for the assessment of periapical healing after selective endodontic retreatment (SER).	Diagnostic validity of periapical and CBCT for determining inflammation in SER-R due to unsuccessful healing, using histology of the periapical lesion as reference for inflammation.	Follow up of teeth previously treated by SER.	77 Teeth from 66 pacient.	Two endodontists and one oral radiologist.	Teeth previously treated by SER at Department of Dentistry, Aarhus University, Denmark.	1.Successful healing 2.Unsuccessful healing
Chogle, 2019	The CBCT imaging has a significant effect in determining the etiologic factors.	This study aimed to deter mine the basis for CBCT recommendations and the effect on diagnosis and treatment planning.	Deidentified electronic dental health records with CBCT scans were selected for this retrospective cohort study, and at least 1 faculty member in the endodontic department verified the appropriateness of and reason that all CBCT scans were prescribed.	45 cases	nonspecific	Endodontic treatment, including consultation, root canal therapy, nonsurgical retreatment, and surgical root canal therapy	1.No Treatment 2.No Treatment at this time 3. Refer to another department 4.Caries control 5.Initiate RCT 6.Initiate Re-treatment 7.Surgical re-treatment 8.Surgical treatment excluding apicoectomy 9.Extraction 10.Other
G. S. P. Cheung, 2013	There werer substantial disagreements between PA and CBCT for assessing the periapical status of molar teeth.	To assess the agreement between periapical radiograph and CBCT for periapical assessment of root filled maxillary and mandibular molars.	Patients who had received root canal treatment of a maxillary or mandibular, first or second permanent molars in a dental teaching hospital between 2001 and 2005.	30 teeth maxilary molar and 30 teeth mandibular molar.	Two pre-calibrated examiners (na endodontist and na oral radiologist).	First or second permanent molars who had received root canal treatment.	1.Number of canals. 2. Number of lesions. 3. Size of lesions(M-D) 4. Size of lesions(C-A) 5.Number of 'J' lesions
Giudice, 2018	Many of the endodontic signs obtained from the analysis of CBCT images have not resulted in the corresponding intraoral radiographs.	Evaluate the accuracy of CBCT in comparison with conventional intraoral radiographs used in endodontic procedures.	Pre- and post-operative intraoral X-ray and the follow-up X-ray between 3 and 6 months.	111 Teeth from 101 Patient.	Two endodontists with more than 10 years of clinical practice.	Teeth previously endodontically treated.	Group A #38 1. Root fractures. 2.Underextended endodontic treatment. 3.Internal/External root reabsorption 4. Lack of superior molar's MB2 treatment. 5. Lack of a inferior incisor's lingual canal Group B #70 1. Under extended endodontic treatment 2.Nontreated MB2 canals 3.Nontreated lingual canals 4.Root fractures 5. Int/ext reabsorption
Jonathan Ee, 2014	CBCT imaging was a more accurate imaging modality. The peroperative CBCT image change significantly the treatment plan.	The aim of this study was to compare the relative value of preoperative periapical radiographs and CBCT scanning in the decision-making process in endodontic treatment planning.	A master list of cases completed in a private endodontic practice over a 12-month period.	30 teeth from 28 patients	Three board-certified endodontists.	1. Initial treatment 2. Nonsurgical retreatment 3. Periapical surgery 4. Vertical root fracture 5. Internal/external resorption 6. Perforation	1.Comparison between gold standard and radiographs. 2.Comparison between Gold Standard and CBCT scans. Treatment Plan Changes between Radiographs and CBCT imaging.

Jorge, 2015	CBCT images provided results similar to those assessed by means of IRs.	This study quantitatively assessed the periapical bone repair following endodontic surgery, using planimetric evaluation based on two- and three-dimensional evaluation.	Eleven patients referred to the Endodontic clinic of Araraquara Dental School (UNESP - Univ Estadual Paulista, Brazil) (both genders, over the age of 18 years) were selected for this study.	11 patients	Three previously trained evaluators made the evaluations (two endodontists and one radiologist)	The teeth selected were maxillary anterior single-rooted teeth, with the presence of radiographically (IR) visible periapical bone rarefaction, and the indication for surgical endodontic surgical treatment.	nonspecific
K Patel, 2016	PRs have significant limitations in the detection, assess ment, and treatment planning of ECR when compared with CBCT imaging.	Evaluate the difference between periapical radiographs (PRs) and cone beam computed tomography (CBCT) in the detection, evaluation and management of external cervical resorption (ECR).	All the patients were 18 years or older and were assessed by a specialist endodontist or a postgraduate endodontic student under the supervision of a specialist endodontist.	115 Teeth from 98 patients diagnosedwith ECR and 40 control teeth.	6 examiners 3 specialist endodontists 3 postgraduate endodontic students	Teeth were diagnosed with ECR after a detailed medical history, clinical examina tion, and appropriate radiographic assessment.	1. Detection of ECR: Yes or no 2. Heithersay classification: 1 to 4 3. Circumferential spread: <180 or >180 4. Location of the lesion: Mesial, distal, buccal, and/or palatal 5. Treatment plan: Restorable, restore (root canal treatment) or unrestorable, and extraction/review
Kenneth M.T., 2008	The CBCT detected 34% of lesions more than periapical radiography.	Comparison of periapical radiography and limited cone-beam tomography in posterior maxillary teeth referred for apical surgery.	Fifty-three consecutive patients were enrolled in the study. The patients were referred to the Department of Oral Surgery and Stomatology at the University of Bern, Bern, Switzerland, for possible apical surgery	45 patients (19 women/26 men) with a mean age of 51 years (range, 31– 80 years). Hence, 74 teeth yielding 156 roots were evaluated.	An oral radiologist and an endodontist.	(1) there were clinical signs or symptoms and/or radiographic findings of apical periodontitis of one tooth in the posterior maxilla. (2) teeth had been previously endodontically treated. (3) teeth involved were examined with PA and CBCT	nonspecific
Kesha Sheth, 2020	CBCT promoted a better visualization of the number of teeth involved by lesion, and helps in accurate treatment planing and providing safer treatment by presenting the clinician with relevant information.	The aim of this study was to compare cone-beam computed tomography (CBCT) and PA radiography to determine the proximity of PA lesions to anatomical structures in the premaxillary area for decision making before apical surgery.	Twenty patients reporting to the Department of Conservative Dentistry and Endodontics were considered for the study. The study group comprised of 14 male (70%) and 6 female (30%) patients, with a mean age of 23.9 ± 6.32 years	20 patients	Three endodontists.	Single-rooted maxillary anterior teeth, teeth with previous root canal treatment, and teeth with previous restorations.	-

Kurt B., 2018	Retreatment plans witch PA radiographs differed from CBCT images in the majority of cases. ECR lesion size is consistently underestimated in both size and extent classification with periapical radiography when compared with CBCT imaging.	Compare treatment plans for external cervical resorption (ECR) developed from periapical (PA) radiographs and cone beam computed tomographic (CBCT) imaging.	Reviewed all images in a database of 928 CBCT images acquired on patients referred to Rohde Dental Clinic, the endodontic specialty clinic at Fort Bragg in North Carolina, a United States Army facility.	30 External cervical resorption teeth (25 patients) and 10 ECR-free control teeth.	6 Examiners.	Matched PA and CBCT images for 30 cases of ECR from 25 patients included in study	1. No treatment/active monitoring 2. Nonsurgical root canal therapy with no attempt to repair the lesion 3. Nonsurgical root canal therapy with an attempt to repair the lesions from an internal approach 4. Nonsurgical root canal therapy in conjunction with an attempt to repair the lesion from an external surgical approach 5. External surgical repair without root canal therapy 6. Extraction
M. Bhatt, 2021	Cbct examinations were prescribed mainly to assist treatment planning rather than for diagnosis.	Compare conventional radiographic and CBCT and determine the effect of the CBCT on the initial diagnoses and treatment plans in a single centre Postgraduate Endodontic Programme.	The clinical CBCT scans of patients, treated at the Endodontic Department of the University of British Columbia, were reviewed for CBCT referrals by comparing them with corresponding radiographs.	128 CBCT examinations performed on 110 patients. No CBCT examination was performed more than once on the same tooth.	Endodontics students and later evaluated by the endodontics supervisor.	CBCT was prescribed only when there were clear clinical indications based on the clinical history presented by the patients and their periapical radiographs.	Endodontic Features 1.Periapical lesion 2.Extra/missed canal 3.Vertical root fracture 4.Complex anatomy 5.Resorptive lesions 6.Calcified canal
Patel S, 2009	CBCT was effective and reliable in detecting the presence of resorption lesions. CBCT's superior diagnostic accuracy also resulted in an increased likelihood of correct management of resorption lesions.	To compare the accuracy of intraoral periapical radiography with cone beam computed tomography (CBCT) for the detection and management of resorption lesions.	Patients who had either been successfully managed by one operator in specialist pratice or by postgraduate students.	15 Teeth from 15 Patients 10 males 5 females	Six examiners (two specialist endodontists and four endodontic post-graduates)	Five teeth diagnosed with interneal resorption, five teeth diagnosed with external cervical resorption, Five teeth were controls.	
Patel S, 2012	CBCT demonstrated a lower rate of healing of periapical lesions compared to periapical radiography, there was a 14-fold increase when observing teeth without preoperative periapical radiolucency.	Compare the radiographic change in periapical status of individual roots determined using digital periapical radiographs versus cone beam computed tomography (CBCT) 1 year after primary root canal treatment and to determine the radiological outcome of treatment for each tooth.	The patients were then reviewed 1 year post-operatively (see later). Only patients whose teeth fulfilled the inclusion criteria were asked to participate in the study (Patel et al. 2012).	123 teeth from 99 patients	2 endodontists	Teeth treated endodontically with 1 year of follow-up.	1. New periapical radiolucency; 2. Enlarged periapical radiolucency; 3. Unchanged periapical radiolucency; 4. Reduced periapical radiolucency; 5. Resolved periapical radiolucency; 6. Unchanged healthy periapical status (no radiolu cency before and after treatment).

Rodríguez, 2017	CBCT scans influence the treatment plan, particularly in difficult cases.	Determine the influence of CBCT imaging on clinical decision-making choices of different specialists when presented with patient scenarios with varying degrees of endodontic complexity. A second objective was to assess the self-reported level of difficulty in making a treatment choice in each different patient scenario before and after viewing a preoperative CBCT scan.	Thirty cases were selected from the archives of the Department of Operative Dentistry and Endodontics, Universitat Internacional de Cata lunya, Barcelona, Spain	30 cases	140 Specialists Examiners	10 cases of minimum difficulty, 10 of moderate difficulty, 10 of high difficulty. A wide range of non endodontically and endodontically treated teeth.	1. No treatment necessary, 2. Wait 6 to 12 months and re-examine (watchful waiting), 3. Endodontic treatment, 4. Nonsurgical retreatment, 5. Apical surgery, 6. Nonsurgical retreatment and apical surgery, or 7. Extraction 2. Assess the difficulty of making a decision by using a rating scale from 1 to 5 (1 and 2 = easy decision, 3 = moderate decision, and 4 and 5 = difficult decision).
Rodríguez, 2017	Preoperative CBCT image provides more diagnostic information than PA.	Determine the impact of CBCT imaging on clinical decision making among general dental practitioners and endodontists af ter failed root canal treatment. A second objective was to assess the self-reported level of difficulty in making a treatment choice before and after viewing a preopera tive CBCT scan.	Eight cases from the archives of the Department of Operative Dentistry and Endodontics (Universitat Internacional de Catalunya, Barcelona, Spain) were randomly selected from a list of patients who received a CBCT scan in order to complete their diagnosis.	8 Patients	120 examiners	Endodontically treated teeth with a range of clinical situations diagnosed as symptomatic apical periodontitis, acute apical abscess, or chronic apical abscess and teeth with definitive and adequate coronal restorations.	1. Nonsurgical retreatment 2. Apical surgery 3. Intentional replantation 4. Extraction
T. von Arx, 2015	A difference in diagnosis between the two imaging models was observed, as 40.5% of ratings in periapical radiography (PA) differed from CBCT findings.	To compare 2D with 3D radiography in assess-ing the treatment outcome 1 year after periapical surgery	All patients had been referred to the Department of Oral Surgery and Stomatology,University of Bern, Switzerland, for periapical surgery.	Sixty-two consecutively treated patients	Three calibrated observers, that is an oral surgeon(SFMJ), an endodontist (SH) and an oral radiologist(MMB	1 year after periapical surgery.	Rating 1: no radiolucency present Rating 2: radiolucency of 'scar' type Rating 3: radiolucency of 'lesion' type
Wanzeler, 2020	The CBCT examination increased endodontists' confidence in their diagnoses and treatment plans, especially in complex endodontic cases.	This study evaluated the influence of CBCT on endodondists' level of confidence in their diagnosis of endodontic cases and their treatment plans.	10 cases classified as moderate and 10 cases considered complex by 3 specialists.	20 Cases.	15 Endodontists and postgraduate students in the last year of the residency course.	Cases were classified as moderate or complex by 2 specialists in Oral and Maxillofacial Radiology and 1 specialist in Endodontics using the evaluation form proposed by the AAE.	Q(1) What is your level of confidence in the case diagnosis? Q(2) After clinical analysis and imaging, which therapeutic decision would you take? Q(3) What is your level of confidence in the treatment plan? (1) Not confident, (2) mildly under confident, (3) uncertain, (4) mildly confident, and (5) very confident

7 CONCLUSÃO

A TCFC realmente promove uma mudança no diagnóstico e no plano de tratamento em casos endodônticos, sendo particularmente impactante em cenários mais desafiadores. Mesmo os avaliadores com menos conhecimento e experiência em tratamentos endodônticos são capazes de obter melhores resultados usando essa modalidade de imagem para a avaliação de casos complexos.

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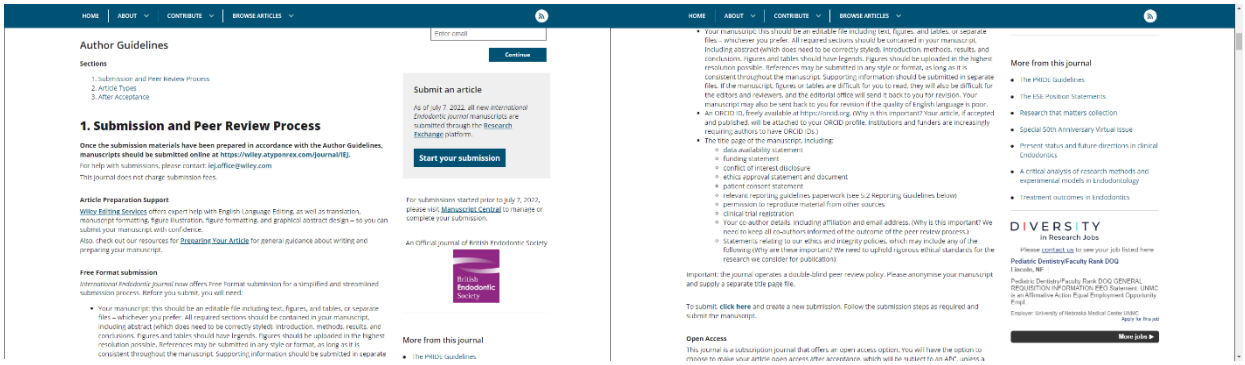
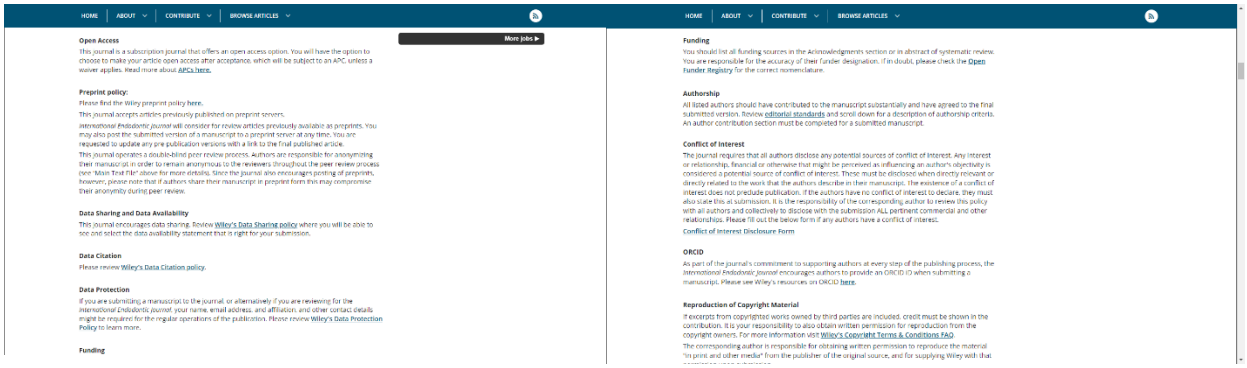
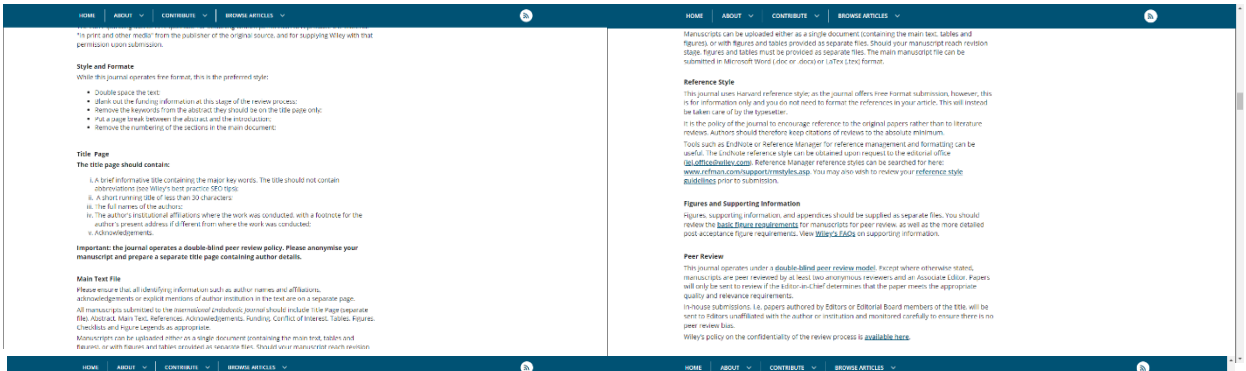
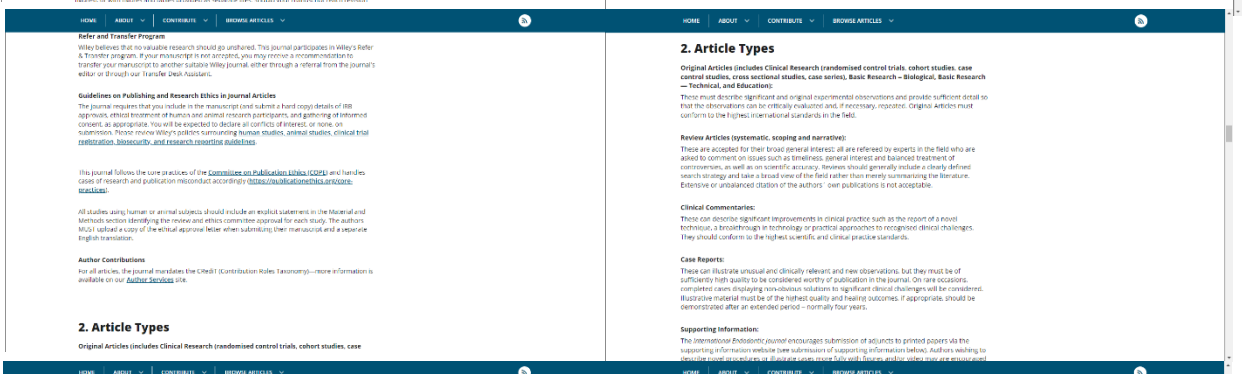
APÊNDICE A

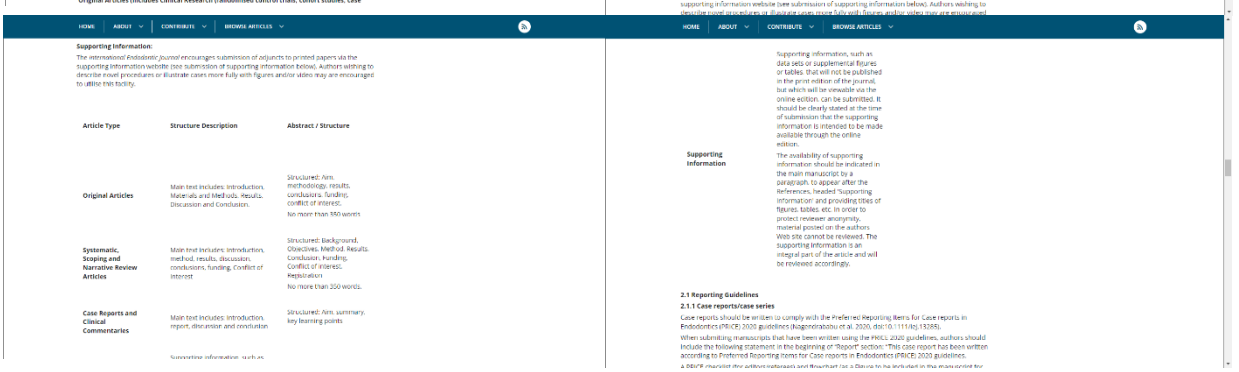
Author Guidelines - *International Endodontic Journal*

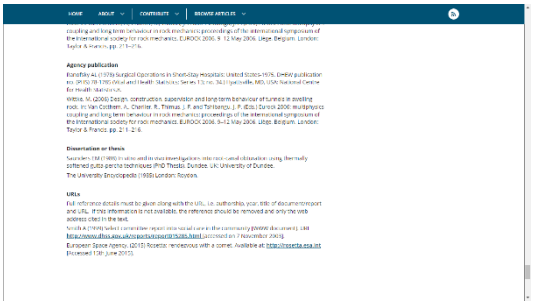








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Full reference details must be given along with the URL, i.e. author/title, year, title of document/report and URL. If this information is not available, the reference should be removed and only the web address cited in the text.
European Space Agency. (2015) Rosetta: rendezvous with a comet. Available at: http://rosetta.esa.int (Accessed 12th June 2015).