Research, Society and Development, v. 10, n. 2, e44910212726, 2021
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v10i2.12726

The impact of cone beam computed tomography in diagnosis and endodontic treatment planning decisions - case reports

O impacto da tomografia computadorizada de feixe cônico no diagnóstico e planejamento do tratamento endodôntico - relato de casos

El impacto de la tomografía computada con haz cono en las decisiones de diagnóstico y planificación del tratamiento endodóntico - informes de casos

Received: 02/05/2021 | Reviewed: 02/12/2021 | Accept: 02/15/2021 | Published: 02/22/2021

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Abstract
Conventional radiographic techniques have limitations, showing a two-dimensional image of a three-dimensional object, making it difficult to recognize the internal root anatomy in endo-dontic therapy. Cone-beam computed tomography (CBCT) is a diagnostic method that allows the visualization of all structures three-dimensionally, showing promising results compared to periapical radiographs. The objective of this study was to report two clinical cases where CBCT was fundamental to the diagnosis and a better treatment planning of the steps that were taken during the endodontic intervention. The CBCT were performed prior to the treat-ments, the volume of the exams were dynamically analyzed in specific software. The data were interpreted and together with the radiographic image and clinical examination data, the diagnosis and treatment planning were carried out. Given the report and discussion of the two clinical cases, it can be concluded that CBCT proved to be an impacting resource to support diagnosis and decision-making in the treatment of complex endodontic cases. CBCT ensured greater reliability in the diagnosis and treatment plan adopted, increasing the predictability of the endodontic therapy.
Keywords: Cone beam computed tomography; Diagnosis; Root canal treatment.

Resumo
As técnicas radiográficas convencionais apresentam limitações, apresentando uma imagem bi-dimensional de um objeto tridimensional, dificultando o reconhecimento da anatomia radicular interna na terapia endodôntica. A tomografia computadorizada de feixe cônico (TCFC) é um método diagnóstico que permite a visualização de todas as estruturas tridimensionalmente, apre-sentando resultados promissores em comparação às radiografias periapicais. O objetivo deste estudo foi relatar dois casos clínicos em que a TCFC foi fundamental para o diagnóstico e um melhor planejamento do tratamento das etapas realizadas durante a intervenção endodôntica. As TCFC foram realizadas prévia aos tratamentos, o volume do exame foi analisado detalhadamen-te de forma dinâmica em software específico, os dados foram interpretados e, juntamente com os dados da imagem radiográfica e exame clínico, o diagnóstico e planejamento dos tratamentos foram executados. Diante do relato e da discussão dos dois casos clínicos, pode-se concluir que a TCFC se mostrou um recurso impactante para apoiar o diagnóstico e a tomada de decisão no

tratamento de casos endodônticos complexos. A TCFC garantiu maior confiabilidade no diag-nóstico e plano de tratamento adotado, aumentando a previsibilidade da terapia endodôntica.
Palavras-chave: Tomografia computadorizada de feixe cônico; Diagnóstico; Tratamento endodôntico.

Resumen
Las técnicas radiográficas convencionales tienen limitaciones, ya que muestran una imagen bidimensional de un objeto tridimensional, lo que dificulta el reconocimiento de la anatomía radicular interna en la terapia endodóntica. La tomografía computarizada de haz cónico (CBCT) es un método de diagnóstico que permite la visualización de todas las estructuras en tres dimensiones, mostrando resultados prometedores en comparación con las radiografías periapicales. El objetivo de este estudio fue reportar dos casos clínicos donde la CBCT fue fundamental para el diagnóstico y una mejor planificación del tratamiento de los pasos que se tomaron durante la intervención endodóntica. Los CBCT se realizaron antes de los tratamien-tos, se analizó dinámicamente en detalle el volumen del examen en un software específico, se interpretaron los datos y, junto con la imagen radiográfica y los datos del examen clínico, se realizó el diagnóstico y la planificación del tratamiento. Dado el informe y la discusión de los dos casos clínicos, se puede concluir que CBCT demostró ser un recurso impactante para apo-yar el diagnóstico y la toma de decisiones en el tratamiento de casos complejos de endodon-cia. CBCT aseguró una mayor confiabilidad en el diagnóstico y plan de tratamiento adoptado, aumentando la predictibilidad de la terapia endodóntica.
Palabras clave: Tomografía computarizada de haz cónico; Diagnóstico; Tratamiento de conductos.

1. Introduction

The main goals of an endodontic treatment are to provide comfort, function, longevity and aesthetics to the tooth. The success is achieved by a significant reduction of the microor-ganisms inside the root canal as well as the prevention of its contamination or recontamination (Nair, 2004).

Taking an initial x-ray is indicated to study the root anatomy of the tooth before the intervention. It will help to define the treatment plan. However, the conventional radiographic techniques independently of being film-based or digital have limitations because they show a two-dimensional image of a three-dimensional object and this may confuse the operator in the essential steps of the endodontic therapy (Estrela et al., 2008; Patel et al., 2007).

The cone beam computed tomography (CBCT) is an imaging method that can produce three-dimensional images of individual teeth and the surrounding tissues. The sagittal, coronal and axial CBCT orthogonal planes allow visualizing the teeth without superimposition of ana-tomical structures. For instance, the entire roots of maxillary posterior teeth and their periap-ical tissues may be visualized separately in all image planes without superimposition of the overlying zygomatic buttress, alveolar bone and adjacent roots (Patel et al., 2007).

The use of CBCT has shown excellent benefits for endodontic treatments. Some of the already well-known examples of its use are the precise identification of periapical lesions (Es-trela et al., 2008), the diagnosis of root fractures (Byakova et al., 2019) as well as the localiza-tion of extra canals in teeth with complex anatomy such as molars (Alexandre et al., 2019).

The prescription of a CBCT should always comply with the ALARA principle (the professional should always use the lowest radiation as possible), ie, the CBCT should be indi-cated in cases where the periapical radiography does not provide an adequate diagnostic in-formation (Patel et al., 2019).

In face of the well-reported benefits of the use of CBCT and according to the indica-tions foreseen in the latest update of the European Society of Endodontics (Patel et al., 2019), this paper aims to report two clinical cases where CBCT was fundamental to the diagnosis and a better treatment planning of the steps that were taken during the endodontic intervention.

2. Methodology

This work is an observational study with a single-arm. There was respect for all ethical procedures corresponding to the type of case report, receiving consent and authorization from the patient for the treatment as well as the pre, trans and post-operative images as well as their scientific exposure.

3. Case Reports

Case Report 1

A 56-year-old, female presenting good general health was referred to a private dental clinic with complaints of a throbbing pain, sensitive to chewing and biting and positive apical palpation test in the buccal region of the tooth 36. The buccal region was redished compared to the adjoining teeth. The radiographic examination was not conclusive regarding to the pres-ence of a periapical lesion in the mesial and distal roots. The obturation apical limit and its quality were considered satisfactory. In the same session, performed by the same professional, it was possible to identify through the patient's medical record that she had underwent to an endodontic treatment (acute irreversible pulpitis) in her tooth 36 three years before. The diag-nostic hypothesis was an acute dentolveolar abscess with sub periosteal location. The proposed urgent treatment was the surgical drainage which consisted of an incision in the most sensitive area on palpation in the vestibular region.

Two days after the procedure the patient was reevaluated presenting no pain. Due to the lack of information data on the radiographic image the CBCT was requested in order to conclude the cause of the failure and give support to a further future treatment planning. The CBCT was dynamically examined using Horos software (Horos Project, GNU Lesser General Public License, Version 3.0). After an accurate analysis it was found out that the root canal distal presented a bifurcation 3mm point before the apex which resulted in a missed canal. A periapical lesion was present and clearly visible on CBCT. Based on the information shown in CBCT two treatment options were proposed to the patient, a non-surgical retreatment or a surgical treatment. The patient’s option was the second one.

An apicectomy of 3mm from the distal root was performed with a BladeSonic ultra-sonic tip (Helse Ultrasonic, Santa Rosa de Viterbo, SP, Brazil), a root-end preparation was applied with a P1 ultrasonic tip (Helse Ultrasonic, Santa Rosa de Viterbo, SP, Brazil) and the bioceramic MTA Flow (Ultradent, South Jordan, UT, USA) putty consistency was used in retrograde filling. The patient was reevaluated 14 days ahead reporting a total absence of signs and symptoms and was also informed about undergoing a new CBCT scan in one year to fol-low-up the case. Figures 1 and 2 depict a radiographic and CBCT images.

Figure 1: In the first horizontal line, observe the preoperative and post-endodontic radiographs in 2016. In 2019, it was not possible to identify signs of failure with periapical radiograph. In the second and third horizontal lines, there is a periapical lesion in the distal root (arrows) and bifurcation of the buccal canal (arrows), clarified in the coronal, axial and sagittal CBCT slices.

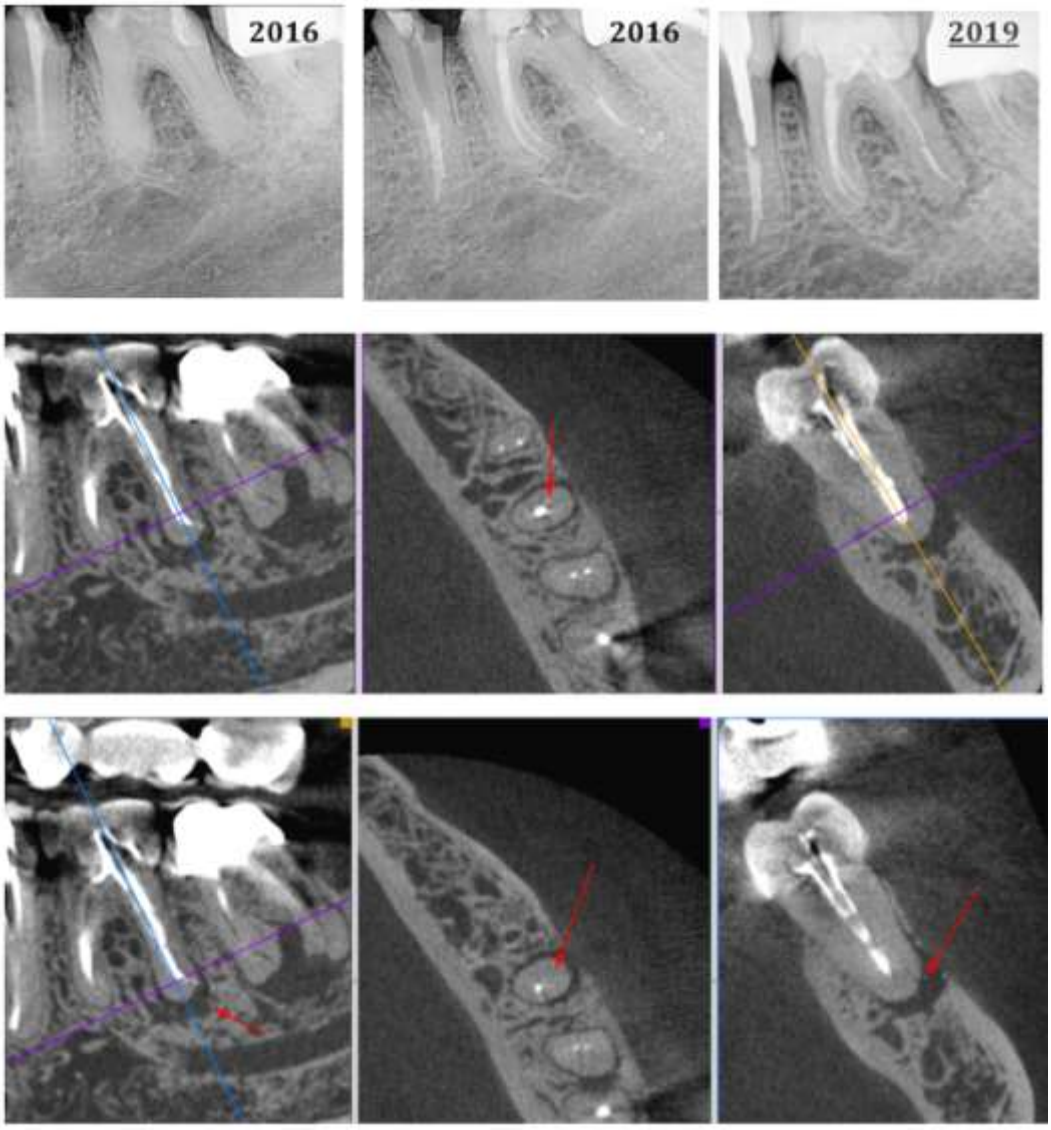

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Figure 2: Photos of the sectioned apical fragment from distal root. A – root canal accessed in the first treatment with filling material. B – root canal not accessed. In the right image we can observe files marking in "C" the missed canal and "D" the canal treated in the first treatment. Periapical radiograph after surgery showing final millimeters that was filling with MTA Flow.

Authors (2021).

Case Report 2

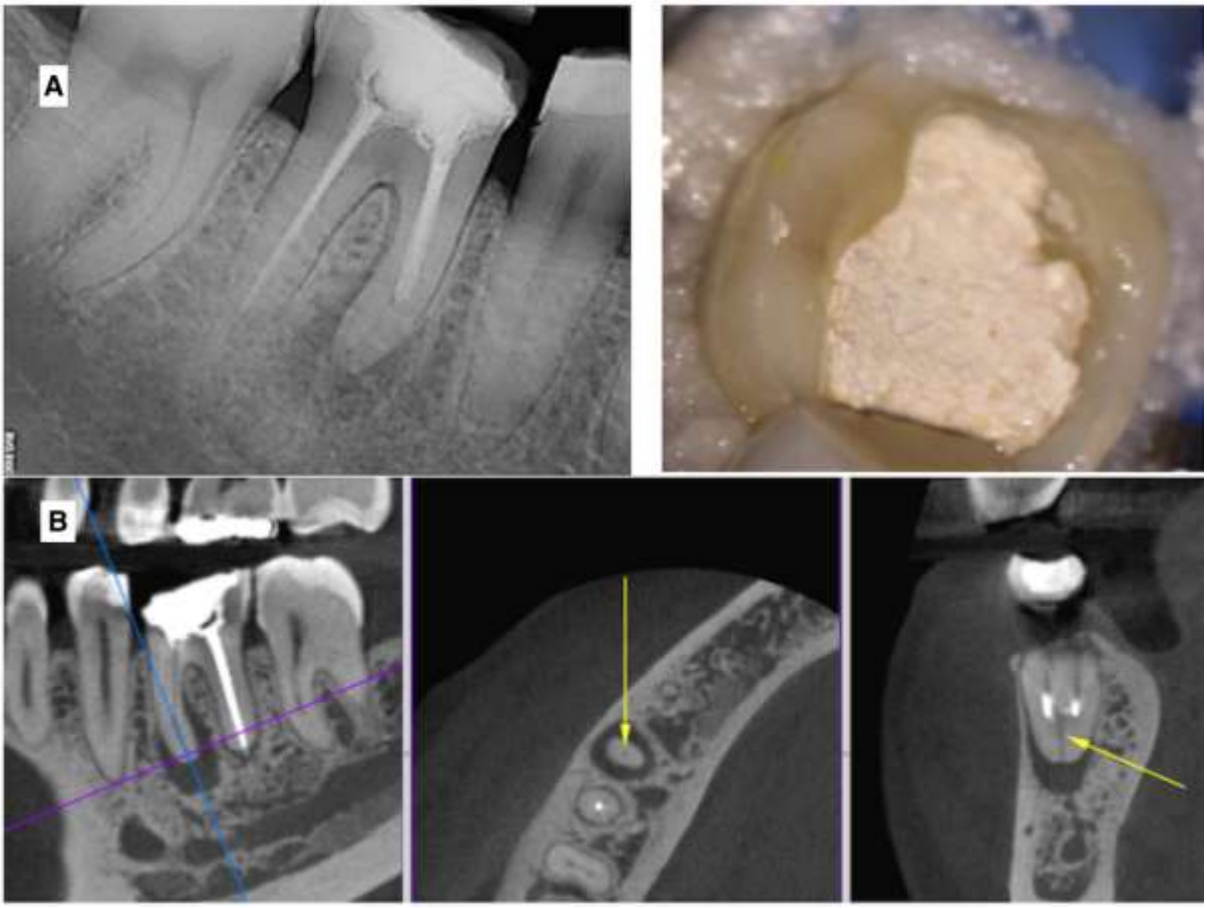
A 32-year-old female in good general health condition was referred to an endodontist for evaluation of the 46 tooth. The patient reported: “I underwent a root canal treatment 1 year ago”. According to the patient the tooth was asymptomatic and the goal of the visit would be an evaluation of the quality of the endodontic treatment for prosthetic crown placement reasons. A clinical and radiographic examination was performed. The tooth had significant crown destruction, no periodontal pocket and was negative for apical palpation test. The percussion was positive; however, the patient had no complaint about chewing func-tion. The radiographic image showed the incomplete filling in the mesial root canals and the presence of a periapical lesion could be seen. Because of the data the CBCT was requested for diagnosis and a treatment planning.

The entire data of the CBCT volume was accessed in all three planes in the same way and with the same software previously mentioned in case 1. After the image analysis process it was possible to conclude that the canal was blocked (ledge)

in the middle third. Beside that, the canal anatomy in the apical third showed only one root canal. The patient was informed about the diagnostic and that a non-surgical retreatment was indicated.

Cleaning procedures at the mesial root canals were performed with ultrasonic tips (the Finder - Helse Ultrasonic, Santa Rosa de Viterbo, SP, Brazil)" and it enabled us to localize a middle mesial root canal. However, it was not possible to access beyond the legde. Similarly, the mesiolingual root canal also had stopped at ledge. The mesiobuccal root canal was the only canal in the mesial root that had reached the apical foramen. The mechanical preparation was performed with Logic files (Easy Equipamentos Odontológicos, Belo Horizonte, MG, Brazil). The last file used in the apical foramen limit was tip 40 and taper .01, some calcium hydroxide was put inside the three root canals (Ultracal XS, Ultradent, South Jordan, UT, USA) per 14 days period. In the next session the patient reported no symptoms and the root canal filling was performed using the single cone technique with a bioceramic sealer Bio C (Angelus, Lon-drina, PR, Brazil). The tooth was filled with composite resin and the patient was released for the prosthetic crown. The patient was also informed about the need for a clinical and radio-graphic control of the case. The entire treatment sequence can be seen in Figures 3 to 5.

Figure 3: A – Clinical aspects of Crown and the periapical radiograph shows an unsatisfactory apical limit on the mesial root. B - CBCT scan revealing the anatomy of the mesial root (only one root canal at apical third) and the presence of a periapical lesion.



Authors (2021).

Figure 4: Procedures for unblocking and locating the medial-mesial canal with ultrasonic tips. In the first and second horizontal lines, filling material withdraw and the middle mesial root canal was localized with ultrasonic tip, the Finder. Third line shows file reaching apical foramen only by mesio buccal root canal.

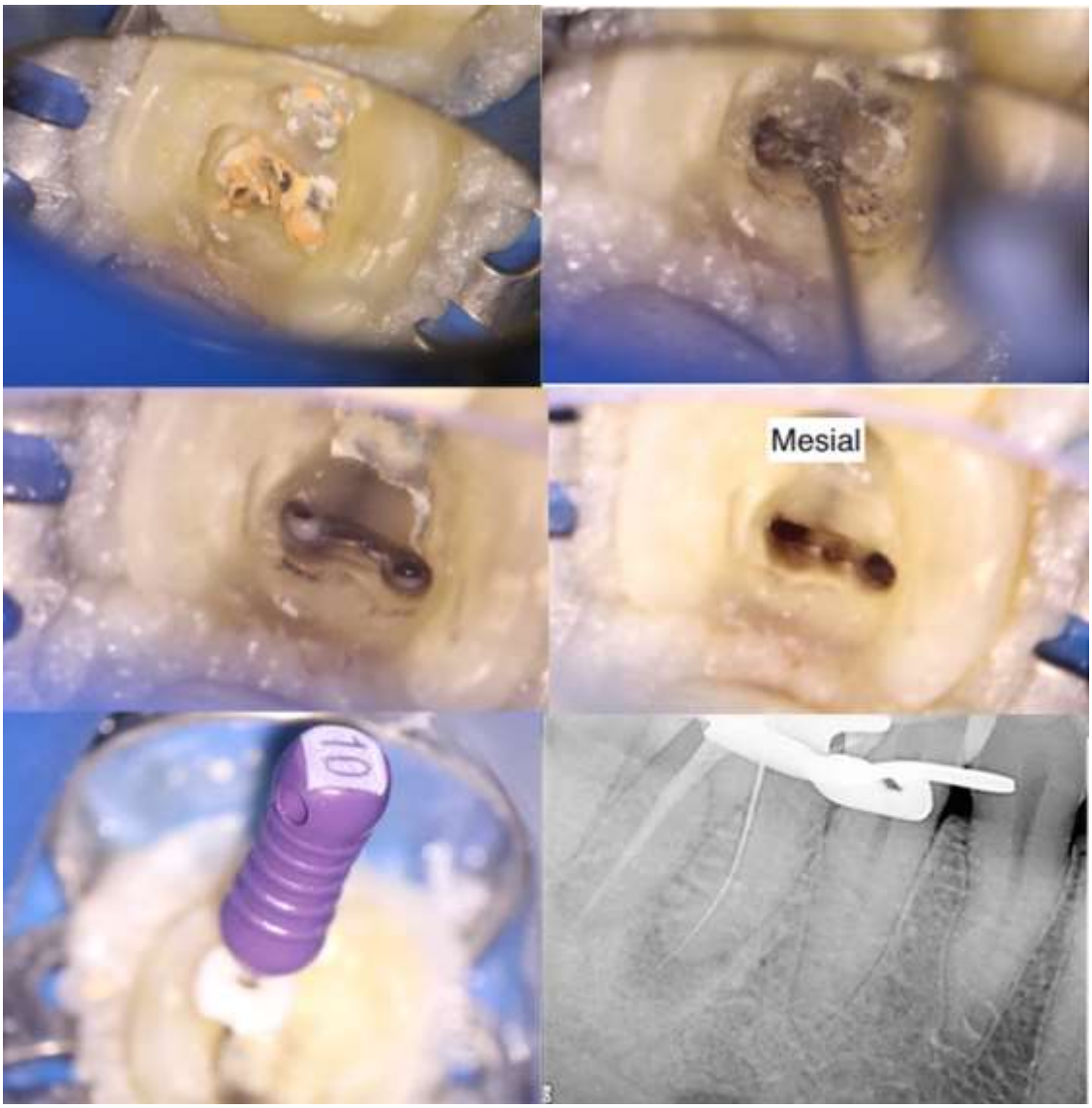


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Figure 5: Obturation procedures with bioceramic sealer and gutta-percha cones.

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4. Discussion

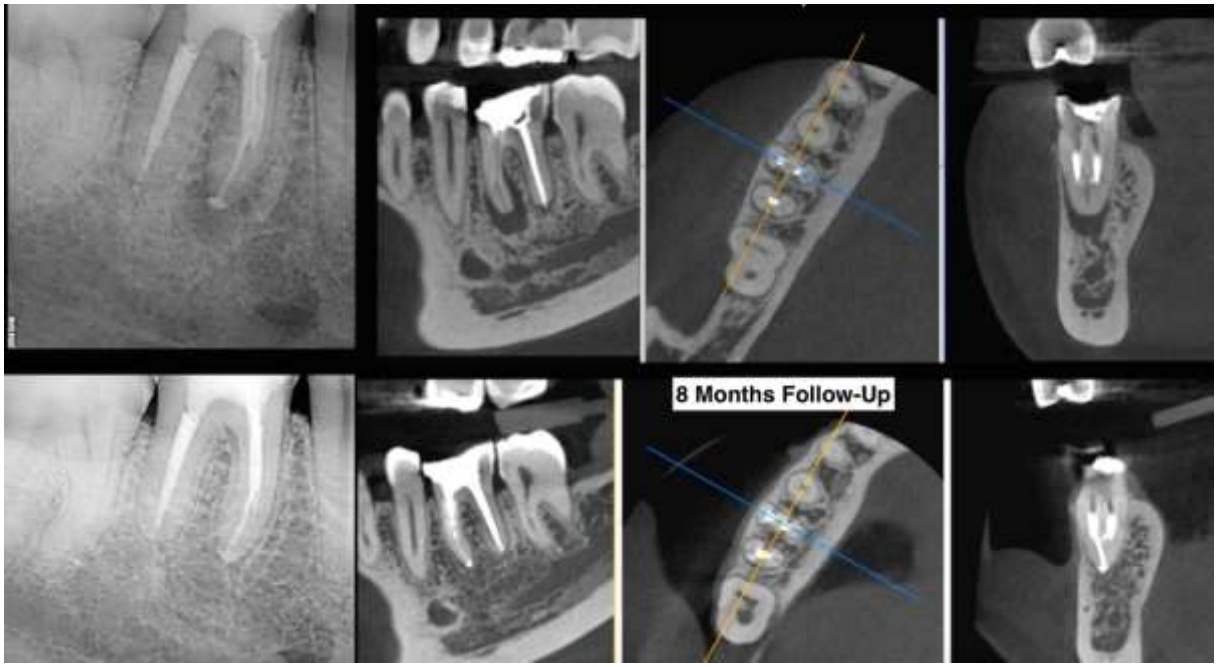
In both cases, after a detailed clinical and radiographic exam it was not possible to provide sufficient information for a confident diagnosis. Therefore, a small FOV CBCT exam-ination proved to be essential for the adequate diagnosis and helped in the making decision process in order to select the best treatment option to both reported cases.

The most common cause for lack of success and consequent reintervention in endo-dontics is the presence of a missed canal due to the failure in its location (Karabucak et al., 2018). The treatment fail in case 1 was related to a missed buccal canal in distal root. This missed canal was absolutely impossible to identify by conventional radiography because its anatomy consisted in a deep split at the apical third. The exact number of root canals in the tooth and the presence of periapical lesion were determined only by CBCT volume analysis. Furthermore, the decision by a surgical intervention became more predictable owing to the information from the reconstructed three-dimensional images such as the vestibular bone thickness, a presence of bone fenestration, the size of the periapical lesion, the inclination of the root, the root thickness, the mandibular canal distance etc (Patel et al., 2007; Nakata et al., 2006).

A non-surgical reintervention was discussed as well but it would be dependent on a localization of the second distal root canal. As the CBCT analysis showed the origin this missed canal at apical third, this task was considered hard and its predictability low. Thus, surgical indication seemed to be more appropriate due to better predictability for the case (Fahey et al., 2011).

The bacterial persistence in the root canals can influence on treatment outcome because it has a strong relationship with the persistence or emergence of apical periodontitis after root canal treatment (Sundqvist et al., 1998; Molander et al., 1998; Pinheiro et al., 2003). In case 2 the clinical history and the conventional radiography suggested the contamination of an un-treated mesial root in its apical third. According to the patient other professionals performed several attempts to reach the apical foramen and they were not successful. Therefore, a canal block at the middle third could be believed as the main cause of the periapical lesion. The anatomical data provided by the CBCT from mesial root canals as the 3 root canal ending in a single canal at apical third raised the possibility to explore the 3 mesial root canals and bypass the block. Therefore, the CBCT provided a higher number of details of the internal dental anatomy and it was crucial to the choice of a non-surgical retreatment. The apical patency was reached by the mesiobuccal canal and all disinfection strategies could be performed in order to reach de success of the treatment. Another CBCT was requested in the 8 months follow-up and we can observe the complete healing of a periapical lesion. (Figure 6).

Figure 6: Follow-up 08 months. Observe the healing of periapical lesion in 2D (X-ray) and 3D (CBCT).



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Currently the new high resolution CBCT scanners and specific softwares have im-proved the quality of tridimensional images (Bueno et al., 2018; Bueno et al., 2019; Estrela et al., 2018). Thus it has allowed a more precise analysis of the root canal anatomy and surround-ing tissues, which can be decisive to the dentist negotiated better the complex cases in endo-dontics (Bueno et al., 2018; Estrela et al., 2018). Finally, in the present reports, the indications of the CBCT were well oriented by guides and articles published in the American Association of Endodontists (AAE/AAOMR, 2015-2016) and the European Society of Endodontics (Patel et al., 2019).

It is worth noting that, like any clinical case, this one has its limitations regarding the number of study participants. More clinical work with an expressive and statistically significant amount should be performed.

5. Conclusion

Given the report and discussion of the two clinical cases, it can be concluded that CBCT proved to be an impacting

resource to support diagnosis and decision-making in the treatment of complex endodontic cases. CBCT ensured greater reliability in the diagnosis and treatment plan adopted, increasing the predictability of the endodontic therapy.

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