Cone beam computed tomography - a diagnosis resource in Endodontics: case report

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ABSTRACT

Introduction: Precise diagnosis is essential for successful endodontic treatment. It is typically achieved based on patient's first interview combined with physical examination and other complementary imaging examinations, including radiography. Endodontics is the dental specialty most often using diagnostic imaging techniques to obtain detailed information on teeth being assessed. Because of its two-dimensional nature, conventional radiographic images present limitations that hinder or make proper endodontic treatment planning impossible. **Objective:** The aim of this paper is to report a clinical case in which cone-beam computed tomography (CBCT) was key to endodontic diagnosis and treatment planning. **Methods:** Conventional periapical radiography revealed an image suggestive of external inflammatory root resorption of maxillary central incisor. Clinically, the tooth presented with chromatic alteration after having been subjected to trauma. CBCT examination was then requested for a more precise investigation. **Results:** The tomographic report of the investigated tooth highlighted no external inflammatory root resorption, but a distinct root anatomy characterized by intense root dilaceration. Endodontic treatment was deemed unnecessary, and veneering of the affected tooth, as well as periodic clinical and radiographic follow-up was recommended. **Conclusion:** The clinical case reported herein reveals the significance of CBCT imaging on treatment decisions in Endodontics.

Keywords: Three-dimensional imaging. Dentistry. Dental radiography.

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Introduction

Reaching proper diagnosis in Endodontics requires extensive research. It typically begins with a comprehensive first interview, taking into account patient's main complaint, combined with pulp sensitivity tests, and other complementary examinations. Once this stage has been reached, cross-information will provide insights to complete definitive diagnosis and determined a treatment planning.[1]

In the context of complementary examinations in Endodontics, periapical radiographic scans have been widely used in clinical practice. However, diagnosis can be limited due to the two-dimensional character of periapical images, that is, a three-dimensional object is converted into a flat image in the radiographic socket, thus leading to overlap of anatomical structures.[2] Digital radiographs are faster than the conventional one, with the advantage of reducing patient's exposure to radiation.[3] Nonetheless, similarly to conventional radiography, digital radiography is also limited with respect to the two-dimensional features of image.[4]

In the 1970s, helical computed tomography (HCT) was developed by Hounsfield and Cormack, revolutionizing medical diagnosis through the use of three-dimensional images. However, due to high levels of radiation involved, its applicability in Dentistry, especially in Endodontics, was rendered unfeasible.[5] Years later, this dilemma was solved by the development of cone-beam computed tomography (CTBT). The final three-dimensional image produced by CBCT can be visualized in the axial, sagittal and coronal planes. As a result, it began to be the imaging examination of choice in Dentistry.[6] CBCT radiation dose depends on a number of factors, such as the nature of the X-ray beam (whether it is continuous or pulsating), the degree of rotation of both X-ray source and detector, and the size of the field of view.[7] It is worth highlighting that the ALARA principle should be respected, as it advocates that radiation should be as low as reasonably achievable.[3]

Many researchers believed that Endodontics would greatly evolve with the possibility of having a clearer three-dimensional representation of the anatomy of dental structures.[7] Thus, despite their limitations, conventional and digital radiographic examinations remain being routinely used in clinical practice, due to being more accessible and providing lower radiation doses to the patient. Only when diagnosis is more challenging and difficult to achieve, CBCT should be considered as a diagnostic and prognostic tool for case planning and treatment.

In Endodontics, CBCT is recommended in specific situations that require a more precise and detailed investigation of dental structures, namely: presence of internal and external root resorptions; assessment of morphological and anatomical aspects of the root canal and its variations; cases of root fractures; as well as pre-surgical endodontic planning, assisting in the assessment of root preparation, filling, retreatment, and detection of bone lesions.[8]

The aim of this paper was to report a clinical case in which CBCT was key to endodontic diagnosis and treatment planning.

Clinical case

A 26-year-old male patient was referred for endodontic treatment of left maxillary central incisor. During his first interview, the patient reported having been subjected to trauma caused by a fall as a child, leading to luxation of the tooth. A few years later, he observed dental crown darkening, the reason why he sought dental care. At the time, the patient was seen by a general practitioner who started endodontic treatment. However, as the clinician was unable to access the pulp chamber and locate the canal, he referred the patient to specialized endodontic care.

During his first interview performed by the endodontist, intraoral clinical examination revealed no fistula, swelling, or mobility. Vertical and horizontal percussion, as well as palpation tests were negative. Response to pulp sensitivity test with refrigerant gas was also negative, leading to the likelihood of pulp necrosis diagnosis.

Conventional radiographic examination revealed pulp obliteration associated with an image suggestive of external inflammatory root resorption. However, due to lack of signs and symptoms, a CBCT scan was requested in order to better assess the periapical resorption process. Tomographic report, carried out by means of transaxial slices, coronal, axial, and sagittal planes, and panoramic reconstruction of tooth #21, revealed distinct root

anatomy, characterized by root dilaceration, with obliteration of the pulp chamber, and narrow root canal in the middle and apical thirds (Fig 1). Axial images allowed topographical location of the root apex of tooth #21 to be found palatally and near the nasopalatine canal (Fig 2). Tomographic examination revealed there were no areas of periapical resorption, as suggested by conventional radiographic examination.

Although the tooth presented a history of trauma and dental crown darkening, which led to the initial diagnosis of periapical inflammatory root resorption, after CBCT, both prognosis and treatment planning were altered. As a result, endodontic treatment was deemed unnecessary. In order to address patient's main complaint (crown darkening), veneering of the affected tooth was recommended. Moreover, the patient was instructed to keep periodic clinical and radiographic follow-ups.

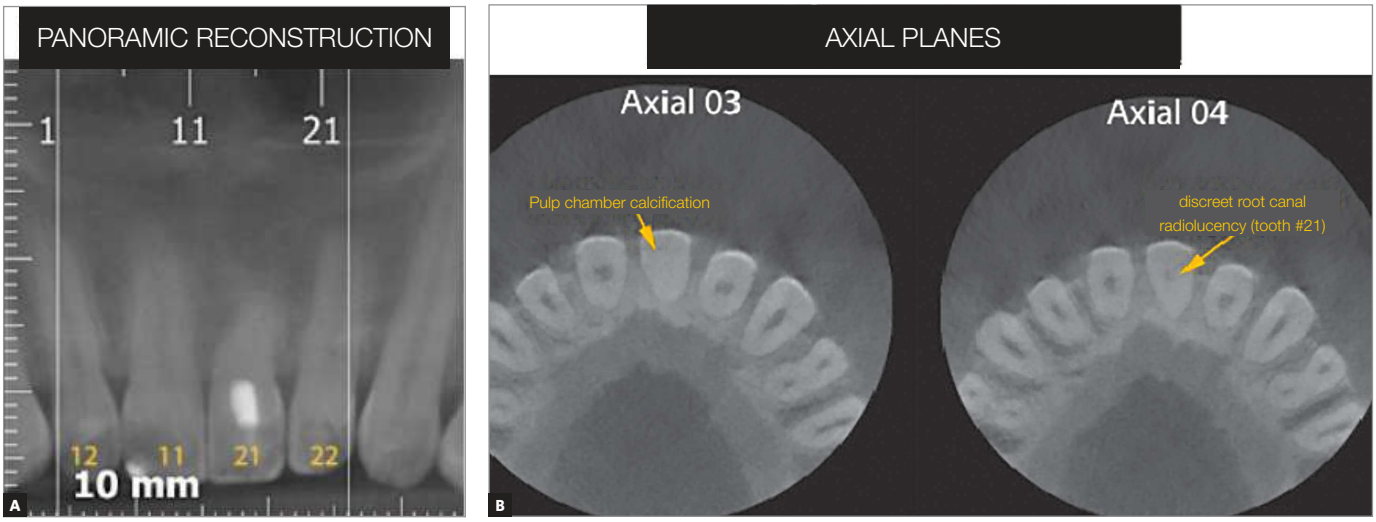

Figure 1. Panoramic radiograph suggestive of external inflammatory root resorption. Axial slices revealing obliteration of the pulp chamber, in addition to root canal calcification.

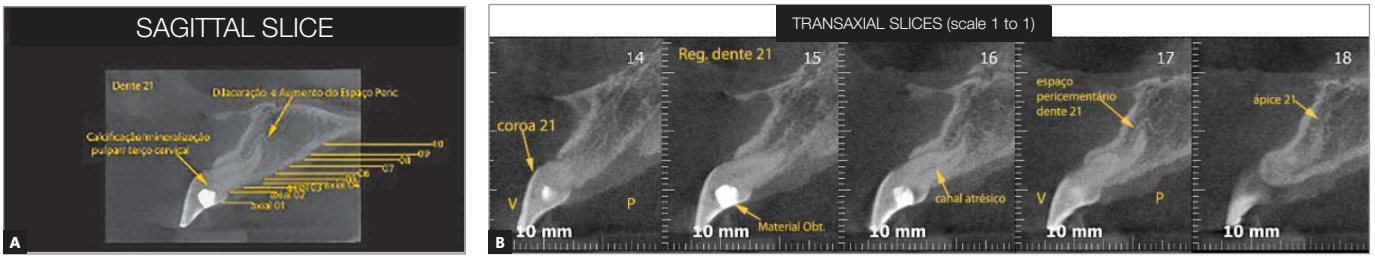

Figure 2. Sagittal slices revealing root dilaceration, with apex palatally placed, in addition to absence of periapical root resorption.

Discussion

Once dental root structures cannot be seen with the naked eye, endodontic treatment planning is broad and often challenging. The clinician depends on imaging examinations, which must be as faithful as possible. Obtaining such images is a key step to achieve successful endodontic treatment.[7]

This study sought to demonstrate the importance of CBCT as a diagnostic tool in Endodontics, due to its capacity to provide clearer details in three-dimensional images, thus contributing to the decision-making process of the best clinical treatment modality.

Since its advent, computed tomography has continuously evolved to the present day. Initially considered unfeasible in Dentistry, due to high radiation doses, it is currently routinely used by many dental professionals as a valuable diagnostic tool.[8]

Way back in 1972, Cormack and Hounsfield discovered that the quantification of X-rays transmitted through an organism, together with the computed mathematical interpretation of such data, made it possible to obtain more satisfactory images for use in Medicine. These initial efforts led to the development of the first computed tomography device, the EMI 800, launched in 1972 in England, which granted its inventors the Nobel Prize in Medicine in 1979.[8] Such breakthrough revolutionized imaging diagnosis in Medicine. However, because of the high cost of the device, interferences caused by metallic material, and high doses of radiation, when compared to conventional radiography, its use in Dentistry was not considered, especially in Endodontics.[9]

As research progressed, CBCT was developed in the last decade. CBCT is a three-dimensional radiographic technique by means of which image is obtained by emission of X-ray beams, so as to form a cone centered around one single rotation, thus exposing the patient to lower radiation doses.[10]

It overcomes the disadvantages of conventional periapical radiography, such as geometric distortion and overlapping of structures.[11] Additionally, the associated software allows two-dimensional images to be obtained, such as panoramic and lateral and frontal cephalograms, a function also known as multiplanar volume reconstruction.[12]

Moreover, due to the digital nature of CBCT, improvements in image quality have been introduced by means of computer graphics. Unlike conventional radiography, the magnification factor of CBCT is near zero, that is, the tomographic image reproduces the size of an object as closest as possible to the real scanned object.

CBCT is an imaging technique that uses a cone-shaped X-ray beam combined with a two-dimensional image receiver. The X-ray source and imager array rotates 360° only once around the region of interest,11 as opposed to conventional CT, which requires many turns for the same sliceing thickness and frame size, ths exposing the patient to much higher radiation doses.[12,13] After X-ray beams are emitted, the final three-dimensional image is generated, which can be visualized in the axial, sagittal and coronal planes with greater clarity. After the entire image manipulation process is completed, images can be analyzed and interpreted.[14] CBCT is performed with the patient sitting, with two acquisitions, one frontal and one lateral. Due to the need to diversify assessment views, the computer is still able to reconstruct original axial slices, obtaining images in other spatial planes, such as coronal and sagittal planes.[14-17]

A previous clinical study assessed the accuracy of CBCT imaging in treatment planning, with latter having before and after CT examination comparisons.18 From an initial sample of 1459 patients, 57 patients (4% of the total population) were initially selected. Out of those, three patients did not report treatment planning determined prior to CBCT, while another patient was assessed with the aid of a different CBTB machine. As a result, four patients were excluded from the analysis. Final analysis included a total of 53 patients, mean age of 56.8 years (12-86 years), and 81 teeth. Only one CBCT scan was acquired for each patient. Anatomical distribution of the examined dental regions followed the arrangement: posterosuperior region in 29 patients; anterosuperior region in 12 patients; posteroinferior region in 10 patients; and anteroinferior region in two patients. Four patients had teeth examined in adjacent regions; however, they were limited to the same quadrant. The most common reason for CBCT referral was to differentiate pathological areas from normal anatomy. Other reasons for referral were:

suspicion of dental fractures, suspicion of root resorption, pre-surgical guides, and identification of foreign bodies. After CBCT examination, treatment planning changed in 29 patients (55%).18 The authors concluded that CBCT had a significant impact on effectiveness of endodontic treatment decision, thus assisting in treatment accuracy of 26 patients (50%). Even in those cases in which treatment was performed as originally planned, tomographic examination increased reliability of procedures. These results suggest that CBCT is increasingly becoming a relevant tool in the diagnosis and treatment planning of several endodontic conditions.

Conclusion

Due to the excellent accuracy and clarity, CBCT is of paramount importance and should be considered in more challenging cases whenever conventional radiography is unable of adding relevant diagnostic information, as in the case presented herein.

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