Planning and diagnosis predictability by means of cone beam CT before endodontic treatment: clinical resolution

José Edgar Valdivia **CARDENAS**[1]
Hair Salas **BELTRAN**[2]
Manoel Eduardo de Lima **MACHADO**[3]

ABSTRACT

Introduction: Diagnosis and planning of new interventions are crucial when implementing a treatment. One method routinely used to assist diagnosis is the periapical radiograph, however, with this technique, anatomical structures are compressed into two-dimensional images. **Objective:** The aim of this study was to show the importance of CBCT in endodontic diagnosis before endodontic retreatment of buccal perforation of which clinical resolution was planned, guided and executed after image visualization with cone beam computed tomography (CBCT). After diagnosis, immediate clinical therapy comprising retreatment via canal, sealing the perforation with MTA, root rehabilitation with fiberglass post and crown shielding with composite resin was carried out in a single session.

Keywords: Cone beam computed tomography. Imaging diagnostic. Combined therapy.

How to cite this article: Cardenas JEV, Beltran HS, Machado MEL. Planning and diagnosis predictability by means of cone beam CT before endodontic treatment: clinical resolution. Dental Press Endod. 2013 Sept-Dec;3(3):62-8.

[1] Professor of Endodontics, São Paulo Military Hospital (HMASP).

[2] Professor of Endodontics, Catholic University of Santa Maria, Peru.

[3] Full professor of Endodontics, School of Dentistry — Univeristy of São Paulo. Professor of the specialization course in Endodontics, Brazilian Academy of Military Medicine and HGeSP.

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

» The patients displayed in this article previously approved the use of their facial and intraoral photographs.

Submitted: August 25, 2013. Revised and accepted: August 27, 2013.

Contact address: José Edgar Valdivia Cardenas
Rua Caio Prado, 340 – Apt 12A – Consolação – São Paulo/SP — Brazil
CEP: 01.303-000 – j.edgar_30@hotmail.com

Introduction

A second intervention is recommended in cases of unsuccessful endodontic treatment, especially those in which accidents and complications occur and, as a result, hinder endodontic therapy to the fullest extent of the root canal. Nevertheless, it is important to highlight that in case of failure, retreatment is the first procedure employed.[1,2] In planning an endodontic reintervention, the affected area and surrounding anatomical structures must be carefully assessed. Assessment of imaginologic examination should not lead to imaging diagnosis limited to observe three-dimensional anatomical structures compressed into two-dimensional images, resulting in overlapping structures of diagnostic interest.[3,4,5] Although panoramic and periapical radiographs reproduce details that are acceptable in meiodistal direction, buccal- lingual observation is considered inadequate.[1,6] One should opt for imaging techniques that provide more information in the region, for instance, computerized tomography.

Computed tomography is a subsidiary diagnostic method. It allows a real three-dimensional overview of pathological lesions which are not radiographically visible, as well as observation of adjacent teeth and surrounding involved anatomical structures, which allows planning and procedures to be carried out with great precision.[7,8]

A clinical approach guided by images obtained by CBCT provides appropriate diagnosis that can act against a particular circumstance, which in this case, is root perforation.

Endodontic perforations are iatrogenic and can be related to lack of anatomical and radiographic knowledge of the possible anatomical variations of a tooth, including dentin thickness and root curvature, as well as the specificities of each case. A perforation prognosis mainly depends on time factor, location, removal of the offending agent, and the material used for sealing, which should be biocompatible and dimensionally stable.[6,9]

Mineral trioxide aggregate (MTA) has been considered an ideal repair material due to its excellent remedial and osteoinductive properties.[10,11] For this reason, it is the first choice among the different materials used for direct sealing.[12]

Thus, well performed root rehabilitation and coronal sealing are of paramount importance for the success of endodontic therapy.[13] Fiber glass posts and composite resin restorations are easy to perform and yield good cosmetic and functional results. For this reason, they are recommended for endodontic reconstruction.[14,15,16] The restorative technique, when appropriately performed with composite resin and fiber glass post, is a useful tool for biomechanical restoration of teeth impaired in color and strength.

The objective of this study is to report a case of endodontic reintervention via root canal, in which the diagnostic hypothesis and proper treatment plan were confirmed by cone beam computed tomography images, which enabled integrated multidisciplinary rehabilitation treatment to be carried out in a single session.

Case report

A 35-year-old male patient attended the Endodontic Clinic of the Army General Hospital of São Paulo (HGESP), complaining about severe pain in the buccal region of tooth #22. The patient reported a history of endodontic retreatment of tooth #22, with the last intervention being performed four months before. At clinical examination, the patient reported pain on palpation and vertical percussion of tooth #21 and 22. The examination also revealed the presence of edema in the buccal region and tooth mobility level I in #22, absence of periodontal pockets at probing and negative response to pulp vitality tests of teeth #21 and 22. The diagnostic radiograph showed a circumscribed radiolucent apical image that suggested a periapical lesion. In spite of that, a radiopaque image, compatible with root filling material, was observed in the middle and apical thirds of the canal (Fig 1). The patient was not subject to unnecessary diagnostic procedures.

A CT scan was requested for detailed assessment of the case. The result of the high resolution digital CT, yielded by means of the 3D-image visualization software (i - Dixel 2.0 - One Volume Viewer, Accuitomo 80 - J. Morita Mfg. Corp., Kyoto, Japan) was clear. The 3D MIP plan of volumetric reconstruction did not reveal vestibular cortical bone loss (Fig 2). Assessment of the frontal plane revealed inappropriate root filling.

In the sagittal and axial planes, the exact location of the root perforation with slight overflow of

radiopaque material on the buccal surface could be observed (Figs 3, 4).

After analysis of the tomographic images, diagnosis and endodontic reintervention plan were carried out. Treatment plan comprised immediate clinical intervention that included retreatment via canal, perforation sealing with MTA, root rehabilitation with fiber glass post and crown shielding, all of which were performed in a single session.

After anesthesia and isolation of the operating field, the endodontic access surgery began via root canal, with odontometry obtained by means of coronary and sagittal tomographic images. The filling material was removed with engine-driven rotary NiTi files (Protaper retreatment D-1, D-2 and D-3) (Maillefer / Dentsply, Ballaigues, Switzerland). Afterwards, gutta-percha was removed for apical finishing of the chemical-surgical preparation, for which Protaper Universal F3, F4 and F5 files were used (Dentsply Maillefer, Ballaigues, Switzerland). Throughout the canal preparation procedures, ultrasonic irrigation with saline solution was carried out. After canal preparation, ultrasonic irrigation was performed by alternating saline solution and EDTA (Odahcam Herpo Prod. Dent. Ltda. - Brazil) during 30 seconds, within the root canal. Subsequently, new irrigation/aspiration procedures were performed with saline solution. At last, the root canal was dried with absorbent paper points (Dentsply Ind. Com. Ltda., Petrópolis/RJ — Brazil) compatible with the diameter of the last instrument used in the real working length.

Filling was performed with gutta-percha and AH PLUS sealer (Dentsply/Maillefer) by means of the continuous wave condensation technique. Obturation was performed from the apical third to the level of root perforation so as to allow sealing with MTA

Figure 1. Initial radiograph.

Figure 2. Tomographic 3D reconstruction.

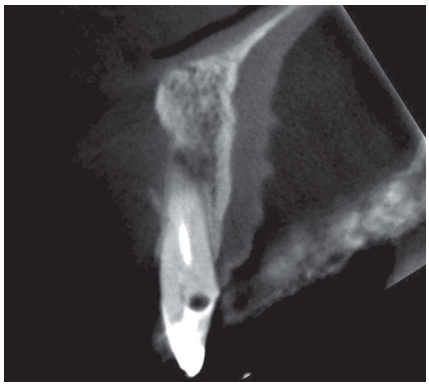

Figure 3. Sagittal tomographic view.

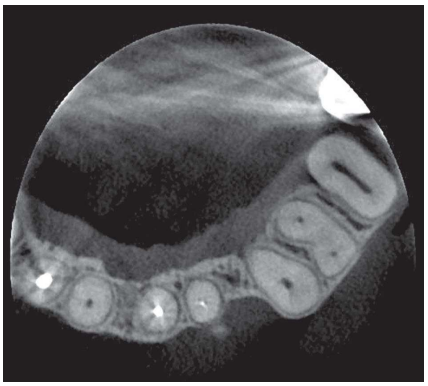

Figure 4. Axial tomographic view.

(Angelus, Londrina/PR Brazil) (Fig 5) and intracanal anchorage with fiber glass post. In this case, an esthetic fiber glass post (Reforpost/Angelus) was selected. The middle and cervical thirds were conditioned with 37% phosphoric acid gel, and one-bottle adhesive system (Single Bond®) was applied. The post was cemented with resin cement (Rely X® - 3M). Afterwards, the fiber glass post was coated, and coronary filling was carried out with light-cured resin Z100 (3M Brazil). At treatment completion, radiographic images were retaken, revealing correct crown shielding (Fig 6).

The patient was informed of the need for periodic follow-up appointments. After 6 months of endodontic treatment (Fig 7), the patient reported having neither pain nor symptoms, and the periodontal examination revealed that the periodontal tissue surrounding the tooth had no inflammatory signs.

After 12 months of follow-up, a CT scan was requested in order to assess, in the sagittal and axial planes, the sealing of the perforation in the buccal-palatal direction (Fig 8).

In the last follow-up appointment, 22 months after treatment, the periodontal ligament and lamina dura surrounding the tooth were intact, whereas periapical radiolucency was absent (Fig 9).

Discussion

Imageology is considered an important tool for endodontic diagnosis. Information obtained by clinical and image examinations directly influence clinical decisions,[1,4,5] given that accurate data allow appropriate decisions and a more favorable prognosis. Within this context, CBCT allows clinicians to have more relevant information which could not be obtained by conventional radiographs. Conventional radiography

Figure 5. Obturation of the apical third and perforation sealing with MTA.

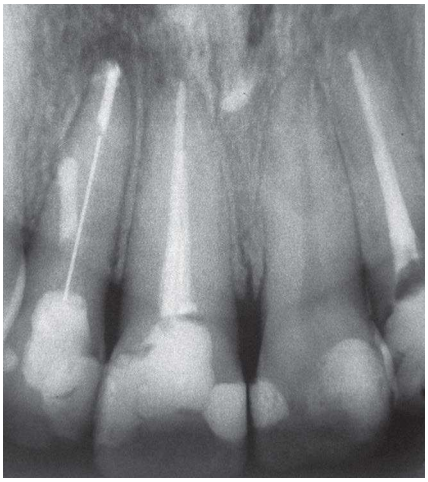

Figure 6. Final radiograph. Root and crown shielding with fiber glass post and composite resin.

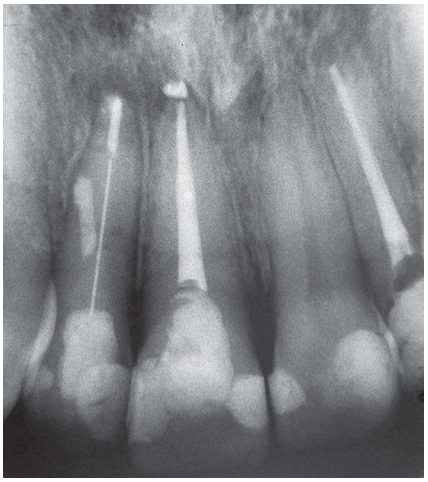

Figure 7. Follow-up radiograph after 6 months.

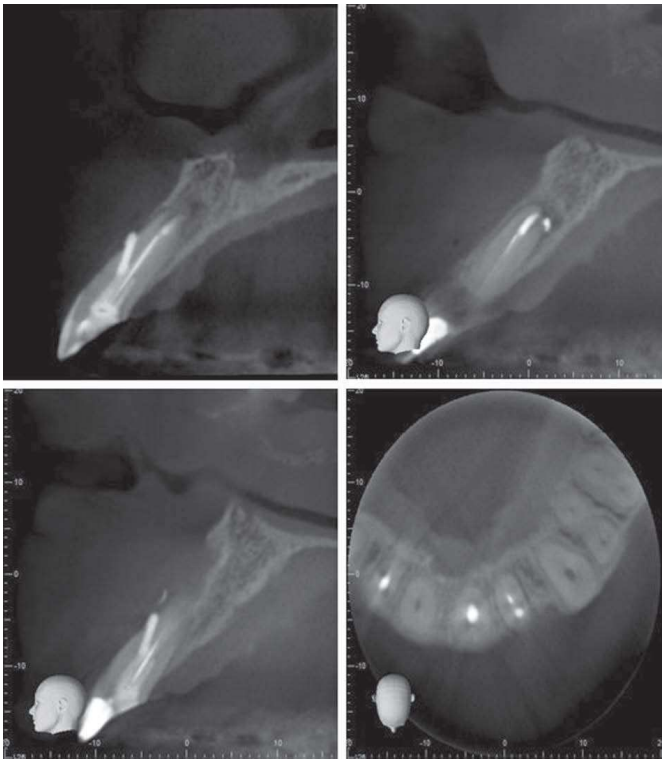

Figure 8. Annual follow-up tomograph taken to assess, in the sagittal and axial planes, the perforation sealing in the buccal-palatine direction.

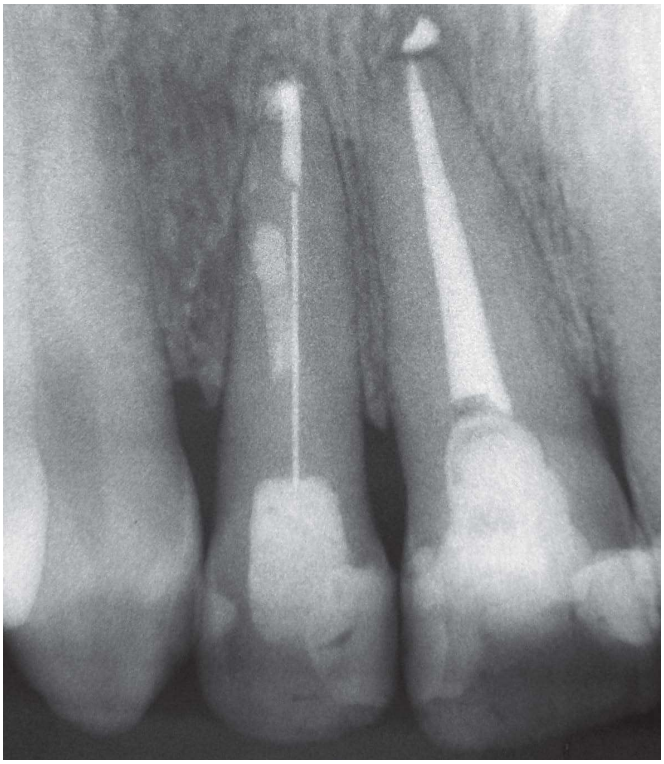

Figure 9. 24-month follow-up tomograph. Note intact periodontal ligament, absence of periapical radiolucency and intact lamina dura surrounding the tooth.

is the most used method due to being practical and providing images that can assist the professional in solving a large number of cases. However, the limitations of this method on the difficulty in viewing these images in certain regions and in two dimensions can hinder treatment planning of specific cases. Computed tomography has been used to overcome these limitations, since it enables the visualization of anatomical regions and identifies the presence of diseases that are not often diagnosed by conventional radiography.[5,7,8] Patel et al[2] stated that the major advantage of CBCT is its three-dimensional geometric accuracy, which eliminates overlap in the area of interest. Images obtained with CBCT are more detailed, which enables one to detect potential bone imperfections more easily in comparison to conventional radiographs. Scarfe et al[17] were able to prove not only the accuracy of 3D images, but also that these images closely resemble real measurements.

With regard to the images obtained in the case reported herein, the periapical and panoramic radiographic images allowed an overall visualization of the quality of obturation, limits of the lesion and adjacent structures; not showing, however, the actual details, the type of pathology and its relation with anatomic structures. The initial clinical planning, based on the radiographs, included retreatment via canal, exposing the patient to an uncertain and subjective reintervention and an invasive diagnostic scanning, which could have led him to a situation of stress and discomfort due to a symptomatic clinical presentation and the limited information provided by the periapical radiographs.

The analysis of images obtained with cone beam computed tomography in a cross section plane allowed the professional to plan the endodontic reintervention via root canal. The diagnosis and proper treatment plan were confirmed by the images and enabled integrated multidisciplinary rehabilitation treatment to be carried out in a single session. The iatrogenic perforation could not be identified by conventional radiography, which proved it to be a difficult

and inaccurate diagnostic method, especially when the defect is located in the buccal or lingual surface of the root.[1,6,18] The prognosis of a perforation directly depends on the location of this perforation, the contamination exposure time, the feasibility of sealing and accessibility of the main canal. The site of perforation, middle third of the root canal and the small diameter of the perforation may have contributed to the good performance of the repair material.[6,9] Tsesis et al[6] found worse prognosis of root perforations in humans when the former were located in the cervical third of the root where contamination can occur.

In this clinical case, the sealing material of choice was the MTA. It is considered a suitable material for having a good sealing effect, being biocompatible and cementogenic, as well as for being attached in the presence of moisture.[10,11,12] Many authors agree that MTA is a material with excellent physical-chemical properties and good acceptance by the periodontal tissues, i.e., biocompatibility[10,11], which was confirmed by studies that evaluated the material's cytotoxicity and tissue inflammatory response.[11,12]

Restoration of endodontically treated teeth must follow the biological principles of endodontic treatment and prevent contamination of the root canal system caused by weakness of the remaining tooth structure, which is a natural consequence that compromises the structural unit of the tooth and its mechanical strength. Hepburn[19] shows the importance and the need for functional rehabilitation of teeth endodontically treated with intraradicular posts. The author also asserts that the main function of the post in the root canal is to create a connection between the root portion and the coronary, in addition to mechanical stabilization of the latter. Advances in adhesive Dentistry allowed the use of composite resin associated with intra-radicular fiber glass posts to be considered a good therapeutic method for the reconstruction of anterior teeth endodontically treated.[14,15,16]

Conclusion

Based on the results of this study, it is reasonable to conclude that the detailed three-dimensional dental structures obtained by CBCT guided the treatment planning and therapeutic decision. CBCT was essential to avoid doubtful diagnosis and unnecessary clinical intervention. The combination of imageology and clinical practice provides a high degree of treatment predictability, a key factor for the success of integrated multidisciplinary rehabilitation root treatment.

References

1. Valdivia JE, Leonardo MFP, Machado MEL. Importancia diagnóstica de la TVD en la detección de una perforación vestibular. Rev Canal Abierto. 2012;2(1):28-31.
2. Patel S, Dawood A, Pitt Ford T, Whaites E. The potential applications of cone beam computed tomography in the management of endodontic problems. Int Endod J. 2007;40(10):818-3.
3. Estrela C, Bueno MR, Leles CR, Azevedo B, Azevedo JR. Accuracy of cone beam computed tomography and panoramic and periapical radiography for detection of apical periodontitis. J Endod. 2008;34(3):273-9.
4. Huumonen S, Kvist T, Gröndahl K, Molander A. Diagnostic value of computed tomography in retreatment of root fillings in maxillary molars. Int Endod J. 2006;39(10):827-33.
5. Cotton TP, Geisler TM, Holden D T, Schwartz SA, Schindler WG. Endodontic applications of cone-beam volumetric tomography. J Endod. 2007;33(9):1121-32.
6. Tsesis I, Fuss Z. Diagnosis and treatment of accidental root perforations. Endod Top. 2006;13(1):95-107.
7. Pohlenz P, Blessmann M, Blake F, Heinrich S, Schmelzle R, Heiland M. Clinical indications and perspectives for intraoperative cone beam computed tomography in oral and maxillofacial surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007;103(3):412-7.
8. Nakagawa Y, Kobayashi K, Ishii H, Mishima A, Ishii H, Asada K, et al. Preoperative application of limited cone beam computerized tomography as an assessment tool before minor oral surgery. Int J Oral Maxillofac Surg. 2002;31(3):322-6.
9. Young GR. Contemporary management of lateral root perforation diagnosed with the aid of dental computed tomography. Aust Endod J. 2007;33(3):112-8.
10. Torabinejad M, Chivian N. Clinical applications of mineral trioxide aggregate. J Endod. 1999;25(3):197-205.
11. Torabinejad M, Rastegar AF, Kettering JD, Ford TR. Bacterial leakage of mineral trioxide aggregate as a root-end filling material. J Endod. 1995;21(3):109-12.
12. Osorio RM, Hefti A, Vertucci FJ, Shawley AL. Cytotoxicity of endodontic materials. J Endod. 1998;24(2):91-6.
13. Gutmann JL. The dentin-root complex: anatomic and biologic considerations in restoring endodontically treated teeth. J Prosthet Dent. 1982;67(4):458-67.
14. Souza FHC, et al. Reconstrução coronária com resina composta e pino estético intracanal. J Clin Dent. 2002;(15):52-7.
15. Melo MP, Valle AL, Pereira JR, Bonachela WC, Pegoraro LF, Bonfante G. Evaluation of fracture resistance of endodontically treated teeth restored with prefabricated posts and composites with varying quantities of remaining coronal tooth structure. J Appl Oral Sci. 2005;13(2):141-6.
16. Mondelli RFL, Moura RC, Iwata DF, Pereira LCG. Reconstrução coronária através de reforço interno da raiz e pino estético em um dente tratado endodonticamente. J Bras Dent Estét. 2002;(2):97-104.
17. Scarfe WC, Farman AG, Sucovick P. Clinical applications of cone-beam computed tomography in dental practice. J Can Dent Assoc. 2006;72(1):75-80.
18. Tsurumachi T, Honda K. A new cone beam computerized tomography system for use in endodontic surgery. Int Endod J. 2007;40(3):224-32.
19. Hepburn B. Rehabilitación postendodóntica: postura filosófica para la rehabilitación posendodóntica. 1ª ed. Buenos Aires: Panamericana; 2012.
20. Scotti R, Ferrari M. Pernos de fibra. Bases teóricas y aplicaciones clínicas. Barcelona: Masson; 2004.