Dental Traumatology

Dental Traumatology 2013; **29**: 404–409; doi: 10.1111/j.1600-9657.2011.01092.x

Use of cone-beam tomography and digital subtraction radiography for diagnosis and evaluation of traumatized teeth treated with endodontic surgery and MTA. A case report

CASE REPORT

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Accepted 26 October, 2011

Abstract – The aim of this paper was to report the diagnosis and evaluation of periradicular bone repair by using computed tomography and digital subtraction radiography in an endodontic surgery case treated with mineral trioxide aggregate (MTA). The patient had local swelling and fistula 7 years after trauma in the upper jaw. Periapical lesion on tooth #12 and root resorption of tooth #11 were detected radiographically. Endodontic therapy and placement of intracanal medication were carried out. After 3 months, with no improvement in the clinical signs and symptoms, computed tomography was performed, showing extensive apical bone resorption on tooth #12 and dental resorption promoting communication of the root canal with the periodontium of tooth #11. The patient was referred to endodontic surgery. After surgery and postoperative periods of 15, 30, 60, 90, and 120 days, standardized radiographs were taken, digitized, and subjected to digital subtraction of the images using Adobe Photoshop CS software. Four years later, a cone-beam computed tomography was performed, showing bone repair and absence of root resorption at tooth #11. In this clinical case, digital subtraction radiography was effective for early detection of new bone formation and evolution of repair.

Pulp necrosis, root canal obliteration, periapical pathosis, and root resorption are common complications of dentoalveolar trauma. The traumatic effect to the periodontium depends on the type and severity of the injury and can be associated to different types of resorptions (1).

Treatment of traumatized teeth with root resorption is a clinical challenge with respect to its diagnosis, treatment plan, and prognosis. One of the reasons is related to the fact that with a conventional radiograph, the extent of the resorption and areas of communication with the periodontium cannot be visualized (1, 2).

Cone-beam computed tomography (CBCT) is becoming a popular tool in modern dental practice for the diagnosis of dentoalveolar fractures and to get more detailed information of the maxillofacial region (3). The determination of location and extent of the root resorption is important for proper treatment. In addition, the observation of adjacent anatomical structures is important for a surgical approach (1).

The use of calcium hydroxide–based root canal medication is a conventional therapy for teeth with chronic periodontal periodontitis, including cases with root resorption, in an attempt to stimulate repair of adjacent tissues, a process that requires some months (4, 5). Recently, mineral trioxide aggregate (MTA) has been shown to be a potential root-end filling material in several clinical applications such as treatment of traumatized teeth with immature apices (5–7) and treatment of root resorptions and root perforations (8, 9).

Digital subtraction radiography is a technique in which standardized radiographs taken in different time periods are superimposed to detect changes in teeth and bone structures. This method has great precision in detecting small bone changes such as loss or gain of bone tissue and present higher sensitivity and specificity when compared with conventional radiographs (10). It is a valuable tool to evaluate healing process of periapical lesions after endodontic treatment, detecting minimal changes of periapical tissues during short-time intervals

(11). However, the technology involved in digital subtraction radiography and the use of specific software make this technique difficult to be used in daily practice.

Adobe Photoshop CS image-analysis software is a program for image editing that has different tools for digital image manipulation. This software represents an alternative for the digital subtraction radiographic technique in the evaluation of healing or increase of periapical lesions after endodontic treatment or endodontic surgery (12).

This case report describes an endodontic surgery treatment for root resorption and the use of CBCT and digital subtraction radiography for a 48-month follow up.

Case report

A 19-year-old female patient presented to the dental clinic with pain and edema on the buccal mucosa adjacent to maxillary right lateral incisor (tooth #12) and maxillary right central incisor (tooth #11). The patient reported trauma to that region 7 years before.

Clinical examination showed discoloration of the crown on tooth #11, swelling of the buccal mucosa, and presence of fistula. Radiographs showed a periapical lesion on tooth #12 and root resorption on tooth #11.

The teeth were isolated with rubber dam and endodontic treatment was carried out. Root canal preparation was performed on both teeth by using conventional instrumentation, and irrigation with 5.25% sodium hypochlorite (Biodinâmica, Ibiporã, PR, Brazil). After that, the root canals were dried with paper points (Dentsply, Petrópolis, RJ, Brazil) and irrigated with 17% ethylenediaminetetraacetic acid for 3 min for removal of the smear layer. Following this procedure, root canals were filled with a calcium hydroxide–based root canal dressing (Calen/PMCC; SSWhite, Rio de Janeiro, RJ, Brazil) and the coronal access cavities were sealed with Coltosol (Coltene Whaledent, Altstatten, Switzerland).

The intracanal medication was monthly changed. Three months after endodontic therapy, the signs and symptoms had not improved, with persistence of sensitivity, sinus tract, and swelling in the region (Fig. 1). The patient was referred to computed tomography (Mx8000; Philips, Andover, MA, USA, voxel 0.5 mm), which demonstrated extensive apical bone resorption on tooth #12 and communication of the root canal with the periodontal tissues at the buccal apical third of tooth #11 (Fig. 2).

After analysis of the images, endodontic surgery was recommended. A written consent form was signed by the patient after explaining the surgical procedure. Surgery consisted in apicoectomy and apical curettage on tooth #12. The root-end was resected with a Zekrya bur at high speed under constant irrigation with saline. Alveolar curettes complemented the removal of pathological tissue from the surgical cavity. The intracanal dressing was removed from tooth #11 during the surgical procedure. The root canal was irrigated with saline and dried with paper points, then filled with MTA (Angelus, Londrina, PR, Brazil) through the apical communication. The surgical cavity was filled with blood clot before the suture. Seventy days after the surgery, the root canal of tooth #12 was filled by lateral condensation of guttapercha and Sealapex sealer (SybronEndo, West Collins, Orange, CA, USA).

Immediately after the surgical procedure and at follow-up appointments 15, 30, 60, 90, and 120 days postsurgery, periapical radiographs were taken. A film holder was stabilized with Optosil Comfort impression material (Heraeus Kulzer, Germany), to assure standardized image geometry. All radiographs were taken by using periapical film (Insight; Eastman Kodak Company, Rochester, NY, USA) with GE 1000 X-ray device (General Electric, Milwaukee, WI, USA) at 90 kVp, 10 mA, and 0.12-second exposure time.

The obtained images were digitized by using a desk scanner (SnapScan 1236s Flatbed Scanner; Agfa-Gevaert NV, Mortsel, Belgium) with 2400 dpi resolution. The resulting images were stored in JPEG format at low-compression level.

Radiographic images were submitted to digital subtraction in pairs (0 and 15 days; 15 and 30; 30 and 60; 60 and 90; 90 and 120) using Adobe Photoshop CS image-analysis software, according to Carvalho et al. (12). Before digital subtraction, both radiographs were moved in horizontal, vertical, or rotational directions applying software tools to reduce geometric distortion. To remove bright and contrast variations, both images were enhanced based on the mean of pixel intensity shown in histogram scale. Then, these images were superposed and

Fig. 1. Clinical and radiographic exam 3 months after the beginning of treatment.

Fig. 2. Computed tomography showing extensive bone resorption associated with the apex of tooth #12 and communication of the root canal with the periodontium on the buccal surface at the apical third of tooth #11.

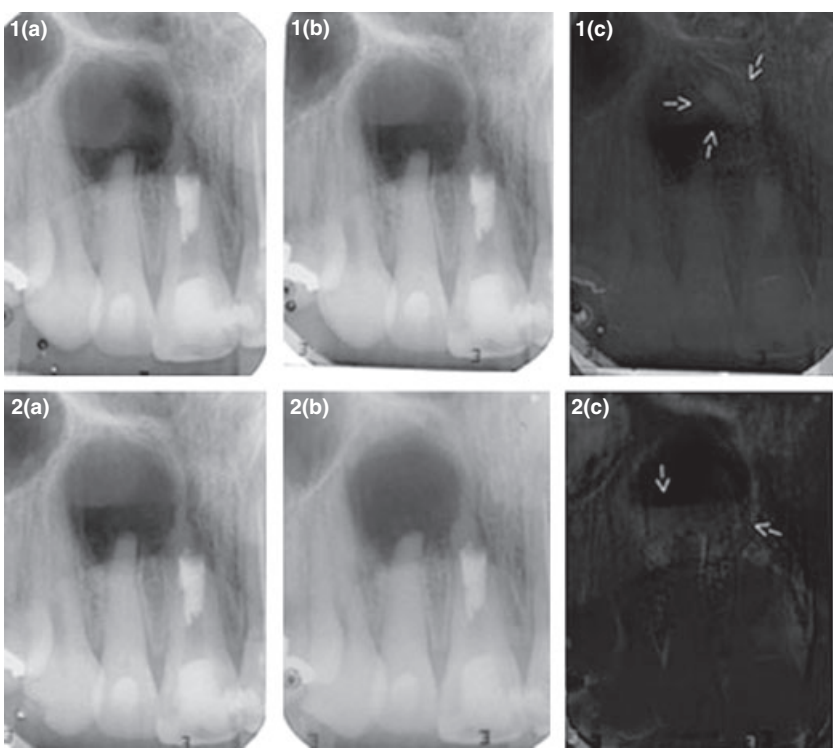

Fig. 3. Radiographs immediately (1a) and 15 days after surgery (1b). Digital subtraction between them (1c). Radiographs 15 (2a) and 30 days after surgery (2b). Digital subtraction between these radiographs (2c).

subtracted. First, 'Image' option was selected on the main menu of Adobe Photoshop CS image-analysis software. Next, in the 'Image' submenu, the 'Calculation' tool was selected by a left click. A toolbar box was opened, and the following commands were chosen: 'source 1' (later radiographic image), 'source 2' (earlier radiographic image), 'blending' (subtract), and 'result' (new document). The images resulting from digital subtraction were enhanced with brightness and contrast tools to facilitate the observation of new bone tissue areas.

New bone formation was observed in all follow-up periods, except between 60 and 90 days, when extrusion of sealer occurred while filling the root canal of tooth #12. This extrusion probably induced inflammation in the periapical region in the initial period. However, in the subsequent periods, new bone formation was observed (Figs 3 and 4).

Forty-eight months after surgery, a (CBCT) was performed using Classic I-Cat (Imaging Sciences International, Hatfield, PA, USA, voxel size 0.3). Images were analyzed using Xoran software (Xoran Technologies, Ann Arbor, MI, USA), showing bone repair, with a suggestive image of apical scar at tooth #12 region and root resorption stop at tooth #11 (Fig. 5).

Discussion

Mineral trioxide aggregate (MTA) can be used in wet environments, preventing bacterial microleakage and alkalinizing the adjacent tissues. Owing to the large presence of calcium oxide in the formulation of MTA (13), its biological properties are similar to those of calcium hydroxide, stimulating tissue healing (9). In this clinical case, MTA was used to seal the root resorption, because it has proved to be potential root-end filling material in the treatment of root resorptions (8, 9).

Cone-beam computed tomography (CBCT) has been considered an important tool for endodontic evaluation and has been recommended for detecting periapical and/or root changes and morphologic changes in the root canal anatomy that are not visible in conventional

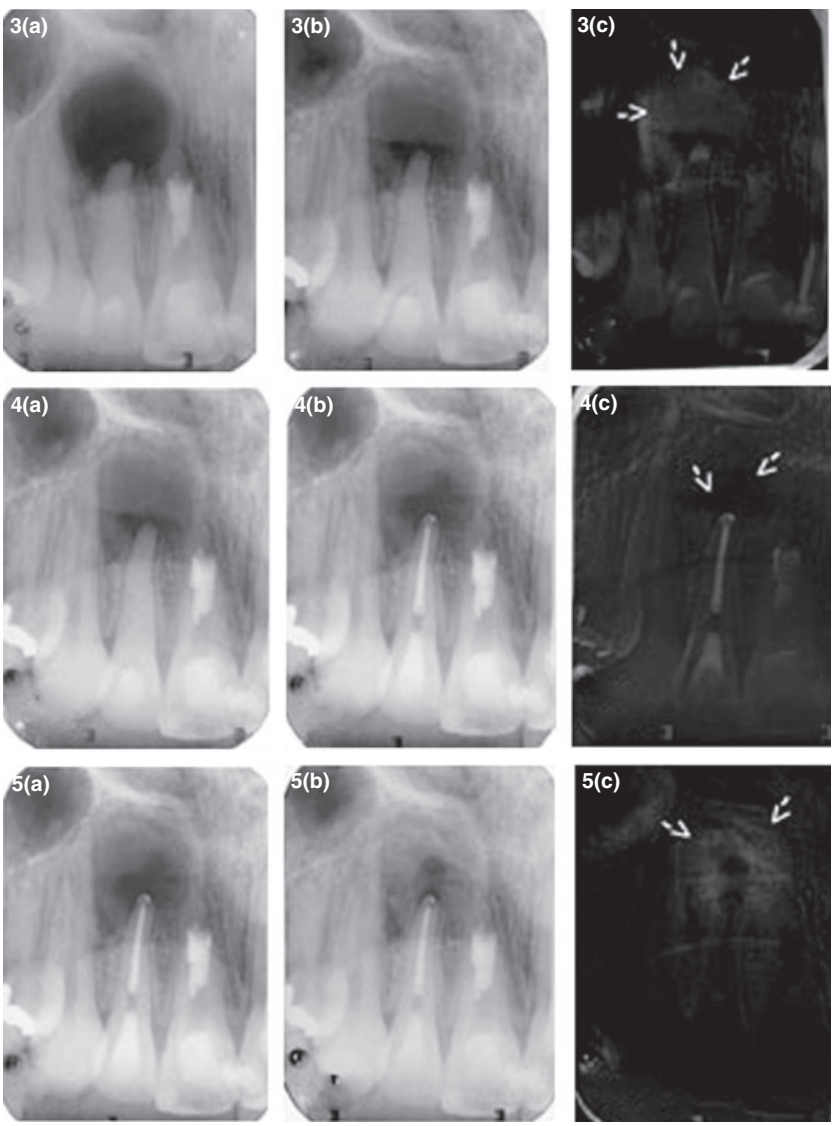

Fig. 4. Radiographs 30 (3a) and 60 days after surgery (3b). Subtraction between them (3c). Radiographs 60 (4a) and 90 days after surgery (4b). Subtraction between them (4c). Radiographs 90 (5a) and 120 days after surgery (5b). Subtraction between them (5c).

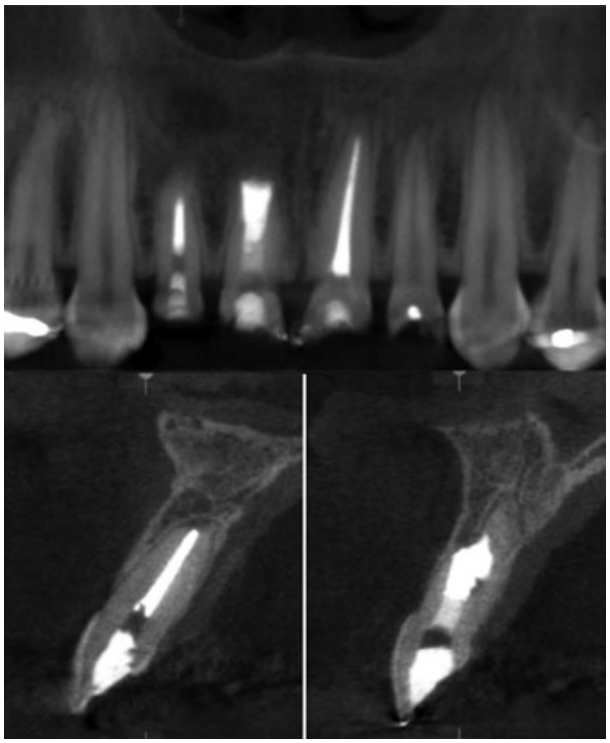

Fig. 5. Computed tomography 4 years after endodontic surgery showing bone healing and absence of root resorption in tooth 11.

radiographs (14). The diagnosis and 3D imaging assessment of the resorption are important to determine the complexity of treatment based on the location and extension of the root defect. In addition, the proximity to anatomical structures is visualized for a surgical approach (1).

In the present case, the use of conventional computerized tomography (CCT) was essential for the diagnosis and to indicate the endodontic surgery, as the images allowed visualization of the periapical lesion of tooth #12 and the root resorption of tooth #11. Nowadays, the (CBCT) has been widely used and consists in a technique developed specifically for use in dental and maxillofacial analysis. It has higher resolution and requires a lower dose of radiation compared with CCT (15). Additionally, this technique provides a highly detailed image of the selected area, because it can be adjusted for small areas and specific diagnosis (16).

Estrela et al. (17) reported a high probability of apical periodontal lesions remaining undetected by periapical and panoramic radiographs. Patel et al. (14) showed the importance of CBCT for endodontic treatment outcome evaluation, because this method can detect cases of apical periodontitis that are undetectable by conventional radiograph. Also, Tanomaru-Filho et al. (18) showed the importance of 3-dimensional imaging provided by CBCT in the diagnosis and planning of endodontic and surgical treatment, as well as during the follow up of these cases.

Healing by scar tissue after surgical endodontic treatment is well recognized (19). In this case, using CBCT forty-eight months after surgery, bone repair was observed, with an area suggestive of scar in the apical region of the tooth #12. According to Love & Firth (20), only 2% of radiolucent apical images are postsurgical scars.

One of the challenges of diagnosis by images is detecting slight changes in mineralized tissues. The use of digital subtraction radiography can improve the detection of small changes in mineral content (1–5%), while with conventional radiographs such changes would only be perceptible at 30% or more (21).

In our study, subtraction of the digital radiographic images revealed new bone formation 15 days after endodontic surgery, demonstrating the extreme sensitivity of this method in detecting early repair following endodontic surgical therapy. This finding is in agreement with previous studies (11, 12).

The use of non-specific software for digital subtraction can represent an important tool in follow-up evaluations both in research field and clinical practice. The use of this software for image subtraction procedures is described by Carvalho et al. (12).

There has been an intense search for methods that prevent any subjectivity in image interpretation; digital subtraction radiography is one of these techniques. This method allows reproducible evaluation of periapical bone changes, with better results when comparing with conventional radiograph interpretation (22).

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