Clinical indications for digital imaging in dento-alveolar trauma. Part 2: root resorption

Cohenca N, Simon JH, Mathur A, Malfaz JM. Clinical indications for digital imaging in dento-alveolar trauma. Part 2: root resorption. © Blackwell Munksgaard, 2006.

Abstract – Common complications of dento-alveolar trauma are pulp necrosis, pulp canal obliteration, periapical pathosis and root resorption. Different types of root resorption have been identified with traumatic injuries. Repair-related (surface), infection-related (inflammatory), ankylosis-related (osseous replacement) or extraradicular invasive cervical resorption are among the most common. Recent developments in imaging systems have enabled clinicians to visualize structural changes effectively. The diagnosis and three-dimensional imaging assessment of the resorption is important in order to determine the treatment complexity and expected outcome based on the location and extension of the root defect. This article discusses and illustrates the clinical application of cone beam computed tomography for diagnosis and treatment plan of root resorption. Four clinical cases are presented to illustrate the potential use of the NewTom 3G for root resorption.

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The aim of any imaging examination is to demonstrate the positions of the anatomic elements, both hard and soft tissue, in three spatial planes (1). Recent improvements in digital radiographic imaging have introduced a new dimension to dental practice. Digital radiography (2), computed tomography (CT) (3–5), magnetic resonance imaging (MRI) (6) and more recently cone beam computed tomography (CBCT) (7–10) have become increasingly important in diagnosis and treatment planning. A review and comparison of three-dimensional (3D) techniques has been previously reported by Cohenca et al. (11).

Compared with the traditional projection (plain film) radiograph, 3D imaging allows us to visualize the third dimension while eliminating superimpositions. The use of CBCT was reported recently for maxillofacial surgery (1, 8, 12–14), diagnosis and orthodontic treatment plan (15–19), differential diagnosis of periapical pathology (20, 21) and for diagnosis of dento-alveolar traumatic injuries (11).

Common complications of dento-alveolar trauma are pulp necrosis, pulp canal obliteration, periapical pathosis and root resorption. The traumatic effect to the periodontium depends on the type and severity of the injury and can be related to different types of resorptions. These have been identified as repair-related (surface), infection-related (inflammatory), ankylosis-related (osseous replacement) or extraradicular invasive cervical resorption (22, 23). Eventually the resorptive process may lead to tooth loss. Treatment of root resorption is often complex, time consuming, expensive and unpredictable. One of the reasons is related to the fact that with a plain two-dimensional radiograph, the extent of the resorption and portals of entry cannot be visualized. In most cases, the treatment requires a multidisciplinary team of specialists that include the following areas: endodontics, pediatric dentistry, periodontics, oral surgery, implantology – prosthodontics, community dentistry and orthodontics.

The diagnosis and 3D imaging assessment of the resorption is important to determine the treatment complexity and expected outcome based on the location and extension of the root defect. In addition, the proximity to anatomical structures is

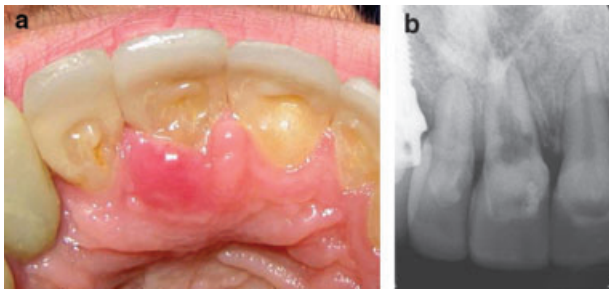

Fig. 1. (a) Photograph showing a localized palatal swelling cervical to the maxillary right central incisor. (b) Preoperative radiograph of the maxillary right central incisor. A diffuse radiolucency consistent with root resorption is noted.

visualized for a surgical approach. Several studies (9, 19, 24) reported the geometrical accuracy of CBCT particularly regarding linear measurements. Lascala et al. (24) found that the measurements made from the CBCT images are similar to those of real *in vivo* distances between skull sites and therefore it is a reliable method for linear measurement between anatomical sites.

The purpose of this review is to discuss and illustrate the clinical application of CBCT for diagnosis and treatment plan of root resorption.

Case 1

A 25-year-old female patient presented to the Endodontic Graduate Clinic at the University of Southern California with a complaint of palatal swelling on her front upper teeth. Her medical history was unremarkable. Dental history revealed an impact injury to the face that occurred approximately 15 years earlier and orthodontic extrusion of an impacted maxillary right canine performed 3 years prior. The treatment rendered was unsuccessful and a year later the maxillary right canine was extracted and rehabilitated with a single implant-supported prosthesis. Due to esthetic considerations the maxillary incisors were restored with porcelain veneers.

Upon clinical examination a localized palatal swelling cervical to the maxillary right central incisor was diagnosed (Fig. 1a). The tooth did not respond to electric pulp sensitivity test (Vitality Scanner; Analytic Technologies, Redmond, WA, USA) neither to cold sensitivity test at −50°C (Endo Frost; Roeko, Langenau, Germany). The adjacent teeth were asymptomatic and responded normal to cold and electric pulp tests. The maxillary right central incisor was tender to percussion and palpation and non-mobile. Periodontal probing confirmed the presence of a deep periodontal defect on the palatal surface of the maxillary right central incisor with pocket depths of 6 and 9 mm. Radiographic examination showed evidence of marginal bone loss due to generalized periodontitis and a diffuse radiolucency in the maxillary right central incisor consistent with root resorption (Fig. 1b). The NewTom 3G DVT 9000 (Quantitative Radiology S.R.L., Verona, Italy) analysis at 0.2 mm cross-sectional and axial cuts (Fig. 2) showed the resorption and a large root perforation on the palatal aspect of the root that correlates with the periodontal defect and the localized swelling. The cross-sectional cuts also helped to determine the portal of entry of the resorption (Fig. 2d,e). Volumetric reconstruction demonstrated the extension of the resorptive lesion and the irreversible damage to the tooth structure (Fig. 3). Based on the available data and the results of the clinical and radiographic

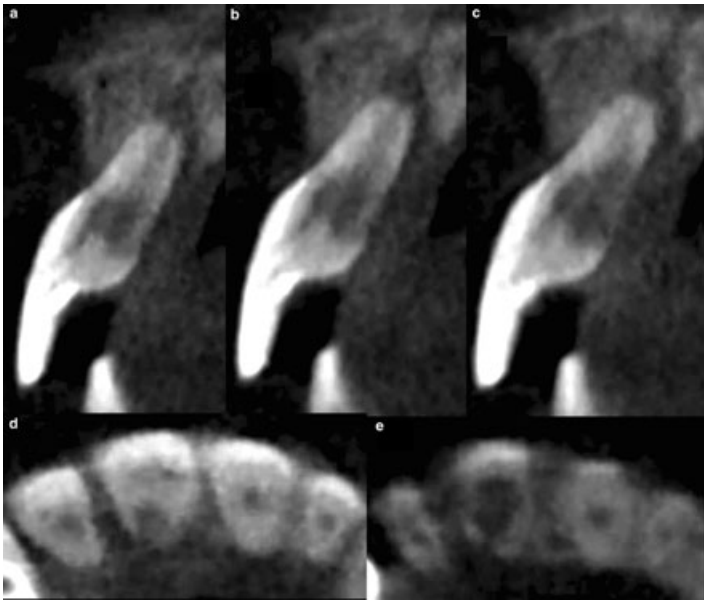

Fig. 2. (a–c) Series of cross-sectional 0.2 mm cuts showing the extension and location of the resorptive process and the palatal perforation of the root. (d) The axial view demonstrates the resorption at the cemento-enamel junction. Note that at this level there is no communication with the pulp space. (e) A different axial cut at a more apical level reveals a larger resorption with direct communication with the pulp.

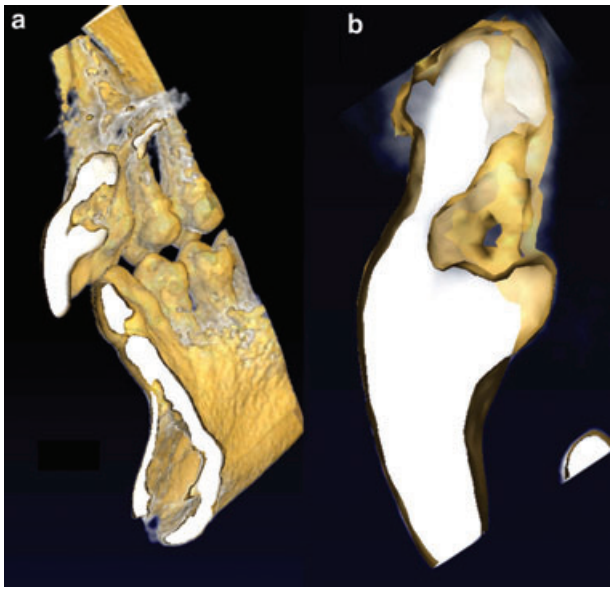

Fig. 3. Proximal volumetric reconstruction using the NewTom 3G DVT 9000.

examination the diagnosis established was extra-radicular invasive resorption with the subsequent pulp necrosis. Most probably the etiology of the lesion was related to the previous trauma and orthodontic treatment.

Due to the extension and location of the resorptive lesion a treatment plan was presented to the patient and included the non-surgical root canal therapy and repair of the perforation with an orthograde and surgical approach using gray mineral trioxide aggregate (MTA) (Pro Root; Dentsply, Tulsa Dental, Johnson City, TN, USA) (Fig. 4).

During the 8 month follow-up period the patient remained asymptomatic. Clinically, the tooth was not tender to percussion or palpation. Periodontal examination showed evidence of healing and probing depths were within normal limits. Periapical radiographs demonstrated evidence of apical bone healing and no recurrence or progression of resorption (Fig. 5).

Case 2

A 20-year-old male patient was referred to the Endodontic Graduate Clinic at the University of Southern California for endodontic evaluation prior to orthodontic treatment. His medical history was non-contributory. The dental history revealed an automobile accident 13 months prior. As a result of the traumatic injury a double fracture of the mandible was diagnosed and treated by open reduction and fixation using titanium plates and screws.

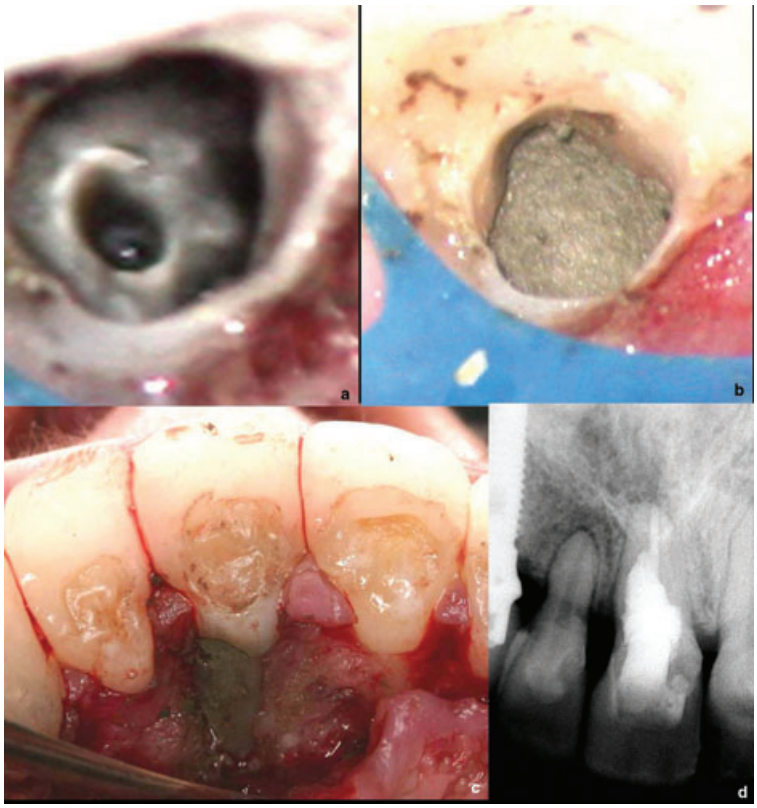

Fig. 4. (a) Clinical view of the resorption immediately after access was gained. (b) Internal repair with gray mineral trioxide aggregate. (c) Palatal flap showing the external surgical repair of the defect. (d) Immediate postoperative radiograph.

Fig. 5. At 8 months follow-up, periapical radiographs demonstrate evidence of apical bone remodeling and no recurrence or progression of the resorption.

Fig. 6. Periapical radiographs revealing the presence of an external root resorption on the mesial aspect of the mandibular right canine (Courtesy of Dr Esther Cho).

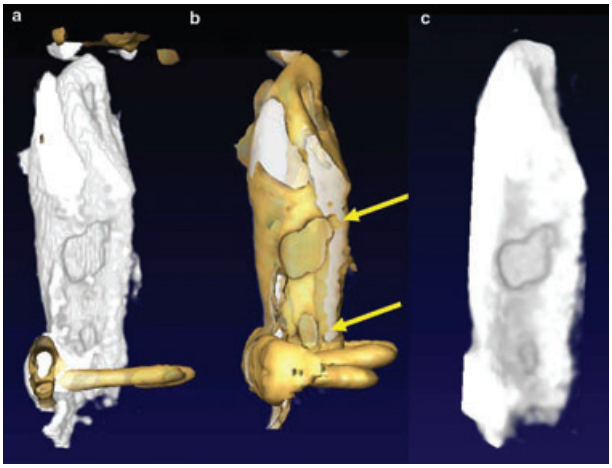

Fig. 7. Proximal volumetric reconstruction using the NewTom 3G DVT 9000 illustrating the presence of two independent areas of resorption on the mesial surface of the mandibular right canine.

The patient was asymptomatic and reported no previous history of pain or swelling. Clinically, severe crowding and malocclusion was evident. The mandibular right lateral incisor and mandibular

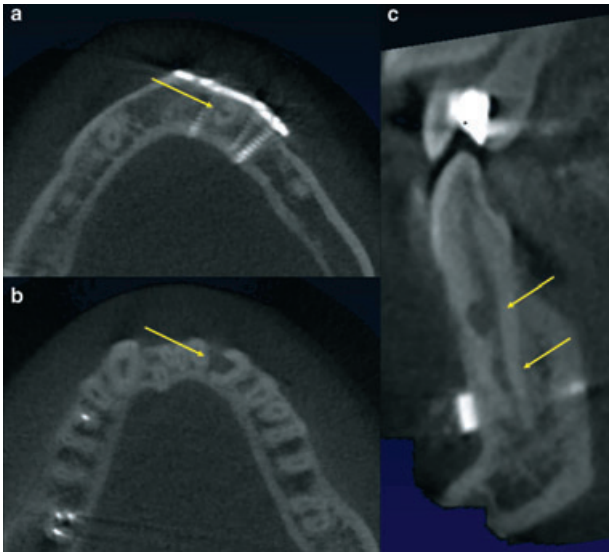

Fig. 8. (a) Axial cut at apical level showing the apical resorption. Note the relation with the buccal titanium plate. (b) A different axial cut at a more cervical level shows the location and extension of the cervical resorption as well as the perforation of the mesial wall. (c) Cross-sectional 0.2 mm cut showing two areas of resorption in close relation with the root canal.

Fig. 9. Periapical radiograph of the mandibular right central incisor revealing the presence of an external root resorption. The root canal can be traced throughout the resorptive process.

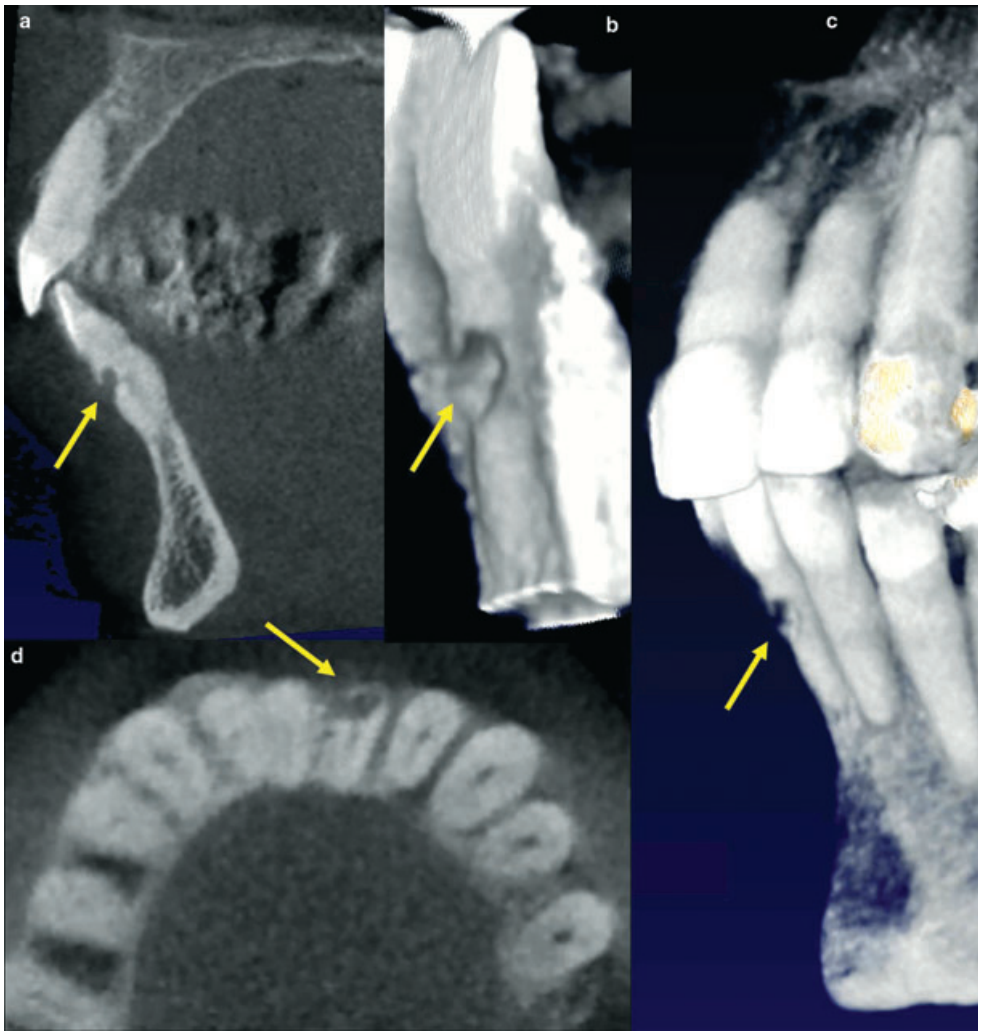

Fig. 10. (a–c) Proximal volumetric reconstruction using the NewTom 3G DVT 9000 illustrates the presence of a root resorption on the buccal surface of the mandibular right central incisor. (d) An axial cut showing the location and extension of the resorption as well as its relation with the root canal.

right canine were not responsive to electric pulp test and to cold sensitivity test. However, no sensitivity to percussion and palpation could be diagnosed. Periapical radiographs revealed the presence of an external root resorption on the mesial surface of the mandibular right canine (Fig. 6). Furthermore, CBCT analysis with the NewTom 3G DVT 9000 confirmed the presence of two independent areas of resorption (Fig. 7) which were related to the root canal (Fig. 8). Without this axial view the second resorption defect would not have been diagnosed and thus missed in both diagnosis and treatment.

Taking into consideration the guarded prognosis of the mandibular right canine and the severity of the crowding, the tooth was referred to extraction while the mandibular right lateral incisor was endodontically treated.

Case 3

A 76-year-old female subject presented to the Endodontic Graduate Clinic at the University of Southern California with a referral for diagnosis and treatment of the mandibular right central incisor. Medical history was non-contributory. The dental history revealed orthodontic therapy more than 60 years earlier. She did not recall any history of trauma. Her main complaint was discomfort and dull pain in the lower anterior teeth. Upon clinical examination the mandibular right central incisor responded with a sharp non-lingering pain to vitality tests. The tooth was negative to percussion and tender palpation. Periodontal probing revealed a 6-mm pocket in the mesio-buccal aspect of the mandibular right central incisor and the tooth had more than 1 mm lateral mobility (class 1).

During the initial radiographic examination, an external root resorption was evident on the mandibular right central incisor (Fig. 9). The NewTom 3G DVT 9000 illustrates the presence of an external root resorption in the buccal aspect of the mandibular right central incisor (Fig. 10). Although the prognosis of the tooth was poor considering the bone loss due to periodontal disease, a conservative approach was recommended to the patient and included the non-surgical root canal therapy followed by the surgical repair of the resorption. Unfortunately, the patient refused further treatment.

Case 4

A 40-year-old male subject was referred to the Endodontic Graduate Clinic at the University of Southern California for diagnosis and treatment of the mandibular right first premolar. Medical history was non-contributory. During a routine radiographic examination, his general dentist diagnosed a radiolucent lesion at the cervical level of the mandibular right first premolar (Fig. 11). The patient reported a traumatic injury to his face that occurred approximately 15 years earlier during a baseball game. No treatment was rendered. He denied any history of orthodontics or bleaching. Upon clinical examination the tooth was vital and negative to percussion and palpation. Periodontal probing was within normal limits. Although the lesion seemed to be too small to be detected by the NewTom 3G DVT 9000, the study clearly revealed the location, extension and portal of entry of the resorption, both in cross-sectional cuts (Fig. 12) and in volumetric images (Fig. 13). Based on the infor-

Fig. 11. (a, b) Preoperative periapical radiographs of the mandibular right first premolar showing a small cervical radiolucency consistent with extraradicular invasive root resorption.

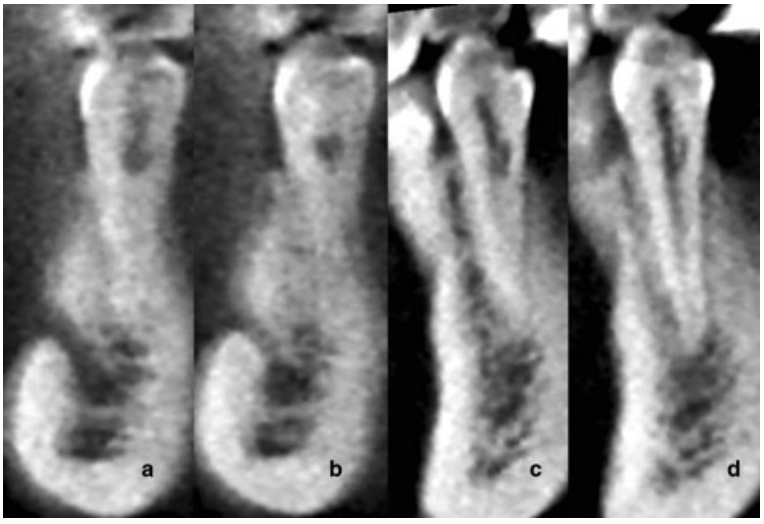

Fig. 12. (a, b) Cross-sectional bucco-lingual 0.2 mm cuts. (c, d) Mesio-distal 0.2 mm cuts.

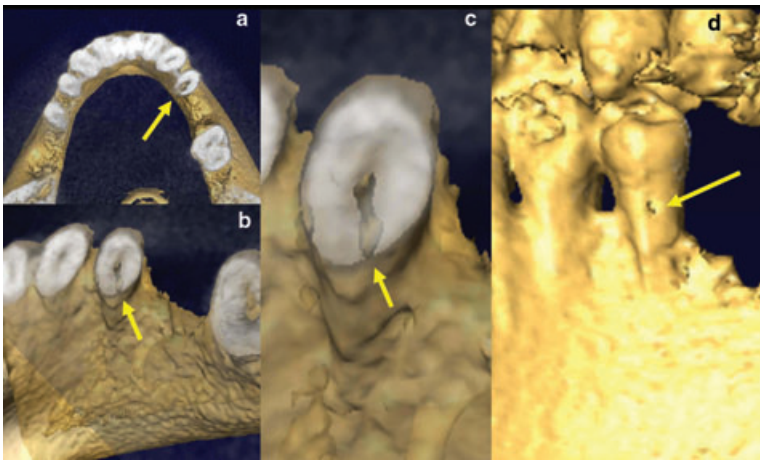

Fig. 13. (a) Axial volumetric reconstruction of the lower arch. (b, c) Closer view of the lesion demonstrating the location, extension and portal of entry of the resorption. (d) Lingual view of the portal of entry.

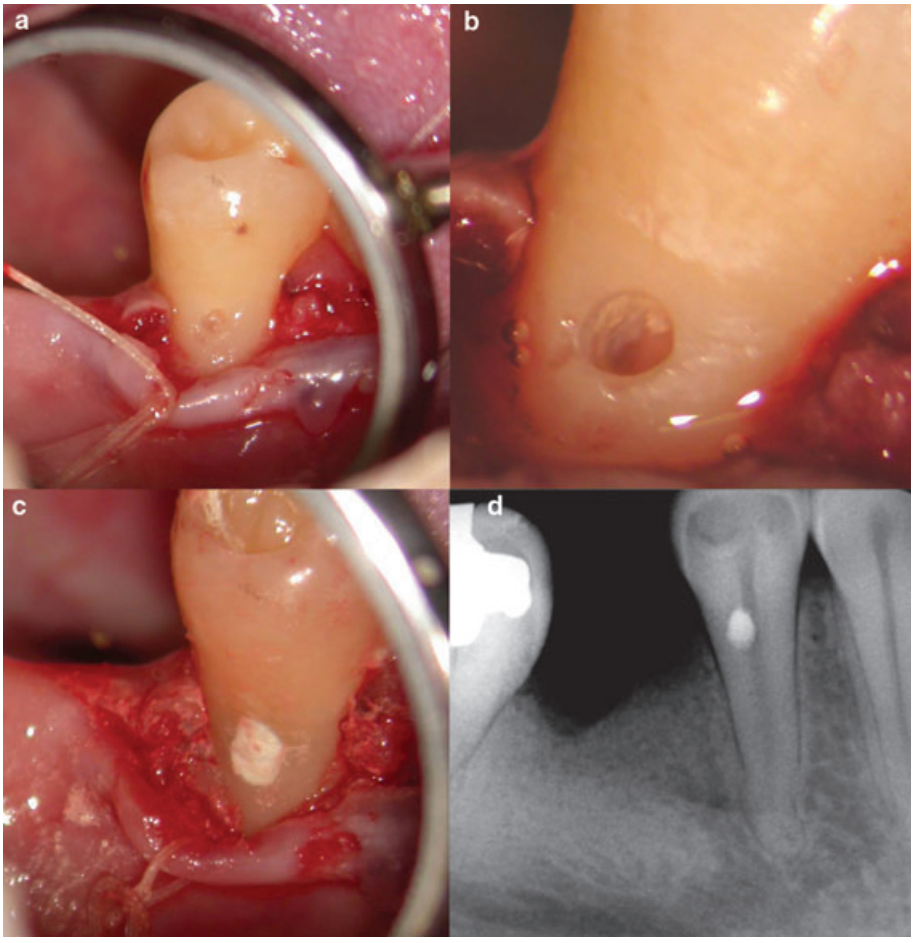

Fig. 14. (a) Clinical photograph showing the portal of entry immediate after flap reflection. (b) Closer view of the lesion after conservative curettage of the resorptive tissue. (c) Repair with mineral trioxide aggregate. (d) Postoperative periapical radiograph immediate after surgery.

mation obtained with the NewTom, the patient was scheduled for surgical repair of the lesion. During the surgical procedure the pulp was not exposed and the lesion was cleaned and repaired with MTA (Fig. 14).

Discussion

External inflammatory, internal inflammatory, non-inflammatory osseous replacement and extra-radicular invasive (also called cervical resorption)

are among the most common types of root resorption. The resorptive process involves a complex interaction of inflammatory cells, resorbing cells, hard tissue, cytokines and enzymes such as collagenase, matrix metalloproteinase and cysteine proteinase (25). Moreover, it appears that all types of resorption share common cellular mechanisms and eventually the process may lead to tooth loss. Treatment of root resorption varies depending on the type of resorption and the degree of extension of the defect. Some cases require a multidisciplinary approach that includes the services of endodontists, periodontists, orthodontists and prosthodontists.

A clinical diagnosis of root resorption is frequently made following an incidental radiographic finding. This is because most cases remain asymptomatic until the resorption reaches an advanced stage. Hence, the radiographic interpretation of the resorptive process is crucial for the differential diagnosis, treatment and prognosis of the tooth. CBCT offers the advantage of a 3D visualization of the defect and facilitates determining the location, portal of entry/exit and the extension of the resorption. Although CBCT does not have the resolution of the traditional plain radiograph, new improved 3D system such as flat panel volumetric computed tomography (FD-VCT) is currently being developed for clinical use (26, 27). Recently, Hannig et al. (28) reported that FD-VCT allows precise visualization of vertical root fractures and cracks at a higher resolution of 140 μm. While this *ex vivo* study was performed using extracted teeth with clinical signs of vertical root fracture, further *in vivo* studies are needed to evaluate the influence of the superimposition of hard and soft tissue on image quality.

Three-dimensional imaging is becoming an important and available tool in dentistry. In selected cases, treatment planning becomes easier and more accurate when using CBCT. Better preoperative assessment and understanding of the pathology can help the operator to find and repair the affected tissues, thus, increase the outcome of the therapy and avoid further complications. The cases illustrated in this paper emphasize the need for treatment planning based on a comprehensive evaluation using all diagnostic modalities available including new 3D digital imaging techniques.

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