

ROOT PERFORATIONS IN ENDODONTICALLY-TREATED POSTERIOR TEETH: A CONE-BEAM COMPUTED TOMOGRAPHY STUDY

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ABSTRACT

Root perforations represent artificial communication between the endodontic system and the periodontal space or the oral cavity. While it is true that they can reduce the success rates of endodontic treatment in the long term, nevertheless, with the new bioceramic materials, the evolution is promising. The aim of this retrospective study was to assess the prevalence of perforations in root canal-treated maxillary and mandibular posterior teeth based on findings from images taken using cone-beam computed tomography (CBCT) and to review the most predictable, appropriate non-surgical treatment procedures for the clinical management of these conditions, highlighting some relevant clinical cases of complex oral rehabilitation.

Keywords: perforation, Cone-beam computed tomography, posterior teeth, bioceramic materials

INTRODUCTION

During endodontic treatment, various incidents may occur. As a consequence, they can more or less influence the prognosis of the endodontic treatment, leading to persistent periapical disease and root canal treatment failure that can jeopardise the survival of the tooth [1], as it turned out that nearly 10% of all failed cases consisted of perforations [2].

According to the American Association of Endodontists (AAE), perforations are mechanical or pathological communications between the root canal system and the external tooth surface [3] and as such, perforations, through the communication of the endodontic system with the periodontal space, represent one of the most serious accidents. Unlike the fracture of instruments, under-filling, or

ledges, which may remain without consequences for a long time, perforations immediately produce the breakdown of the periodontium and this injury to the periodontium leads to inflammation and bone defect formation. This is why they need to be either prevented, or at least recognized and addressed by clinicians when they occur to improve the prognosis of the root canal treatment [4], as their prognosis depends on three important factors: time, size and location.

They may occur iatrogenically, during any stage of root canal treatment or pathologically (resorptions or caries). This study assessed the prevalence of intraoperative procedural errors either during access, canal shaping, or canal preparation for a post in relation to posterior

teeth, molars, and premolars, using cone-beam computed tomography (CBCT).

Unlike the traditional diagnosis and evaluation of endodontic treatments on a periapical radiograph [5], the use of CBCT for this purpose brings valuable information regarding not only the buccal-oral plane, which cannot be exposed by radiographs, but also the mesio-distal one is often obscured by overlapping of various anatomical structures, leading to a blurred or distorted image, subjected to inaccurate interpretation of the radiographs [6,7].

Although radiopaque materials could distort the CBCT image, due to severe artifacts, however, exposure parameters and recent software with various attenuation filters, can improve the image and thus not only the location, but also the diameter can be precisely established [8].

Information is limited in the literature regarding these incidents in posterior teeth and even less studies performed with CBCT. In this regard, our study adds valuable information to the existing research.

MATERIAL AND METHOD

We retrospectively analyzed 2208 CBCT-scanned teeth from a patient database registered in a private clinic. The scans were recommended for diagnostic purposes and to establish the treatment plan, either endodontically or surgically, they were not specifically recommended for this study. The CBCT images were acquired with Veraviewepocs 3D P (R100) equipment (J. Morita MFG Corp., Kyoto, Japan). The scan parameters were 90 kV, 5 mA, 9.4 s exposure time, 125 μ m spatial resolution and 40×40 mm field of view (FoV). The CBCT scan examination was performed by an endodontist with CBCT training and

experience. The CBCT imaging assessment methodology involved orienting the long axis of the tooth under examination with the reference lines within the visualization software, followed by an interpretation performed across the coronal, sagittal and axial planes.

Our examiner looked for any deviation from the natural path of the endodontic system in the treated teeth, namely any communication between the root canal system and periodontium, in all three planes.

Results

684 posterior teeth had previous endodontic treatment. There was a prevalence of 4,67% (n=32) perforations shown on CBCT scans. Most of the perforations were found in maxillary molars 40,62% (n=13), followed by mandibular molars 31,25% (n=10), 21,87% (n=7) in upper premolars and 6,25% (n=2) in lower premolars.

Overall, perforations were more common in molars, 71,87%, than premolars, 28,12%.

There were 11 cases of strip perforations (8 in molars), 11 of furcal perforations (all in molars) and 10 cases of perforations in the apical or middle third of the canal on the external curvature (8 in molars).

Clinical Cases

Clinical case 1

The 37-year-old female patient was referred to the specialist Endodontist by her general dentist, who perforated the mesial root whilst retreating 47, right second mandibular molar. The patient reported sensitivity when biting on the right side, which appeared after the retreatment attempt. Clinical examination was performed, with tooth 47 tender to percussion and periodontal probing of less

than 2 mm. The periapical radiograph (fig. 1a) exposed the perforation in the middle third of the mesial root. The distal canal had a previous obturation. The mesial root presented no root canal obturation, apical to the perforation. The CBCT scan (fig. 1b,c) revealed the direction of the false path towards the buccal aspect and the joining mesial canals (coronal plane). Under the magnification of a dental microscope we located the mesio-lingual canal and gained patency. We removed the previous materials from the distal canal and then we used Rotate files (VDW) to 25.06 for root

canal shaping. We irrigated with sodium hypochlorite 3% throughout the mechanical shaping and EDTA 17% to remove the debris before the obturation. We placed a bioceramic material (Well-Root PT premixed) to seal the perforation and the canals were filled with NeoSealer Flo (Avalon Biomed) and gutta-percha (fig. 1e). The postoperative radiograph showed the obturated canals and perforation (fig. 1d,f) and the final restoration. The tooth was asymptomatic and functioning at the 1 month follow-up.

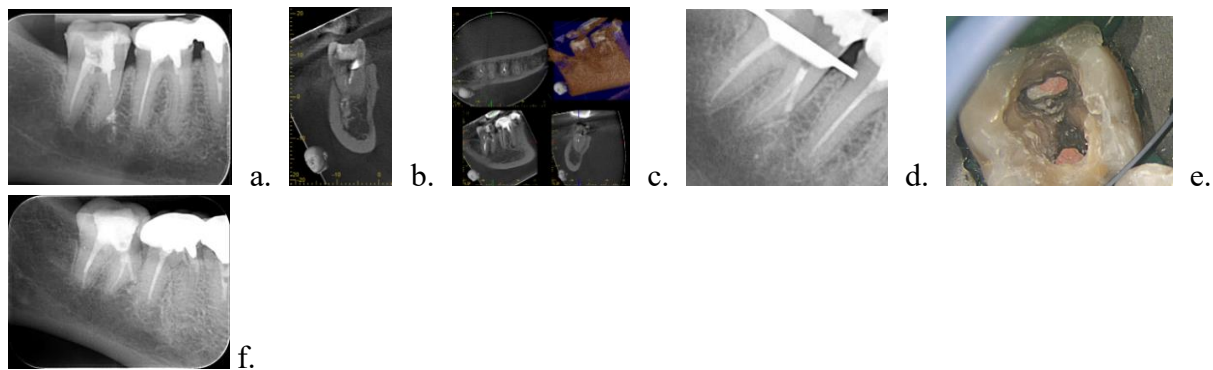


Figure 1 a. preoperative radiograph b. preoperative CBCT coronal section c. preoperative CBCT d. intraoperative radiograph e. intraoperative image f. postoperative radiograph

Clinical case 2

The 54-year-old female patient was referred to our clinic for retreatment of 15, right second maxillary premolar. The patient reported sensitivity on the right side of the upper jaw since cementing the bridge 2 years ago. Clinical examination revealed tenderness to percussion of tooth 15 and normal periodontal probing. The periapical radiograph (fig. 2a) showed a post inserted in a false path, an incomplete root canal obturation and a periapical lesion. The CBCT scan (coronal plane) revealed the actual perforation towards the palatal side

of the root and a slightly radiolucency in relation to the perforation (fig. 2b). During the ultrasonic removal of the post (which was actually a diamond bur), the tip, which was beyond the root, fractured (fig. 2c), but we were able to retrieve it, as well. The perforation was sealed with Well-Root putty and in the next appointment, after 2 weeks, the canal was prepared with the same clinical protocol as case 1 and then filled with Neosealer and gutta-percha (fig. 2d,e). 8 months CBCT scan showed normal periradicular bone and the tooth is completely asymptomatic (fig. 2f).

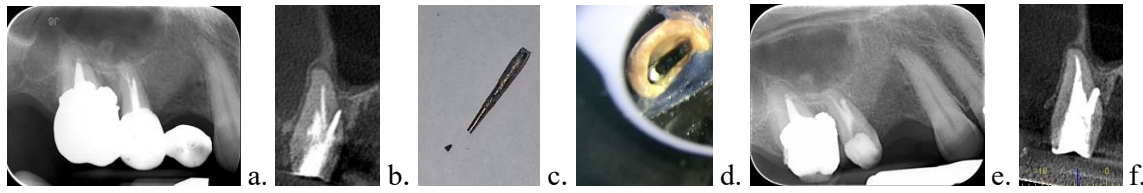


Figure 2 a. preoperative radiograph b. preoperative CBCT coronal section c. post removed d. intraoperative image e. postoperative radiograph f. 8 months follow-up CBCT coronal section

Clinical case 3

The 27-year-old female patient was referred to our clinic for the retreatment of tooth 26, left first maxillary molar. The patient recently (6 months ago) had a root canal treatment carried out on the tooth 26 and since then it was painful on biting. Clinical examination revealed the tenderness to percussion of tooth 26 and an extended distal caries. The periapical x-ray showed two root canals, disto-buccal and palatal were incompletely obturated (fig. 3a), while the mesio-buccal root had no obturation. The CBCT scan revealed the furcal perforation and a missed mesio-buccal

canal (fig. 3b). all the roots had a close relationship with the maxillary sinus, which presented no signs of inflammation. After rubber dam isolation, we removed the coronal restoration and were able to identify the large furcal perforation under magnification. We sealed the perforation with Well-Root putty (fig. 3c) and in a second appointment, after one week, we followed the same clinical protocol as case 1 and the canals were filled with Neosealer and gutta-percha (fig. 3d). When she returned for the final restoration, after two weeks, the tooth was no longer sensitive.

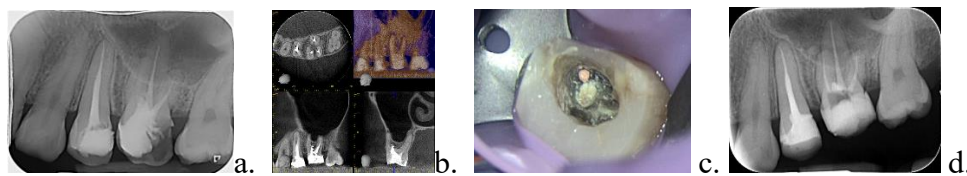


Figure 3 a. preoperative radiograph b. preoperative CBCT scan c. intraoperative image d. postoperative image

DISCUSSION

There may be different causes for root perforations that can occur both during and after endodontic treatment: searching for canals, negotiating calcified canals, the attempt to remove the root canal previous filling during retreatment, the removal of a considerable amount of dentin around separated instruments, or the post space preparation [9]. Some of these involve the furcation, others the external curvature, and others the danger zone, that area of thin dentin of the concave roots of the molars most of the time, but also of the buccal root

of the first maxillary premolars. They appear as a result of the improper use of endodontic tools, either with burs or endodontic files, but also with ultrasonic tips.

In some cases, the pathological consequences derive not only from the creation of an unnatural communication with the periodontium near the perforation, but also due to the fact that the canal apical to the perforation is not treated endodontically, just like a missed canal. This can be the cause of chronic apical periodontitis [10].

Therefore it is mandatory not only to close this communication, but also to succeed in accessing the original root canal beyond the perforation. This is not easy, often the lumen of the canal is obliterated at least in the first mm after the perforation. Or it is extremely difficult to access due to a severe curvature. In these cases CBCT is essential in creating a treatment plan with the valuable information it brings.

In a Cone-Beam computed tomography study which assessed the prevalence of procedural errors in maxillary posterior teeth, the authors reported 5% apical perforations and no strip perforations [11], while other radiographic studies there were 3-4% strip perforations and 1% furcal perforations [12,13].

After the clinical investigation and imagistic assessment, management of perforations depends on three main factors: time, size and location. The longer the time, the greater the size and the cervical location have the worst prognosis. Immediate sealing of the perforation defect with an adequate bio-material such as calcium silicate cement is crucial to the long-term survival of the affected tooth and induce tissue repair [14].

Due to the fact that perforations do not occur frequently, there is a lack of agreement on the treatment protocols. There are some studies that indicate that time and size are no longer critical factors, but mainly the periodontal condition of the defect, that is increased probing depths and loss of attachment [15].

Repair materials for perforations should be biocompatible and have the ability to seal the communication with the periodontal ligament [16,17].

Mineral trioxide aggregate (MTA) and similar bioceramic materials are bioactive endodontic cements and have these properties and on top of that, moisture

tolerance and the potential to promote regeneration of cementum [18].

For the subcrestal perforations these are the material of choice and depending on the size of defect, an internal matrix should be used, as a barrier to prevent excessive extrusion. If we take into consideration aesthetic demands, then MTA with its potential for discolouration as a drawback, should be avoided and instead an alternative to MTA should be used, as are other similar bioceramic putty materials [19].

(MTA) and other bioceramic putty enhanced the fracture resistance of endodontically treated teeth to levels similar to molars without strip perforations [20].

As for the supracrestal perforations, the use of adhesive materials can provide an adequate seal and a fast setting time [21,22].

The bioceramic materials can ensure a high success rate for treatment of root perforations in all areas of the root and appears to be a valid treatment option, The success rates vary in studies, but still these values are high enough to try to close these perforations as they reach 70%-90% favorable evolution [23-27].

Although the advantages of these biomaterials with excellent properties are obvious, they are currently expensive materials and difficult to handle and apply in certain clinical situations, when different techniques are required to obturate the canal beyond the perforation and then to close the perforation. Thus, for a successful management of such clinical situations, technical equipment, magnification, materials, but also the doctor's skill and experience are unmistakably necessary.

Our clinical study demonstrates the use of CBCT in diagnosis of root perforations in posterior teeth. The presented clinical cases

are complex, their treatment was performed by experienced operators, aided by operating microscope. Improvement in technology and highly trained clinicians have an impact on treatment outcome of these severe complications.

CONCLUSIONS

Because the time is critical for a favorable outcome, it is mandatory to diagnose and treat a perforation soon after it occurred.

The diagnosis of perforations is challenging, as it often involves buccal-

lingual plane, which is not exposed by the radiographs. Paramount information regarding the accurate location and the size of perforation are revealed by the CBCT and help to determine an ideal treatment plan, which will lead to a favorable outcome in these teeth with strategic value. Dental operating microscope and bioceramic materials are the assets with which the endodontic treatment of these conditions can offer real success rates and the functional preservation of these teeth.

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