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Case Report

Mid-root Lateral Perforation Repair using A Novel Bioceramic Material: A Case Report with 3-Month Follow-up

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Abstract

Introduction: Root perforations may negatively affect endodontic treatment outcome if not managed properly. This case report describes successful non-surgical endodontic management of a maxillary first molar diagnosed to have iatrogenic root perforation using a calcium-silicate based root repair material. **Body:** A 38-year-old female patient presented with a mild pain on biting related to maxillary left first molar. Pre-operative radiograph revealed previous endodontic treatment with a missed mesiobuccal canal having an ill-defined periapical radiolucency. The patient was scheduled for non-surgical endodontic retreatment. Gutta-percha removal was done using M-pro rotary files and hand H-files. During negotiation of the mesiobuccal canal, a lateral perforation was detected in the middle third. Upon cone beam computed tomography (CBCT) examination, a separated instrument was observed in mesiobuccal canal at the level of the perforation. The original pathway of the canal was re-established using precurved manual k-files under high magnification. All canals were prepared using E-flex rotary NiTi files with 2.5% NaOCl irrigation. The perforation was sealed during obturation using a calcium-silicate based root repair material. At 3-month follow-up, the patient was asymptomatic with evidence of periapical lesion healing. **Conclusion:** The use of CBCT, and advancement in magnification, illumination, rotary instrumentation and disinfection played great role in lateral mid-root perforation management. Calcium-silicate based cements as a perforation repair material showed favorable clinical and radiographic outcome.

Keywords: Perforation repair, calcium-silicate, mid-root perforation.

Introduction

The ultimate goal of endodontic therapy is to prevent or heal apical periodontitis. Apical periodontitis is an inflammatory disease of the periapical tissue caused mainly by root canal infection. The key for successful and predictable endodontic treatment outcome is thorough root canal disinfection followed by three-dimensional obturation to provide a hermetic seal between root canal filling materials and radicular dentin. However, procedural errors such as missed canals, ledges, separated instruments, and root perforations may cause endodontic treatment failure. **(Gulabivala and Ng, 2023)**

Post-treatment apical periodontitis can be managed either by non-surgical or surgical endodontic retreatment. The first treatment choice for inadequately root-filled teeth is non-surgical endodontic retreatment; aiming to eliminate or reduce the microbial load, remove infected root filling material, and

finally disinfect and re-obturate the root canal system. **(Torabinejad and White, 2016)**

Root perforation is a pathological or iatrogenic communication between the root canal space and periodontal tissues. Pathological root perforation caused mainly by root resorption or extensive tooth decay. On the other hand, iatrogenic root perforation is a significant complication that may occur during different stages of root canal treatment as well as during post space preparation. **(Clauder, 2022)**

The presence of root perforations is one of the main factors that may compromise the outcome of non-surgical endodontic retreatment because of the prolonged periodontal break down associated with pathological or iatrogenic perforations. Root perforation repair can be done surgically or non-surgically depending on the location and size of the perforation. Sometimes, orthograde repair of root perforations is very challenging because of the limited visualization and accessibility to the perforation site. However, technological advancement such as CBCT improved identification and management of root perforations. Furthermore, the improved magnification of the Dental Operating Microscope (DOM) enhanced the prognosis of non-surgical perforation repair. **(Clauder, 2022)**

Calcium-silicate based cements are the material of choice for root perforation repair; premixed bioceramic putty is a bioactive root repair material with superior handling properties, promoting hydroxyapatite formation **(Dawood et al., 2017)**. NeoPutty is delivered as a ready-to-use material for immediate placement with zero waste, saving cost and chair time. Its firm, non-tacky consistency, wash-out resistance and bioactivity makes it the preferred material for sealing perforations.

Therefore, this case report describes the successful non-surgical endodontic retreatment of a maxillary first molar with lateral perforation repair using a novel calcium-silicate based cement.

Case report

This case report has been written according to the Preferred Reporting Items for Case reports in Endodontics (PRICE) 2020 guidelines. A 38-year-old female patient was referred to the Department of Endodontics, Faculty of Dentistry, Cairo University for non-surgical retreatment of a maxillary left first molar. The patient had a mild pain on biting. The medical history was non-contributory. Previous dental history revealed a primary root canal treatment for the maxillary left 1st molar (tooth #26).

Clinical examination revealed that tooth #26 had a defective composite resin restoration. The patient reported tenderness to percussion and palpation. There was no mobility, swelling or sinus tract and periodontal probing depth was with in normal limits. The radiographic examination for tooth #26 showed inadequate previous root canal filling with a missed mesiobuccal canal. An ill-defined periapical radiolucency related to the mesiobuccal root was observed (Fig.1A,B). According to the patient's signs and symptoms, clinical and radiographic findings; tooth #26 was diagnosed as previously treated with symptomatic apical periodontitis. The proposed treatment plan was non-surgical endodontic retreatment for tooth #26. The procedural steps and possible complications were discussed with the patient, then an informed consent was obtained before treatment.

On the first visit, local anesthesia was achieved with buccal infiltration injection using 1.8 ml of 4% Articaine with epinephrine (1:100,000). After removal of the defective coronal restoration, the access cavity was modified, and isolation was achieved using rubber dam. Gutta-percha removal was performed using M-pro rotary files (IMD; China) and H-files (Mani Inc.,

Kiyohara Industrial Park, Utsunomiya, Tochigi, Japan) with 2.5% NaOCl irrigation. Residual root canal filling was removed with the aid of XP-Endo Shaper (FKG Dentaire SA, La Chaux-de-Fonds, Switzerland).

For the palatal and distobuccal canals, apical patency was successfully achieved, and the working length was determined using E-PEX electronic apex locator (Eighteeth; Changzhou City, China). Complete mechanical preparation was done using E-Flex gold and blue NiTi rotary files (Eighteeth; Changzhou City, China) at a rotational speed of 350 rpm and 2 Ncm torque till size #35/.04 with 3 ml of 2.5% NaOCl irrigation between the successive files. During negotiation of the mesiobuccal canal, a lateral perforation was detected in the middle third of the root (Fig.1C). Reestablishing the original pathway of the canal was attempted using manual k-files (Mani Inc., Kiyohara Industrial Park, Utsunomiya, Tochigi, Japan), however the canal was blocked (Fig.1D). The tooth was sealed with a temporary filling material, then a CBCT scan (90 kVp, 8 mA, 15 s and a 75 µm voxel size) was requested.

The coronal and sagittal CBCT scanning images showed a radiopaque object obstructing the pathway of the mesiobuccal canal (Fig.1E). The exact location of the perforation and the mesiobuccal canal length beyond the perforation level were determined by measuring the distance from the root apex up to the perforation site using the measurement tool on the CBCT software (Planmeca Romexis). The lateral perforation was located on the buccal surface of the mesiobuccal root about 6 mm from the root apex (Fig.1F). In addition, a well-defined periapical radiolucency related to the distobuccal root was observed (Fig.1E).

On the second visit, mesiobuccal canal negotiation and apical patency was achieved by means of bypassing using small pre-curved manual k-files (#10 and #15) (Mani Inc., Kiyohara Industrial Park, Utsunomiya, Tochigi, Japan) under high magnification (Fig.1G). Mechanical preparation was performed using E-flex blue NiTi rotary files (Eighteeth; Changzhou City, China) at a rotational speed of 350 rpm and 2 Ncm torque till size #30/.04 with 2.5% NaOCl irrigation. For better canal disinfection, NaOCl irrigation was activated using XP-Endo Finisher rotary file (FKG Dentaire SA, La Chaux-de-Fonds, Switzerland) at 800 rpm for 60 seconds in each canal. After that, the canals were dried, and a periapical radiograph was taken for master cone verification (Fig.1H).

Root canal obturation in the palatal and distobuccal canals was done using cold lateral compaction technique. For the mesiobuccal canal, Cera Seal bioceramic sealer (Meta biomed, Cheongju-si, Chungbuk, Korea) was injected into the apical third of the canal, then a master gutta-percha cone (#30/.04) was introduced into the canal and severed with a heat plugger beyond the level of the perforation (Fig.1I). After that, the middle and coronal thirds were sealed with a premixed bioceramic putty (NeoPutty) (Avalon Biomed, Houston, United States) (Fig.1J). Finally, the tooth was temporized, and a postoperative radiograph was taken to confirm the obturation quality (Fig.1K). One week later, the patient was asymptomatic and was referred to the Operative Dentistry department and the tooth was restored with a composite resin restoration. At 3-month follow-up, the patient was asymptomatic with radiographic evidence of bone healing (Fig.1L).

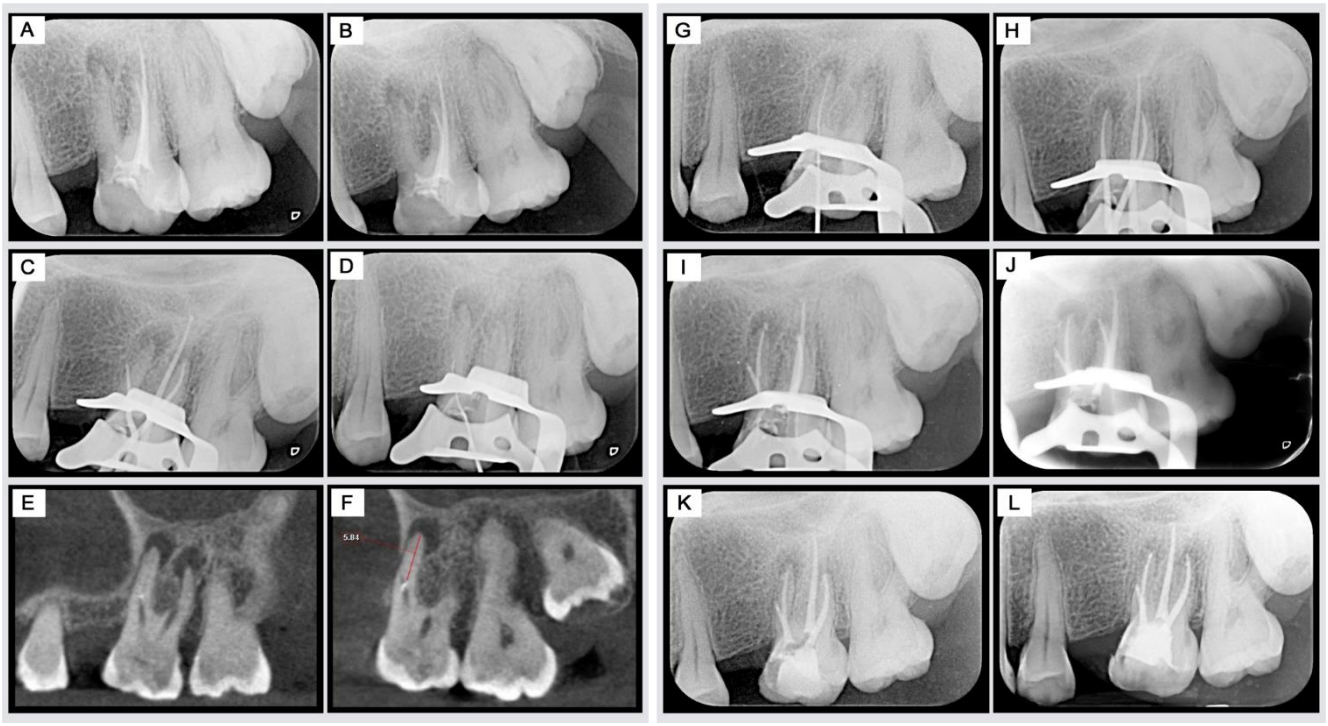

Figure (1): (A,B): Pre-operative radiographs at different angulations, (C): Master cone radiograph showing strip perforation at the middle third of the MB root, (D): Blockage at MB canal pathway, (E,F): CBCT images showing radiopaque object in middle third of the MB canal with a lateral perforation located 6 mm from the root apex, (G): Apical patency for the MB canal, (H): Master cone radiograph, (I,J): MB canal obturation, (K): Post-operative radiograph, (L): Follow up radiograph after 3 months.

Discussion

The prevalence of post-treatment apical periodontitis in endodontically treated teeth is usually associated with inadequate root canal treatment. In this case, tooth preservation decisions could include either surgical or non-surgical endodontic retreatment. When non-surgical endodontic retreatment is the proposed treatment plan, then gaining access to the root canal space is essential for removal of the infected root canal filling, addressing deficiencies and repair of any iatrogenic or pathological defects if present. **(Ruddle, 2004)**

In the present case, gutta-percha removal was done using both hand and rotary files to improve the cleaning ability and minimize the percentage of remaining gutta-percha and sealer. The supplementary use of XP-Endo Shaper increased the cleaning efficiency and improved the removal of residual filling material **(Yang et al., 2022)**. Furthermore, XP-Endo Finisher was used for irrigant activation because of its ability to develop a spoon shape in the body temperature as well as the helical movement that allows it to reach previously untouched areas of the canal walls **(Carvalho et al., 2019)**.

The lateral perforation in the mesiobuccal root presented a difficulty in obtaining the original canal pathway which was furtherly complicated by the presence of a separated instrument into the canal. Management of separated instruments could be done either by a conservative or surgical approach; a conservative approach involves bypass or retrieval of the broken fragment. In this case, the separated instrument was bypassed as retrieval requires removal of excessive amounts of dentine which may cause further weakening of the tooth structure. **(McGuigan et al., 2013)**

In addition, iatrogenic root perforation negatively affects endodontic treatment outcome by eliciting an inflammatory response which may cause periodontal tissue damage and alveolar bone resorption. The inflammatory reaction may result in granulation tissue formation, epithelial proliferation, and periodontal pocket development **(Saed et al., 2016)**. The prognosis of teeth with root perforations also depends on location and size of the perforation, time interval till perforation repair, presence of a pre-operative radiolucency adjacent or periapical to the perforation, accessibility to the main canal, and sealing ability of the perforation repair material **(Siew et al., 2015)**.

Regarding root perforation location, the present case would have a favorable prognosis since the location of root perforations relative to the level of the crestal bone has a considerable impact on prognosis. Root perforations occurring in the critical zone at the level of the crestal bone have the worst prognosis because of their close proximity to gingival tissues, which in turn increases the risk of bacterial contamination. On the other hand, perforations occurring beyond the critical zone at the middle and apical root thirds have a good prognosis, since these areas provide better accessibility with less risk of bacterial contamination **(Siew et al., 2015)**.

In the present case, the perforation was sealed non-surgically because it was in the middle third of the root with sufficient access through the pulp chamber. Additionally, the use of DOM played an effective role in locating the exact perforation site. Traditionally, root perforations were managed surgically, but with the advancement in magnification and illumination, non-surgical perforation repair become more feasible. **(Biswas et al., 2011)**

Perforation repair was performed using NeoPutty which is a premixed bioceramic putty to be used as a root repair material. Mineral trioxide aggregate (MTA) was considered the material of choice for sealing root perforations because of its biocompatibility, excellent sealing ability, antimicrobial activity, osteoconductive potential, and ability to set in the presence of moisture **(Torabinejad et al., 1995)**. However, MTA has prolonged setting time and difficult handling properties **(Kaur et al., 2017)**. Other calcium-silicate based materials such as premixed bioceramic putty can serve as a perforation repair material with favorable soft tissue response. Compared to MTA, bioceramic putty has a relatively short setting time and better handling properties. Premixed bioceramic putty was proved to enhance the fracture resistance of root-filled teeth with strip perforations to be equal to that of molars without strip perforation **(Kabtoleh et al., 2023)**.

Conclusion

The use of CBCT, and advancement in magnification, illumination, rotary instrumentation and disinfection played great role in lateral mid-root perforation management. Calcium-silicate based cements as a perforation repair material showed favorable clinical and radiographic outcome.

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