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CASE REPORT

Conservative Management of a Maxillary Lateral Incisor with an Apical Third Root Perforation: A Case Report

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ABSTRACT

Perforation is one of iatrogenic factors responsible for endodontic failure. Root canal perforation can occur at the cervical, mid-root, or apical levels. Non-surgical (conservative) perforation repair offers less tissue destruction and easy isolation during treatment. **Objective:** To explain the management of apical third root perforation using the conservative technique. **Case Report:** This case report describes a 29-year-old patient who came for management of right maxillary lateral incisor with apical third root perforation on the labial aspect. The location of apical third root perforation was evaluated using cone beam computed tomography (CBCT). Root perforation was sealed using mineral trioxide aggregate (MTA). MTA was applied in conservative technique with hand filling. MTA was dispensed into the original canal while maintaining the patency of the perforated canal, followed by dispensed of MTA into the perforated canal. **Conclusion:** Root perforation should be identified as soon as possible and could be easily examined using CBCT. Non-surgical root perforation treatment is recommended in intact periodontal attachment and in absence of inherent complication. Repairing the root perforation promote the proper healing of the periapical tissue and increase the success rate of retreatment.

Key words: conservative management, maxillary lateral incisor, mineral trioxide aggregate, root perforation

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INTRODUCTION

Retreatment is usually recommended for symptomatic or asymptomatic teeth subjected to an improper endodontic treatment. Endodontic failure is caused by local factors, such as infections, incomplete debridement of the root canal system, excessive hemorrhage, overinstrumentation, chemical irritants, corrosion of root canal fillings, anatomic factors, root fractures, traumatic occlusion, periodontal considerations, and iatrogenic errors. Iatrogenic factors include separated instruments, canal blockage and ledge formation, incompletely filled teeth, root canal overfilling, and perforation.¹

Perforation refers to the mechanical or pathological communication between a root canal and an external tooth surface, and this procedure is performed during

cavity access preparation or instrumentation. A root canal can be perforated at cervical, midroot, and apical levels.¹ It can be repaired in two ways; nonsurgically by approaching defects internally through the affected tooth or surgically by using an external approach through periradicular tissues. Nonsurgical treatments are less invasive than surgical treatments because the former cause a lesser degree of destruction to periradicular tissues and are more easily isolated from microbes during treatments.²

A perforation is repaired using different materials, including amalgam, calcium hydroxide, IRM, Super EBA, gutta-percha, glass ionomer cement, biodentine, mineral trioxide aggregate (MTA), and various composite materials.^{1,2,3} Among them, MTA can be used as root end filling reparation cement, apical plug formation, and direct pulp capping.⁴ It is biocompatible

because it rarely elicits any response from periapical tissues, exhibits a good sealing ability, and shows a high degree of clinically favorable long-term outcomes when it is used as a perforation repair material.

A root perforation often occurs during endodontic treatment. This case report aims to explain the management of the apical third root perforation by using a conservative technique. Nonsurgical (conservative) perforation repair offers a low degree of tissue destruction and easy isolation during the treatment. This conservative technique is a potential alternative before surgery, intentional replantation, or extraction becomes necessary.

CASE REPORT

A 29-year-old female patient came to the Conservative Dentistry Clinic of Prof. Soedomo Dental and Oral Hospital, Universitas Gadjah Mada and primarily complained of discoloration, dental filling failure, and pain in the right upper anterior tooth upon contact with an antagonist. She underwent a root canal treatment on her right upper anterior tooth about 5 years ago and experienced the pain about 2 months ago. She lost the left side of the complained tooth, which was identified to be tooth 11 by using the dental numbering system of the World Health Organization, because it was extracted for orthodontic treatment about 5 years ago.

Intraoral examination revealed composite restoration with poor marginal adaptation on the mesiolabial and palatal surface and the discoloration of the right maxillary lateral incisor (tooth 12). An enamel crack was observed on the labial surface. Tooth examination indicated positive percussion, negative palpation, and zero mobility. Gingival examination showed a stippling texture without a periodontal pocket or gingival recession. Tooth 11 was lost, and tooth 12 was in contact with tooth 21 (Figure 1).

The periapical radiography of tooth 12 revealed a cavity on the medial aspect. The examination of the tooth also showed underfilling obturation with a periapical lesion. The periodontal ligament of the medial and distal aspects was widening at the apical third (Figure 2A).

A cavity access was prepared on the palatal surface of tooth 12. The gutta-percha on the pulp chamber and root canal was removed using a heat carrier plugger (Dentsply, Switzerland), a Hedstrom file (Dentsply, Switzerland), and a gutta-percha solvent (Citrol, Biodinamica, Brazil). Another periapical radiograph was taken to confirm the gutta-percha removal. The old restoration and caries lesions were then removed using a diamond round bur and a carbide round bur until only the healthy enamel and dentin remained (Figure 2B, 2C).

Figure 1. (A–E) Pretreatment intraoral photographs. The black arrows show the clinical view of tooth 12.

Figure 2. (A) Periapical radiograph before the removal of the gutta-percha. Periapical radiograph of the underfilling obturation, (B) Periapical radiograph after the removal of the gutta-percha, and (C) Clinical view after the removal of the old restoration.

The working length estimated from the diagnostic radiograph was 22.5 mm. This result was then confirmed using an apex locator (Propex Pixi, Dentsply, Switzerland) and a periapical radiograph. Periapical radiography revealed that the tip of K-file #25 (Dentsply, Switzerland) was located about 1 mm from the apex. In this working length, the patient experienced pain when the K-file was inserted into the root canal. As such, a cone-beam computed tomography (CBCT) radiographic examination was performed. The CBCT radiographic examination showed that the labial aspect of the apical third root was perforated (Figure 3).

Figure 3. CBCT examination of the root perforation. The white arrows show the location of the root perforation. The black arrow indicates the original root canal.

In the right maxillary lateral incisor (tooth 12), the dentin was excessively lost, and the apical third root on the labial aspect was perforated. The decision to provide nonsurgical perforation management was made after the patient learned about her different treatment options and signed the informed consent. The case report was prepared with the patient's consent.

The root canal was carefully negotiated by using K-file #10 under rubber dam isolation and by directing the K-file along the palatal wall of the root canal until the working length (22.5 mm) was achieved. Then, the negotiation was confirmed using an apex locator. The patient did not feel any pain when the K-file was inserted using this method. This condition indicated that the original glide path was found. The negotiation was continued using K-file #15 until the same working length was obtained. Glide path and root canal preparation instruments were inserted by directing them along the palatal wall of the root canal.

The root canal of the apical third was prepared using a conventional technique. K-files #20, #25, #30, #35, and #40 were used in filling and reaming motion with a working length of 22.5 mm. The root canal was irrigated with 2 mL of 2.5% NaOCl and rinsed with distilled water between each instrument used. The root canal was dried using a paper point and dressed with calcium hydroxide paste. The cavity was sealed with temporary restoration, and another appointment was set one week later.

The patient did not experience pain until the next visit. Her intraoral examination revealed good temporary restoration, positive percussion, negative palpation, and zero mobility. The temporary filling was removed, and her root canal was irrigated with a copious amount of 2.5% NaOCl and distilled water. Root canal preparation and dressing were repeated to obtain an asymptomatic condition. The root canal was prepared with K-file #40 at a working length of 22.5 mm in circumferential motion. Calcium hydroxide was used as intracanal medicament for one week.

Figure 4. Periapical radiograph of tooth 12 after MTA placement. Root perforation was sealed with MTA.

Subjective examination revealed no pain complaint between visits, and intraoral examination showed an asymptomatic condition. Tooth 12 was isolated using a rubber dam, and the temporary filling was removed. The root canal was irrigated with 2.5% NaOCl for 5 min, 17% EDTA for 1 min, and 2% chlorhexidine for 30s. Distilled water was used between irrigated solutions

The perforated root was sealed using MTA (ProRoot MTA, Dentsply, Switzerland). MTA powder and distilled water were mixed in accordance with the manufacturer's instructions. MTA paste was inserted into the root canal with a microapical placement (MAP) System (Dentsply, Switzerland) and a hand plugger (Dentsply, Switzerland). MAP was inserted into the root canal and directed toward the palatal aspect. Afterward, MTA was dispensed, and a small file was inserted toward the perforation. MTA was condensed using the hand plugger until the canal furcation, and a small file was removed from the canal. The MAP was inserted again into the root canal and directed toward the labial aspect. MTA was dispensed into the perforated canal and condensed with the hand plugger until it was slightly coronal to the root perforation and about 6 mm from the apex. A moist cotton pellet was inserted into the pulp chamber to help the MTA set. The cavity was sealed with a temporary restoration, and periapical radiography was conducted (Figure 4).

After one week, the set recall appointment revealed no pain complaint between visits, and intraoral examination showed good temporary restoration, negative percussion, negative palpation, and zero mobility. The final restoration was carried out with a prefabricated fiber post (Dentsply, Switzerland) and a lithium disilicate glass ceramic. The color of the porcelain crown was selected using a shade guide by synchronizing with the next tooth, and the chosen color was A3. A temporary composite resin crown was inserted while the crown was being made in our laboratory.

Figure 5. (A) Clinical view after the cementation of the lithium disilicate glass ceramic crown (black arrow). (B) Periapical radiography after the treatment.

Figure 6. (A) Labial view after 27 months of evaluation. (B) Palatal view after 27 months of evaluation. No gingival inflammation was observed. (C) Radiographic view after 27 months of evaluation. No periapical lesion was detected, and a decrease in the widening of the periodontal ligament was found.

The recall appointment revealed that the temporary crown was in good condition, and no gingival inflammation around tooth 12 was detected. The temporary crown was removed using a crown remover. A lithium disilicate glass ceramic crown was cemented with self-adhesive resin cement (RelyX U200, 3M ESPE, USA) and cured on each side for 20 s. A traumatic occlusion was checked with articulating paper. Periapical radiography showed a good contact area and good marginal adaptation between the crown and the teeth. After one week, another recall appointment was set. No pain and no gingival inflammation around tooth 12 were recorded (Figure 5).

In the recall appointment 27 months later, no pain complaint was recorded. In the intraoral examination, good temporary restoration, negative percussion, negative palpation, zero mobility, and no gingival inflammation around tooth 12 were observed. In periapical radiography, no periapical lesion was detected, and a decrease in the widening of the periodontal ligament was found (Figure 6).

DISCUSSION

In this case report, the patient needed endodontic retreatment, perforation repair, intracanal retention, and crown restoration. The periapical inflammation attributed to the incompletely filled teeth and root perforation indicated endodontic failure. These conditions allowed the initial bacteria to survive in the root canal or new bacteria to enter the root canal via the apical foramen and the root perforation. Repairing the root perforation and sealing the apical foramen promote the proper healing of the periapical tissue and increase the success rate of retreatment because these procedures prevent (1) the leakage of bacteria, (2) the leakage of nutritional elements, (3) the influx of the periapical fluid, and (4) the influx of the released bacterial elements.⁵

Root perforation can be recognized by placing an instrument into the opening and taking a radiograph, using a paper point, observing the sudden onset of bleeding, and complaining of pain by patients when the instrument touches the periodontal tissue.¹ In the present case, periapical radiography was conducted to confirm the working length, but it did not reveal any perforation. The tip of the K-file was located about 1 mm from the apex, but the patient experienced pain when the K-file was inserted into the root canal at this working length. However, periapical radiography hinders the accurate detection of a perforation because the perforation occurs in the labiopallatal plane.⁵ Root perforation is often difficult to localize with conventional imaging, including periapical radiography, because no information about the buccolingual dimension can be obtained. In our case, further CBCT examination showed the root perforation at the labial aspect of the apical third. CBCT can present dental and pulpal structures in full 3D representation and in thin slices in all anatomic planes, i.e., axial, sagittal, and coronal planes. With this capability, this technique can be applied to visualize the root morphology, which is usually not observable via conventional imaging.²

The prognosis of perforation repair depends on the size, location, time of diagnosis and treatment, visibility, accessibility, degree of periodontal damage, infection control, skill of operators, and sealing ability and biocompatibility of repair materials.^{1,2,6} In the present case, the perforation was large (more than #20 endodontic instrument), old, and located at the apical third of the root. It was also found at the apical to the crestal bone, and epithelial attachment had good prognosis because of the absence of communication with the oral cavity; however, a large old perforation has a questionable prognosis.^{1,6}

A root perforation can be repaired using a conservative treatment (nonsurgical) or a surgical technique depending on the size and location of perforations.⁷ A conservative treatment is recommended for a small perforation, which is easily accessible, has an intact periodontal attachment, has no pocket formation, and has no inherent complication.^{1,7,8} Surgical intervention is reserved in cases when conservative treatments cannot be performed, patients' failure to respond to conservative treatments, or periodontal management is required.⁷ In the present case, tooth 12 had a large perforation, a widened periodontal ligament only at the apical third of the root without a periapical lesion, no periodontal pocket or gingival recession, and zero mobility. A conservative retreatment is initially considered with appropriate diagnosis and advanced biomaterials to improve prognosis without the risk of damaging root structures or apical tissues.^{5,9}

In our case, the root canal perforation was repaired using MTA because this substance has excellent sealing, antibacterial, biocompatible, and hydrophilic properties. Therefore, it is resistant to moisture.⁸ The MTA used in our case consisted of Portland cement (75%), bismuth oxide (20%), and calcium sulfate dihydrate or gypsum (5%). The Portland cement component in this white MTA was composed of tricalcium silicate, dicalcium silicate, and tricalcium aluminate. MTA has a working time of 5 min and sets within 4 h.¹⁰ When MTA in contact with tissue fluid is set, calcium oxide is converted into calcium hydroxide. Calcium hydroxide then dissociates into calcium and hydroxyl ions, thereby increasing the pH to approximately 12.5 and releasing calcium ions. The bioactive properties of MTA are indicated by the dissolution of calcium, which subsequently complexes with phosphate to form hydroxyapatite crystals. These crystals grow and fill the space between MTA and the dentin, and this mechanical layer becomes a chemically bonded seal over time. The sealing ability and bond of MTA are better than those of other dental materials because of its bioactive properties.^{4,10} MTA also expands by less than 0.1% when it sets, so its expansion helps create a barrier.¹¹

Coronal and radicular accesses to defects are prepared before a perforation is repaired conventionally. A root canal is instrumented to create a sufficient coronal shape that protects the root canal from blockage by MTA. A disinfectant irrigating solution of 2.5% NaOCl is used, but it may cause severe complications via NaOCl extrusion through the perforation.² Sterile water can be utilized as an irrigation solution to prevent complications caused by its extrusion into the periradicular tissue, but it does not have antibacterial activities. Chlorhexidine can be an alternative solution if it does not cause allergic reactions.¹²

Garg and Garg explained the management of perforation in the apical third of the root.¹ MTA is dispensed into

a perforation site by using an MTA carrier (MAP) and condensed with pluggers or a paper point. A file or other instruments are placed into the canal while placing MTA to maintain the canal patency. The file is moved up and down in short strokes (1–2 mm) until MTA sets to avoid the file from being frozen in the MTA. A moist cotton pellet is placed over MTA to hydrate its repair material, and the tooth is sealed to allow MTA to set. A root canal can be obturated in the next appointment.^{1,2} Ultrasonic energy transmission can be administered after MTA condenses. When the coronal extent of the file touches the ultrasonic tip to vibrate MTA, MTA “slumps” into the defect when direct condensation is impossible. In the present case, MTA was applied to the root perforation and the main root by using a hand filling method until it was slightly coronal to the perforation. Some studies have revealed that ultrasonic energy can enhance MTA sealing against bacteria; however, other studies have shown that the wall adaptation of MTA is poorer when the apical extent of the canal is subjected to ultrasonic condensation filling than when it is subjected to hand filling.²

Moisture is a critical component that allows MTA to set and establishes the optimal properties of MTA.⁴ In our case, a moist environment was created by drying the root canal with a paper point before MTA was applied; then, a moist cotton pellet was placed over MTA. A deficient moisture content may lower the properties of MTA, whereas excessive moisture may wash out MTA during setting and increase its porosity. Moisture from the teeth and surrounding tissues may also influence the setting of MTA. Exposure to serum also affects the hardness and setting time of MTA. Exposure to blood compromises the resistance, compressive strength, and microhardness of MTA.⁴

The final restoration in the present case was carried out with a prefabricated glass fiber post and a porcelain crown. A post should be used when the remaining tooth structure is insufficient to support the final restoration. It helps retain the core and distribute stress through the radicular dentin to the root apex.¹ In our case, a glass fiber post was selected because its modulus elasticity is similar to that of dentin; as such, the peak stresses inside the root are low. The glass fiber post was made of a high percentage of continuously stretched unidirectional reinforced glass fibers embedded in a polymer matrix, which retained the fibers intact. These fibers provide resistance against flexure, while the resin matrix offers resistance against compression stress.¹³

The fracture resistance of the teeth decreases as more tooth structures are lost because of decay, dental procedures, and endodontic therapy.¹ In our case, full crown restoration was selected because a significant amount of the coronal tooth structure was lost due to caries, previous restoration, and endodontic procedure. Ceramics are preferred for long-term esthetic indirect restoration. For example, lithium disilicate is a new

ceramic material that offers high strength, high fracture toughness, and high translucency degree.² A lithium disilicate glass ceramic is primarily applied to an anterior crown, a premolar crown, and an anterior three-unit bridge. It is also applied to anterior laminate veneers, posterior three-unit bridges, and the second premolar. However, this material is not recommended for high-stress posterior conditions, bridges involving the molar teeth, and patients with bruxism.¹¹ Therefore, lithium disilicate provides highly esthetic solutions for color and shape corrections. Its translucency ensures the closest match of the light properties of natural teeth.¹⁴

The healing mechanism of the present case can be associated with the bacteriostatic nature, sealing ability, and bioactivity of MTA that can influence its surrounding environment.^{1,10} MTA can seal the communication pathways between the root canal and periradicular tissues. When MTA comes in contact with periapical tissues, its biocompatibility promotes the healing of inflammation and the formation of connective tissues and the cementum.¹

CONCLUSION

A perforation is an iatrogenic error that should be avoided by proper care during cavity access preparation or instrumentation. A root perforation should be identified as soon as possible and can be easily examined with CBCT. A nonsurgical root perforation treatment is recommended for intact periodontal attachment and in the absence of inherent complications. Repairing the root perforation promote the proper healing of the periapical tissue and increase the success rate of retreatment. In our case, the treatment success is indicated by the absence of patient complaints, negative percussion, negative palpation, zero mobility, no gingival inflammation around tooth 12, no periapical lesion, and a decrease in periodontal ligament widening.

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