CASE REPORT

Treatment of Pulp Floor and Stripping Perforation by Mineral Trioxide Aggregate

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Mineral trioxide aggregate (MTA) has been widely used to repair various kinds of tooth perforations, but its use for obturation of the entire root canal has not been reported. We report two cases of tooth perforation successfully repaired with MTA. The first patient was a 78-year-old male with calcified canal and pulp floor perforation in the left maxillary first premolar. After bypass of the calcified palatal canal, both buccal and palatal canals were filled with gutta percha, and the pulp floor perforation was repaired with MTA. Clinical success with no evident radicular lesion was found at the 18-month follow-up. The second patient was a 51-year-old female with a stripping perforation in a C-shaped root canal of the right mandibular second molar detected after removal of a post. Following root canal debridement and calcium hydroxide therapy to control inflammation at the stripping perforation site, apical and furcation bone healing were observed by radiographic examination. The stripping perforation was repaired by obturation of the entire C-shaped root canal with MTA. Observation at the 9-month follow-up revealed bone healing without any clinical symptoms and signs. These cases suggest that MTA is an alternative root canal obturation material for treatment of stripping perforation in a C-shaped root canal and for repair of pulp floor perforation. [*J Formos Med Assoc* 2006;105 (6):522–526]

Key Words: C-shaped canal, mineral trioxide aggregate, stripping perforation

Perforation of the teeth has been reported to be a major factor in up to 9.6% of endodontic failures.[1] Mechanical and chemical irritants as well as microorganism present in the root canal may induce the inflammation and bony destruction of the periodontium. Repair of furcation and lateral perforation can be performed via a surgical approach or nonsurgical approach by sealing the tooth defect using different materials such as glass ionomer cement, calcium hydroxide, and mineral trioxide aggregate (MTA).[1–3] However, there are few reports describing the treatment of stripping perforation, especially in a C-shaped root canal, which is different from furcation and lateral perforation.

Stripping perforation of the root canal during endodontic treatment is usually caused by enlargement of the cervical shoulder during access preparation by Gates-Glidden drills. Improper filing technique can also lead to stripping perforation in the dangerous zones of roots. This is commonly observed on the distobuccal aspect in the curved or ribbon-shaped mesiobuccal root of maxillary molars, the mesial root of mandibular molars,[4] and the C-shaped root canals in mandibular molars, where the thickness of dentin is minimal.[5] This iatrogenic perforation may induce mechanical trauma to adjacent radicular tissue, leading to periodontal inflammation and evident osseous destruction.[3,4] This kind of perforation shows a dis-

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cernible difference to those of furcal and lateral perforation due to its large affected areas, irregular edge of the perforation site,[6] oval shape, and the lack of an adequate cavity for retention of repair materials. Stripping perforation in C-shaped canal is commonly noted clinically but is especially difficult to repair.

Case Reports

Case 1

A 78-year-old male was referred from a local dentist due to persistent pain in the left maxillary first premolar after root canal treatment. Examination showed that the affected tooth was sealed coronally by temporary cement, and percussion elicited pain. After access opening, a perforation site was noted (Figure 1A), which was confirmed using an apex locator (Root-ZX; Morita Corp, Osaka, Japan). After negotiation with a No. 10 K-file (Mani Inc, Tochigi, Japan) and RC-Prep (Premier Dental Product Co, Plymouth Meeting, PA, USA) at the distal aspect of the perforation site, the calcified palatal canal was identified (Figure 1B). Root canal debridement and shaping of both buccal and palatal canals were performed using K-Flexo files (Maillefer, Ballaiques, Switzerland) with the aid of 2.5% NaOCl. Calcium hydroxide was used as inter-appointment root canal medication, and the access cavity was sealed regularly by intermediate restorative material (IRM®; Dentsply, York, PA, USA). Two months later, the symptoms had resolved and the root canals were filled with gutta percha and Canals (Showa Shizai Kako Co, Japan) by lateral condensation technique (Figure 1C). The pulp chamber and floor were debrided briefly with cotton and by an ultrasonic instrument (ENAC; Osada Electric Co, Tokyo, Japan). Then, the perforation site was repaired with MTA (ProRoot; Dentsply/Tulsa Dental, Tulsa, UK) with the aid of Schilder plugger and moist cotton (Figure 1D,

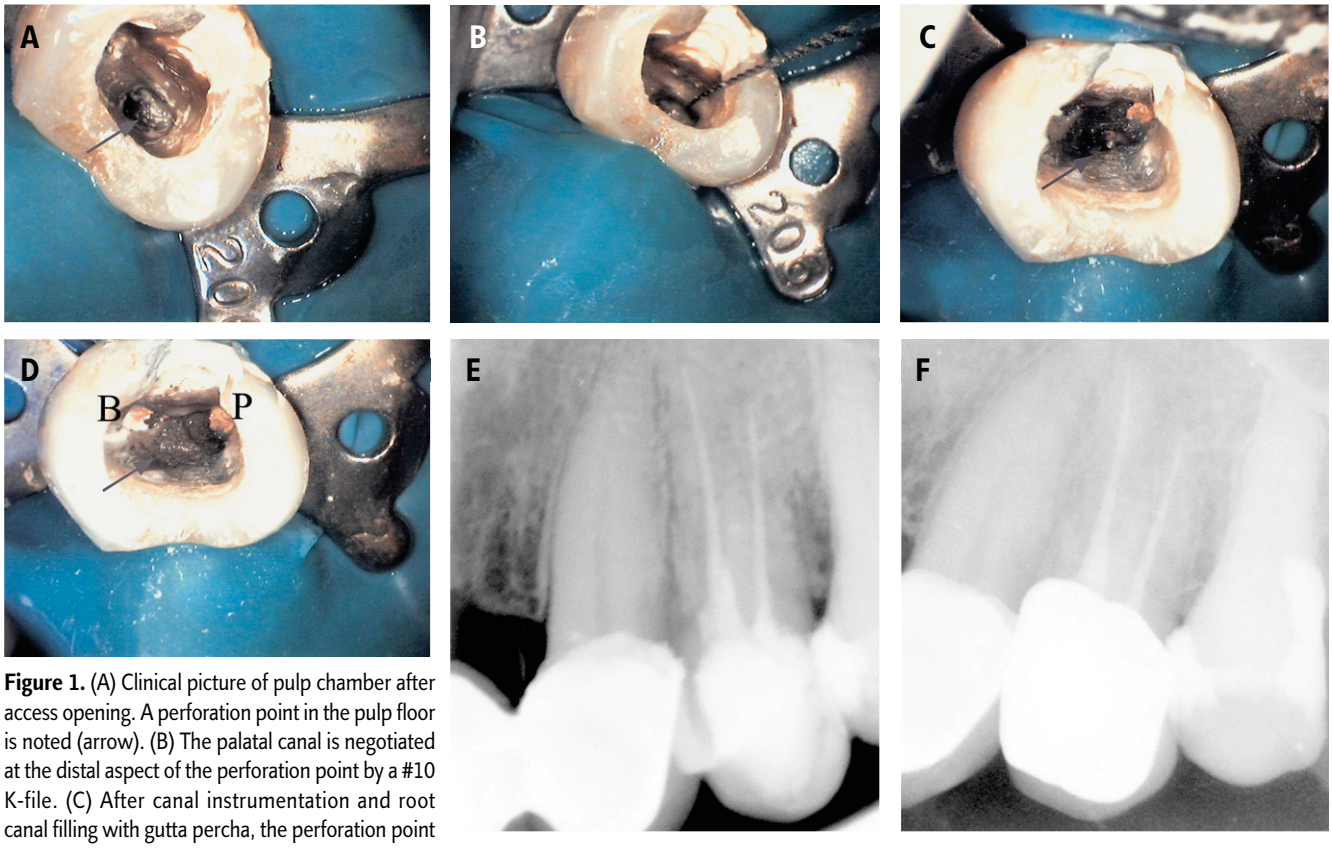

Figure 1. (A) Clinical picture of pulp chamber after access opening. A perforation point in the pulp floor is noted (arrow). (B) The palatal canal is negotiated at the distal aspect of the perforation point by a #10 K-file. (C) After canal instrumentation and root canal filling with gutta percha, the perforation point is well-clarified (arrow). (D) After calcium hydroxide therapy, the perforation point is repaired with mineral trioxide aggregate (MTA) (arrow). (E) Periapical radiograph showing adequate root canal filling and MTA repair. (F) Periapical radiograph at the 18-month follow-up demonstrating adequate bone healing.

arrow). Radiographic examination revealed adequate sealing of the root canal and perforation point (Figure 1E). Follow-up radiographic examination 18 months later showed no obvious radicular lesion (Figure 1F). A PFM (porcelain fused to metal) crown was fabricated without insertion of post and core. The patient had no obvious clinical symptoms or signs at the 18-month follow-up.

Case 2

A 51-year-old female was referred from a local dentist for endodontic treatment of the right mandibular second molar (#47) with necrotic pulp and mild chewing pain. A large area of decay was noted. No evident tooth mobility, deep pocket, or soft tissue swelling around the tooth was found, whereas percussion of the tooth elicited a sensation of slight pain. Radiographic examination revealed evident furcation and apical bone loss, with a possible furcation defect thought to have been created during root canal instrumentation or post placement (Figure 2A). A C-shaped root canal system was suspected from the X-ray. Necrosis of dental pulp with apical periodontitis was diagnosed.

Coronal amalgam and post were easily removed mechanically by a high-speed rotary instrument. A C-shaped root canal system was found (Figure 2B); however, a bloody exudate was observed during exploration of the root canal by hand file. Stripping perforation of the C-shaped root canal was further confirmed by an apex locator. Working length was then determined in the mesial canal and distal C-shaped canals (Figure 2C). Instrumentation was placed, accompanied by irrigation of the root canal with 2.5% NaOCl under rubber dam, and calcium hydroxide was used for root canal medication to control inflammation, dissolve necrotic tissue, and promote periodontal repair. No symptoms or signs were observed during the 10-month calcium hydroxide treatment period and radiographic examination revealed partial bone healing. MTA was used for filling the entire C-shaped canal and repairing the stripping perforation using a Schilder hand plugger for condensation. This procedure was followed by placement of wet cotton over the MTA, and then IRM® was used for coronal sealing. One week later, setting of MTA was observed (Figure 2D), and the mesial canal was then filled with gutta percha and Canals using the lateral condensation technique (Figure 2E). No signs and symptoms were reported by the patient 4 months after root canal filling. Radiographic examination revealed bone healing in the apical region (Figure 2F). Furcation and apical bone healing could be detected by radiography 9 months after root canal filling (Figure 2G). A metal crown was then fabricated with no evident soft tissue lesion (Figure 2H).

Discussion

Various materials such as Cavit, calcium hydroxide, glass ionomer cement and MTA have been used for repair of the furcation and lateral perforation with evident defect cavity for retention of repair materials.[3] However, repair of the perforation in calcified canals should be delayed after finding the original canals to prevent canal obstruction during repair as indicated in case 1. On the other hand, stripping perforations are more difficult to treat because they usually lead to wider ovoid communication between the lateral canal wall and the periodontal tissue.[4] Stripping perforation is usually observed on the distobuccal aspect in the mesiobuccal root of maxillary molars and the mesial root of mandibular molars during canal preparation.[4] C-shaped root canals also pose high risk for stripping perforation because of their thin lingual canal wall,[5] as shown in case 2 of this report. To prevent stripping perforation, the dentist should evaluate the root anatomy from the initial radiograph, and take care of the dangerous zone in C-shaped root canals during filing and post preparation.

The treatment outcome of stripping perforation depends on control of tissue inflammation and clinical symptoms, sealing of the perforation site with biocompatible materials, and prevention of microleakage.[4] Control of bleeding, canal cleansing, and lateral condensation for root canal sealing followed by surgical management to remove

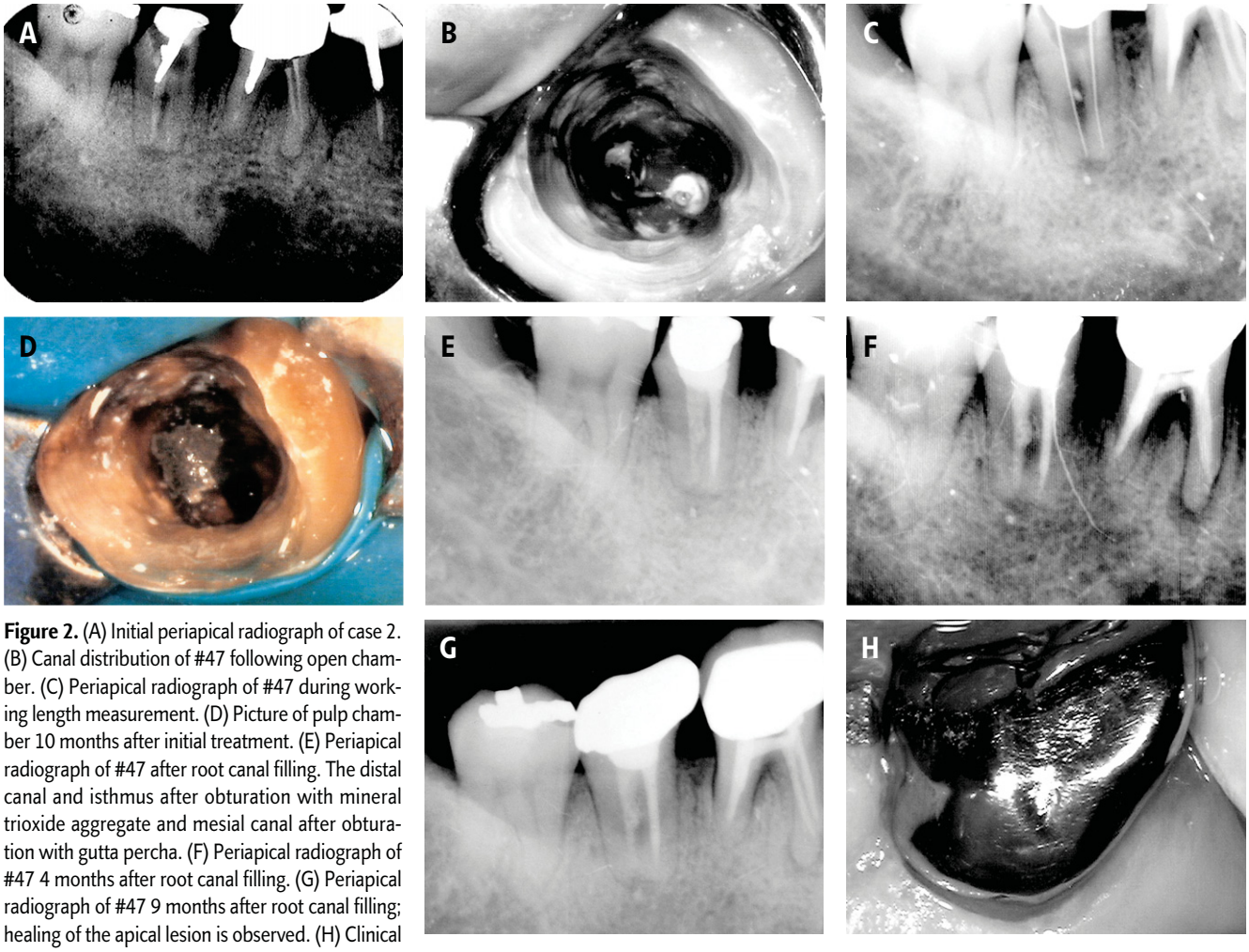

Figure 2. (A) Initial periapical radiograph of case 2. (B) Canal distribution of #47 following open chamber. (C) Periapical radiograph of #47 during working length measurement. (D) Picture of pulp chamber 10 months after initial treatment. (E) Periapical radiograph of #47 after root canal filling. The distal canal and isthmus after obturation with mineral trioxide aggregate and mesial canal after obturation with gutta percha. (F) Periapical radiograph of #47 4 months after root canal filling. (G) Periapical radiograph of #47 9 months after root canal filling; healing of the apical lesion is observed. (H) Clinical picture of #47 9 months after root canal filling; a metal crown has been fabricated and put in place.

excess gutta percha has been suggested for treatment of stripping perforation.[4] Bargholz[2] and Kratchman[7] suggested placing collagen-type material and calcium sulfate prior to MTA packing to repair lateral perforation sites. Zenobio and Shibli successfully corrected the bony defect associated with endodontic perforation by grafting of demineralized freeze-dried bone and guided tissue regeneration.[8] However, these methods are not feasible for the management of stripping perforation in C-shaped canals due to lack of internal matrix and the difficult surgical approach from the lingual furcation in most C-shaped roots. Intentional replantation is another choice that has had some success in the treatment of root perforation,[9] but this method is also difficult for repair of the furcation area of C-shaped root canals. Recently, we reported sealing the apical region of a root canal with gutta percha followed by repair of internal resorption-associated perforation with MTA in a maxillary central incisor.[10] Main et al also successfully used MTA to repair various kinds of perforation.[11] However, our review of the literature found no reports of the use of MTA for obturation of the entire root canal. The successful treatment of stripping perforation in the middle and cervical third of a C-shaped canal by direct MTA condensation in our two patients suggests its potential as an alternative strategy for treatment of stripping perforation of C-shaped canals. MTA has been used for pulp capping, induction of apexification, root end filling, and perforation repair.[12] Recently, we reported that MTA is the most biocompatible repair material for periodontal ligament fibroblasts when compared with amalgam, glass ionomer cement and IRM®.[13] In case

2 of this report, MTA was used to obturate the entire C-shaped root canal 10 months after initial endodontic treatment, and detection of the partial healing of the furcation and apical lesions. Since the MTA could not be removed after setting, calcium hydroxide was used to induce the healing of the periradicular region prior to obturation of the root canal with MTA. Moreover, further management will be difficult if pain develops after sealing of the perforation site with MTA. MTA has been tested *in vitro* as a root canal obturation material using an adherent interfacial hydroxyapatite layer between the MTA and dentin.[14] The successful treatment of stripping perforation with MTA in these two cases highlights the possible usage of MTA as a root canal filling material in stripping perforation. More clinical studies are needed to evaluate the periodontal healing and long-term prognosis of stripping perforation treated by different methods.

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