Healing of Horizontal Intra-alveolar Root Fractures after Endodontic Treatment with Mineral Trioxide Aggregate

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Abstract

Introduction: The purpose of this retrospective study was to evaluate the healing type and assess the outcome of horizontal intra-alveolar root fractures after endodontic treatment with mineral trioxide aggregate (MTA) as filling material. **Methods:** The clinical database of the Department of Conservative Dentistry at Yonsei University Dental Hospital, Seoul, Korea, was searched for patients with histories of intra-alveolar root fractures and endodontic treatments with MTA between October 2005 and September 2014. Radiographic healing at the fracture line was evaluated independently by 2 examiners and was classified into 4 types according to Andreasen and Hjørting-Hansen. **Results:** Of the 22 root-fractured teeth that received endodontic treatment with MTA, 19 cases participated in the follow-up after a period of at least 3 months. Seventeen of the 19 teeth (89.5%) exhibited healing of the root fractures. For each healing type, 7 teeth (36.8%) showed healing with calcified tissue, 8 teeth (42.1%) showed interposition of connective tissue, 2 teeth (10.5%) showed interposition of connective tissue and bone, and 2 teeth (10.5%) showed interposition of granulation tissue without healing. **Conclusions:** Within the limitations of this study, intra-alveolar root fractures showed satisfactory healing outcomes after endodontic treatment with MTA. MTA could be considered to be suitable filling material for the endodontic treatment of horizontal intra-alveolar root fractures. *(J Endod 2016;42:230–235)*

Key Words

Endodontic treatment, healing, horizontal root fracture, mineral trioxide aggregate

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It is generally known that the prognosis of horizontal intra-alveolar root fractures is good with proper diagnosis and treatment (1–6). However, there are also possibilities of pulpal and periodontal complications in the presence of bacterial contamination, and the sequelae of root fractures can be complex. When the pulp goes through degenerative changes, necrosis usually only occurs in the coronal fragment, whereas the pulp of the apical fragment remains vital (7, 8). Therefore, it is recommended that the endodontic treatment of a root-fractured tooth should be mainly limited within the coronal fragment (9) with the intention of achieving hard tissue formation between the fragments. Healing of intra-alveolar root fractures can be divided into 4 types by radiographic and histologic observations (7):

1. Healing with calcified tissue
2. Interposition of connective tissue
3. Interposition of connective tissue and bone
4. Interposition of granulation tissue without healing

The reported frequencies of pulp necrosis in intra-alveolar root fractures were between 22% and 26% (2, 3, 10), and the healing rates after endodontic treatment of the coronal fragment ranged from 71% to 84% (4, 5, 8). However, studies that separately indicated 4 healing types of endodontically treated root-fractured teeth were rare (5), and from other studies, we could only compute the overall healing rates.

Until now, dressing with calcium hydroxide ($Ca[OH]_2$) followed by filling with gutta-percha (GP) and sealer has been regarded as the treatment of choice for the endodontic treatment of root-fractured teeth. However, it is difficult to seal the coronal fragment with GP because it is often hard to obtain an apical stop that is similar to the treatment of immature teeth (8). Considering the short length of the coronal fragment and the vulnerability for reinfection, it is important to seal the coronal fragment properly.

In 1993, mineral trioxide aggregate (MTA) was introduced, and it has been widely used in endodontic procedures because of its superior sealing ability (11), bactericidal effects (12), and biocompatibility (13). Moreover, it induces the formation of cementumlike hard tissue when placed adjacent to periradicular tissues (14). MTA has been recommended for teeth with open apices (15); however, the use of MTA in intra-alveolar root fractures has only been described in a few case reports (16–20). Some authors have stated that it is too early to make a comparison of MTA as an alternative to $Ca(OH)_2$ and GP in root fractures (21). Therefore, the purpose of this retrospective study was to evaluate the healing type and assess the outcome of horizontal intra-alveolar root fractures after endodontic treatment with MTA as the filling material.

Materials and Methods

Case Selection

The clinical database of the Department of Conservative Dentistry at Yonsei University Dental Hospital, Seoul, Korea, was searched for patients with histories of horizontal root fractures and endodontic treatments with MTA between October 2005 and September 2014. Teeth with previous apical periodontitis, extra-alveolar root fractures, lost coronal fragments, and root fractures that occurred after endodontic treatment were excluded from the study.

Treatment Protocol

Except for emergency treatments that occurred outside of normal working hours, all clinical procedures were performed by the endodontic faculty and residents in the Department of Conservative Dentistry, Yonsei University Dental Hospital. Although there were some differences among cases, the major concepts and common treatment procedures were as follows.

At the first visit, the history was taken, and clinical and radiographic examinations were performed. The clinical information from inspection and percussion as well as the mobility test and sensitivity test using ice or an electrical pulp testing instrument was recorded. Periapical radiographs were taken from 2 different angles (straight and vertical 20°) to identify possible root fractures. When the tooth was diagnosed as an intra-alveolar root fracture, the location of the fracture line, diastasis between the fragments, and additional trauma to the tooth were recorded. The coronal fragment was manually repositioned, and the tooth was stabilized with a resin wire splint. Endodontic treatment was performed if pulpal complications (discoloration, increased pain, spontaneous pain, sinus tract, and/or abscess) were found during the follow-up period. Endodontic procedures (pulp extirpation, working length measurement, canal irrigation, and enlargement) were performed and limited to the coronal fragment. When the clinical signs and/or symptoms subsided, the coronal fragment was filled with MTA. MTA was delivered into the root canal by an amalgam carrier for a wide one and by a MTA gun for a narrow one; it was condensed with the bulky side of a sterile paper point within the premeasured length to the fracture line. A postoperative radiograph was taken to verify the correct placement of material. After the fragment was obturated to the appropriate length, a moistened cotton pellet was placed on MTA, and the cavity was filled with intermediate restorative material. At the next visit, the setting of MTA was confirmed, and the access cavity was filled with composite resin. Intracoronal bleaching was performed before the restoration procedure if needed. The tooth was reinforced with a full veneer if it had an extensive crown fracture.

Clinical and Radiographic Evaluation

Follow-up examinations were conducted up to 7 years postendodontic treatment. At every recall visit, a routine examination was performed, and periapical radiographs were taken. Clinical data, including the signs and/or symptoms or loss of function, tenderness to percussion or palpation, subjective discomfort, mobility, sinus tract formation, and periodontal pocket formation at follow-up, were recorded.

The radiographic evaluation was performed at least 3 months after endodontic treatment; Andreasen et al (10) suggested that it is possible to make a reliable determination of the healing type after 3 to 6 months. At the final follow-up, the radiographic healing at the fracture line was evaluated independently by 2 examiners according to the methods of Andreasen and Hjørting-Hansen (7); the healing type was classified into the following 4 types:

1. Healing with calcified tissue
2. Interposition of connective tissue
3. Interposition of connective tissue and bone
4. Interposition of granulation tissue without healing

The Cohen kappa statistic was used to evaluate the interexaminer agreement. Any disagreement was resolved by discussion until an agreement between the 2 examiners was reached.

Assessment of Outcome

The criteria for *healing* included the absence of clinical signs and/or symptoms and radiographic evidence of healing with calcified tissue, connective tissue, or connective tissue and bone. The criteria for *nonhealing* included any clinical signs and/or symptoms or radiographic evidence of an interposition of the granulation tissue without healing. If a tooth was extracted because of the failure of the endodontic treatment, it was recorded as *nonhealing* although the follow-up period was less than 3 months.

Results

We initially identified 22 teeth in 21 patients (66.7% male, 33.3% female) aged 12–65 years (average = 33.5 years) who had horizontal intra-alveolar root fractures and who had received endodontic treatments with MTA between October 2005 and September 2014. Of the 22 teeth, 19 cases (18 patients) participated in the follow-up after a period of at least 3 months (3 months–7 years, average = 3.0 years). The kappa between examiners was 0.77; this result showed substantial agreement according to Landis and Koch (22).

The clinical information and healing type of these 19 evaluated teeth are presented in Tables 1 and 2. The roots of 19 teeth were all completely developed. Seventeen of the 19 teeth (89.5 %) exhibited healing of the root fractures. For each healing type, 7 teeth (36.8%) showed healing with calcified tissue, 8 teeth (42.1%) showed interposition of connective tissue, 2 teeth (10.5%) showed interposition of connective tissue and bone, and 2 teeth (10.5%) showed interposition of granulation tissue.

Discussion

When the pulp becomes necrotic, endodontic treatment of a root-fractured tooth should be performed only in the coronal fragment because the pulp of the apical fragment usually remains vital (7, 8). However, it is difficult to seal the coronal fragment because it is often impossible to obtain an apical stop, such as in an immature tooth with an open apex. $Ca(OH)_2$ has been used to make an apical stop in the immature tooth, but this procedure has some drawbacks; it takes time for the formation of a calcified barrier (23), multiple appointments are required, there is reinfection susceptibility, and it has an adverse effect on the mechanical properties of root dentin (24). For these reasons, it has been proposed that MTA could offer an alternative treatment for teeth with immature roots or open apices (15). Studies have observed higher fracture resistance (25), higher success at inducing apical closure, and greater amount of hard tissue formation with the use of MTA compared with $Ca(OH)_2$ (26). Despite its remarkable biological performances, there have been some clinical problems in using MTA, such as a discoloration potential (27) and the difficulty of its removal after setting (28) that makes it difficult to retreat a failed case and prepare post space in a fractured tooth. We can prevent the complications in a way by limited use of MTA within the deeper part of a root canal; however, it is inevitable if a root fracture occurs at the cervical portion of the root. Nevertheless, considering the short length of the coronal fragment and the vulnerability of reinfection in a root-fractured tooth, it is important to seal the coronal fragment properly. Hence, MTA may be appropriate for the endodontic treatment of intra-alveolar root fractures to improve the prognosis of the teeth.