Long-term Success of Nonvital, Immature Permanent Incisors Treated With a Mineral Trioxide Aggregate Plug and Adhesive Restorations: A Case Series from a Private Endodontic Practice

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Abstract

This case series evaluated the long-term clinical outcome of nonvital immature teeth treated with mineral trioxide aggregate (MTA) as an apical barrier and an adhesive restoration with or without a fiber post. Eighty-three teeth in 72 patients were treated by the first author with an apical MTA plug and an adhesive restoration of composite resin and in 45 of the 83 teeth 1 or more fiber posts. All of the patients had been referred to the first author's private endodontic practice with at least 1 immature tooth with signs of pulpal necrosis and subsequent apical periodontitis that had been caused by a variety of traumatic dental injuries. Three teeth presented had dens invaginatus. Of 83 teeth, 69 teeth in 60 patients were available for follow-up after 5 to 15 years (recall rate = 83%). The mean follow-up time was 8.29 years. No teeth were lost because of a root fracture. Ninety-six percent (66/69) of the recalled teeth were characterized as healed. Based on periapical radiographs and clinical examination, 96% of teeth treated with the MTA barrier technique and adhesive restorations were characterized as "healed" and were in function after 5 to 15 years (mean = 8.29 years). These results indicate that this is a viable and predictable treatment approach for the long-term success of nonvital immature teeth. *(J Endod 2017;■:1–8)*

Key Words

Apical barrier technique, clinical outcome, fiber posts, mineral trioxide aggregate, nonvital immature teeth, root strengthening

Significance

Nonvital immature teeth treated with an MTA apical barrier and adhesive restorations healed and remained in function for up to 15 years with no fractures. It can be concluded that this treatment approach is viable and predictable for long-term tooth survival.

Treatment of young permanent teeth with pulpal involvement is an endodontic and restorative challenge. When pulp vitality is lost, dentin formation stops, resulting in a tooth with thin dentin walls that are prone to fracture. Traditional apexification procedures used calcium hydroxide (1), and successful outcomes are reported (2–5). However, it is a lengthy procedure requiring 5 to 20 months (6) and multiple appointments. During this period, the tooth is restored temporarily with the risk of fracture (3). In addition, several *in vitro* studies reported a reduction in the mechanical properties of radicular dentin after exposure to calcium hydroxide for 5 weeks or longer (7).

Mineral trioxide aggregate (MTA) was introduced in 1993 (8) and has been studied extensively since that time. Its commercial introduction as ProRoot MTA began in 1998 (Tulsa Dental Specialties, Tulsa, Ok). It is part of a class of materials known as calcium silicate cements and is a bioactive material with excellent biocompatibility and antimicrobial properties with good sealing properties, even in the presence of moisture (9). MTA's drawbacks include a long setting time, handling properties that some clinicians describe as difficult, and dentin discoloration (9, 10).

MTA has been widely used as an apical barrier in immature, nonvital teeth as an alternative to calcium hydroxide apexification (10, 11). The apical MTA barrier technique has proven to be a successful and predictable procedure for nonvital immature teeth (11–15) in either 1 (12, 13) or 2 treatment sessions (13, 14). Several case series and prospective studies with MTA plugs reported high success rates at 1- and 2-year follow-ups (11–14). A recently published 10-year case series of 17 patients with nonvital, immature teeth showed that the apical plug technique was effective (15).

One of the concerns about the apical plug technique is whether teeth with thin dentinal walls are susceptible to root fracture after treatment (16). Studies have reported high short-term (11) and long-term (3) failure rates, primarily because of root fractures. This susceptibility to root fractures is often used as an argument to promote the use of revascularization/regeneration as an alternative treatment, with the possibility of continued hard tissue formation, root development, and strengthening of the

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TABLE 1. Diagnosis and Radiographic Findings

Diagnosis, type of trauma/anomaly	Number of teeth treated	Number of teeth with preoperative periapical radiolucency	Number of teeth without preoperative periapical radiolucency	Number of teeth with previous treatment	Number of teeth without previous treatment	Number of teeth recalled	Number of teeth without periapical radiolucency at recall	Number of teeth with periapical radiolucency at recall
(Un)complicated crown or crown/root fracture	13	12	1	10	3	11	10	1
(Sub)luxation	26	25	1	12	14	19	19	0
Horizontal root fracture	5	5	0	5	0	5	5	0
Avulsion	9	8	1	5	4	7	7	0
Intrusion	6	5	1	1	5	6	5	1
More than 1 type of injury: (sub)luxation/intrusion/avulsion/horizontal root fracture AND (un)complicated crown or crown/root fracture	21	18	3	10	11	18	17	1
Dens invaginatus	3	3	0	1	2	3	3	0
Total	83	76	7	44	39	69	66	3

root structure (17, 18). Although periapical healing on a radiograph is impressive, a true "patient-centered" outcome is long-term tooth retention after treatment, including normal function and comfort. Because there are limited long-term data in the endodontic literature on the "apical plug" technique, the first author, in 2015, undertook a recall of all the patients she treated with this technique in her practice between 2000 and 2010 (83 teeth in 72 patients, 5- to 15-year recalls). The results are reported in the sections that follow.

Materials and Methods

Patient/Tooth Characteristics

All of the patients in this case series were referred to the first author's private endodontic practice with at least 1 immature tooth in need of treatment. Between 2000 and 2010, a total of 83 teeth were treated in 72 patients (32 females and 40 males) with an age range of 7–27 years (mean age = 12.9 years).

Seventy-six of the 83 teeth presented preoperatively with an apical radiolucency. Of the remaining 7, 3 teeth were retreated because of an insufficient root canal filling; 2 because of a history of avulsion and intrusion, respectively; 1 because of a complicated crown/root fracture; and 1 because of symptoms after a prior pulpotomy. Of the 83 teeth in the study, 44 teeth had previous root canal treatment before the first consultation. They were obturated with gutta-percha and sealer (26 cases) or a calcium hydroxide dressing (13 cases) or left with an empty pulp canal space (5 cases). Thirty-nine teeth had not received any type of treatment (Table 1). Seventy-seven teeth had a diagnosis of apical periodontitis, 2 had necrotic pulps because of avulsion/intrusion, and 3 had insufficient root canal fillings without a periapical radiolucency. One tooth had a vital pulp, but root canal treatment was indicated for restorative reasons.

In the majority of cases, pulpal necrosis and subsequent apical periodontitis had been caused by a variety of traumatic dental injuries (Table 1). There were 3 teeth in the study that presented with dens invaginatus. In 1 of these, there was a history of trauma.

Endodontic Treatment

The first author treated all of the patients in a similar manner. Informed consent was obtained from the patients and/or parents. Patients received conventional digital radiographs (Digora, Soredex Medical Systems, Helsinki, Finland) with an aiming device (Super-Bite; Kerr Corporation, Orange, CA). Some of the patients who were treated later (4/72) were also imaged with cone-beam computed tomographic imaging (Kodak 9000; Carestream Dental LLC, Atlanta, GA) for diagnostic reasons and more precise treatment planning. Standard testing established a pulpal and periapical diagnosis for each tooth. Periodontal probing, mobility assessment, and evaluation for cracks and fractures were also performed. If a sinus tract was present, it was traced with a gutta-percha point, and a periapical radiograph was made.

Treatment was generally performed in 3 sessions. When internal bleaching was indicated or when there were persistent signs and symptoms, 1 to 2 additional sessions were required.

In the first treatment session, local anesthesia was administered, and the tooth was isolated with a rubber dam. The tooth was accessed with a diamond bur in a high-speed handpiece, and very gentle mechanical (LightSpeed rotary instruments, marketed in its current form by Kerr Corporation) and chemical debridement was performed, including irrigation with sodium hypochlorite 5% (local compounding pharmacy). The apical foramen was gauged with a LightSpeed rotary instrument, and an apex locator (Elements-Diagnostic, Kerr Corporation) was used for electronic working length determination. The indication for an MTA plug was teeth with an apical foramen that gauged to size 70 (0.70 mm) or larger. Otherwise, a traditional root canal filling of gutta-percha and sealer was used. The canals were dried with paper points, an interappointment dressing of calcium hydroxide was applied (UltraCal XS; Ultradent, South Jordan, UT), and the tooth was temporized. The second session was scheduled 3 to 4 weeks later. The calcium hydroxide was removed with ultrasonically activated 5% sodium hypochlorite and 17% EDTA (Vista Dental Products, Racine, WI), and the working length was confirmed. If the patient was asymptomatic and a dry canal could be obtained, treatment proceeded. If those criteria