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Management of Open Apex in a Central Incisor using Mineral Trioxide Aggregate

Abstract: Trauma to an immature tooth can result in pulpal devitalization and arrested apexogenesis, resulting in open apices; this is most common in anterior teeth of the permanent dentition. The attainment of an apical seal in such cases is challenging. The management of an open apex in a central incisor in a 16-year-old male patient is described in this report. The satisfactory result achieved suggests that mineral trioxide aggregate (MTA) can be used successfully as a filling material in teeth with open apices.

Clinical Relevance: Preservation of anterior teeth following trauma is essential, especially in young patients. A good option is the use of mineral trioxide aggregate in the treatment of open apices.

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The treatment of immature permanent teeth with necrotic pulps and apical periodontitis poses significant challenges because of the large canal space, wide open apex and thin fragile root walls. A satisfactory apical barrier needs to be created to prevent egress of bacteria and their toxins from the root canal system into the periradicular tissues. The barrier also facilitates compaction of the root canal filling material without it encroaching on the periodontal tissues.

Calcium hydroxide has been successfully used to form an apical calcific barrier in a procedure known as apexification. High success rates in the range of 79–96% have been reported.[1] Despite such success rates, however, calcium hydroxide has its limitations associated with the long treatment time needed. The formation of the apical calcific barrier generally takes, on average, 12.9 months.[2] Patient compliance cannot be guaranteed. There is also an increased risk of loss of coronal seal and tooth fracture owing to prolonged dressing with calcium hydroxide.[3] Additionally, the calcific barrier formed has been found to be porous and often containing small amounts of tissue.[4]

Mineral trioxide aggregate (MTA) has recently emerged as a material suitable to overcome the problems associated with calcium hydroxide.[5] It offers good sealing ability,[6] biocompatibility,[7] antibacterial properties[8] and the ability to induce apical hard tissue formation.[5] The setting time for MTA can vary from 3–4 hours ((White ProRoot® MTA, Dentsply, Maillefer, Ballaigues, Switzerland) to only 15 minutes (Angelus, Londrina-PR, Brazil) which has higher gypsum content), depending on the type of MTA material used. Treatment time is thus substantially decreased, with the potential for fracture of the immature roots and crowns significantly reduced. Unlike calcium hydroxide, MTA does not weaken the mechanical properties of dentine.[9] It could, however, be argued that this is more due to the fact that MTA is placed apically and does not require multiple applications over a prolonged period, as is the case with calcium hydroxide.

Various techniques have been described for the delivery and compaction of the MTA plug, which include hand and ultrasonic methods and the use of MTA carriers. It has been demonstrated that ultrasonic compaction methods resulted in significantly less adaptation of MTA to a simulated root canal than hand methods.[10] The placement of the apical MTA plug is technique sensitive. The material needs to be positioned precisely, with the use of an operating microscope, at the root apex to provide a satisfactory seal without impinging on the periapical tissues. The recommended adequate thickness of an apical plug is ideally greater than 3 mm.[11] The sandy, grainy nature of the material makes it difficult to handle. A technique that facilitates easy and accurate placement of MTA would improve the predictability of this procedure.

This article reports a case where an apical MTA plug was placed, using the Micro-Apical Placement (MAP) system, in an immature central incisor with a necrotic pulp and apical periodontitis. A very satisfactory result was obtained.

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Figure 1. Pre-operative photograph at presentation showing the fractured incisal edge of the UL1.

Figure 2. Pre-operative upper arch photograph showing the temporary restoration on the palatal aspect of the UL1.

Figure 3. Pre-operative radiograph of the UL1 showing the wide open apex, thin root walls and large canal space.

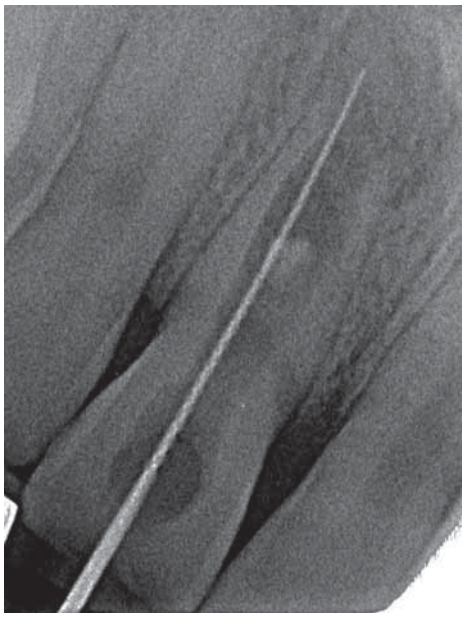

Figure 4. Diagnostic radiograph of the UL1 with a size 20 K-file placed in the canal to determine the working length.

Figure 5. Components of the MAP system.

Case report

A 16-year-old Caucasian male, was referred by his General Dental Practitioner, after presenting with an acute apical abscess associated with his UL1. He had suffered trauma to his upper anterior teeth at the age of 8 years.

Clinical examination revealed that the UL1 was mildly discoloured and had an uncomplicated incisal edge fracture (Figure 1). There was a palatal access cavity which was restored with a temporary filling material (Figure 2). The tooth was not tender to percussion and there was no buccal swelling or sinus present. The periodontal probing depths were within normal limits. It was noted that the UL1 was grade I mobile. Radiographic examination of the tooth revealed a large canal space with a wide open apex and thin root walls. There was also evidence of periapical inflammation around the root apex (Figure 3).

The patient, accompanied by his mother, was advised that the prognosis of the tooth was guarded as it was susceptible to fracture because of the thin status of the root walls. Given that the patient was young and keen to retain this tooth, it was decided that creating an artificial apical barrier with MTA (White Pro-Root® MTA, Dentsply Maillefer, Ballaigues, Switzerland) would provide the best prognosis.

A rubber dam was used for isolation and a palatal access cavity was prepared through the temporary restoration. The access cavity was refined under x5 magnification to facilitate adequate visualization of the canal space. Irrigation was performed carefully with 0.2% chlorhexidine gluconate (Corsodyl, GlaxoSmithKline, Middlesex, UK). The pre-operative radiograph was used to estimate the working length and a further radiograph was taken with a size 20 K-file placed into the canal to confirm the length of the root (Figure 4). Careful cleaning of the canal was performed by gentle instrumentation with ultrasonically activated K-files and irrigation with 0.2% chlorhexidine gluconate. The canal was dried with sterile paper points and filled with calcium hydroxide (Hypo-Cal Ellman, International Inc, Oceanside, NY, USA), and the access cavity was sealed with IRM (Caulk/Dentsply, Milford, DE, USA).

The patient was seen after one month. A clinical examination revealed no signs of infection. It was decided to proceed with placement of the MTA plug. Calcium hydroxide was flushed out of the canal carefully using NaOCl 2.5% and gentle hand instrumentation with K-files was performed before drying with sterile paper points. The MAP system (Roydent, Dental Products, Johnson City, TN, USA) was used to place the MTA plug (Figure 5). This system includes a variety of tips, straight and curved, in two different sizes, ideal for delivering repair material during orthograde obturation. Before the MTA was placed, however, an appropriate curved needle, 0.9 mm in diameter, was inserted into the canal to ensure that it would fit to the working length. The rubber stop on the needle was set at 1 mm short of the working length (Figure 6). The largest

Figure 6. Rubber stop positioned on the MAP carrier.

Figure 7. Radiograph showing the MTA apical plug.

Figure 8. Radiograph showing the UL1 back-filled with gutta-percha.

diameter matchou plugger that would fit into the canal at this length was chosen. The larger diameter facilitated easier compaction of the MTA.

The MTA was mixed according to manufacturer's recommendations. It was introduced into the canal using the MAP system under x12 magnification. The matchou pluggers were used to compact the MTA. The matchou pluggers were also used to evaluate the height of the apical plug, adjusting the rubber stops on the MAP system as necessary. After a few applications of MTA, a diagnostic radiograph was taken to evaluate the height of the plug and ensure that it was well condensed with no voids. The radiograph revealed that the first 2 mm of the MTA plug had been accurately positioned. Further applications of MTA were made before re-evaluating radiographically the final MTA plug. The apical plug was deemed satisfactory (Figure 7). A moist cotton pellet was placed in the canal before the access cavity was temporarily sealed with IRM.

The patient was seen again after a period of 5 weeks. The hardness of the MTA plug was evaluated by probing and the canal was back-filled with injection-moulded thermoplastic gutta-percha (Obtura Corp, Fenton, MO, USA) and sealer (AH-Plus, Dentsply Ltd, Weybridge, UK) (Figure 8). Vitrebond™ (3M ESPE, St Paul, MN, USA) was placed over the gutta-percha and the access cavity and incisal edge was restored with a composite resin on the same visit. The patient was reviewed two months later and no abnormalities were detected on clinical examination. No radiograph was taken on this visit. The patient was happy and scheduled for a further review after 6 months.

Discussion

The case presented was very challenging owing to the wide open apex, presence of peri-radicular infection and the thin root walls. The tooth, a central incisor, was in the aesthetic zone in a 16-year-old male. It was decided, from the outset, to root treat the tooth. Other possible treatment options, such as an implant or the provision of an adhesive bridge, were discarded. The implant option was ruled out as the patient's dento-alveolar development may not have ceased, as well as for aesthetic considerations.[12] The provision of an adhesive bridge was not an ideal option, again on aesthetic grounds, and loss of bone in the area was likely as a consequence of extraction of the tooth. The latter may well have complicated possible future implant work. Understandably, the root canal treatment option was also preferred by the patient as he was very keen to save his own tooth.

Calcium hydroxide has been used successfully for root end closure for a large number of years.[13] This technique, however, requires long periods of time for apexification to take place, which can be anything from 3–24 months.[14] It was judged that this case, having a wide apical diameter and thin root walls, would not lend itself favourably to multiple calcium hydroxide applications. Compliance can also be an issue with young patients.[15]

An alternative technique to the use of calcium hydroxide is the placement of an MTA plug.[5] MTA provides a predictable treatment outcome in root end closure and was considered as the preferred option in this case. The handling properties of MTA, however, can be difficult.[16] Accordingly, the access cavity was widened to enhance visibility of the root apex and provide straight line access. The tooth had a necrotic pulp, therefore, calcium hydroxide was used as an interim dressing to decrease the bacterial infection.[17] The treatment was completed over a period of two months and a very satisfactory result was obtained, as demonstrated in Figure 8, which shows periradicular healing. The use of the operating microscope was essential to enable direct placement of the MTA at the apical extent of the root. A feature of the technique was the use of the MAP system. This system played a pivotal role in placing the MTA accurately at the correct depth through use of the rubber stops. The compaction was satisfactory, which was verified radiographically, with no voids present (Figure 7). In this way, a superior result was obtained and also, a surgical approach with retrograde placement of MTA was avoided. It is recognized that orthograde delivery of MTA in such situations is more technique sensitive.[18,19] The operator, therefore, needs to follow a systematic approach, as outlined in this case, to ensure a good and predictable outcome.

References

1. Cvek M. Prognosis of luxated non-vital maxillary incisors treated with calcium

hydroxide and filled with gutta-percha. A retrospective clinical study. *Endodont Dent Traumatol* 1992; **8**(2): 45–55.
2. Dominguez Reyes A, Munoz Munoz L, Aznar Martin T. Study of calcium hydroxide apexification in 26 young permanent incisors. *Dent Traumatol* 2005; **21**(3): 141–145.
3. Andreasen JO, Farik B, Munksgaard EC. Long-term calcium hydroxide as a root canal dressing may increase risk of root fracture. *Dental Traumatol* 2002; **18**(3): 134–137.
4. Binnie WH, Rowe AH. A histological study of the periapical tissues of incompletely formed pulpless teeth filled with calcium hydroxide. *J Dent Res* 1973; **52**(5): 1110–1116.
5. Torabinejad M, Chivian N. Clinical application of mineral trioxide aggregate. *J Endodont* 1999; **25**(3): 197–205.
6. Arens DE, Torabinejad M. Repair of furcal perforations with mineral trioxide aggregate: two case reports. *Oral Surg Oral Med Oral Pathol Oral Radiol Endodont* 1996; **82**(1): 84–88.
7. Torabinejad M, Hong CU, Pitt Ford TR, Kaiyawasam SP. Tissue reaction to implanted super-EBA and mineral trioxide aggregate in the mandible of guinea pigs: a preliminary report. *J Endodont* 1995; **21**(11): 569–571.
8. Torabinejad M, Hong CU, Pitt Ford TR, Kettering JD. Antibacterial effects of some root end filling materials. *J Endodont* 1995; **21**(8): 403–406.
9. Twati WA, Wood DJ, Liskiewicz TW, Willmott NS, Duggal MS. An evaluation of the effect of non-setting calcium hydroxide on human dentine: a pilot study. *Eur Arch Paediatr Dent* 2009; **10**(2): 104–109.
10. Aminoshariae A, Hartwell GR, Moon PC. Placement of mineral trioxide aggregate using two different techniques. *J Endodont* 2003; **29**(10): 679–682.
11. Valois CRA, Costa ED. Influence of the thickness of mineral trioxide aggregate on sealing ability of root-end fillings *in vitro*. *Oral Surg Oral Med Oral Pathol Oral Radiol Endodont* 2004; **97**(1): 108–111.
12. Yap AKW, Klineberg I. Dental implants in patients with ectodermal dysplasia and tooth agenesis: a critical review of the literature. *Int J Prosthodont* 2009; **22**(3): 268–276.
13. Granath LE. Some notes on the treatment of traumatized incisors in children. *Odont Rev* 1959; **10**: 272.
14. Frank AL. Therapy for the divergent pulpless tooth by continued apical formation. *J Am Dent Assoc* 1966; **72**(1): 87–93.
15. Heling I, Lustmann J, Hover R, Bichacho N. Complications of apexification resulting from poor patient compliance: report of case. *J Dent Children* 1999; **66**(6): 415–418.
16. Camilleri J. Modification of mineral trioxide aggregate: physical and mechanical properties. *Int Endodont J* 2008; **41**(10): 843–849.
17. Leonardo MR, da Silva LA, Leonardo RdeT, Utrilla LS, Assed S. Histological evaluation of therapy using a calcium hydroxide dressing for teeth with incompletely formed apices and periapical lesions. *J Endodont* 1993; **19**(7): 348–352.
18. Park J-B, Lee J-H. Use of mineral trioxide aggregate in the open apex of a maxillary first premolar. *J Oral Sci* 2008; **50**(3): 355–358.
19. Ghaziani P, Aghasizadeh N, Sheikh-Nezami M. Endodontic treatment with MTA apical plugs: a case report. *J Oral Sci* 2007; **49**(4): 325–329.