CASE REPORT

Mineral trioxide aggregate (MTA) apexification: a novel approach for traumatised young immature permanent teeth

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SUMMARY

Here, we report a case of 9-year-old boy who came with a chief complaint of pain and fractured upper front teeth. Significant history of trauma was revealed 6 months before reporting, during playing at his school time. Proper diagnosis was made with the help of radiological investigations. The available treatment options were discussed with the patient's parents and root canal therapy, using mineral trioxide aggregate, as an apical barrier was carried out in his upper right front teeth. However, later on, the boy was aesthetically rehabilitated in relation to his fractured upper front teeth with the help of post and core and acrylic crown.

BACKGROUND

The primary objective in endodontic therapy is complete obturation of root canal space to prevent reinfection. In teeth with incomplete root development caused by trauma, caries and other pulpal pathosis, the absence of natural constriction at the end of the root canal presents a challenge and makes control of filling materials difficult. The aim is to seal a sizeable communication between the root canal system and the periradicular tissue and provide a barrier against which obturation material can be compacted.¹

Owing to the lack of an apical constriction, an alternative to standard root canal treatment, apexification or root end closure has been advocated.² Hence, we decided to write this up.

CASE PRESENTATION

A 9-year-old boy reported with fractured upper right and left central incisors (11, 21; figure 1). The medical history was not contributory. No significant family history was revealed. Extraoral findings were unremarkable. Clinically, we found that there was complicated crown fracture (Ellis class III) in relation to upper right central incisor (11)

Figure 1 Intraoral image showing fractured upper right and left central incisor (11, 21).

and Ellis class II fracture in relation to upper left central incisor (21). The incisors were slightly tender to percussion. No mobility was seen. On electric pulp testing, the upper right central incisor (11) was non-responsive. However, the upper left central incisor (21) gave a positive finding. On the basis of clinical and radiographical findings, a diagnosis of traumatised young permanent immature teeth was made with respect to upper right central incisor (11).

INVESTIGATIONS

An intraoral periapical radiograph was taken which showed incomplete root formation with wide open apices in both upper central incisors. No other periapical pathology was seen. Electric pulp testing was carried out which showed that the upper right central incisor (11) was non-responsive.

TREATMENT

In the first appointment, root canal therapy with apexification using calcium hydroxide was planned in relation to upper right central incisor (11) as the upper left central incisor (21) was asymptomatic (figure 2). The tooth was isolated under a rubber

Figure 2 Preoperative radiograph.

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dam and an access cavity was prepared. Apexification was carried out with calcium hydroxide and left for 3 months.

After 3 months, calcium hydroxide dressing was removed from the root canal and checked radiographically which revealed no satisfactory results. Thus, mineral trioxide aggregate (MTA) apexification was carried out (11). MTA (Dentsply, Tulsa Dental, Johnson City, Tennessee, USA) was mixed with distilled water according to the manufacturer's instructions and carried to the canal with an amalgam carrier. Apical plug of about 3 mm of MTA was placed and confirmed radiographically (figure 3). A sterile cotton pellet moistened with sterile water was placed over the canal orifice and the access cavity was sealed with Cavit (3 M ESPE, Seefeld, Germany). After 72 h, the hard set of MTA was confirmed and the remainder of the root canal was obturated with thermoplasticised gutta-percha (figure 4) (Obtura II, Obtura Spartan, Fenton, Missouri, USA). In the same visit, the access cavity was restored with composite.

After 2 weeks, the patient was recalled for his aesthetic rehabilitation. As there was minimum crown structure left, a fibre post and core was placed in the upper right central incisor (11) (figure 5). The rest of the crown structure was then built with the help of a composite and crown cutting was performed in the upper right central incisor (11), and the upper left central incisor (21) was aesthetically rehabilitated using composite build-up (figure 6). An acrylic crown was fabricated in relation to upper right central incisor (11; figure 6).

OUTCOME AND FOLLOW-UP

The patient is now under follow-up.

DISCUSSION

Dental injuries are very common in children between 6 and 9 years of age. A serious complication of these traumas is pulp necrosis whose prevalence varies with the type of traumatism from 1% to 6% for crown fractures to nearly 100% for intrusions. Pulp necrosis of permanent immature teeth implies the

Figure 3 Mineral trioxide aggregate apical plug placed in relation to upper right central incisor (11).

Figure 4 Obturated root canal.

interruption of root formation and apical closure. It is then necessary to implement a therapy, called apexification to induce a hard calcific barrier at the apical end of the root, to achieve definitive root canal filling.³

The completion of root development and closure of the apex occurs up to 3 years after eruption of the tooth. The treatment of pulpal injury during this period provides a significant challenge for the clinician. Depending on the vitality of the affected pulp, two approaches are possible—apexogenesis or apexification.⁴ Apexogenesis is defined as 'a vital pulp therapy procedure performed to encourage continued physiological development and formation of the root end'. Apexification is defined as 'a method to induce a calcified barrier in a root with an open apex or the continued apical development of an incomplete root in teeth with necrotic pulp'.⁵ As always, success is related to accurate diagnosis and a full understanding of the biological processes to be facilitated by treatment.

It is important to discuss root development to understand its modalities of treatment. Root development begins when enamel and dentin formation have reached future cemento-enamel junction. At this stage, the inner and outer enamel epithelium are no longer separated by the stratum intermedium and stellate reticulum, but develop as a two-layered epithelial wall to form Hertwig's epithelial root sheath. When the differentiation of radicular cells into odontoblasts has been induced and the first layer of dentin has been laid down, Hertwig's epithelial root sheath begins to disintegrate and lose its continuity and close relationship to the root surface. Its remnants persist as an epithelial network of strands or tubules near the external surface of the root. Hertwig's epithelial root sheath is responsible for determining the shape of the root or roots. The epithelial diaphragm surrounds the apical opening to the pulp and eventually becomes the apical foramen. An open apex is found in the developing roots of immature teeth until apical closure occurs approximately 3 years after eruption.⁶ The root sheath of

Figure 5 Intraoral periapical radiograph showing placement of fibre post in upper right central incisor (11).

Hertwig is usually sensitive to trauma but because of the degree of vascularity and cellularity in the apical region, root formation can continue even in the presence of pulpal inflammation and necrosis.^{7 8} Owing to the important role of Hertwig's epithelial root sheath in continued root development after pulpal injury, every effort should be made to maintain its viability. It is thought to provide a source of undifferentiated cells that could give rise to further hard tissue formation. It may also protect against the in-growth of periodontal ligament cells into the root canal, which would result in intracanal bone formation and arrest of root development.⁹

A variety of materials have been proposed for induction of apical barrier formation. Calcium hydroxide ($\text{Ca}(\text{OH})_2$) has become the material of choice for apexification; it is bactericidal with an alkaline pH that may be responsible for stimulating apical calcification.¹⁰

Despite its popularity for the apexification procedure, $\text{Ca}(\text{OH})_2$ therapy has some inherent disadvantages, including variability of treatment time, unpredictability of apical closure, difficulty in patient follow-up and delayed treatment.¹¹ Also, it has some tissue altering and dissolving effects.¹² Therefore, the

Figure 6 Image showing placement of acrylic crown in upper right central incisor (11) and composite build-up in relation to upper left central incisor (21).

search continues for procedures and materials that may allow for more natural continued apical closure in teeth with immature apices.

The US Food and Drug Administration approved mineral trioxide aggregate (MTA) in 1998 as a therapeutic endodontic material for humans.^{13–15} MTA has been shown to have superior sealing ability to amalgam, zinc oxide eugenol, intermediate restorative material (IRM) and super-ethoxybenzoic acid.^{16–19} MTA has also been shown to have superior characteristics as a direct pulp-capping agent when compared with $\text{Ca}(\text{OH})_2$ in animals and humans in the root canal, which would result in intracanal bone formation and arrest of root development.^{20–22}

More recently, white ProRoot (white MTA) root canal repair material was introduced as an aesthetic improvement over the original material (grey MTA) for placement in anterior teeth. The major components of white MTA are tricalcium silicate, dicalcium silicate, tricalcium aluminate, calcium sulphate dehydrate and bismuth oxide. The cement's setting time is 3–4 h, and its compressive strength after setting is 70 MPa—comparable with that of IRM.²⁰

MTA is a material which has less leakage, better antibacterial properties, high marginal adaptation, short setting time (4 h) and a pH of 12.5 and is more biocompatible. Scaffolding is provided for hard tissue formation by MTA. It stimulates the production of interleukins and cytokines release. Hence, it is capable of promoting hard tissue formation. Clinicians may restore the tooth after setting of MTA. Thus, the fracture resistance of teeth with thin dentinal walls increases. MTA can be used in teeth with pulp necrosis and inflamed periapical lesions because it may set in moist environments.²³

In the MTA plug technique, root canals must be disinfected with temporary calcium hydroxide before placing MTA for 2 weeks. This is because performing chemo-mechanical preparation alone is not effective for complete elimination of microorganisms. Hence, we used calcium hydroxide, in this case, in between the appointments in the root canal for disinfection.

Learning points

- ▶ Careful examination of the fractured teeth should be performed and should be classified accordingly.
- ▶ Thorough history of the trauma should be taken.
- ▶ Calcium hydroxide should be placed in between the appointments for disinfecting the root canal which is the utmost important step for success of the treatment.
- ▶ Mineral trioxide aggregate therapy can be considered as replacement therapy for calcium hydroxide.

Competing interests None.

Patient consent Obtained.

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