Apical Closure of Nonvital Permanent Teeth: 15 Months Follow-up Study of Four Cases

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How to cite the article:
Umashetty G, Patil B, Rao N, Aigaonkar N. Apical closure of nonvital permanent teeth: 15 months follow-up study of four cases. J Int Oral Health 2015;7(5):71-73.

Abstract:
Obtaining a complete seal of the root canal system is a major problem in performing root canal treatment in nonvital teeth with incomplete root development and wide open apices. The aim was to study apexification using mineral trioxide aggregate (MTA), clinically and radiographically over a period of 15 months. MTA was used in four cases of teeth with incomplete root development in order to achieve an apical seal and the remaining canal was obturated with gutta-percha. Clinical and radiographic assessments of teeth were done. The clinical and radiographic results indicated that apexification procedure was predictable by using MTA. The total number of patients' visits and the total time duration required to obtain an apical barrier using MTA was markedly less than that of conventional techniques using calcium hydroxide.

Key Words: Apexification, calcium hydroxide, mineral trioxide aggregate

Introduction
Apexification is the procedure, which induces a hard tissue stop at the tooth apex. This procedure aims to arrest bacterial infection and create a favorable environment for production of mineralized tissues in the apical region.¹ The commonly used material for this purpose is calcium hydroxide.² Recently, mineral trioxide aggregate (MTA) developed by Mahmud Torabinejad in 1993, has been proposed as a potential material to create an apical plug. MTA (Pro Root MTA; Dentsply Tulsa dental, Tulsa, UK) is a powder containing fine hydrophilic particles, which need moisture for complete setting. MTA sets in presence of moisture in less than 4 h and has a pH of 12.5. Composition of MTA includes tricalcium silicate being the major component, tricalcium aluminate, tricalcium oxide and silicate oxide.³ This report presents four cases of central incisors those had premature interruption of radicular development caused by trauma. All immature central incisors had clinical and radiographic signs of pulpal necrosis and periapical abscess.

Case Reports
All the four cases reported with a chief complaint of pain and discolored tooth in the upper anterior region of the jaw. The patients gave a history of trauma. History of present illness revealed continuous pain, throbbing in nature and not relieved on medication. The teeth were tender on vertical percussion. Radiographic examination revealed teeth with incomplete root development with wide open apices and a radiolucent area in the proximity to the apex of teeth. Pulp vitality tests gave a negative response.

Treatment modality
After careful examination and diagnosis, a common treatment protocol was formulated and performed for all the above cases as mentioned below.

Case 1
A 12-year-old female patient presented to the Department of Conservative Dentistry and Endodontics for treatment of fractured maxillary right central incisor tooth. There was a history of trauma to maxillary right central incisor 4 years ago. Clinical examination revealed discoloration and Ellis Class III fracture with 11. A large radiolucent lesion around the apex of the maxillary right central incisor along with incomplete root formation was detected by intraoral periapical radiograph (Figure 1). Proper aseptic precautions were carried out, and access opening was done using high-speed handpiece (NSK). Necrotic pulp and other organic debris were extirpated using barbed broach under copious irrigation using normal saline. The working length was determined using apex locator and confirmed radiographically, and the root canal was instrumented using K-type hand files. The canal was irrigated, dried, and short term canal dressing with calcium hydroxide powder mixed with saline was placed for a period of two weeks for disinfection.

The patient was recalled, calcium hydroxide dressing of tooth was removed. Irrigation was performed using 3% sodium hypochlorite, 17% EDTA followed by normal saline. The canal was dried, and MTA (Pro Root MTA; Dentsply Tulsa dental, Tulsa, UK) was placed in the apical region of the canal as per manufacturers' instructions and guidelines. MTA was mixed.
with distilled water to the sandy consistency and was placed with MTA carrier in the apical portion of the canal. Hand pluggers were used to condense the increments till thickness of 3-4 mm. A wet cotton was inserted into the canal, and the access cavity was sealed. In subsequent appointment, tooth was subsequently obturated using thermoplasticised gutta-percha, permanent restoration was done with tooth and patient was evaluated subsequently. 15 months follow-up radiographs (Figure 2) revealed resolution of periapical radiolucency, trabecular bone formation and closure of the root apex with totally asymptomatic tooth.

**Case 2**
A 16-year-old female patient reported to the Department of Conservative Dentistry and Endodontics with a chief complaint of pain in maxillary anterior region. There was a history of trauma to maxillary right central incisor 8 years ago. Intraoral examination revealed fracture of maxillary right central incisor involving enamel and dentin. Intraoral periapical radiograph revealed open apex with 11 (Figure 1). The tooth gave negative results on electric and cold pulp testing. Intraoral examination revealed discoloured 11 with the loss of the major portion of the crown of 11. A radiographic image revealed periapical radiolucency with 11 along with incomplete root formation (Figure 1). Apexification was carried using MTA similar to Case 1. 15 month’s follow-up (Figure 2) showed complete healing of the lesion. As more than two-third of crown structure was lost, post and core of 11 was done, followed by ceramic crown prosthesis.

**Case 3**
An 18-year-old male patient suffered trauma to his maxillary front teeth 10 years ago while playing cricket. Intraoral examination revealed discoloured 11 with the loss of the major portion of the crown of 11. A radiographic image revealed periapical radiolucency with 11 along with incomplete root formation (Figure 1). Apexification was carried using MTA similar to Case 1. 15 month’s follow-up (Figure 2) showed apical closure and totally asymptomatic tooth.

Following are the clinical radiographs of all the four cases (Figures 1 and 2).

**Discussion**
The most common drawback in the classic apexification technique using calcium hydroxide is the lengthy duration
of the therapy, ranging from 3 to 21 months. Other disadvantages include unpredictability of apical closure, difficulty in patient follow-up, susceptibility to coronal microleakage and weakening of the root structure by neutralizing, denaturing or dissolving the acidic components of the dentin. Once canal disinfection with calcium hydroxide is done, obturation can be performed in one appointment using MTA apical plug technique. In comparison with other potential apical barriers like tricalcium phosphate, dentin plugs, calcium phosphate cement, MTA shows excellent sealing ability, proper marginal adaptation with good biocompatibility and a setting time of about 4 h. This property is important in nonvital teeth with necrotic pulps and inflamed periapical lesions. The clinical cases treated in this report by using MTA exhibited apical closure and healing during subsequent follow-ups. MTA induces apical hard tissue formation with less inflammation than other test materials.

Conclusion
Both clinical and radiographic follow-ups in the four cases reported, showed new hard tissue formation and healing taking place in the apical area of affected teeth. MTA appeared to be a reliable option for apexification along with the advantage of speedy of completion of therapy. These results show that apexification in one visit by placing an apical plug of MTA after short canal disinfection is a predictable and reproducible clinical procedure.

Figure 2: 6, 9 and 15 months follow-up radiographs of Cases I, II, III and IV respectively.

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