Case Report

International Journal of Dental and Health Sciences
Volume 01, Issue 05

# APICAL PLUG WITH WHITE MTA IN TOOTH WITH IMMATURE ROOT FORMATION: A REPORT OF TWO CASES AND REVIEW OF LITERATURE

Rakesh Vadher[1], Abhishek Parmar[2], Girish Parmar[3], Radhika Chavada[4], Iti Negi[5], Rihan Desai[6]

1.Post Graduate Student, Department Of Conservative Dentistry And Endodontics, Government Dental College And Hospital, Ahmedabad
2.Assistant Professor, Department Of Conservative Dentistry And Endodontics, Government Dental College And Hospital, Ahmedabad
3.Dean And Head Of Dept, Department Of Conservative Dentistry And Endodontics, Government Dental College And Hospital, Ahmedabad
4.Post Graduate Student, Department Of Conservative Dentistry And Endodontics, Government Dental College And Hospital, Ahmedabad
5.Post Graduate Student, Department Of Conservative Dentistry And Endodontics, Government Dental College And Hospital, Ahmedabad
6.Post Graduate Student, Dept Of Prosthodontics, Ahmedabad Dental College, Ahmedabad

## ABSTRACT:

Pulp necrosis is one of the main complications of dental trauma. When it happens on an immature tooth, pulp necrosis implies a lack of root maturation and apical closure. It is challenge to successfully treat the teeth with immature root development, necrotic pulps, and apical periodontitis. This condition can be treated by providing an artificial calcified apical barrier to allow for optimal filling or obturation of the canal, and by reinforcing the weakened root canal walls against fracture. This therapy is called apexification. Many materials can be used to treat these type of cases like Calcium Hydroxide, Portland Cement and Mineral Trioxide Aggregate. Disadvantage of calcium hydroxide is very long treatment time, the possibility of tooth fracture, and incomplete calcification of the bridge. Use of an apical plug for open apices has gained popularity in recent years, employing mineral trioxide aggregate for optimal results. We report a case series wherein Mineral Trioxide Aggregate (MTA) materials used to induce root-end closure by two stage apexification procedure in necrotic permanent immature incisors.

**Key Words:** Mineral Trioxide Aggregate (MTA), apexification, apical plug, pulp necrosis

## INTRODUCTION:

Complete asepsis and three dimensional obturation of the root canal system are

*Corresponding Author Address: Dr. Rakesh Vadher Post Graduate Student, Department Of Conservative Dentistry And Endodontics, Government Dental College And Hospital, Ahmedabad Email: rakeshvadher@gmail.com

crucial for long term endodontic success. One of the aims of root canal treatment is to fill the root canal system totally to prevent re-infection. When an infected or traumatized immature tooth associated with vital pulps, the clinical treatment is to preserve normal pulp tissue by traditional apexogenesis or recent alternative revascularization to allow complete formation of the root.[1–3]

In teeth with defective root development as a consequence of pulp necrosis through trauma or caries, the absence of a natural constriction at the end of the root canal creates control of filling materials tricky.[4] A completion of the root filling may be facilitated by inducing a hard tissue apical barrier for those teeth with non-vital pulps. There have been many attempts to achieve an apical barrier for the incompletely formed apex.

When teeth with incomplete root formation suffer pulp necrosis, the formation of dentine stops, and root development ceases. Consequently, the canal remains large, with thin and fragile walls, and the apex remains open. These features make instrumentation of the canal difficult and hinder the formation of an adequate apical stop.[5]

Because of the lack of an apical constriction, an alternative to standard root canal treatment, apexification or root-end-closure, has been advocated.[4] For that reason, one of the aims of endodontic treatment is to form an apical barrier or a stop against which one can place root canal filling material avoiding overextrusion.[5]

According to American Association of Endodontics, Glossary of Endodontics Terms apexification can be defined as a method to induce a calcified barrier in a root with an open apex or the continued apical development of an incompletely formed root in teeth with necrotic pulps.[6]

The essence of this treatment approach lies in the expedient cleaning and shaping of the root canal system, followed by replacement of an apical seal with a material that is amenable to tissue healing and regeneration.[7,8] Obtaining an optimal apical seal in teeth with immature apices is a challenge because the wide apical foramen requires a large volume of filling material that may extrude into the periradicular tissue initiating the foreign-body reactions.[9]

Clinicians have tried several materials to form apical barrier in the past. These include, calcium hydroxide powder, calcium hydroxide mixed with different vehicles, collagen calcium phosphate, osteogenic protein, bone growth factor and oxidized cellulose. Deliberate over instrumentation to produce blood clot that will induce apical closure has also been described.[10]

The maximum advocated medicament for apexification has been Ca $(OH)_2$ (calcium hydroxide).[9,11,12] Calcium hydroxide has been the first choice material for apexification,[9] with repeated changes over the course of 5–20 months to induce the formation of a calcific barrier.[10] The unpredictable and often lengthy course of this treatment modality presents challenges, including the vulnerability of the temporary coronal restoration to re-infection.[11] Even though the clinical success rates for $Ca(OH)_2$ apexification is high, complications like risk of re-infection and root fracture has gradually turned clinician toward the use of alternative material such as mineral trioxide aggregate (MTA) as an apical barrier.[15-17]

Mineral trioxide aggregate (MTA) was developed at Loma Linda University as root end filling material. MTA apexification in single visit is advantageous over traditional calcium hydroxide apexification which requires treatment time of 5–20 months to induce the formation of a calcific barrier.[18]

Special placement techniques, using manual, [19] ultrasonic [20] or ultrasonic-assisted hand delivery for MTA [21] have been suggested to minimize extrusion of the material. Despite this, difficulties in delivering and filling the canal with MTA material from an orthograde direction have been reported.[19,22] While positive clinical outcomes from one-visit MTA apexification have been reported [23-25] in complete closure of the immature apex was observed in the case of overfilling.[26]

Mineral trioxide aggregate (MTA) has been recommend as a material suitable for one visit apexification,[17,27,24] as it combines biocompatibility,[28,29] and a bacteriostatic action,[30] with favorable sealing ability when used to repair root/pulp chamber perforations [31, 32] or as root-end filling material.[33, 34] which stimulates cell growth, adhesion and proliferation.[35]

Apexification using MTA has other advantages like it neither gets resorbed nor weakens the root canal dentin and also sets in wet environment. Satisfactory compaction of filling material can be achieved as MTA forms hard and non resorbable apical barrier.[36] Successful outcome of MTA apexification has been reported.[37]

MTA apexification may be carried out as a one- or two-visit procedure and lessen the need for extended period of dressing with Ca $(OH)_2$. This technique has advantage of immediate restoration and reduces the potential of catastrophic, vertical or oblique root fracture that often affects such teeth.[38]

MTA offers a barrier at the end of the root canal (so called apical plug) in cases with necrotic pulps and open apex teeth [17] that permits vertical condensation of warm gutta percha in the root canal.

The aim of this report was to present the short-term follow-up results in two different patients with nonvital pulps and open root apices which were managed with an MTA apical plug technique.

## CASE DETAIL:

**CASE: 1**

A 16 year old female patient with non contributory medical history came to Govt. Dental College and Hospital, Ahmedabad with chief complaint of dull pain, continuous type and pus discharge in the upper front tooth region of the mouth since 3 months. Clinical examination revealed discolored left maxillary central incisor was associated with a sinus opening in the attached gingival on the facial aspect. Tooth was tender on percussion and failed to respond to cold and electric pulp testing. No periodontal pocket was pocket. No intra oral or extra oral swelling was seen. On Intra Oral Periapical (IOPA) view of #21 a wide open, incompletely formed apex surrounded by a diffuse radiolucent lesion with a wide-open apex and a diffuse periapical radiolucent area in relation to maxillary central incisor. [fig. 1] Provisional diagnosis was established of open apex with necrotic pulp and chronic periapical abscess in relation with #21.

Because of owing to favorable periodontal condition conservation of #21 with closure of open apex with MTA after Ca(OH)2 dressing followed by root canal treatment was considered. Access opening was done and working length was taken with radiograph and electric pulp testing (Root ZX II, J. Morita). [fig. 2] Cleaning and shaping was done with intracanal instruments and copious passive irrigation was done with 3 % NaOCl and normal saline (0.9% w/v). Canal was dried with sterile absorbant paper points. Calcium hydroxide was given for 15 days. [fig. 3] On follow up visit dressing was removed, and canal was irrigated then dried. For creating periapical barrier small piece of resorbable collagen (Surgicel, Johnson & Johnson, USA) were condensed beyond canal apex. After application of collagen, white *MTA-Angelus* (Angelus, Londrina, PR, *Brazil*) powder was mixed with sterile water, to a soft paste consistency. Angelus MTA was delivered in the apical third of the canal (4-5 mm average) using an MTA carrier and modified pluggers. A radiograph was taken to determine the correct placement of cement. [fig. 4] Cotton pellet moistened with sterile water was placed in the pulp chamber and the access cavity was filled with temporary filling material. Patients were instructed to return next day & the obturation was completed using Thermo Plasticized Gutta Percha (Obtura II). [fig 5] Coronal part of pulp chamber was sealed with light cured micro hybrid composite (Tetric N Ceram, Ivoclar Vivadent). Post operative radiograph was taken to confirm satisfactory root canal filling.

At six months follow up, clinical and radiographic examination was done. Radiograph showed reduction in the size of the periapical lesion.[fig. 6]

**CASE 2:**

A 20 year male patient with non contributory medical history came to GDCH, Ahmedabad with a chief complaint of pain and discolored tooth in upper front region of mouth. Patient gave history of trauma before 10 years. On clinical examination, maxillary central incisor was discolored. Patient was undergoing orthodontic treatment for malocclusion. There was sinus present in the apical region of the tooth. On percussion the tooth was tender on percussion failed to respond to cold and electric pulp testing. No intra oral or extra oral swelling was seen. Periodontal pocket of 10 mm was measured with William's probe. Radiographic examination shows that an immature maxillary central incisor with a wide-open apex and a periapical radiolucent area. [fig. 7] Provisional diagnosis of open apex with necrotic pulp and chronic apical periodontitis was considered.

Patient was notified about the condition of his tooth and treatment plan of apical plug with MTA followed by root canal treatment. Access opening was done with no #1 and #2 round burs. Working length was established with radiograph and apex locator (Root ZX II, J. Morita) [fig. 8]. Biomechanical preparation was completed with intracanal instruments and copious passive irrigation was done with 3 % NaOCl and normal saline (0.9% w/v). Canal was dried with sterile absorbant paper points. Calcium hydroxide was given for 15 days. [fig. 9] On next visit, dressing was removed, and canal was irrigated then dried. For creating periapical barrier small piece of resorbable collagen (Surgicel, Johnson & Johnson, USA) were condensed beyond canal apex. After application of collagen matrix, white *MTA* (Angelus, Londrina, PR, *Brazil*) powder was mixed with sterile water, to a soft paste consistency. MTA was delivered in the apical third of the canal (4-5 mm average). An IOPA was taken to determine the correct placement of cement. [fig. 10] One cotton pellet moistened with sterile water was placed in the pulp chamber and the access cavity was filled. Patient was recalled on next day & the obturation was completed using Thermo Plasticized Gutta Percha (Obtura II). [fig. 11] Access cavity was sealed with light cured micro hybrid composite (Tetric N Ceram, Ivoclar Vivadent). IOPA was taken to confirm proper root canal filling.

On twelve month follow up visit, radiographic examination showed healing of periapical radiolucency. Clinically pocket was in normal limits. [fig. 12]

## DISCUSSION:

Apexification treatment is assumed to create an environment to allow deposition of cementum, bone and periodontal ligament to continue its function of root development. The objective of this treatment is to obtain an apical barrier to prevent the passage of toxins and bacteria into periapical tissues from root canal. Officially this barrier is necessary to allow compaction of root filling material.[18, 36]

In such teeth, the outcome of conventional gutta-percha fillings would be uncertain, whereas MTA has the potential to provide predictable results.[39]

The age of both patients was bigger than 11 years, i.e. beyond the predictable age of complete root formation in maxillary incisors. At the first visit, medication with calcium hydroxide was required during a time gap of 14 days in order to obtain a dry canal. It can be believed that the very large preoperative apical lesion would need a longer period of time to heal.

In both of the cases, only one intracanal medication with calcium hydroxide was performed before the canal was dry and ready for filling. The use of calcium hydroxide is still contentious. Study showed that remains of calcium hydroxide that remain on the canal walls had no significant effect on MTA leakage or displacement resistance.[22]

In spite of higher success rate of apical barrier formation using calcium hydroxide long term follow-up is essential. Previous studies have described the disadvantages of calcium hydroxide apexification such as failure to control infection, recurrence of infection and cervical fracture.[24]

Calcium hydroxide for apexification requires compliance from the patient and will require many appointments over a period of time ranging from 3 to 24 months during such long follow-up period the immature tooth is prone to fracture or re- infection.[40] Long term calcium hydroxide has also been reported to weaken the root structure.[15]

On the contrary, researchers suggested that remnants of calcium hydroxide on the canal walls may react to form calcium carbonate, and interfere with the seal produced.[41] In the present work, complete removal of calcium hydroxide from the canal walls was accomplished by alternate irrigation with NaOCl 3% and EDTA 17%.[42]

MTA has good biological properties [43, 44] and stimulates repair [45] a major achievement over calcium hydroxide would the reduction in treatment time, because with its use apexification can be done in a single sitting.

Mineral trioxide aggregate as an apexification material represents a primary monoblock. Appetite like interfacial deposits form during the maturation of MTA result in filling the gap induced during material shrinkage phase and improves the frictional resistance of MTA to root canal walls. The formation of nonbonding and gap filing appetite crystals also accounts for seal of MTA.[17]

In teeth with necrotic pulps and open apices, the irregular dentinal walls and the divergent apices make the adaptation of MTA more difficult. Scientists suggested from their laboratory study that hand condensation resulted in better adaptation and fewer voids than ultrasonic compaction.[46] According to studies, the type of intracanal delivery technique may contribute to the final success of treatment in one visit apexification.[47]

In the current study, the MTA apical plugs were placed by a standardized hand condensation technique in all cases. The apical plug created with MTA can be interpreted as an artificial barrier to condense the subsequent root canal filling material, in order to prevent reinfection of the canal system. Some authors have postulated that possible leakage of MTA could be influenced by the thickness of the apical plug. A recent study reported that the orthograde use of MTA provided an adequate seal against bacterial infiltration regardless of the thickness of the apical plug.[48]

Studies show that the thickness of the apical pug may have a significant impact only on displacement resistance.[22] In the current case report, the thickness of the

MTA apical plug varied from 3 mm to 5 mm. In teeth with a short root canal the thickness of the apical plug was reduced to 3 mm to allow for the succeeding filling of the more superficial portion of the canal with resin materials. Based on the results of this investigation, the nonsurgical management of teeth with necrotic pulps and incomplete apex formation with MTA was successful. 5mm barrier is significantly stronger and shows less leakage than 2mm barrier.[8]

However, recent statistics suggest that the combination of MTA and calcium hydroxide in apexification procedures may favorably influence the regeneration of the periodontium.[48]

It must be further emphasized that orthograde delivery placement of the apical plug is more technique sensitive than the retrograde method. Study showed that when MTA was used as a root-end filling material and condensed against a physical barrier, the sealing ability was superior to when MTA was used as an orthograde apical plug.[22]

MTA comprise superior biocompatibility and it is less cytotoxic due to its alkaline pH and presence of calcium and phosphate ions in its formulation results in capacity to attract blastic cells and promote favorable environment for cementum deposition.[48, 49]

Both cases treated with White MTA healed uneventfully as evidenced by the follow up radiographs. The very fact that these teeth healed indicated that the apical seal required was achieved with the use of white MTA.

The novel approach of apexification using MTA eases the patient's treatment time between first appointment and final restoration. Importance of this approach rests in thorough cleaning of root canal followed by apical seal with material that supports regeneration. In addition there is less chance of root fracture in immature teeth with slender roots because the material instantly bonds with the roots and strengthens it.

## REFERENCES:


1. Chueh LH, Huang GT. Immature teeth with periradicular periodontitis or abscess undergoing apexogenesis: a paradigm shift. J Endod 2006; 32(12): 1205–1213.
2. Jung IY, Lee SJ, Hargreaves KM. Biologically based treatment of immature permanent teeth with pulpal necrosis: a case series. J Endod 2008; 34(7): 876–887.
3. Ding RY, Cheung GS, Chen J et al. Pulp revascularization of immature teeth with apical periodontitis: a clinical study. J Endod 2009; 35(5): 745–749.
4. Seltzer S (1988) Endodontology: Biologic Considerations in Endodontic Procedures, 2nd edn. Philadelphia: Lea & Febiger.
5. Felippe WT, Felippe MC, Rocha MJ. The effect of mineral trioxide aggregate on the apexification and periapical healing of teeth with incomplete root formation. *Int Endod J.* 2006;39(1):2-9.

6. Paul D. Eleazer D.D.S., M.S., Gerald N. Glickman, D.D.S., MS, M.B.A., J.D., Scott B McClanahan. D.D.S., M. S., Terry D Webb DDS, MS, Bruce C. Justman DDS. Board Liaison American association of endodo ntists, glossary of endodontic terms, revised 2011, 51
7. Steinig TH, Regan JD, Gutmann JL. The use and predictable placement of mineral trioxide aggregate in one-visit apexification cases. Aust Endod J 2003; 29(1): 34–42.
8. Matt GD, Thorpe JR, Strother JM et al. Comparative study of white and gray mineral trioxide aggregate (MTA) simulating a one- or two-step apical barrier technique. J Endod 2004; 30(12): 876–879.
9. Rafter M. Apexification: a review. Dent Traumatol 2005; 21(1): 1–8.
10. Coomaraswamy KS, Lumley PJ, Hofmann MP. Effect of bismuth oxide radioopacifier content on the material properties of an endodontic Portland cement-based (MTA-like) system. *J Endod.* 2007;33:295-298.
11. Citrome GP, Kaminski EJ, Heuer MA. A comparative study of tooth apexification in the dog. J Endod 1979; 5(10): 290–297.
12. Weisenseel JA Jr, Hicks ML, Pelleu GB Jr. Calcium hydroxide as an apical barrier. J Endod 1987; 13(1): 1–5.
13. Sheehy EC, Roberts GJ (1997) Use of calcium hydroxide for apical barrier formation and healing in nonvitalimmature permanent teeth: a review. British Dental Journal 183, 241–6.
14. Magura ME, Kafrawy AH, Brown CE Jr, Newton C (1991) Human saliva coronal microleakage inobturated root canals: an in vitro study. Journal of Endodontics 17, 324–31.
15. Andreasen JO, Farik B, Munksgaard EC. Long-term calcium hydroxide as a root canal dressing may increase risk of root fracture. Dent Traumatol 2002; 18(3): 134–137.
16. Pace R, Giuliani V, Pini Prato L et al. Apical plug technique using mineral trioxide aggregate: results from a case series. Int Endod J 2007; 40(6): 478–484.
17. Torabinejad M, Chivian N. Clinical applications of mineral trioxide aggregate. J Endod 1999; 25(3): 197–205.
18. Komabayashi T, Spångberg LS. Comparative analysis of the particle size and shape of commercially available mineral trioxide aggregates and Portland cement. *J Endod.* 2008;34:94-97.
19. Bogen G, Kuttler S. Mineral trioxide aggregate obturation: a review and case series. J Endod 2009; 35(6): 777–790.
20. Witherspoon DE, Ham K. One-visit apexification: technique for inducing root-end barrier formation in apical closures. Pract Proced Aesthet Dent 2001; 13(6): 455– 460.
21. Yeung P, Liewehr FR, Moon PC. A quantitative comparison of the fill density of MTA produced by two placement techniques. J Endod 2006; 32(5): 456–459.
22. Hachmeister DR, Schindler WG, Walker III WA et al. The sealing ability and retention characteristics of mineral trioxide aggregate in a model of apexification. J Endod 2002; 28(5): 386–390.
23. Giuliani V, Baccetti T, Pace R et al. The use of MTA in teeth with necrotic pulps and open apices.

Dent Traumatol 2002; 18(4): 217–221.
24. Maroto M, Barberia E, Planells P et al. Treatment of a non-vital immature incisior with mineral trioxide aggregate (MTA). Dent Traumatol 2003; 19(3): 165–169.
25. D'Arcangelo C, D'Amario M. Use of MTA for orthograde obturation of nonvital teeth with open apices: report of two cases. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007; 104(4): e98–e101.
26. Shabahang S, Torabinejad M, Boyne PP et al. A comparative study of root-end induction using osteogenic protein-1, calcium hydroxide, and mineral trioxide aggregate in dogs. J Endod 1999; 25(1): 1–5.
27. Shabahang S, Torabinejad M (2000) Treatment of teeth with open apices using mineral trioxide aggregate. Practical Periodontics and Aesthetic Dentistry 12, 315–20.
28. Koh ET, McDonald F, Pitt Ford TR, Torabinejad M (1998) Cellular response to mineral trioxide aggregate. Journal of Endodontics 24, 543–7.
29. Holland R, de Souza V, Nery MJ, Otoboni Filho JA, Bernabe PF, Dezan Junior E (1999) Reaction of rat connective tissue to implanted dentin tubes filled with mineral trioxide aggregte or calcium hydroxide. Journal of Endodontics 25, 161–6.
30. Torabinejad M, Hong CU, Pitt Ford TR, Kettering JD (1995a) Antibacterial effects of some root end filling materials. Journal of Endodontics 21, 403–6.
31. Arens DE, Torabinejad M (1996) Repair of furcal perforations with mineral trioxide aggregate: two case reports. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics 82, 84–8.
32. Holland R, Filho JA, de Souza V, Nery MJ, Bernabe PF, Junior ED (2001) Mineral trioxide aggregate repair of lateral root perforations. Journal of Endodontics 27, 281–4.
33. Torabinejad M, Smith PW, Kettering JD, Pitt Ford TR (1995b) Comparative investigation of marginal adaptation of mineral trioxide aggregate and other commonly used root-end filling materials. Journal of Endodontics 21, 295–9.
34. Xavier CB, Weismann R, de Oliveira MG, Demarco FF, Pozza DH (2005) Root-end filling materials: apical microleakage and marginal adaptation. Journal of Endodontics 31, 539–42.
35. Kogan P, He J, Glickman GN, Watanabe I. Effects of various additives on setting properties of MTA. *J Endod.* 2006;32:569-572.
36. Martin Trope .Treatment of immature teeth with non vital pulps and apical periodontitis. *Endotopic.* 2007;14:51-59.
37. Holden DT, Schwartz SA, Kirkpatrick TC et al. Clinical outcomes of artificial root-end barriers with mineral trioxide aggregate in teeth with immature apices. J Endod 2008; 34(7): 812–817.
38. Hatibovic-Kofman S, Raimundo L, Chong L et al. Mineral trioxide aggregate in endodontic treatment for immature teeth. Conf Proc IEEE Eng Med Biol Soc 2006, 1: 2094–2097.
39. de Leimburg ML, Angeretti A, Ceruti P, Lendini M, Pasqualini D, Berutti E (2004) MTA obturation of pulpless teeth with open apices: bacterial

leakage as detected by polymerase chain reaction assay. Journal of Endodontics 30, 883–6.

40. Frank AL (1966)Therapy for the divergent pulpless tooth by continued apical formation.Journalof american Dental Association 72,87-93.
41. Porkaew P, Rettief H, Barfield RD, Lacefield WR, Soon S (1998) Effects of calcium hydroxide paste asan intracanal medicament on apical seal. Journal of Endodontics 24, 176–9.
42. Calt S, Seper A (1999) Dentinal tubule penetration of root canal sealers after root canal dressing with calcium hydroxide. Journal of Endodontics 25, 431–3.
43. Torabinejad M,Hong CU,Pitt Ford TR,Kariyawasam SP(1995)Tissue reaction to implanted,super-EBA and mineral trioxide aggregate in the mandilal of guinea pigs, Journal of Endodontics 21,569-71
44. Torabinejad M, Ford TR,Abedi HR,Kariyawasam SP,Tang HM (1998) Tissue reation to implanted root end filling materials in the tibia and mandible of guinea pigs.Journal of Endodontics 1998, 24-7, 468-71.
45. Economides N,Pantelidou O, Kokkas A,Taziafas D (2003) short term periradicular tissue response to mineral trioxide aggregate(MTA)as root end filling material. International endodontic Journal 36,44-8.
46. Aminoshariae A, Hartwell GR, Moon PC (2003) Placement of mineral trioxide aggregate using two different techniques. Journal of Endodontics 29, 679–82.
47. Al-Kahtani A, Shostad S, Schifferle R, Bhambhani S (2005) In-vitro evaluation of microleakage of an orthograde apical plug of mineral trioxide aggregate in permanent teeth with simulated immature apices. Journal of Endodontics 31, 117–9.
48. Weldon JK Jr, Pashley DH, Loushine RJ, Weller RN, Kimbrough WF. Sealing ability of mineral trioxide aggregate and super-EBA when used as furcation repair materials: a longitudinal study. *J Endod.* 2002;28:467- 470.
49. De-Deus G,Petruccelli V, Gurgel-Filho E, Coutinho- Filho T. MTA versus Portland cement as repair material for furcal perforations: a laboratory study using a polymicrobial leakage model. *Int Endod J.* 2006;39:293-298.

## FIGURES:

### CASE 1:

Fig 1: Pre Operative

Fig 2: Working Length

Fig 3: Ca(OH)2 Dressing

Fig 4: Apical Plug with MTA

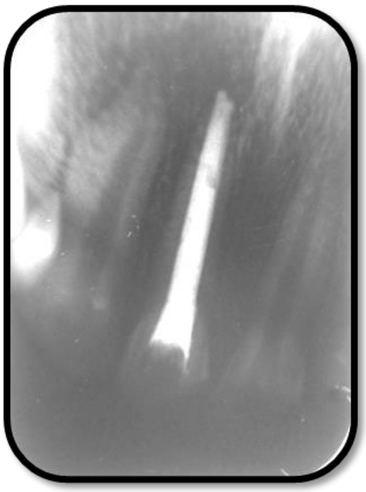

Fig 5: After Obturation

Fig 6: 6 month Follow up

**CASE 2:**

Fig 7: Pre Operative X ray

Fig 8: Working Length

Fig 9: Ca(OH)2 Dressing

Fig 10: Apical Plug with MTA

Fig 11: After Obturation

Fig 12: 12 Month Follow Up