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Apexification – Apex Fixed Then And Now: Review of Case

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Abstract

Apexification is a technique to generate a calcific barrier in a root with an open apex or the sustained apical development of an incomplete root in teeth with necrotic pulp. In contrast, apexogenesis describes the continued physiologic development and formation of the root's apex in vital young permanent teeth. Apexification has been routinely practiced in immature teeth with necrotic pulp for many decades. This paper reviews the past and current concepts of management of immature permanent teeth.

Introduction

According to American Association of Endodontists- 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.[1]

The most widely used material until recently was calcium hydroxide that was replaced over intervals for several months, to stimulate calcific barrier formation. Torabinejad and Chivian (1993) introduced mineral trioxide aggregate (MTA) as an apical plug and now it is an accepted material for apexification till date.[1]

The use of calcium hydroxide affects various mechanical properties of radicular dentin. The alkaline pH of calcium hydroxide increases the chances of fracture due to denaturation of dentinal organic proteins. Hence, it is not recommended in teeth with thin dentinal walls.

Mineral Trioxide Aggregate is a powder consisting of fine hydrophilic particles of tricalcium silicate, tricalcium aluminate, tricalcium oxide and silicate oxide. It also contains small amounts of other mineral oxides, which modify its chemical and physical properties. Radio opacity is provided by bismuth oxide.[2]

Compared to MTA, Biodentine handling is easy and needs much less time for setting. Unlike other Portland cement-based products, it is sufficiently stable so that it can be used both for pulp protection and temporary fillings.[3]

Nature and Source of Cells Participating In Apexification Process[4]

- Mesenchymal or pleuripotent precursor cells in the periapical region (Hertwigs epithelial root sheath).
- Cells of the dentinal sac which surround the apex and retain their genetic code, Klein and Levi 1974.
- Odontogenic activity of residual pulp cells (most prevalent and most productive).

- Connective tissue –cells may be mesenchymal or fibroblastic in origin (with the possibility that they have retained their predetermined genetic pattern to form cementoblasts) Torneck and co-workers(1970,1973).

Indications Of Apexification[3]

1.Immature teeth with an infected pulp

2.No history of spontaneous pain

3.No sensitivity on percussion

4.No haemorrhage

5.Teeth must be ultimately restorable

6.No vertical or horizontal root fracture

7.No radiographic evidence of replacement resorption (ankylosis)

8.Root length must be approximately half or more established

9.Periapical radiolucency

Contraindications of Apexification[3]

1.Purulent drainage

2.History of prolonged pain

3.Very short roots

4.Marginal periodontal breakdown

5.Vital pulp

Advantages of Apexification[3] -

It is successful in resolving periapical lesions.

MTA apexification could be completed in one appointment.

Avoids surgical treatments as surgical removal of tooth structure further weakens the remaining tooth.

Induces root end closure in necrotic immature permanent teeth.

Disadvantages of Apexification[3]

High incidence of root fractures in teeth after apexification due to thin dentinal walls.

Restorative efforts should be directed towards strengthening the immature root.

Teeth to be used as overdenture abutments.

Although MTA has more benefits, using MTA in teeth with funnel shape apices and large periapical lesions is difficult and it often spreads beyond the apex.

Apexification Using Calcium Hydroxide[3]

It is used because it biologically stimulates the hard tissue,it is easy to prepare,any material beyond the apex is rapidly resorbed, it has high alkalinity.

Types of calcium hydroxide products used for Apexification[5]

- Prepared products
- Commercially available products

Prepared products

- Alkaline pastes
- Frank's paste: calcium hydroxide and camphorated parachlorophenol
- Leonardo's paste
- Calcium hydroxide and cresatin
- Calcium hydroxide and saline[5]

Commercially available products

- Pulpdent
- Calasept
- Calcicur
- Hypocal

Advantages of Calcium hydroxide[6]

- Initially bactericidal then bacteriostatic.
- Promotes healing and repair.
- High pH stimulates fibroblasts.
- Neutralizes low pH of acids.
- Stops internal resorption.
- Inexpensive and easy to use.

Disadvantages of Calcium hydroxide[6]

- Does not exclusively stimulate dentinogenesis.
- Does exclusively stimulate reparative dentin.
- Associated with primary tooth resorption.

- May dissolve after one year with cavosurface dissolution.
- May degrade during acid etching.
- Degrades upon tooth flexure.
- Long treatment period,
- Long duration due to multiple appointment.
- Weakens the root leading to fracture.
- Does not adhere to dentin or resin restoration.

Mechanism of action[6]

When CH is placed against the pulp, the high PH of CH results in zone of liquefaction necrosis subjacent to CH and a deeper zone of coagulation necrosis next to vital pulp within the first week (approximately 1.5mm combined width incase of non-setting CH).

Dentine matrix appeared around 30 days later once the cellular and vascular inflammatory events began to fade. Growth factor proteins, bone morphogenic proteins and bioactive molecules are released from dentin matrix and stimulate the differentiation of pulpal stem cells into odontoblasts-like cells. Collagen is laid down approximating the necrotic zone and mineralized crystals are deposited in the region. Thickening of barrier and appearance of dentine-like tissue has been reported to be observed at around 4 weeks after pulp capping procedure and then dentin deposition begins.

Procedure

- Periapical radiograph showed incomplete root formation with wide open apices for the same tooth (Figure 1)
- Apexification with calcium hydroxide dressing was planned.
- In the first visit, an access cavity was prepared with a straight line entry into the root canal.
- The working length was established within one mm of the radiographic apex by using size 30 Hedstrom file.
- Next, pulp extirpation and complete debridement of the canal was done using H file number 40 followed by copious irrigation with normal saline.
- After drying of the canal using paper points, calcium hydroxide powder was mixed with normal saline and this mixture was placed into the canal and pushed to the short of apex using plugger.
- Access opening was restored with glass ionomer cement (Figure 2). Patient was called after 3 months.
- After 3 months when patient came back, a periapical radiograph was taken, which showed complete formation of the root apex in maxillary right central incisor, without any signs and symptoms and periapical radiolucency.
- Clinically, apical barrier formation was confirmed by using a size 30 Gutta-percha (GP) point to check for the presence of a resistant “stop” and absence of hemorrhage, exudates or sensitivity (Figure 3)
- In the next visit, complete obturation was carried out with GP using lateral condensation technique(Figure 4) followed by composite restoration.

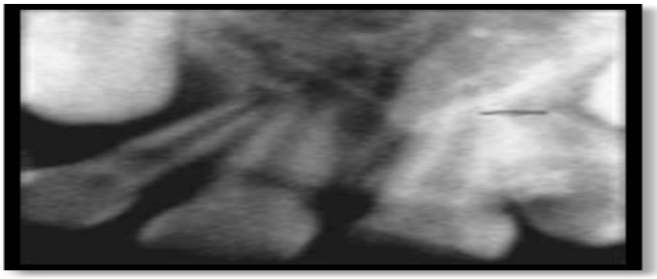

Figure 1; Periapical radiograph showing wide open apex

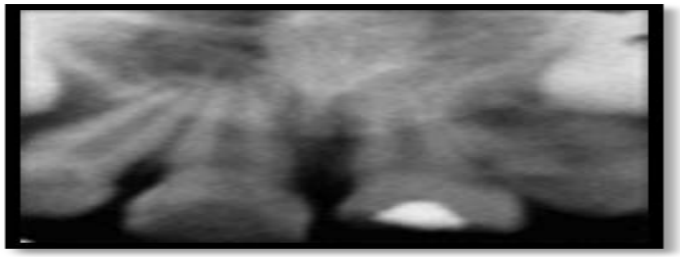

Figure 2 :Periapical radiograph showing placement of CaOH dressing

Figure 3 :Periapical radiograph taken after 3 months shows confirmation of apical barrier with gutta-percha point

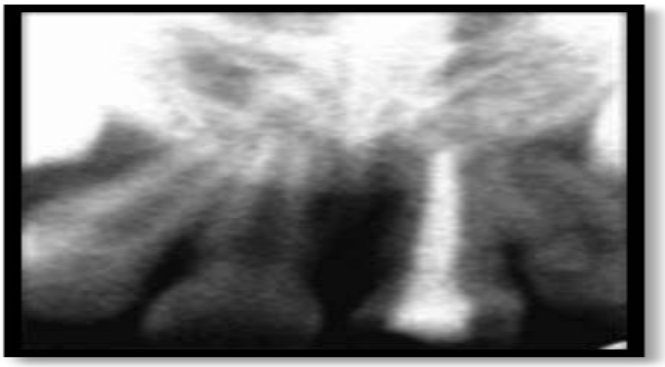

Figure 4: Radiograph showing complete obturation

Disadvantages of conventional technique[7]:

- Poor patient compliance as many fail to return for scheduled visits
- The temporary seal may fail resulting in reinfection and prolongation or failure of treatment.
- The rationale is to establish an apical stop that would enable the root canal to be filled immediately.
- No attempt at root end closure. Rather an artificial apical stop is created.

MTA as Choice of Material for Apexification

Advantages[8]

- Saves treatment time
- Can induce formation (regeneration) of dentin, cementum, bone &periodontal ligament.
- Excellent biocompatibility and appropriate mechanical properties.
- Excellent sealing ability.
- Produces an artificial barrier, against which an obturating material can be condensed.
- Hardens (sets) in the presence of moisture.
- More radiopaque than calcium hydroxide
- Vasoconstrictive

Disadvantages[8]

- Long setting time(2-4hr after mixing)
- Poor handling properties.The loose sandy nature of the mixture causes much difficulty for insertion and packing of MTA.
- High cost

Uses[8]

- Apexogenesis,direct pulp capping and pulpotomy
- Apexification and root end filling
- Repair of root perforations
- Repair of external and internal root resorption

Reaction and formation of hydroxyl apatite[9]**:**

Hydration reaction;

Hydration reaction of MTA was reported to be similar to that of Portland cement. The setting reaction of MTA and Portland cement is a complex process. At first, the particles of tricalcium silicate react with water.

In this process, the periphery of the tricalcium silicate powder is melted and form calcium silicate hydrate. Calcium silicate hydrate is known to be composed of calcium and silicon which were derived from MTA and hydroxyl ion which is supplied from mixing liquid.

ProRoot MTA contains bismuth oxide as a radiopacifier. In the setting reaction of ProRoot MTA, it was reported that bismuth is incorporated into calcium silicate hydrate and to form calcium-silicatebismuth-hydrate, which is similar to calcium silicate hydrate.[9]

Effect of pH on hydration reaction of MTA

It was reported that physical and chemical properties of MTA are adversely affected in a low-pH environment. It was also reported that the quality of crystals which is areaction product of hydrated MTA was poor in acidic pH compared to alkaline pH. Another study recommended that the acid-etching of ProRoot MTA should be delayed until 96 hours after MTA placement to avoid the harmful effect of acid etching on MTA surface. Regarding the alkaline environment, there is a report that calcium hydroxide induced alkalinity, increased porosity and unhydrated microstructure of MTA. Generally, there is no consensus on whether the calcium hydroxide affects the sealability of MTA.In this sense, further studies on the effect of calcium hydroxide on hydration reaction of MTA is necessary.[9]

Manipulation[10]

Mixing: The powder is mixed with supplied sterile water in a 3:1 powder/liquid ratio. A paper pad or a glass slab and a plastic or a metal spatula is used to mix the material to obtain a putty-like consistency. The mixing time should be less than 4 minutes, as prolonged mixing can cause dehydration of the mixture.The mixture can be carried with a plastic or metal carrier. The unused portion of MTA powder can be stored in sterilized empty film canisters.

Note: Poor handling properties. The loose sandy nature of the mixture causes much difficulty for the insertion and packing of MTA.

Thickness[11]

Mineral trioxide aggregate apical plugs were placed in the apical portion of canals with athickness of 3–5 mm, as recommended by the manufacturer, using an MTA Endo Gun (Dentsply Maillefer, Ballaigues, Switzerland) and posterior pluggers sized according to the apical diameter under x10 magnification.[11]

A sterile sponge pellet moistened with sterile water was placed over the canal orifice and the access cavity was sealed temporarily. Correct placement of MTA was confirmed radiographically. After one week, the canals were back-filled with injection-moulded thermoplastic gutta-percha (Obtura Corp., Fenton, MO, USA) and sealer (Pulp Canal Sealer Kerr, Romulus, MI, USA). At the same appointment, the teeth were restored with dentine and enamel-bonded composite.

Procedure

- Intraoral periapical radiograph using radio-visiography (Kodak 5100, France) revealed short root.(figure 5)

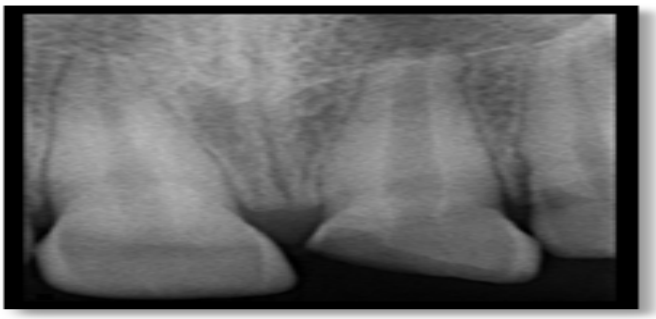

Figure 5: IOPA revealed open apex

- Following isolation with a rubber dam an endodontic access opening was made.
- Working length was established with the help of intraoral periapical radiograph using 80K file. (Figure 6)

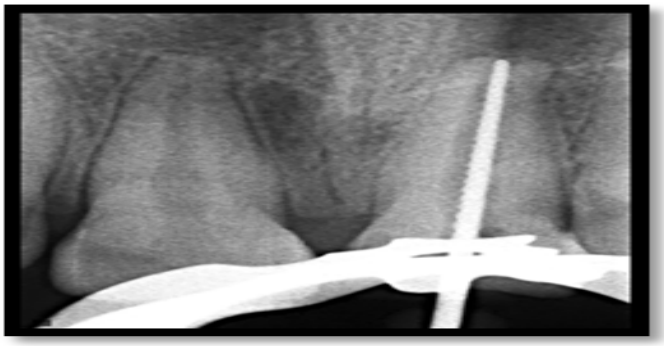

Figure 6:Working length determination

- Minimum instrumentation was done and the walls of canal were circumferentially cleaned with 80K file.

- The root canal was copiously irrigated with 5.25% sodium hypochlorite and normal saline.
- Intracanal dressing with calcium hydroxide (Ultradent Products inc, USA) was given for one week and the provisional restoration with Cavit(Cavit GTM) was given.
- On recall visit, the tooth was asymptomatic. The temporary restoration was removed and canal was irrigated with normal saline and dried with size 80 absorbent paper point(Ultradent Products inc, USA).
- A suitable plugger size that fitted loosely within 2mm of apex was chosen. MTA was mixed with distilled water to a consistency of wet sand and placed in increments in the apical region of the canal using Micro Apical Placement (MAP) system(DENTSPLY Tulsa).
- Mineral trioxide aggregate was compacted with the plugger previously fitted to the root canal system. Care was taken to prevent extrusion of the material into the periapical area. (Figure 7)

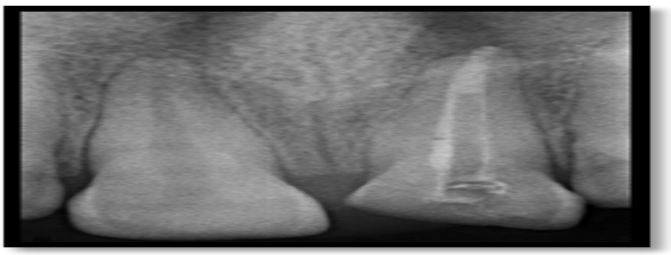

Figure 7 :Mineral trioxide aggregate plug

- A moist cotton pellet was placed against it, as the presence of moisture is essential for the material to set.The access cavity was temporized.
- The patient was recalled after 24 hours. At the next appointment, the MTA felt hard to an endodontic explorer DG-16 (Hu-Friedy International).
- The remaining part of the root canal was backfilled with injection moulded thermoplastic gutta-percha (Obtura III, USA) and sealer (AH 26, Dentsply, Germany).
- Post obturation radiograph was taken.The patient was asked to report after a week for clinical evaluation and the post endodontic restoration.(figure 8)

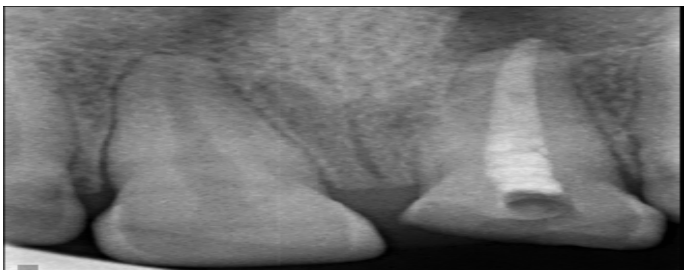

Figure 8: Post obturation radiograph

- During recall, the tooth was asymptomatic and post endodontic composite (Tetric Ceram, Ivoclar Vivadent Inc) restoration was placed and patient was recalled after 3,6,12 months for the follow-up.

Frank has described four successful results of apexification treatments

1) The periapex closes with a definite (though minimal) recession of the root canal. The apical aspect continues to develop with a seemingly obliterated apex.

2) The obliterated apex develops without any change in the root canal space.

3) A thin, calcific bridge that is not radiographically discernable develops.

4) A calcific bridge forms just coronal to the apex and can be determined radiographically.[12]

Final obturation only if

Absence of any symptoms

Absence of any fistula or sinus

Absence or decrease in mobility

Evidence of firm stop clinically as well as radiographically.[12]

Conclusion

Knowledge of pulp biology, intracanal medicaments, and dental trauma lays the framework in which this procedure

should be understood in order to perform it properly and successfully. A working knowledge of biological and mechanical skill is required to attain the highest results in order to make regenerative endodontics a success in clinical practice.[13] Single visit apexification with a novel biocompatible material like MTA is a new boon in effective management of teeth with open apex, this innovative procedure is predictable and less time consuming one.Mineral trioxide aggregate showed clinical and radiographic success as a material used to induce root end closure in necrotic immature permanent teeth.MTA is a suitable replacement for calcium hydroxide for the apexification procedure.[14] The development of MTA is a milestone in field of dentistry. The properties of MTA like its bioactivity, sealing ability and biocompatibility prove it to be an excellent tool for cases that have poor prognosis. Many advantages of this material along with single appointment apical closure outweigh any disadvantage of MTA.

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