CASE REPORT

Management of teeth with blunderbuss canals and its esthetic rehabilitation

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Introduction

The most important factor in endodontics is proper debridement of the canal, to obturate it effectively and three dimensionally as possible. This leads to proper apical seal with a “fluid-tight” obturation which prevents bacterial ingress and ensures favorable outcome.

However, having a proper apical seal becomes difficult in patients with open apices. Obturation becomes a challenge due to the large open apex, diverging walls, thin dentinal walls that are susceptible to fracture, and associated frequent periapical lesion.

The most common teeth with open apex are maxillary anterior. This is due to its position in the jaw which is more prone to trauma and less due to caries.

There are two types of open apex:

1. Non-blunderbuss type.
2. Blunderbuss type.

Non-blunderbuss type: Walls are parallel or slightly convergent as the canal exits the root. Apex can be broad (cylinder shape) or slightly tapered (convergent).

Blunderbuss type: Walls of the canal are divergent, flaring, especially in buccolingual direction. Mostly, apex is funnel shaped, wider than the coronal aspect.

"Blunderbuss" is referred to as the 18th century weapon which has a short and wide barrel. It derives its origin from the Dutch word "DONDERBUS" which means "thunder gun."

Causes of open apices are as follows:

1. Incomplete development of the tooth due to necrosis of pulp due to caries or trauma before root formation is completed.
2. Extensive apical resorption due to orthodontic treatment, periapical pathosis, or trauma.
3. Root-end resection in periapical surgeries.
4. Over instrumentation.

Treatment options

1. Blunt-end or rolled cone (customized cone obturation).
2. Induction of root-end formation (apexogenesis).
3. Root-end closure (Apexification).
4. Revascularization by stem cells of apical papilla and multipotent pulp stem cells.

Indications of apexification (Abu-Hussein Muhamad et al., 2016)

1. Immature teeth with an infected pulp.
2. No history of spontaneous pain.
3. No sensitivity to percussion.
4. No hemorrhage.
5. Teeth must be ultimately restorable.
6. No vertical or horizontal root fracture.
7. No radiographic evidence of replacement resorption (ankylosis).

Abstract

The management of open apex with pulpal necrosis and periapical pathology poses a great endodontic challenge for obturation of the canal and obtaining a hermetic seal. The conventional apexification using calcium hydroxide has certain drawbacks such as the need for long-term therapy to enable barrier formation. The recent trends include formation of an artificial apical stop. To treat such open apices and induce barrier, mineral trioxide aggregate is the calcium silicate material which has gained popularity recently. Access cavity was prepared and working length was determined. Canals were medicated with intracanal medicament for 2 weeks. Then, mineral trioxide aggregate (MTA) apical plug was place in apical third of the canal and rest was filled with thermoplasticized gutta-percha. MTA seems as an effective material for the apical plug method for the treatment of non-vital permanent teeth with open apices.

Keywords: Apexification, apical plug, biodentine, blunderbuss canal, mineral trioxide aggregate, open apex

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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 (Abu-Hussein Muhamad et al., 2016)
1. Purulent drainage.
2. History of prolonged pain.
3. Very short roots.
4. Marginal periodontal breakdown.
5. Vital pulp.

Advantages of apexification (Abu-Hussein Muhamad et al., 2016)
1. It is successful in resolving periapical lesions.
2. Mineral trioxide aggregate (MTA) apexification could be completed in one appointment.
3. Avoids surgical treatments as surgical removal of tooth structure further weakens the remaining tooth.
4. Induces root-end closure in necrotic immature permanent teeth.

Disadvantages of apexification (Abu-Hussein Muhamad et al., 2016)
1. High incidence of root fractures in teeth after apexification due to thin dentinal walls.
2. Restorative efforts should be directed toward strengthening the immature root.
3. Teeth to be used as overdenture abutments.
4. Although MTA has more benefits, using MTA in teeth with funnel-shaped apices and large periapical lesions is difficult and it often spreads beyond the apex.

Materials and Methods
In the current case reports, apexification was the treatment option employed. Materials used for the clinical procedures are as follows:
1. Mineral trioxide aggregate.
2. Calcium hydroxide.

Apexification treatment protocol was used in these case reports. After trauma, if the patients report after 24 h of pulp exposure or there are no signs of vitality of the pulp, apexification is the conservative treatment option.

Apexification is 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 (American Association of Endodontists, 2013).

Chemomechanical debridement of the canal is necessary in apexification process followed by intracanal medicament to assist or stimulate apical healing and formation of apical barrier at the apical end of the root canal to facilitate the obturation of the canal without excess material extruding in the periapical tissues.

Apexification was the choice of treatment because the teeth presented in these case reports were non-vital and patients did not agree to long span of time as in other treatment options such as revascularization and calcium hydroxide apexification.

Furthermore, apexification with calcium hydroxide and length of the time required for this ranges from 3 to 18 months. Problems associated with using calcium hydroxide are patient’s compliance, reinfection due to loss of temporary restoration and also it disposes tooth to fracture.[5]

MTA has been described as a good material for this procedure due to its good canal sealing property, biocompatibility, and ability to promote dental pulp and periradicular tissue regeneration. Therefore, MTA can be used for inducing hard tissue barrier allowing prompt obturation of the canal, leading to longevity of the tooth and maintain proper function and esthetics.[5]

Other calcium silicate-based materials used to induce hard tissue barrier are biodentine. A modified composition of powder, which has additional setting accelerators and softeners, and pre-dosed capsule formulation for use in a mixing device, enhanced the physical properties of the biodentine making it more user-friendly with a shorter setting time.[6]

In the current case report, a clinical case report of teeth with open apex is treated by creating an apical barrier by apexification process, mineral trioxide aggregate, and esthetically rehabilitated with all-ceramic crowns.

Case Report
A 26-year-old patient came to the department of conservative dentistry and endodontics, with a chief complaint of pus discharge and discoloration in upper front surface of the region of jaw and wants to get it treated. Patients gave no history of pain or discomfort associated with the tooth of chief complaint (i.e.,11 and 21) [Figure 1a]. The patient had noticed discoloration for 2 years. He had a history of trauma in the front region of jaw 2½ years before. He gave a history of intermittent pus discharge from the vestibule area from 6 months. Patient’s medical history was non-contributory. Clinical examination revealed Ellis Class III fracture with 11 and 21.

The teeth were not tender to percussion. There was no evidence of swelling and mobility. The periodontal probing depths were within normal limits and there was no bleeding on probing. Thermal and electrical pulp testing showed no response.

Figure 1: (a) Pre-operative clinical image of tooth showing discoloration (11 and 21) with pus draining sinuses from the vestibule area. (b) Radiograph view showing open apex with teeth (11 and 21) and radiolucency seen with periapical region.
Radiographic examination revealed open apex with teeth 11 and 21 and radiolucency seen with periapical region for same [Figure 1b]. Pus draining sinus was seen in the vestibule area above teeth 11 and 21 [Figure 1a].

On the basis of above subjective and objective findings, a final diagnosis of pulp necrosis with chronic apical abscess was made.

In the first appointment, teeth were isolated with rubber dam and widgets. Gingival barrier was applied and access opening was done. Working length determination was done with the help of radiovisual graphic. The canal was debrided and irrigated throughout the procedure with 2.5% sodium hypochlorite. The canals were debrided slightly as remaining dentin thickness is important in cases with open apices.

Cleaning and shaping was done with circumferential filing up to #60 K-file.

After cleaning and shaping, the calcium hydroxide dressing was placed in the canals. Two dressings of intracanal medicament were placed in the canal. The dressing was changed after 15 days.

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After two dressings of intracanal medicament, the draining sinuses were completely healed.

An apical barrier of 3–4 mm was placed in the canals with MTA carrier and condensed with hand plugger [Figure 2]. A moist cotton pellet was placed in the canal and the access opening was sealed with temporary restoration.

The patient was recalled after 2 days and setting of MTA was confirmed using finger plugger and root canals were obturated with thermoplasticized gutta-percha [Figure 3].

Keeping in mind patients aesthetic desire and also because of location of the teeth in anterior region, an all ceramic (E-max) crown was decided to deliver.

The E-max crowns are usually translucent and it would reflect the dark color of the underlying teeth which would look esthetically unpleasant, so before proceeding with teeth preparation, 11 and 21 were bleached so that teeth will have a lighter shade and not the dark discolored one.

Two millimeters of gutta-percha were removed from the canal space to a level below the cementoenamel junction. At the same visit, a RMGIC (Fuji II LC, GC) barrier of 2 mm was placed over the gutta-percha and light cured to prevent apical penetration of the bleaching material and minimize the possibility of internal resorption.

In-office (inside-outside), bleaching was the technique employed.

The teeth were isolated using rubber dam and the adjacent teeth, i.e., 12 and 22 were wrapped with Teflon tape so that bleaching material does not come in contact with them which would adversely bleach them.

Bleaching was done with Pola Office kit and the contents of the syringe were carefully extruded into the pot and both powder and liquid were immediately mixed using a brush applicator to get a homogenous gel. A thick layer of gel was then applied to the buccal and palatal surface of teeth undergoing treatment. The gel was also applied inside the canal using applicator tip.

The gel was left on tooth and light cured using a light-emitting diode curing light (BT cool machine) for 10 min. Both operator and patient were given protective eyeglasses. The gel was changed and the procedure was repeated for 3 times. Three cycles of bleaching were completed for 10 min each. The same procedure was repeated for the next appointment also.

After three visits, a drastic change in tooth color with satisfactory results was achieved. There was visible difference in shade of teeth that were seen. Later, teeth were restored with packable composite and teeth preparation was done [Figure 4a] and restored with all-ceramic crowns (E-max), thus restoring function and esthetics [Figure 4b]. Crowns were luted with bioceramic luting cement (Calibra).

After 3 months, the patient was recalled for follow-up, on which complete resolution of the periapical lesion was seen.

**Discussion**

The outcome of the above treatment results in closure of the apex by the formation of the apical barrier which prevents extrusion of
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Figure 4: (a) Teeth preparation done for all-ceramic restoration (E-max). (b) Post-operative – after crown cementation

gutta-percha material from the apex. It also prevents passage of bacteria and toxins into the periradicular region from the root canal. Certain biocompatible materials used for apexification reduce leakage in sealing material and allow healing of the periodontal tissues and apexification.

Other treatment options available for these cases could be calcium hydroxide apexification, biodentine apexification, and pulp revascularization.

According to some studies, apexification by calcium hydroxide results in apical barrier associated with:[7]
1. Unpredictable apical closure,
2. Extended time taken for barrier formation,
3. Difficulties in patient compliance and the risk of reinfection resulting from the difficulty in creating long-term seals with provisional restorations and,
4. Susceptibility to root fractures arising from the presence of thin roots or prolonged exposure of the root dentine to calcium hydroxide.

Calcium hydroxide leads to incomplete barrier production which results in Swiss cheese appearance. This leads to an apical microleakage.

Pulp revascularization remains a good treatment option for such cases, but this treatment was not agreeable due to the time constraints. Hence, apexification with MTA and biodentine was decided for these cases.

Apexification was done in three steps, in the first step, canal debridement and placement of calcium hydroxide placement in canal was done, the second step includes forming an apical plug, and the third step includes obturation.

Calcium hydroxide stimulates the formation of mineralized and fibrous tissue formation in apical part of the root canal by stimulation of granulation tissue cells. This stimulation is due to alkalinity of the non-setting calcium hydroxide.[7]

MTA has an alkaline pH exhibited superior biocompatibility and cytotoxicity. MTA provides a favorable environment for the cementum deposition due to the presence of calcium and phosphorus ion which induces osteoblastic or cementoblastic activity and provides favorable environment for cementum deposition. The high pH creates an antibacterial environment.[3]

MTA has superior sealing property, its ability to set in the presence of blood and its biocompatibility. Moisture contamination at the apex of tooth before barrier formation is often a problem with other materials used in apexification. Due to its hydrophilic property, the presence of moisture does not affect its sealing ability.[5]

The major drawback with MTA is its long setting time and presence of toxic elements in its composition.[6]

Biodentine can be used as an effective alternative to MTA. Apexification with biodentine requires significantly less time. This can reduce the time period from the patient’s first appointment to the final restoration. The importance of this approach lies in the effective cleaning and shaping of the root canal, followed by apical seal with a material that favors regeneration. This also reduces fracture of immature teeth with thin roots, due to immediate placement of bonded core within the root canal.[6]

The thickness of the Ca- and Si-rich layers increased overtime, and the thickness of the Ca-and Si-rich layer was significantly larger in Biodentine™ compared to MTA after 30 and 90 days, concluding that the dentine element uptake was greater for Biodentine™ than for MTA.[6]

Kokate and Pawar conducted a study that compared the microleakage of glass ionomer cement, MTA, and biodentine when used as a retrograde filling material and concluded that biodentine exhibited the least microleakage when compared to other materials used.[9]

Research suggests that a high pH and released calcium ions are required for a material to stimulate mineralization in the process of hard tissue healing.

Sulthan carried out a study to evaluate the pH and calcium ion release of MTA and biodentine when used as root-end fillings. He concluded that biodentine presented alkaline pH and ability to release calcium ions similar to that of MTA. The 24-h push-out strength of MTA was less than that of biodentine. Blood contamination affected the push-out bond strength of MTA Plus irrespective of the setting time.[9]

Biodentine does not require a two-step obturation as in the case of MTA. Since the setting time is quicker, this reduces the risk of bacterial contamination.[6]

Different materials which can be used for apexification are as follows:
1. Calcium hydroxide
2. Mineral trioxide aggregate
3. Biodentine
4. Tricalcium phosphate
5. Dentin chips
6. Calcium phosphate ceramics and hydroxyapatite
7. Bone morphogenetic proteins
8. Bioceramics.

Other important factors while placing silicate cements at the apex are that they tend to extrude from the apex. To avoid these extrusions, platelet-rich fibrin (PRF) should be used. PRF consists of leukocyte-PRF matrix composed of a tetramolecular structure with cytokines, platelets, and stem cells within it which acts as a biodegradable scaffold that guides epithelial cell to migrate to its surface.

The cells involved in tissue regeneration may be carried by PRF and release growth factors in a period between 1 and 4 weeks.

Thus, MTA sets in canal in the presence of moisture and does not require moisture-free environment. Another advantage
of using PRF as a matrix is that it promotes wound healing and repair.[10]

According to the previous studies, it was noted that initial periapical healing was better in tooth filled with biodentine. Furthermore, MTA filled tooth had long-term periapical healing. This may due to the fact that MTA has superior marginal adaptation.[4]

Due to all these, MTA was the choice of the material for this case considering its longevity.

**Conclusion**

It can be concluded that MTA and biodentine both as a calcium silicate material can be successfully used for closure of open apex. Furthermore, calcium hydroxide plays an important role in periapical healing and induction of root formation. PRF can also be used to prevent extrusion of the filling material. Single-visit apexification can also be done with these materials in cases presenting with open apex. From the above case reports, and the available data from the previous studies, it can be concluded that biodentine showed better initial healing while MTA had better long-term effect.

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