Clinical Success of MTA Apical Barrier in a Tooth with Open Apex: Two Case Reports and Literature Perspective

ABSTRACT

Open apices in non-vital immature teeth present a significant endodontic challenge. The lack of apical constriction compromises the ability to establish an effective apical seal, complicating obturation and increasing the risk of periapical pathology. Various techniques have evolved, including apexification using calcium hydroxide, and the use of biocompatible materials such as mineral trioxide aggregate (MTA) and Biodentine for apical barrier formation. This case report highlights the successful management of a non-vital maxillary central incisor with an open apex using MTA apical barrier technique, providing clinical and radiographic healing.

Keywords: Open apex, apexification, mineral trioxide aggregate, apical barrier, immature tooth.

INTRODUCTION

An open apex results from the cessation of root development due to pulp necrosis in immature permanent teeth, often caused by trauma or caries[1]. Managing such cases is complex due to the absence of an apical stop, which impedes proper condensation of root filling material and apical seal formation[2]. Historically, apexification using long-term calcium hydroxide was the mainstay of treatment[3]. However, calcium hydroxide has drawbacks including prolonged treatment duration and increased risk of root fracture[4]. Contemporary approaches favor one-visit apexification using materials such as mineral trioxide aggregate (MTA), which offers excellent biocompatibility, sealing ability, and induction of hard tissue formation[5]. MTA reduces treatment time and enhances prognosis, especially in young patients where compliance can be variable[6]. This report presents the clinical management of a maxillary incisor with an open apex treated with MTA apical barrier technique.

Blunder buss canals referred to as Absence of sufficient root development to provide a conical taper to the canal as referred by **Franklein S. Weine in the year 1972** . Due to trauma or carious exposure, the pulp undergoes necrosis, dentin formation ceases and root growth is arrested. The resultant immature root will have an apical opening that is very large. This is called an open

apex, also referred to previously as a blunderbuss canal defined by **Thomas R.Pittford,1989.** This case report signifies the use of MTA as an apical barrier for open apex root canal cases for apexogensis.

PULP INJURY IN TEETH WITH DEVELOPING ROOTS

Hertwig epithelial root sheath is sensitive to trauma which effects increases the vascularity and cellularity. Complete destruction of Hertwig's epithelial root sheath results in cessation of normal root development. Hertwigs epithelial sheath (HERS)forms from the outer and inner enamel epithelium. HERS is responsible for responsible for determining shape of the root or roots. Important role of Hertwig's epithelial root sheath in continued root development after pulpal injury hence every effort should be made to maintain its viability. Unfortunately traumatic injuries to young permanent teeth and are said to affect 30% of children. The majority of these incidents occur before root formation.

Hard tissue can be formed by :

- Cementoblasts -apical region
- Fibroblasts of the dental follicle
- Periodontal ligament that undergo differentiation after the injury to become hard tissue producing cells.

CAUSES OF OPEN APICES

Incomplete development

- The open apex typically occurs when the pulp undergoes necrosis as a result of caries or trauma, before root growth and development are complete.
- The normal crown /root ratio is compromised and may cause mobility.
- It becomes difficult to achieve an apical seal with conventional root canal filling.

An open apex can also occasionally form in a mature apex as a result of following :

- Extensive apical resorption due to orthodontic treatment,
- Periapical pathosis

- Trauma
- Root end resection during periradicular surgery
- Over-instrumentation

These can be of two configurations :

- **Non-blunderbuss-** The walls of the canal may be parallel to slightly convergent as the canal exits the root. The apex, therefore can be broad (cylinder shaped) or tapered (convergent)
- **Blunderbuss-** The word 'blunderbuss' basically refers to an 18th century weapon with a short and wide barrel. It derives its origin from the Dutch word 'DONDERBUS' which means 'thunder gun'. The walls of the canal are divergent and flaring, more especially in the buccolingual direction. The apex is funnel shaped and typically wider than the coronal aspect of the canal.

PROBLEMS ASSOCIATED WITH INCOMPLETE RHIZOGENESIS

- Large open apices- convergent, parallel, divergent
- Thin dentinal walls- which are susceptible to fracture before, during or after treatment
- Frequent periapical lesions - with or without associated apical resorption
- Short roots - thus compromising crown-root ratio
- Fractures of crown - compromising esthetics especially in the anterior region - necessitating post endodontic
- Rehabilitation of both crown and root

TREATMENT PROTOCOLS

Treatment is based on the vitality of the pulp.

- If the immature tooth has vital pulp, exhibiting reversible pulpitis, then physiological root end development or **apexogenesis** is attempted.

- On the other hand if irreversible pulpitis is present or pulp is necrotic, then root end closure or **apexification** is induced.

CASE REPORT-1

A 14-year-old boy reported to our clinic with a history of prior impact of trauma 2 years before his initial visit. He reported with no pain and only discolored tooth in the upper front tooth since 3 weeks . No spontaneous pain was reported by the patient. Clinical examination showed discoloration and tenderness on percussion of maxillary left central incisor (tooth 21). The tooth was non-responsive to pulp vitality tests. Periapical radiograph revealed an incompletely formed root with divergent canal walls and an open apex, confirming diagnosis of pulp necrosis with open apex.
The patient's medical history was noncontributory. After informed consent, access cavity was prepared under rubber dam isolation. Working length was determined radiographically. Canal was gently debrided using saline and 3.5% sodium hypochlorite, avoiding mechanical shaping to prevent thinning of dentinal walls[7]. Calcium hydroxide was placed as an intracanal medicament for one week to ensure disinfection[8].

At next appointment, canal was irrigated and dried. Mineral trioxide aggregate (MTA Angelus) was mixed and delivered using MTA carrier to form an apical plug of 4 mm. A wet cotton pellet was placed, and the cavity sealed with temporary cement. After 24 hours, MTA set was confirmed, and the canal was backfilled with thermoplasticized gutta-percha and resin-based sealer[9]. Composite resin was used to restore access cavity.

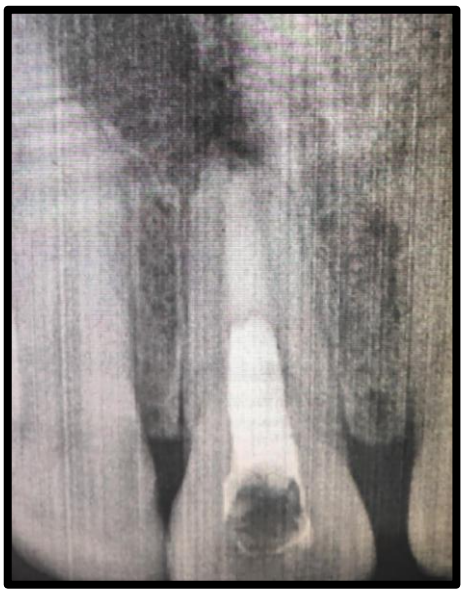
The case demonstrated successful management using the MTA apical barrier technique.

CASE REPORT 1 - OPEN APEX WRT 11

FIG. 1- MTA PLUG

FIG. 2- PRE OPERATIVE TOOTH FRACTURED WRT 11 & 21

FIG. 3- POST OPERATIVE ESTHETIC BUILD UP



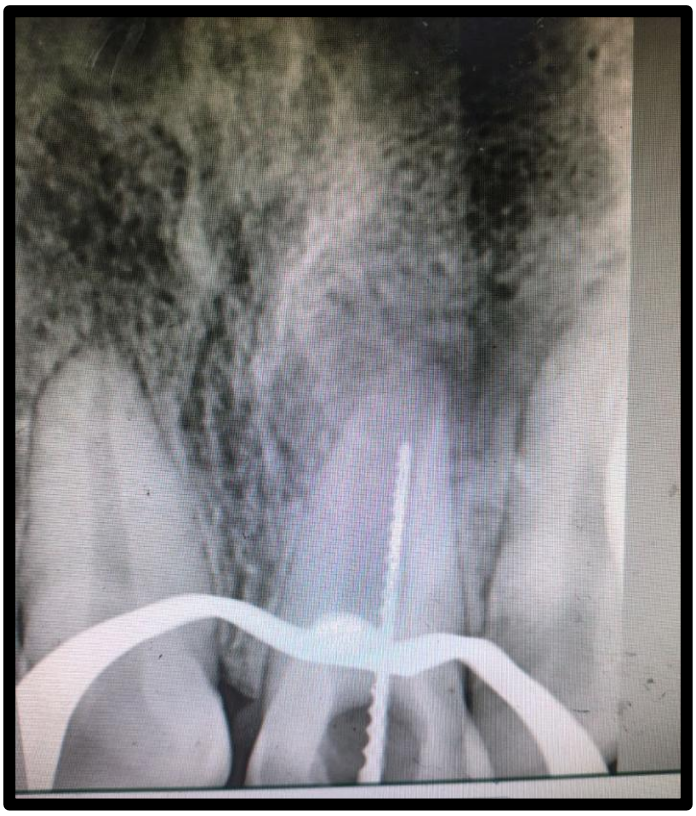
CASE REPORT 2- BLUNDER BUSS CANAL WITH OPEN APEX WRT 21

FIG. 4-PRE OPERATIVE WORKING LENGTH RAIOGRAPH

FIG. 5- MTA PLUG

FIG. 6-POST OBTURATION AND CORE BUILD UP

FIG. 7- POST OPERATIVE



DISCUSSION

In anatomy, the apical foramen is the opening at the A**pex** of the **root** of a **tooth**, through which the nerve and blood vessels that supply the dental pulp pass. Thus it represents the junction of the pulp and the periodontal tissue. The anatomy of the apical foramen changes with age as root formation is yet to be completed when the tooth erupt. The completion of root development and closure of the apex occurs up to three years after eruption but sometimes the root apex remains open, which is known as Immature Permanent Teeth With Immature Root Apex Formation. The aetiology of pulp necrosis in immature permanent teeth can include caries , Trauma , Presence of the dental anomalies, Dens invaginatus , Dens evaginatus. Trauma or caries in immature permanent teeth often leads to pulpal damage, interrupting root development and increasing the risk of fractures due to shorter roots with thin walls. Open apices pose a unique challenge in endodontics due to the inability to create an apical stop[10]. Traditional approaches like calcium hydroxide apexification or mineral trioxide aggregate (MTA) apexification have shown success in controlling infection and creating an apical seal.

The traditional calcium hydroxide apexification requires multiple appointments over 6–24 months and risks cervical fracture due to prolonged exposure[11]. (MTA) in apexification has shown accelerated success outcome as compared to calcium hydroxide.One-visit apexification using MTA has revolutionized treatment by allowing formation of an artificial apical barrier that enables effective obturation[12]. MTA is a calcium silicate-based cement with excellent sealing ability, biocompatibility, and the ability to set in moist conditions[13]. It induces cytokine release from bone cells and promotes cementogenesis[14]. In this case, MTA allowed predictable closure of the apex and successful healing, aligning with literature reports of high success rates[15]. **Mineral trioxide aggregate (MTA)** was introduced as an alternative to traditional materials for the repair of root perforations, pulp-capping and as a retrograde root filling due to its superior biocompatibilty and ability to seal the root canal system.

Alternatives such as Biodentine and bioceramic materials have also shown promise in apexification and root-end sealing[16]. However, MTA remains the most researched and clinically validated material for open apex management[17]. Care must be taken during placement to avoid extrusion into periapical tissues, which can provoke inflammatory reactions in some cases. [18] Irrigation protocols must be conservative in immature teeth. Overzealous instrumentation or high concentration irrigants may weaken dentin and cause transportation[19]. Gentle debridement with

calcium hydroxide disinfection remains essential to reduce microbial load prior to barrier placement. [20]

UPDATED OVERVIEW: MTA APEXIFICATION IN ENDODONTICS (2024–2025)

The latest research (2024–2025) on Mineral Trioxide Aggregate (MTA) used for apexification, particularly in immature teeth with blunderbuss canals.

1. Microleakage Study (BMC Oral Health, Sep 2024)[21]

An in vitro study comparing MTA and Biodentine apical plugs showed that while MTA had moderate microleakage, Biodentine performed better, indicating a tighter apical seal. This suggests Biodentine may be superior in sealing ability in open apex cases.

2. Modified MTA Materials (BMC Oral Health, Mar 2024)[22]

Systematic reviews indicate that adding 2.5% Na_2HPO_4 or 5% $CaCl_2$ can shorten MTA setting time without compromising biocompatibility. Higher concentrations may affect strength or increase toxicity.

3. Long-term Clinical Outcomes (Australian Endodontic Journal)[23]

A 17–20 year follow-up of MTA apexification cases showed excellent long-term outcomes including sustained function and periapical healing, reinforcing the durability of MTA.

4. Systematic Reviews & Meta-analyses[24]

Meta-analyses confirm that MTA creates apical barriers significantly faster than calcium hydroxide and has comparable or better clinical success. Bioceramic alternatives such as EndoSequence are also effective but MTA remains the gold standard.

Table 1-Key Takeaways

Aspect	What's New	Clinical Relevance
Sealing Ability	Biodentine may outperform MTA in microleakage tests	Consider Biodentine for tighter seal in open apices
Modified MTA	Additives reduce set time without toxicity	Faster apical barrier in fewer visits

Success Rates	MTA yields faster barrier formation vs $Ca(OH)_2$	Shorter treatment time, better compliance
Durability	Proven success up to 20 years	Supports long-term reliability of MTA

CONCLUSION

Management of non-vital teeth with open apices requires a strategic and biologically sound approach. The use of MTA as an apical barrier enables a predictable, single-visit apexification with excellent healing outcomes. This case reaffirms the clinical efficacy of MTA in managing immature teeth, ensuring preservation and long-term function.

MTA offers reliability in achieving apical closure, while regenerative approaches, particularly with PRF, show promise for enhanced tissue regeneration. Further studies are needed to determine long-term success and establish definitive guidelines.

Management of immature teeth with large blunderbuss canals presents a clinical challenge due to the absence of an apical constriction, making obturation and periapical healing unpredictable. Mineral Trioxide Aggregate (MTA) has proven to be an ideal material for apexification in such cases, owing to its excellent biocompatibility, sealing ability, and capacity to induce hard tissue formation. In teeth with wide open apices, MTA facilitates the formation of an artificial apical barrier, allowing for predictable obturation and periapical repair. Clinical and radiographic outcomes have consistently demonstrated successful healing and apical closure with MTA, making it a reliable and efficient option in managing blunderbuss canals. However, proper case selection, canal disinfection, and controlled placement of MTA are essential for optimal results.

Aspect	**What's New**	**Clinical Relevance**
Sealing ability	MTA provides effective seal, but Biodentine may be superior in microleakage tests.	Consider Biodentine for tighter seal
Modified MTA	Additives like Na_2HPO_4 & $CaCl_2$ can shorten set-time without compromising safety	Faster barrier formation in single visits
Success &	MTA still matches or exceeds $Ca(OH)_2$ in outcomes,	Quicker, patient-friendly

Aspect	What's New	Clinical Relevance
efficiency	with significantly faster barrier formation	treatment
Long-term durability	Case reports show sustained success up to 20 years	Strong evidence for lasting outcomes

Table 2- Different aspects of Mineral Trioxide Aggregate (MTA)and its clinical relevance

SUMMARY

- MTA seals, sets fast, and yields reliable long-term results.
- Biodentine may outperform MTA in sealing ability—especially in wide-open ("blunderbuss") canals.
- Chemical modification of MTA (e.g., with $CaCl_2$ or Na_2HPO_4) offers faster setting while retaining safety.
- MTA continues to be a **top-tier apexification agent in 2025**, balancing speed, safety, and durability.

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