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Management of Blunderbuss canals with Three Different Calcium Silicate–Based Materials: Aclinical Case Series

Abstract:
The present case series highlights the endodontic management of immature permanent teeth with blunderbuss canals using three different calcium silicate–based materials—Mineral Trioxide Aggregate (MTA), Biodentine, and Bio-C Repair. All three teeth exhibited open apices with periapical pathology and were treated using minimal instrumentation, calcium hydroxide intracanal medicament, and subsequent placement of 4–5 mm apical plugs. Clinical and radiographic evaluation at a six-month follow-up revealed complete periapical healing and evidence of apical barrier formation in all cases. The findings emphasize that calcium silicate–based materials are effective alternatives for one-step apexification, offering predictable sealing ability and favorable biological outcomes. Awareness of their properties and proper case selection are crucial to optimize clinical success in managing teeth with open apices.

Key-words: Blunderbuss canal, open apex, apexification, mineral trioxide aggregate, Biodentine, Bio-C Repair, calcium silicate–based materials.

Introduction:

Immature permanent teeth with necrotic pulps and wide-open apices, commonly referred to as *blunderbuss canals*, represent a complex clinical challenge in endodontics. These teeth often develop following trauma, caries, or developmental disturbances that cause early pulpal necrosis, arresting normal root maturation. The resulting anatomy is characterized by thin dentinal walls, lack of an apical constriction, and increased susceptibility to fracture, making conventional root canal therapy and obturation techniques difficult and often unpredictable [1,2].

Historically, apexification using long-term calcium hydroxide dressings was the treatment of choice for such cases. This method allowed for calcified barrier formation at the apex but required multiple visits, was heavily dependent on patient compliance, and was associated with risks of reinfection during treatment. Furthermore, prolonged calcium hydroxide use has been shown to weaken dentinal walls, increasing the likelihood of cervical root fractures[3,4]. These drawbacks prompted the exploration of materials that could achieve *one-step apexification* and provide immediate apical sealing.

Mineral trioxide aggregate (MTA) was a breakthrough in this regard, demonstrating excellent sealing ability, high biocompatibility, and the ability to stimulate cementogenesis and periapical healing (5,6). It remains one of the most widely studied and clinically accepted materials for apical plug formation. However, certain shortcomings-such as prolonged setting time, difficult handling, solubility in early stages, and potential for tooth discoloration-limit its universal use, particularly in anterior esthetic regions [7,8].

To overcome these challenges, newer calcium silicate–based biomaterials such as Biodentine and Bio-C Repair have been introduced. Biodentine, a tricalcium silicate–based material,

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offers faster setting, better handling, and reduced discoloration potential compared with MTA. It demonstrates bioactivity by releasing calcium ions, stimulating mineralization, and forming tag-like crystalline structures within dentinal tubules, thus enhancing the seal (9–11). Both clinical studies and in vitro investigations support its use as a reliable alternative to MTA in apexification and restorative procedures[12].

Bio-C Repair, a premixed ready-to-use calcium silicate–based bioceramic, represents the latest advancement in this material category. Its premixed formulation eliminates errors related to powder–liquid mixing and provides consistent clinical handling. Bio-C Repair possesses a high alkaline pH, antibacterial properties, and excellent sealing ability, while also exhibiting low cytotoxicity and the ability to induce biomineralization[13–15]. Furthermore, unlike MTA, it has no significant risk of discoloration, making it particularly advantageous for anterior teeth. Nevertheless, its relatively recent introduction means that long-term clinical data remain limited compared to MTA and Biodentine[16].

This case series highlights the management of blunderbuss canals using three different calcium silicate–based materials-MTA, Biodentine, and Bio-C Repair-demonstrating their clinical application, advantages, and healing outcomes. By documenting real-world evidence, this report aims to contribute to the growing body of literature on bioceramic-based management strategies for immature teeth with necrotic pulps.

Case Reports:

Case 1 and Case 2(in same patient): Open Apex Treated with MTA and Biodentine:

A 14-year-old male patient was referred to the department of Conservative Dentistry and Endodontics, K.D Dental College and Hospital, Mathura. He gave a history of trauma to the anterior teeth two years prior, presenting with intermittent pain in maxillary right central incisor and lateral incisor (tooth #11 and tooth #12). He gave a dental history of previous treatment initiated in tooth 12.

Clinical examination revealed tenderness on percussion and negative response to vitality testing irt tooth #11 and #12. Examination also revealed a sinus tract in the labial vestibule of the maxillary right central incisor. On radiographic examination IOPA radiograph revealed wide open apices with periapical radiolucency in relation to 11 and 12. Root canal walls were thin with blunderbuss canal morphology, and a radio-opaque material in canal of tooth 12 was seen. **Diagnosis was** Pulpal necrosis with chronic apical periodontitis in an immature permanent maxillary central incisor and lateral incisor (tooth 11 and 12). The patient was given a detailed explanation concerning the treatment and prognosis.

FIGURE 1: Preoperative clinical photograph

FIGURE 2: Preoperative radiograph showing incomplete root formation along with a periapical lesion in 11 and 12 and a radioapaque material in 12.

In the first appointment, access opening was done with a round bur in tooth 11 and the already existing access cavity in tooth 12 was refined with a safe-end tapered bur under rubber dam isolation. The existing material in the canal of tooth 12 was removed using 60 H file and irrigation with 1.5% NaOCl.

Working length was measured using a hand 60 K file radiographicallyirt 11 and 12.

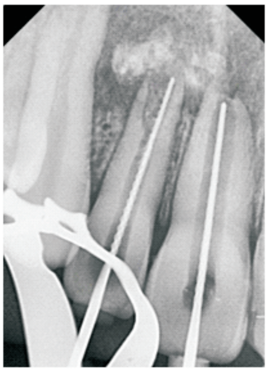

FIGURE 3: Working length determination

Minimal instrumentation was done upto 70k file with gentle irrigation using 1.5% NaOCl followed by saline and 17% EDTA. Calcium hydroxide was placed as an intracanal medicament for two weeks. On recall in the second appointment, the sinus tract had resolved.

For tooth 12, MTA apical plug was planned and for tooth 11 Biodentin apical plug was planned.

Tooth 12 (Lateral Incisor): MTA Apical Plug

White MTA Angelus was mixed according to manufacturer's instructions and using hand pluggers, gently condensed against the matrix to form 4 mm of apical plug. After placing a moist cotton pellet, the access cavity was restored with cavit.

FIGURE 4: MTA apical plug in tooth 12

Next day, root canal was obturated using lateral condensation of Gutta-percha and resin sealer.

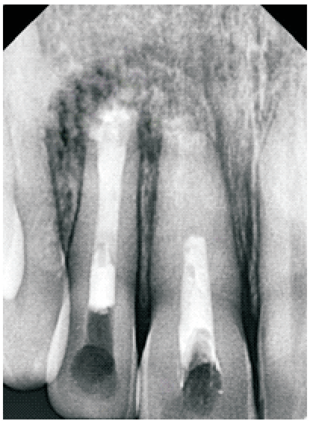

FIGURE 5: Obturation in 12 and Biodentin apical plug in tooth 11 followed by obturation in 11.

Tooth 11 (Central Incisor): Biodentin Apical Plug

In the same appointment, Biodentine (Septodont) was used for the apical plug with tooth 11. Following the manufacturer's instructions, Biodentine was inserted into the canal up to 5 mm from the working length with the help of a plugger. It was then decided to obturate the canal on the same visit using the the rmoplasticized technique. Tooth 11 and 12 was restored with composite resin. Composite build up was done done in tooth 21.

FIGURE 6: Post-operative radiograph

FIGURE 7: Post-operative clinical picture

Follow-up and Outcome- The patient was recalled after 6 months for clinical and radiographic evaluation. At follow up , 11 and 12 were clinically asymptomatic with no sinus tract opening and periapical healing was seen radiographically .

FIGURE 8: Follow-up radiograph after 6 months

Case 3: Open Apex Treated with Bio-C Repair

A 15-year-old male patient reported with persistent swelling in relation to the maxillary left lateral incisor (tooth 21) following trauma three years earlier. Intraoral examination revealed a discolored tooth with buccal vestibular tenderness. Vitality testing was negative. Periapical radiographs revealed a blunderbuss canal with thin dentinal walls and a large periapical lesion. **Diagnosis** was Pulpal necrosis with chronic apical periodontitis in an immature permanent maxillary central incisor (tooth 21).

FIGURE 9: Pre-operative clinical picture

Treatment:

After rubber dam isolation,the access cavity was made and working length was measured using 60K file which was estimated to be 21 mm and confirmed with a radiograph. The canal was irrigated using 1.5% sodium hypochlorite, saline, and 17% EDTA. Minimal mechanical preparation was performed till 70K file. Calcium hydroxide paste was placed for three weeks as intracanal dressing. On recall, the tooth was asymptomatic with reduction of swelling. An apical plug of Bio-C Repair material was placed using a prefilled syringe delivery system to a thickness of approximately 4 mm. The remaining canal was obturated with gutta-percha and resin sealer, and the access cavity restored with composite resin. After a week zirconia crown was given in relation to 21.

FIGURE 10: Working length radiograph

FIGURE 11: Bio-c repair apical plug in 21

FIGURE 12: Obturation in 21

FIGURE 13: Post-operative radiograph

FIGURE 14: Post-operative clinical picture

Follow-up: At 6 months, the tooth was clinically asymptomatic with radiographic evidence of healing and apical barrier formation.

FIGURE 15: Follow-up radiograph after 6 months

Discussion:

Management of blunderbuss canals has evolved significantly over the past few decades, moving from long-term apexification with calcium hydroxide to contemporary one-step apical barrier techniques with calcium silicate–based bioceramics. The shift has been largely driven by the desire to overcome the disadvantages of extended treatment duration, susceptibility to root fracture, and risk of reinfection associated with calcium hydroxide therapy (3,4).

Mineral trioxide aggregate (MTA) has long been considered the gold standard for single-step apexification. Its excellent sealing ability, biocompatibility, and ability to promote hard tissue formation are well documented (5,6). MTA stimulates release of bioactive molecules from dentin, encourages cementoblast differentiation, and supports periapical healing (17). Clinical studies have shown high success rates with MTA apical plugs in immature teeth (18). However, MTA is not without limitations—it has a long setting time, challenging handling characteristics, potential for washout in moist environments, and risk of tooth discoloration, particularly in anterior esthetic regions (7,8,19). These drawbacks have encouraged research into alternative calcium silicate–based materials.

Biodentine, a newer tricalcium silicate-based material, was developed as a "dentin substitute" with improved physical and biological properties. It offers a faster setting time, easier manipulation, and less discoloration potential compared with MTA (9,10). Biodentine exhibits bioactivity through calcium ion release, promotes mineralization, and forms tag-like structures within dentinal tubules that enhance the seal (11). Clinical reports and in vitro studies suggest superior handling and reduced microleakage compared to MTA, while maintaining comparable biological outcomes (12). In cases of blunderbuss canals, Biodentine facilitates predictable apical sealing with the added advantage of being less technique-sensitive for clinicians.

Bio-C Repair, a more recently introduced premixed bioceramic material, represents the next step in calcium silicate cement evolution. Its ready-to-use formulation eliminates the risk of operator-dependent mixing errors. The material has a high pH, exhibits excellent biocompatibility, and possesses bioactivity that promotes periapical healing and hard tissue deposition (13–15). Studies report favorable sealing ability and antibacterial properties, similar or superior to MTA (20,21). Additionally, Bio-C Repair has demonstrated lower cytotoxicity, ease of delivery, and reduced setting time compared to MTA (16). Importantly, its non-discoloring formulation makes it particularly suitable for anterior teeth. However, long-term clinical evidence on Bio-C Repair remains limited compared to MTA and Biodentine.

From a clinical standpoint, material selection for managing blunderbuss canals should balance biological efficacy, handling characteristics, and esthetic considerations. MTA remains a reliable and well-researched option, particularly where operator familiarity and long-term outcomes are priorities. Biodentine offers a favorable alternative where faster setting and improved handling are desired, with minimal compromise in biological response. Bio-C Repair, though relatively new, appears highly promising for clinicians seeking ease of use and esthetic predictability in anterior cases.

In the present case series, all three materials were effective in creating an apical barrier and promoting periapical healing, consistent with findings from previous studies. While individual clinical variables may influence the choice of material, this comparative documentation underscores the versatility of calcium silicate–based materials in the management of immature necrotic teeth. Long-term controlled clinical trials are, however, needed to establish the superiority of one material over another with greater certainty.

Conclusion:

Calcium silicate–based materials such as MTA, Biodentine, and Bio-C Repair provide predictable and successful management of blunderbuss canals in immature permanent teeth. All cases demonstrated satisfactory apical barrier formation and periapical healing within six months. MTA remains a dependable material with proven long-term outcomes; however, Biodentine and Bio-C Repair offer improved handling, faster setting, and superior esthetic properties. A comprehensive understanding of each material's clinical behavior and appropriate selection can greatly enhance treatment prognosis. Long-term studies are required to further validate their comparative performance.

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