Majalah Kedokteran Gigi Indonesia
Vol 12 No 1 – April 2026
ISSN 2460-0164 (print), ISSN 2442-2576 (online)
Available online at https://jurnal.ugm.ac.id/mkgi
DOI: http://doi.org/10.22146/majkedgiind.111285

CASE STUDY

Apexification using mineral trioxide aggregate and intracanal post in non-vital upper left lateral incisor

Wisna Darmastuti*, Naresworo Apsari, Wignyo Hadriyanto***, Tunjung Nugraheni***✉**

*Specialist Conservative Dentistry Program, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia
**Endodontist, Dhea Klinik Gigi, Yogyakarta, Indonesia
***Department of Conservative Dentistry, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia
***Jl Denta No 1, Sekip Utara, Yogyakarta, Indonesia; ✉ correspondence: drgtunjungnugraheni@ugm.ac.id

Submitted: 5th December 2023; Revised: 27th February 2024; Accepted: 28th May 2024

ABSTRACT

Trauma to young permanent dentitions often occurs. The prevalence of incisor maxillae is quite high. This causes pulp necrosis, which results in dental pulp roots that are not completely formed and apical closure stops. As a result, apex is wide and open. The opening of apex caused by trauma can be coped with apexification. This procedure as first treatment is used for the formation of apical barrier, which can close the apex, before applying gutta-percha. This case report seeks to show the achievement of apex closure in one visit treatment using mineral trioxide aggregate (MTA) in incisor lateral non vital maxillae caused by dental trauma. A 16-year-old male patient admitted to falling from a motorcycle accident 2 months prior. His incisor lateral maxillae left ¾ of its crown, while the orthodontic appliance remained fixed on his teeth. A clinical examination of non-vital teeth used the fracture Ellis IV class with open apex, confirmed with periapical radiograph and CBCT. Apexification in one visit treatment with MTA was performed before a root canal treatment. In the following visit, gutta-percha was cut and fiber post installed, followed by direct resin composite restoration using mock up technique. In conclusion, apexification in one visit treatment using MTA can accelerate treatment with formation of calcium barrier to allow obturation using gutta-percha. This is followed by intracanal retention after treatment to prevent fracture and direct final restoration.

Keywords: apexification; fiber post; mock up; MTA

Copyright: © 2026, Majalah Kedokteran Gigi Indonesia (CC BY-NC-SA 4.0)

INTRODUCTION

Some immature teeth become necrotic because of severe caries or trauma. Root development stops in necrotic teeth and results in thin dentinal walls in the root and divergent, open apex.[1] These type of teeth are more susceptible to fracture. Trauma that occurs in maxillary anterior teeth is a commonly encountered case. The prevalence of this trauma is 6-37% with 96% involving maxillary incisor. Teeth that experience trauma or caries during their young permanent stage can lead to tooth necrosis, causing root growth to stop, which results in persistent open apex.[2]

Apexification is a nonsurgical technique that allows the creation of an apical barrier in open apex teeth, with success rates standing between 81% and 100%, considering 1 to 5 years reported follow-ups.[3–5] This process should ideally be performed before root canal treatment because of the condition of open apex, in which the dentin walls can easily break, and the root canal becomes larger, making it difficult to achieve compaction of the root canal filling material, such as gutta-percha. Apexification is a treatment option in such cases.[6]

The traditional approach of apexification with calcium hydroxide has shown a high success rate. Nevertheless, it has significant potential disadvantages, including multiple treatment sessions and a lengthy treatment time, the difficulty of maintaining the integrity of the coronal seal in between appointments, and noncompliant patients.5 Apexification has several risks, one of which is cervical root fracture.7 Therefore, materials containing hydraulic calcium silicate-

Majalah Kedokteran Gigi Indonesia. April 2026; 12(1): 51-57
ISSN 2460-0164 (print)
ISSN 2442-2576 (online)

based cement (HCSCs) such as mineral trioxide aggregate (MTA) are used as apical sealants that can be applied in a single visit. Treatment with MTA can shorten the time between the patient's first visit and the completion of the final restoration.8 The benefits of employing MTA for apexification encompass shortening of the treatment duration, the potential to restore the tooth promptly, preservation of dentine's mechanical properties, exceptional biocompatibility, promotion of tissue repair, prevention of bacterial leakage, and stimulation of cytokine release from bone cells, which promotes hard tissue formation.9 MTA has shown better healing in terms of clinical and radiographic success, and the apical barrier is formed within a short period of time compared to calcium hydroxide. As a result, the long-term success rate of apexification with MTA is higher.9,10

Intracanal retention is thus needed to support the final restoration to be made on a tooth that has undergone apexification. Subsequent treatment involves the creation of direct restoration as an effort to reduce stress on the remaining tooth structure and at the tooth restoration interface. The use of fiber-reinforced post can enhance resistance to fractures due to their elastic modulus resembling dentin, allowing for effective stress distribution.[11] The purpose of this article is to discuss a one-visit apexification treatment using MTA on a maxillary left permanent lateral incisor that experienced necrosis with an open apex due to trauma. Written informed consent for this publication was obtained from the patient.

METHODS

A 16-year-old male patient, who was in pain, came to the Conservative Dentistry Clinic at the RSGM Prof. Soedomo, Faculty of Dentistry, Universitas Gadjah Mada, with a referral from the Oral Surgery Clinic for the treatment of his upper front teeth. He had a motorcycle accident 2 months prior, in which his upper front teeth were hit and dislodged. Two of the front teeth were outside the mouth, and one was still inside, but all three were still attached to his braces. The patient arrived at the dental clinic 3 hours after the accident. The dislodged front teeth were replanted and stabilized by the oral surgery dentist at RSGM Prof. Soedomo. The stabilization was carried out for a month. The patient had no history of systemic disease or drug allergies and was not under the medication and care of any healthcare provider. The treatment plan was to perform apexification and direct restoration. The patient was informed about this research and signed all informed consent forms.

During an objective examination, it was found that tooth 22 had an Ellis class IV fracture with pulp necrosis and an open apex. Vitality testing, cavity examination, percussion, and palpation were all negative. Radiographic periapical examination revealed an open apex, which was further confirmed by a cone beam computed tomography (CBCT) examination to support and assess the size, extent, and openness of the apex of tooth 22. The treatment plan consists of apexification treatment in single visit using mineral trioxide aggregate (MTA) followed by root canal treatment and obturation with gutta-percha. Then, placement of fiber-reinforced core material for intracanal retention and composite resin restoration using mock up technique were carried out. The prognosis for this case was good because the tooth had a single, straight, and large-diameter root canal. The remaining hard tissue structure of the tooth could still be directly restored, and the periapical lesion was not extensive, suggesting good apical healing potential. Additionally, the patient had no history of systemic disease and adhered to the treatment.

On the first visit, informed consent was obtained. Isolation was achieved using rubber dam and saliva ejector. Access through the cavity was established using an endo access bur (Dentsply) and then further widened using a non-cutting-ended fissure bur (Diamendo, Dentsply) until a straight-line access was achieved. Root canal irrigation was performed using 1.25% NaOCl within the cavity with the opened orifice. From the preoperative radiography, the estimated working length of the root canal was determined to be 17 mm. The actual working length was confirmed



(A) (B) (C)

Figure 1. (A) Clinical representation, (B) Preoperative radiographs 22 revealing radiolucent areas at the apical regions. Tooth 22 exhibits an open apex. (C) CBCT shows open apex as well



Figure 2. Radiographic overview of the measurement of the working length of tooth 22 shows the file tip reached apical constriction and indicates apical closure with MTA reached the apical end and hermetic

using a K-file #15 inserted into the root canal and confirmed using periapical radiograph.

Subsequently, root canal preparation was carried out circumferentially. The master apical file (MAF) used was a K-file #50 with a working length of 17 mm. Root canal irrigation was performed repeatedly. After the root canal preparation was completed, the root canals were irrigated with a 2.5 ml solution of 1.25% NaOCl, left in place for approximately 1 minute, followed by a solution of 17% EDTA (Smear Clear, SybronEndo). The canals were disinfected with 2% chlorhexidine digluconate (Cavity cleanser, Bisco) for 30 seconds. Intermediate irrigation was carried out using sterile water (aquadest). Root canals were then dried using paper points.

Next, apical closure along a 4 mm length was performed using MTA (ProRoot MTA, Dentsplay). MTA powder was mixed with sterile water on a mixing pad using a spatula until a creamy consistency was achieved. Subsequently, it was introduced into the root canal using a micro apical placement (MAP) technique. The MTA application was carried out along the apex. The MTA placed in the root canal was compacted with a hand plugger marked using rubber stop to the desired height (4 mm from the apex). Residual MTA adhering to the walls of the root canal was cleaned with microbrush moistened with sterile water, and confirmation was done with periapical radiography (Figure 3). The cavity was then sealed with temporary filling (Cavitron, GC), and the patient was instructed to return a week later.

On the second visit, the patient reported no complaints, and the objective examination was satisfactory. Rubber dam isolation was applied and temporary filling was removed. Gutta-percha point selection was made using #35. The gutta-percha points were sterilized with a 2.5% NaOCl solution for a minute, rinsed with 70% alcohol, and dried.

Majalah Kedokteran Gigi Indonesia. April 2026; 12(1): 51-57
ISSN 2460-0164 (print)
ISSN 2442-2576 (online)



Figure 3. Root canal filling in tooth 22 shows a hermetic obturation

The lateral condensation obturation technique was performed. Epoxy resin sealer (Topseal, Dentsply) was introduced using lentulo marked with rubber stop along the working length. Then the main gutta-percha #35 was coated with sealer and a finger spreader was inserted between the gutta-percha and the root canal wall. Once filled, the gutta-percha was cut 2 mm below the orifice and lightly condensed plugger (Heat carrier plugger, Denstply). The cavity was cleaned of residual sealer and confirmed with periapical radiography. Tooth 22 was temporarily filled (Cavitron, GC). The rubber dam was removed, then upper and lower jaw impressions were taken using alginate impression material (Aroma, GC) to create a mock-up model.

On the third visit, intracanal retention using fiber reinforced core material (Built It Fr, Pentron) was installed. Gutta-percha was reduced approximately 5 mm below the alveolar crest. The canal was irrigated with sterile water, followed by the preparation of a bevel on the cavosurface margin using a flame-shaped bur. Phosphoric acid etchant 37% (DenFil Etchant-37 syringe, Vericom) was applied to the root canal, cavity, and prepared enamel. The root canal surface and the prepared cavity of the tooth were thinly coated with fifth bonding material (Stae, SDI) using a microbrush. The microbrush was placed at the base of the cavity then moved throughout the cavity, left for 20 seconds, and gently blown with air for 2 seconds. The air blow did not directly enter the cavity but was directed only above the cavity. Excess resin bonding in the root canal was absorbed using paper points. Light curing was performed for 10 seconds after the fiber reinforced core material was inserted up to 2/3 of the crown. Subsequently it was cured for 40 seconds using a light curing unit.

In the last visit, cavity preparation involved creating a Class IV cavity with a hollow ground bevel, using a tapered round-end bur extending 2-3 mm along the entire cavosurface margin (indicated by the yellow arrow).

Tooth 22 which had been etched labial and palatal was coated with fifth-generation bonding material using a microbrush. The bonding material was left in the cavity for 20 seconds and gently blown with air indirectly into the cavity. The bonding layer was cured using a light curing unit for 10 seconds. A shade A2 resin composite (Palfique LX5, Tokuyama Dental) was applied to the palatal guide using a plastic instrument. A celluloid strip was placed on the palatal sides of teeth 11 and 22 to form the proximal wall. This was done by affixing the celluloid strip and applying A2 shade resin composite to the proximal area, forming the proximal wall. Using a slip-through technique, the celluloid strip was pulled distally from the palatal side to create the proximal contour. Excess composite was then removed, and the area was light cured for 20 seconds. The final layer on the labial was restored using B1 shade resin composite (FiltexTM Z 350 XT, 3M ESPE) and light cured. After the placement was complete, occlusion was adjusted with articulating paper and any traumatic or sharp areas were reduced. The filling was smoothed with a fine finishing bur. A yellow pear-shaped strip was used for the palatal, and the tapered one was used for the labial. The



Figure 4. Preparation of tooth 22



Figure 5. Results of filling for tooth 22

proximal part was refined using finishing and polishing strips. Then the restoration was polished using abrasive aluminium oxide coated rotary disk (Soft lex, 3M Espe).

The patient was instructed to maintain oral hygiene by brushing his teeth at least twice a day (morning after meals and before bedtime), preferably complemented with dental flossing, and to schedule regular dental check-ups every 6 months. Further evaluation for apexification was required.

DISCUSSION

A necrotic tooth with an open apex has thin and brittle dentinal walls and a large root canal, making preparation and conventional filling challenging. Apexification treatment must be performed before filling the root canal with gutta-percha and compacting it through lateral condensation. This treatment is carried out initially to facilitate closure of the root canal, allowing for subsequent filling with gutta-percha.

In this case, apexification was performed in a single visit, and the recommended material for this purpose was MTA. The advantage of MTA is that the patient does not need multiple follow-up visits, thereby expediting the treatment process.[9] MTA acts as an apical plug, inducing the formation of an apical calcific barrier and promoting the healing process.[9,12] This accelerates the root canal filling procedure, prevents fractures, and enhances patient cooperation. To ensure precise MTA placement at the apical end, confirmation is achieved through repeated radiography. According to Shabahang, the radiographic images confirm that MTA filling is appropriate in terms of the length of tooth 22's root. It appears radiopaque in the radiographic area due to MTA containing bismuth, which is radiopaque when viewed through radiography.[13] MTA is a biomaterial that has been utilized in endodontics since the 1990s. It is a mixture of cement and bismuth oxide and contains various minerals such as SO_3, P_2O_5, SiO_2, CaO, MgO, K_2SO_4, and Na_2SO_4.[12]

The application of MTA at the apical root canal should be around 3-5 mm thick.[14] This thickness is required to achieve a harder, more stable apical barrier within the root canal. The diameter of the open apical root canal also influences the success of MTA application, as excessive extrusion of material can potentially affect periapical lesion healing. For very large open apex diameters, a collagen barrier can be used to prevent excessive MTA material extrusion.[15]

In this case, fiber resin composite (FRC) posts were used as intracanal retention before performing direct restoration using the mock-up technique. Nowadays, fiber posts are chosen for their good esthetic, excellent flexure and fatigue strength since it has elastic modulus similar to that of dentin and effective adaptation.[12] This type of post can evenly distribute pressure across the entire tooth, helping prevent fractures compared to metal posts that are prone to corrosion. The selected restoration in our case involved the mock-up technique to restore the anatomical shape of the tooth to match its adjacent tooth. Given that the traumatized tooth was in the anterior maxillae, achieving satisfying esthetic results for the patient was crucial. The mock-up technique visually represented the final restoration for the patient. Additionally, it served as a guide for creating the palatal and incisal aspects of the fractured Ellis class IV tooth 22.

CONCLUSION

This case report has shown that single-visit apexification on a tooth with an open apex using MTA has resulted in favorable results. This treatment is performed prior to canal treatment. Apexification is capable of creating a calcium barrier, allowing for optimal filling with gutta-percha. Intracanal retention using fiber posts

can strengthen the root canal after treatment, distributing pressure evenly across the tooth to prevent fractures. Composite restoration technique with a mock-up provides a comprehensive visual representation of the treatment for the patient.

ACKNOWLEDGMENT

We would like to express our sincere gratitude to our lecturers for their valuable input and constructive feedback. Their contributions have greatly enhanced the quality and rigor of our research findings. The authors declare that they have no conflict of interest with the data in the manuscript.

REFERENCES

1. Purra A, Ahangar F, Chadgal S, Farooq R. Mineral trioxide aggregate apexification: A novel approach. J Conserv Dent. 2016; 19(4): 377-380. doi: 10.4103/0972-0707.186443
2. Duggal M, Tong HJ, Al-Ansary M, Twati W, Day PF, Nazzal H. Interventions for the endodontic management of non-vital traumatised immature permanent anterior teeth in children and adolescents: a systematic review of the evidence and guidelines of the European Academy of Paediatric Dentistry. Eur Arch Paediatr Dent. 2017; 18(3): 139–151. doi: 10.1007/S40368-017-0289-5
3. Songtrakul K, Azarpajouh T, Malek M, Sigurdsson A, Kahler B, Lin LM. Modified apexification procedure for immature permanent teeth with a necrotic pulp/apical periodontitis: a case series. J Endod. 2020; 46(1): 116–123. doi: 10.1016/j.joen.2019.10.009
4. Pace R, Giuliani V, Nieri M, Di Nasso L, Pagavino G. Mineral trioxide aggregate as apical plug in teeth with necrotic pulp and immature apices: A 10-year case series. J Endod. 2014; 40(8): 1250–1254. doi: 10.1016/j.joen.2013.12.007
5. Ree MH, Schwartz RS. Long-term success of nonvital, immature permanent incisors treated with a mineral trioxide aggregate plug and adhesive restorations: a case series from a private endodontic practice. J Endod. 2017; 43(8): 1370–1377. doi: 10.1016/j.joen.2017.02.017
6. Alphianti LT. Apeksifikasi dengan pasta kalsium hidroksida evaluasi selama 12 bulan (laporan kasus). Insisiva Dental Journal. 2014; 3(1): 52-59. doi: 10.18196/di.v3i1.1728
7. Chun M, Silvestrin T, Savignano R, Roque-Torres GD. Effects of apical barriers and root filling materials on stress distribution in immature teeth: finite element analysis study. J Endod. 2023; 49(5): 575–582. doi: 10.1016/j.joen.2023.03.009
8. Krug R, Ortmann C, Reich S, Hahn B, Krastl G, Soliman S. Tooth discoloration induced by apical plugs with hydraulic calcium silicate-based cements in teeth with open apices—a 2-year in vitro study. Clin Oral Investig. 2022; 26(1): 375–383. doi: 10.1007/s00784-021-04009-0
9. Lin J, Lu J, Zeng Q, Zhao W, Li W, Ling J. Comparison of mineral trioxide aggregate and calcium hydroxide for apexification of immature permanent teeth: A systematic review and meta-analysis. J Formos Med Assoc. 2016; 115(7): 523-530. doi: 10.1016/j.joen.2022.06.007
10. Shaik I, Dasari B, Kolichala R, Qadri F, Arokiyasamy J, Tiwari R. Comparison of the success rate of mineral trioxide aggregate, endosequence bioceramic root repair material, and calcium hydroxide for apexification of immature permanent teeth: systematic review and meta-analysis. J Pharm Bioallied Sci. 2021; 13(Suppl 1): S43-S47. doi: 10.4103/jpbs.JPBS_810_20
11. Cohen S, Burns R. Pathways of The Pulp, 8th Ed. St. louis: Mosby; 1998.
12. Madani Z, Harandi A, Geraily E, Bijani A, Gharekhani S. Fracture strength of teeth restored with fiber post and apical plug. Caspian J of Dent Res. 2017; 6(2): 15-22. doi: 10.22088/cjdr.6.2.15
13. Shabahang S, Witherspoon DE. Management of teeth with necrotic pulps and open apices. In: mineral trioxide aggregate. Wiley; 2014. 111–139. doi: 10.1002/9781118892435.ch5

14. Srinivasan R, Bandyopadhyay TK, Bhagabati N, Jaya R. Aesthetic management of a discoloured non-vital immature maxillary central incisor. Med J Armed Forces India. 2015; 71(Suppl 2): S462–S465.
doi: 10.1016/j.mjafi.2014.07.010

15. Tebbeb N, Abdelmoumen E, Zouiten S, Gnaba I, Boughzela A, Student PG. The contribution of collagen matrix in apexification with MM-MTA®. Int Dent J Stud Res. 2017; 5(1): 29-35.
doi: 10.18231/2278-3784.2017.0006