Open Access Library Journal
2026, Volume 13, e15091
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Apexification Using Mineral Trioxide Aggregate in a Previously Treated Tooth with Wide Periapical Lesion and Resorbed Root: A 2-Year Follow-Up Detailed Case Report

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How to cite this paper: Khaoula, S., Radia, S. and Kaoutar, L. (2026) Apexification Using Mineral Trioxide Aggregate in a Previously Treated Tooth with Wide Periapical Lesion and Resorbed Root: A 2-Year Follow-Up Detailed Case Report. *Open Access Library Journal*, **13**: e15091.
https://doi.org/10.4236/oalib.1115091

Received: March 2, 2026
Accepted: March 30, 2026
Published: April 2, 2026

Abstract

Background: Managing teeth with open apices, particularly after trauma, failed root canal treatment and the presence of apical periodontitis, poses significant clinical challenges. Apexification using Mineral Trioxide Aggregate (MTA) has emerged as a predictable technique. Case summary: A 23-year-old patient presented with persistent fistula between the central and the lateral incisor, previously treated and associated with a resorbed open apex and apical radiolucency. Non-surgical retreatment was initiated. After thorough disinfection, an MTA apical plug was placed and backfilled with a bioceramic sealer and gutta-percha. The access was restored with composite. Follow-ups at 6, 12, and 24 months revealed complete resolution of periapical pathology and functional tooth retention. Conclusion: MTA apexification is a reliable option in managing post-treatment apical periodontitis in teeth with open apices and resorption. Long-term follow-up confirms the healing potential of this technique. The use of MTA created a stable apical barrier, while bioceramic sealers enhanced the seal and promoted long-term healing. NaOCl with ultrasonic activation, and double-sided vented needles ensured thorough irrigation and disinfection, especially in complex canal anatomy.

Subject Areas

Dentistry

Keywords

Apexification, Mineral Trioxide Aggregate, Open Apex, Apical Periodontitis, Retreatment, Endodontics

1. Introduction

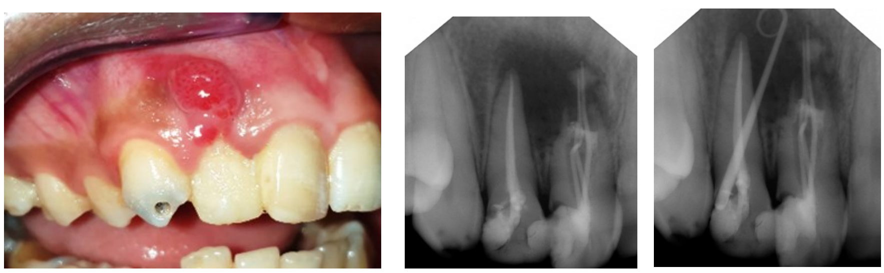
Apexification remains an essential treatment approach for managing teeth with necrotic pulps and incomplete root formation. Appropriate case selection is crucial and typically involves traumatized or caries-infected nonvital permanent teeth with open apices, thin dentinal walls, and wide canal spaces, where conventional obturation techniques fail to provide an adequate apical seal [1].

Achieving apical closure in such cases is technically demanding. The absence of an apical constriction complicates working length determination, while the thin and fragile dentinal walls increase the risk of procedural errors and root fracture. Additionally, the removal of necrotic debris and the control of irrigant extrusion or overfilling are more difficult due to the large apical foramen [1].

Given these challenges, apexification serves as a crucial procedure to consider. It is defined as "a method of inducing a calcified barrier in a root with an open apex, or of promoting continued apical development in an incompletely formed root with necrotic pulp". The primary objective is to create a stable apical barrier that enables effective obturation and long-term tooth retention.

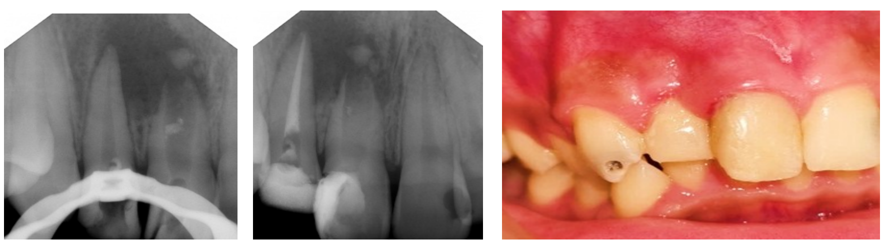
This report describes the successful management of a previously treated maxillary central incisor with a wide periapical lesion and a resorbed open apex, treated by non-surgical retreatment and MTA apexification. A two-year follow-up demonstrated complete periapical healing and long-term functional preservation of the tooth.

2. Case Report



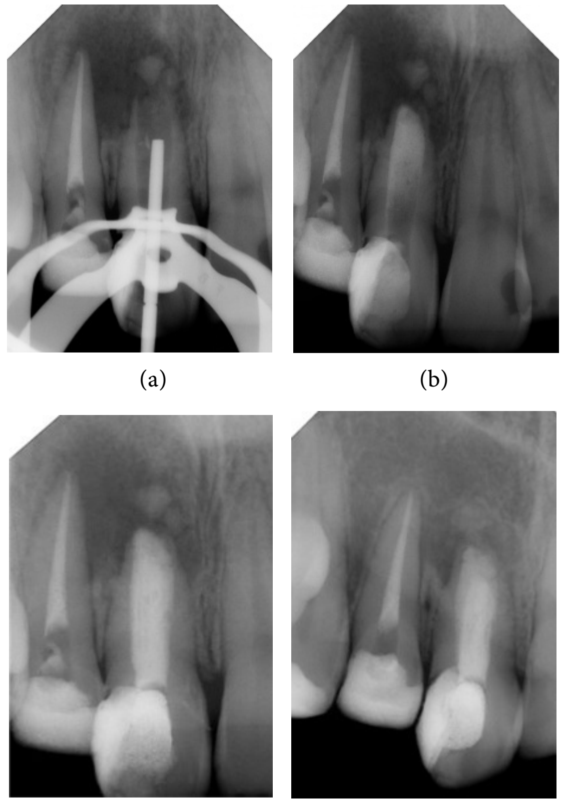
(a) (b) (c)

Figure 1. (a) The preoperative image showing the sinus tract; (b) The initial radiograph; (c) The fistulography.



(a) (b) (c)

Figure 2. (a) Endodontic desobturation of both teeth; (b) Orthograde retreatment of the tooth 12 and calcium hydroxide dressing was placed in tooth 11; (c) No clinical sign of infection.



(a) (b)

(c) (d)

Figure 3. (a) Premeasured gutta percha plugger; (b) 4 mm MTA apical plug; (c) Gutta percha back filling; (d) 24 months follow up.

A 23-year-old young man presented for consultation due to a Sinus tract and a history of trauma to the primary incisors.

The extrusion of the primary incisors affected the underlying permanent tooth germs because of their close anatomical proximity, disturbing their root development and leading to arrested root formation and pulpal necrosis of the permanent incisors.

Clinical examination revealed that teeth and #12 were non-responsive to cold pulp testing. Both teeth were tender to percussion and palpation, while periodontal probing depths were within normal limits and physiologic mobility was noted.

Radiographs showed:

Tooth #11 (central incisor):

- Leaky coronal and canal obturation
- Immature root with an open apex
- Irregular external root surface defects, consistent with external inflammatory root resorption associated with apical periodontitis
- Periapical radiolucency

Tooth #12 (lateral incisor):

- Leaky coronal and canal obturation
- Periapical radiolucency

A sinus tract was observed on the buccal mucosa and traced with a gutta-percha cone, which radiographically led to the apical region of both teeth (**Figure 1**).

The diagnosis was:

- Tooth #11: Chronic apical abscess associated with an immature apex
- Tooth #12: Chronic apical abscess

2.1. The Treatment Strategy Consisted of Two Phases

1) Endodontic phase:

- Removal of the existing coronal obturation material.
- Refinement of the access cavity to ensure proper canal desobturation, disinfection and obturation.
- Orthograde retreatment of tooth #12 (right lateral incisor).
- Orthograde retreatment of tooth #11 (right central incisor) with placement of an MTA apical plug.

2) Restorative phase:

- Placement of a composite resin restoration as a provisional solution, to be replaced after completion of the patient's orthodontic treatment.

2.2. Endodontic Procedure

After local anesthesia and rubber dam isolation, the previous filling material was removed using rotary instruments.

- Tooth #12: Irrigation was performed with 3% sodium hypochlorite.
- Tooth #11: Irrigation was performed with 1% sodium hypochlorite.

Retreatment was carried out first on tooth #12, followed by tooth #11. The canals were gently instrumented manually and carefully disinfected. A creamy mix of calcium hydroxide (Prevest Denpro) intracanal dressing was placed in both canals for 2 weeks, until no clinical signs of infection were present (**Figure 2**).

2.3. Apexification Procedure for Tooth #11

At the second appointment, the canal of tooth #11 was dried. Mineral trioxide aggregate (Trioxident, Vladmiva) was mixed according to the manufacturer's instructions to a wet-sand consistency and placed incrementally 1 mm short of the working length using pre-measured gutta-percha pluggers. The material was condensed with minimal pressure using inverted absorbent paper points.

This procedure was repeated until a 5-mm apical plug was obtained. The thickness and position of the plug were verified with sequential radiographs.

2.4. Canal Obturation and Coronal Restoration

At the following appointment gutta percha back filling followed by immediate coronal composite obturation.

- Tooth #11: gutta-percha backfilling was performed above the MTA apical plug.
- Tooth #12: the canal was obturated conventionally with gutta-percha.

This was followed by immediate coronal restoration with composite resin (**Figure 3**).

2.5. Follow-Up

Clinical and radiographic follow-up examinations were performed at 6, 12, and 24 months.

Clinical healing criteria included:

- Absence of spontaneous pain
- Absence of tenderness to percussion or palpation
- Absence of swelling
- Absence of sinus tract
- Normal periodontal probing depths and tooth function

The sinus tract resolved within two weeks following intracanal disinfection and did not recur during the follow-up period (**Figure 2**).

Radiographic success was defined by:

- Progressive reduction and eventual disappearance of the periapical radiolucency
- Re-establishment of normal periapical bone architecture
- Formation of a mineralized apical barrier at the apex of tooth #11 (**Figure 3**)

No adverse outcomes associated with Mineral Trioxide Aggregate apexification, such as discoloration, reinfection, material extrusion, or need for further intervention, were observed.

3. Discussion

The management of teeth with open apices and persistent periapical pathology remains one of the most challenging aspects of endodontic therapy. Two major treatment modalities have emerged: apexification and revascularization (RET), both of which frequently employ mineral trioxide aggregate (MTA) as a central biomaterial [1].

While RET can promote continued root development, its success is variable, particularly in previously treated or heavily infected teeth. In contrast, MTA apexification provides a predictable and immediate apical barrier, allowing obturation and definitive restoration in fewer appointments. MTA's faster setting time, superior sealing ability, and bioactive potential have made it the gold standard for apical barrier formation [1].

3.1. Apexification versus Alternative Approaches

MTA Apexification vs. Revascularization (RET)

Systematic reviews report comparable long-term survival and clinical success rates between MTA apexification and RET. However, apexification remains the treatment of choice when revascularization is contraindicated. Successful outcomes in either approach depend primarily on case selection, adequate disinfection, and follow-up [1]-[3].

MTA vs. Long-term Calcium Hydroxide

Historically, calcium hydroxide apexification required prolonged treatment-often over six months-with multiple dressing changes. Beyond the practical limitations, extended $Ca(OH)_2$ exposure has been shown to alter dentin's physical properties, decreasing its fracture resistance. In contrast, MTA provides a stable apical barrier within a single or few visits, reducing treatment duration and preserving radicular integrity [4]-[6].

MTA vs. Customized Gutta-percha Cones

An *in vitro* comparison of obturation techniques in simulated immature anterior teeth demonstrated that MTA apical plugs achieved significantly better marginal adaptation to dentinal walls than single customized gutta-percha cones used with calcium silicate–based sealers. This highlights the material's superior sealing capability in cases with wide and irregular apices [7].

3.2. Biological Mechanisms Supporting the Use of MTA

Sealing and Bioactivity

The chemical composition of MTA makes it bioactive, inducing cementogenesis and hard tissue barrier formation [8]. It provides a reliable seal at the apex, helping to control persistent apical inflammation and promote bone healing. A study compared White MTA (WMTA), Biodentine, and a BC-sealer (bio-ceramic sealer) in terms of their ability to release calcium (Ca) ions, uptake calcium (Ca) and silicon (Si) in the adjacent root dentine demonstrates that MTA (WMTA) has significant bioactivity: it can interact with phosphate in body-like fluid, form mineral precipitates and cause ion exchange/uptake by dentine. These features underlie its sealing ability and ability to promote hard tissue barrier formation [9] [10].

Upon hydration, MTA releases Ca^{2+} ions, leading to the formation of $Ca(OH)_2$, which reacts with phosphate ions from tissue fluids to produce hydroxyapatite. This reaction accounts for its progressive increase in alkaline pH-from approximately 10.2 immediately after mixing to 12.5 within 3 hours-creating an environment that is antibacterial, bio inductive, and conducive to cell adhesion and mineralization [8] [11].

Cellular and Molecular Effects

At the biological level, MTA modulates inflammatory mediators and stimulates osteoblastic and odontoblastic activity. It downregulates pro-inflammatory cytokines (IL-1β, TNF-α) and upregulates anti-inflammatory pathways that favor healing. Moreover, it enhances the differentiation and migration of hard tissue–forming cells, contributing to osteogenesis, and periodontal reformation [8] [11].

3.3. Technical Considerations Affecting Prognosis

Irrigation and Disinfection

Effective chemomechanical disinfection is fundamental to the success of apexification. The absence of a natural apical constriction increases the risk of irrigant extrusion and periapical injury. Therefore, irrigation must balance antibacterial efficacy with tissue compatibility [12].

In the present case, a conservative protocol using 1.25% NaOCl, 17% EDTA, and 2% CHX, interspersed with saline rinses, was employed to maximize disinfection while minimizing cytotoxicity. Studies confirm that lower NaOCl concentrations, when used in sufficient volumes and for extended contact times, can achieve effective microbial reduction with lower extrusion risk [12] [13].

Irrigant Activation and Delivery

Activation improves irrigant penetration and biofilm disruption. However, in teeth with thin dentinal walls or open apices, ultrasonic or laser activation may jeopardize the fragile radicular structure. Safer alternatives include manual agitation using a fitted gutta-percha cone and apical negative pressure systems (e.g., EndoVac™), which enable irrigants to reach the apical third without extrusion. The use of double-vented needles and frequent irrigant exchange further enhances cleaning efficacy [14].

For high-risk cases, a collagen apical barrier (CAB) can be temporarily placed beyond the apex to prevent extrusion and allow safe irrigant activation [15].

Intracanal Medication: Role of Calcium Hydroxide

Short-term placement (1 - 4 weeks) of a creamy calcium hydroxide dressing can elevate periapical pH, reduce inflammation, and improve the subsequent marginal adaptation of MTA (3, 4). Since MTA's setting and sealing ability are negatively affected by acidic environments, this preconditioning step enhances treatment predictability [16].

3.4. MTA Plug Technique and Access Design

Micro-CT analyses reveal that access cavity design and placement technique significantly influence MTA plug density and void formation. Conservative accesses, though structurally conservative, may increase porosity within the plug. Therefore, a traditional access cavity was selected in this case to enhance apical visibility and compaction [17].

A 5-mm MTA plug, placed with a calibrated carrier and pluggers under a "reverse tamponade" technique, provided an optimal barrier. Evidence supports a minimum thickness of 4 mm to resist bacterial penetration and mechanical stresses. Delivery systems such as the MAP System or micro-carriers allow precise placement without the need for a matrix [18].

Material Selection: MTA, Biodentine, or Bioceramic Putties

Recent comparative studies indicate that MTA, Biodentine, and premixed bioceramic putties all demonstrate high clinical success and favorable biocompatibility [19] [20].

Biodentine offers advantages in handling and setting time, while MTA retains the longest clinical track record for apical barrier formation. However, MTA may cause coronal discoloration, exhibit porosity under acidic conditions, and has a longer setting time. Despite these drawbacks, the material's apatite layer formation subsequently seals surface voids, ensuring a durable chemical bond with dentin [8].

Prognosis and Clinical Relevance

Apexification with MTA had demonstrated favorable clinical and radiographic outcomes and appears to be a good and reliable treatment option in the open apex teeth [21].

In a case series of 5 - 15 years, MTA as an apical barrier achieved a healing rate of 96%.

The apexification failure rate of an MTA apical plug with a single placement of calcium hydroxide for immature permanent teeth was 7.1% over 2 years [22].

4. Conclusions

The concept of regeneration and revascularization is overtaking traditional methods. Apexification with MTA is a reliable, conservative approach for managing teeth with open apices and persistent periapical pathology following failed endodontic treatment.

It remains a highly effective and biologically sound approach. When combined with conservative disinfection, controlled irrigant delivery, short-term $Ca(OH)_2$ dressing, and precise apical plug placement, it offers excellent sealing, bioactivity, and long-term periapical healing.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Pendse, G., Misra, R., Mandke, L., Maniar, H., Khose, A. and Basmatkar, N. (2025) Comparison of Revascularization and Apexification Using Mineral Trioxide Aggregate in Young Human Immature Nonvital Teeth: A Systematic Review and Meta-Analysis. *Cureus*, **17**, e88732. https://doi.org/10.7759/cureus.88732

[2] Asgary, S., Shamszadeh, S., Nosrat, A., Aminoshariae, A. and Sabeti, M. (2024) Management Strategies for Immature Teeth with Pulp Necrosis: An Umbrella Review of Systematic Reviews. *Iranian Endodontic Journal*, **19**, 242-253.

[3] Murray, P.E. (2022) Review of Guidance for the Selection of Regenerative Endodontics, Apexogenesis, Apexification, Pulpotomy, and Other Endodontic Treatments for Immature Permanent Teeth. *International Endodontic Journal*, **56**, 188-199. https://doi.org/10.1111/iej.13809

[4] Singh, M., Mohammed, D., Khan, M., Bongu, D., Bhavya, L., Tiwari, H., Gupta, P. and Chaoudhary, A. (2021) Success Rate of Calcium Hydroxide vs Mineral Trioxide Aggregate as Apexification Agents: A Systematic Review. *Annals of the Romanian Society for Cell Biology*, **25**, 835-839.

[5] Alyahya, S.A.S., AlMuhaya, S.F.A., Alqahtani, A.N., Adwan, T.A., Aleisa, A.F., Alsabeh, Y.S., *et al.* (2022) Comparison between Calcium Hydroxide and MTA When Used for Apexification: A Systematic Review. *Pharmacophore*, **13**, 115-120. https://doi.org/10.51847/foykshgw6q

[6] Gupta, D., Shaw, A.K., Mali, S.D. and Jadhav, A.B. (2024) Comparison between Calcium Hydroxide with Mineral Trioxide Aggregate and Regenerative Endodontics in

Inducing Root Apex Closure during Apexification—A Systematic Review and Meta-Analysis. *Indian Journal of Dental Research*, **35**, 88-94. https://doi.org/10.4103/ijdr.ijdr_885_23

[7] Mina, M.M., Moussa, S.M. and Aboelseoud, M.R. (2024) Marginal Adaptation of Customized Gutta Percha Cone with Calcium Silicate Based Sealer versus MTA and Biodentine Apical Plugs in Simulated Immature Permanent Teeth (An *in Vitro* Study). *BMC Oral Health*, **24**, Article No. 1069. https://doi.org/10.1186/s12903-024-04765-x

[8] Torabinejad, M., Nosrat, A., Verma, P. and Udochukwu, O. (2017) Regenerative Endodontic Treatment or Mineral Trioxide Aggregate Apical Plug in Teeth with Necrotic Pulps and Open Apices: A Systematic Review and Meta-Analysis. *Journal of Endodontics*, **43**, 1806-1820. https://doi.org/10.1016/j.joen.2017.06.029

[9] Camilleri, J., Sorrentino, F. and Damidot, D. (2013) Investigation of the Hydration and Bioactivity of Radiopacified Tricalcium Silicate Cement, Biodentine and MTA Angelus. *Dental Materials*, **29**, 580-593. https://doi.org/10.1016/j.dental.2013.03.007

[10] Han, L. and Okiji, T. (2013) Bioactivity Evaluation of Three Calcium Silicate-Based Endodontic Materials. *International Endodontic Journal*, **46**, 808-814. https://doi.org/10.1111/iej.12062

[11] Sarkar, N., Caicedo, R., Ritwik, P., Moiseyeva, R. and Kawashima, I. (2005) Physicochemical Basis of the Biologic Properties of Mineral Trioxide Aggregate. *Journal of Endodontics*, **31**, 97-100. https://doi.org/10.1097/01.don.0000133155.04468.41

[12] Zehnder, M. (2006) Root Canal Irrigants. *Journal of Endodontics*, **32**, 389-398. https://doi.org/10.1016/j.joen.2005.09.014

[13] Siqueira, J.F. and Rôças, I.N. (2008) Clinical Implications and Microbiology of Bacterial Persistence after Treatment Procedures. *Journal of Endodontics*, **34**, 1291-1301.e3. https://doi.org/10.1016/j.joen.2008.07.028

[14] Nielsen, B.A. and Craig Baumgartner, J. (2007) Comparison of the EndoVac System to Needle Irrigation of Root Canals. *Journal of Endodontics*, **33**, 611-615. https://doi.org/10.1016/j.joen.2007.01.020

[15] Iandolo, A., Amato, A., Pantaleo, G., Dagna, A., Ivaldi, L., di Spirito, F., *et al.* (2021) An Innovative Technique to Safely Perform Active Cleaning in Teeth with Open Apices: CAB Technique. *Journal of Conservative Dentistry*, **24**, 153-157. https://doi.org/10.4103/jcd.jcd_42_21

[16] Namazikhah, M.S., Nekoofar, M.H., Sheykhrezae, M.S., Salariyeh, S., Hayes, S.J., Bryant, S.T., *et al.* (2007) The Effect of Ph on Surface Hardness and Microstructure of Mineral Trioxide Aggregate. *International Endodontic Journal*, **41**, 108-116. https://doi.org/10.1111/j.1365-2591.2007.01325.x

[17] Odabaşı Tezer, E., Buyuksungur, A., Celikten, B., Dursun, P.H. and Sevimay, F.S. (2024) Effects of Access Cavity Design and Placement Techniques on Mineral Trioxide Aggregate Obturation Quality in Simulated Immature Teeth: A Micro-Computed Tomography Study. *Medicina*, **60**, Article 878. https://doi.org/10.3390/medicina60060878

[18] Roy, M., Bailwad, S.A., Bhatnagar, A., Singh, S., Assiry, A.A., Mohamed, R.N., *et al.* (2024) Evaluation of Microleakage of Mineral Trioxide Aggregate and Biodentine as Apical Barriers in Simulated Young Permanent Teeth. *BMC Oral Health*, **24**, Article No. 1100. https://doi.org/10.1186/s12903-024-04817-2

[19] Eldehna, A.M., Abdelkafy, H., Salem, N.A., Elzahar, S., Ghany, D.M.A., Allah, N.F.A., *et al.* (2025) Micro-CT Analysis of Apical Plug Using Various Premixed Bio-Ceramic

Putties: An *in Vitro* Study. *European Endodontic Journal*, **10**, 18-26. https://doi.org/10.14744/eej.2024.04796

[20] Donnell, C.C. and Kandiah, P. (2024) Comparing the Technical Quality and Clinical Outcomes of Root Canal Treatment on Immature Permanent Incisors in Children: A Retrospective Evaluation of Three Bioceramic Plug Materials. *European Archives of Paediatric Dentistry*, **25**, 821-835. https://doi.org/10.1007/s40368-024-00941-3

[21] Bücher, K., Meier, F., Diegritz, C., Kaaden, C., Hickel, R. and Kühnisch, J. (2016) Long-Term Outcome of MTA Apexification in Teeth with Open Apices. *Quintessence International*, **47**, 473-482.

[22] Ree, M.H. and Schwartz, R.S. (2017) 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. *Journal of Endodontics*, **43**, 1370-1377. https://doi.org/10.1016/j.joen.2017.02.017