

Apexification: A Comprehensive Review

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Abstract

Necrotic pulp in permanent teeth with incompletely formed or wide-open apices results in the death of cells that are effective in the improvement of root. This slows down the possibility of apical closure as well as improvement of root. Endodontic management consisting of diseased or dead pulp with adolescent permanent teeth along with an open expanded root apex is a challenging concern. During obturation in that tooth, it is unimaginable to obtain a proper seal at the tip. There are various techniques to treat an immature tooth with open apex which involve the application of (1) a custom-made cone (blunt end); (2) a short fill technique; (3) periapical surgery; (4) apexification; and (5) one-visit apexification. Mostly recommended treatment of choice is '**apexification**' which is a method to induce root apex development of an immature nonvital tooth by formation of osteocementum or bone-like tissue. The most recommended medicament is *calcium hydroxide* that facilitates the development of a calcific barrier found in the root apex. According to the survey of the clinical involvement and information of journalists, management of an incomplete nonvital tooth can bring noticeable outcomes from the disinfectant and ossification promoting activity of $\text{Ca}(\text{OH})_2$.

Keywords: *Apexification, immature non-vital tooth, apexogenesis, calcium hydroxide, root end closure, apical barrier.*

Introduction

Apexification is a method to prompt calcific blockade in an immature non-vital permanent teeth by removing the necrotic pulp just short of root end and placing a suitable biocompatible agent to close root apex¹. Its purpose is to allow the formation of an apical barrier in immature teeth where advancement, as well as the progression of root, terminate by cause of pulpal death. The mineralized tissue can be consists of osteocementum, osteodentin or bone or combination of the three². Apical closure may be complete or a few millimeters short from the root end. It may be either at the root tip or an uneven solidifying mass over the one-third of the apical part. Most of the cases have apical closure in an irregular and abnormal anatomy². As compared to others; apexogenesis^{3,4} (*root end closure in vital tooth*) gives rise to proper apical closure along with normal-appearing root development. Previously several attempts made for the treatment of an immature non-vital tooth with wide-open root apex by a custom made cone (employing a blunt-ended gutta-percha cone which is large and performing conventional root canal

obturation); a short fill technique (keeping the obturation short of apex); periapical surgery and retrograde filling; *one visit apexification*⁵ (restoration of the root apex by the use of a biocompatible substance like dental chips or tricalcium phosphate) and lastly apexification. Among them apexification¹ is the most popular method which may involve one or many monthly appointments for placing suitable medicament to achieve elimination of intracanal infection that stimulates calcification and produces the apical closure. To carry out apexification, calcium hydroxide is being replaced by MTA⁶ as a single visit technique.

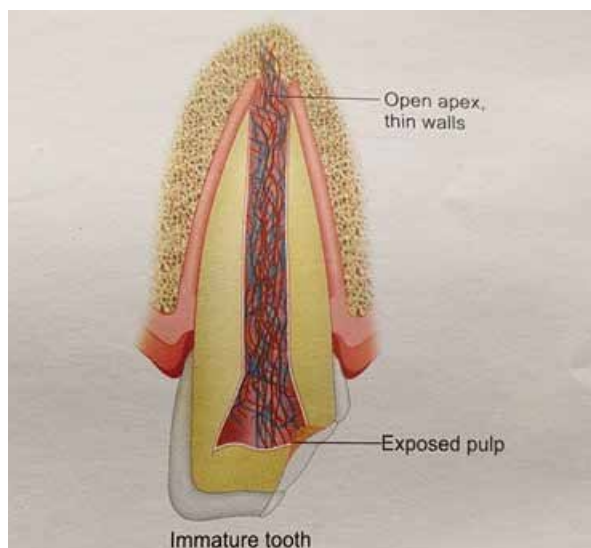


Figure 1. Diagrammatic representation on open apex

Indication Apexification is indicated in Non-vital permanent teeth with wide-open apex

Aim: The purpose of the apexification technique is: the previously mentioned method should prompt apical closure in a non-vital adolescent permanent tooth root based on intermittent radiographic estimation. There should be no history of postoperative unfavorable indication and expressions like sensation for a lengthy period; ache or discomfort as well as inflammation. There should be an absence of irregular canal ossification; inner or outer constriction of the root; disorder at the lateral root; disintegration to periapical or peri-radicular prompting structures at the time of the procedure or after the procedure.

Materials Used: The most commonly used materials to induce root apex closure are: Calcium hydroxide +sterile water; Calcium hydroxide +CMCP; zinc oxide eugenol; resorbable tricalcium phosphate; Corticosteroid paste; Calcium hydroxide + methylcellulose; Chloramphenicol paste; Calcium hydroxide + cresatin; tricalcium phosphate⁷. Various newer materials are suggested for single visit apexification. They are Mineral trioxide aggregate (MTA); Osteogenic protein I & II; and Collagen-calcium phosphate gel.

Procedure: The following measures are involved in the procedure:

Isolate the concerned tooth precisely with the use of rubber dam and gain access to the pulp canal using Gates-Glidden bur. Then keep a file inside the pulp cavity, after that radiograph is taken to build an exact working length of the root. Remember that no instrument should be kept inside apex which may lead to laceration of the tissues. In the first appointment extirpate the fragments of pulp by the help of barbed broaches and files. Next apply hydrogen peroxide for eradicate remnants and canal is flooded via sodium hypochlorite (NaOCl) solution followed by sterile saline solution without applying pressure⁸. The needle should loose within the root canal. By using absorbent points together with cotton pellets the cavity is dehydrated. To avoid destruction of small dentinal walls minimal instrumentation is considered.

A thick cement of calcium hydroxide along with camphorated mono-parachlorophenol (CMCP) or calcium hydroxide with methyl cellulose paste is conveyed to the canal by the use of lentulo spiral seated in a low-velocity engine with specially arranged syringes or with files followed by compression using endodontic plugger due to absence of apical stop. The operator must be careful in the case of rotary instruments as they cause breakage of instruments.

The patient is recalled after 2 to 3 weeks. The main purpose of the second appointment to complete debridement and eradicate tissue fragments distorted by calcium hydroxide dressing which might not be eliminated technically in the first appointment. Radiographically the root length should be established as electronic apex locators are not safe in such teeth. On the second appointment calcium hydroxide paste will be inserted within the canal with the help of endodontic pluggers⁹.

Using an endodontic plugger the paste or cement is forced into the edge of the apex (apical tip), however material that overflows must never be pushed behind apex. Cotton pellet is established above calcium hydroxide [Ca(OH)₂]. Then close the tooth surface with a temporary filling like zinc oxide eugenol paste.

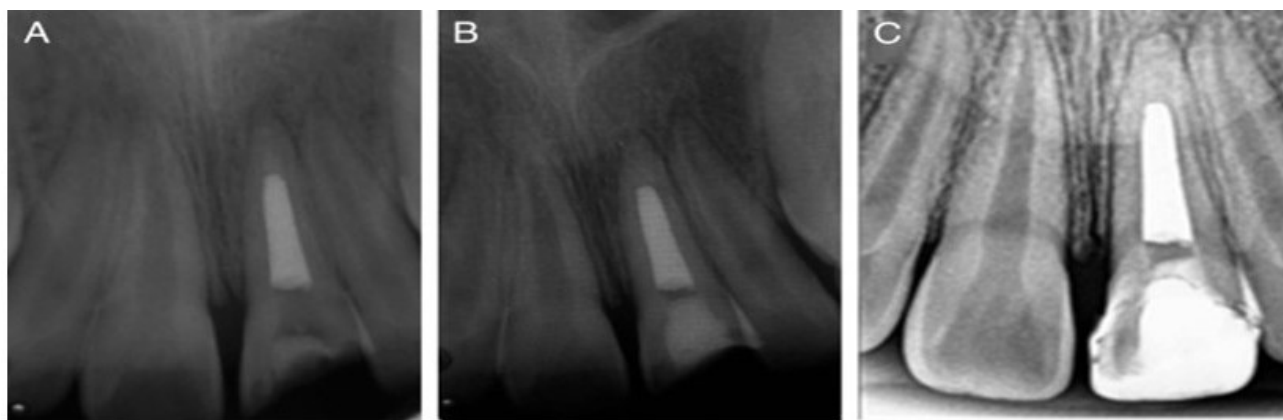


Figure 2. Procedure of apexification

Treatment and Follow up: Signs and symptoms are evaluated regularly. The follow-up assessment is repeated every 3 months up to the successful occurrence of calcified barrier. Then tooth is observed clinically and radiographically¹⁰. While a calcified barrier seen radiographically, then the tooth is re-established followed by flooding with sodium hypochlorite solution (NaOCl). To verify the integrity of the apical barrier, the apical zone should be investigated using a file to get the length of the root. Generally the cement is permitted to stay about 6 months. Then the pulp chamber or pulp cavity is re-established that one may resolve if the tooth is prepared toward traditional gutta-percha restoration being resolved via the existence of a “positive step” while the apical zone is explored using the instrument. Confirmation about radiographic findings for root-end closure is required too¹⁰.

According to Frank, there are some criteria for apexification treatment: (A.) progressed apical closure of the pulp cavity as in normal tooth, (B.) a dome-shaped apex closure maintaining a blunderbuss manifestation, (C.) radiographically appearing calcified or ossified

barrier at the apex, along with (D.) an apical stop with radiographic indication of a barricade coronal to root apex. If barrier or closure of root end is found insufficient within 24 weeks and the patient feels the touch of the file, then the procedure is repeated with calcium hydroxide paste till a complete barrier is developed¹¹. While an ossified barrier constructed coronal to the apex, it should not be penetrated to pack the tooth till the apical end.¹² The apical barrier formed by the tissue considered as healthy tissue. It has been believed that the use of calcium hydroxide can consequentially enhance the chance of root fracture after long-term use. So it is essential to reduce the time required for apexification.^{13,14}

At 3 to 6 months interval re-establishment of the canal for the lengthy-time period resembles justified as the patient stays relieved from unfavorable signs and symptoms as apex closure is likely to develop ultimately. As seen in normal tooth continuity of apical growth and closure expressed by postoperative radiographs. As apical closure takes place, the canal filled with gutta-percha and sealer.



Figure 3. Follow up evaluation of apexification; a, open apex before treatment; b. 3 months follow up; c. 9 months follow up

Types of root apex closure seen after apexification technique:

- Usual root end advancement
 - Radiographic closure along with hard tissue stop conspicuous clinically
 - Clinically noticeable hard stop with no evidence of radiographic bridge formation
 - Development of calcific bridge just coronal to apex
- Complications

Following the apexification procedure, crown-root proportion is unfavorable since the length of the root is short as compared to the normal tooth, therefore the diagnosis of tooth can be inconvenienced. In the case of post-induction (whenever required) is complicated because of the diameter of the root canal as well as induction of permanent crown may be prolonged because of the continued progression of the patient.

Summary & Conclusion

Apexification using calcium hydroxide $\text{Ca}(\text{OH})_2$ remains the most broadly applied method^{1,16} Management of an immature non-vital tooth can bring noticeable outcomes from the disinfectant and calcification promoting activity of calcium hydroxide $\text{Ca}(\text{OH})_2$ which cleanse the canal and encourage apical closure¹⁷. High PH as well as low solubility of calcium hydroxide maintain the antimicrobial action for a lengthy time period¹⁸. Either Calcium hydroxide alone or calcium hydroxide along with sodium hypochlorite enhance disintegration of fatal tissues for which it aids for removal of debris and remnants from pulp cavity.¹⁹

To perform an apexification, using calcium hydroxide is a valid therapy for many years. It may require several appointments and might require ages to carry out to form a barrier at the apex, which permits the pulp cavity restoring substance by gutta-percha along with sealer.²⁰ The time required for this procedure depends upon the condition of root development as well as the state of periapical tissue²¹⁻²³. Though the use of calcium hydroxide brings about favorable outcomes and percentage of auspicious apical barrier development is huge, deep-rooted follow up is mandatory. Tooth which managed by apexification is sensitive to break due to frailty arising from non-vitality as well as from thin dentinal walls of root²⁴⁻²⁶. Another demerit includes a period of treatment.

After all MTA barrier is a technique used as a substitution to calcium hydroxide²⁷. This procedure does not require several appointments and there is no need for an external factor for the development of barrier as well as in pulp regeneration.²⁹⁻³³

Ethical permission: Not required

Conflict of Interests: None

Funding: None

References

1. Rafter M. Apexification: a review. *Dent Traumatol* 2005; 21:1-8
2. Nicholls E *Endodontics*, ed 2. Bristol, England, John Wright and Sons Ltd, 1977, pp 254, 258.
3. Tenica JJ, Sam SA. Continued root end development: apexogenesis and apexification. *J Pedod* 1978;3:144-156.
4. Shabahang S. Treatment options: Apexogenesis and apexification. *Pediatr Dent* 2013;35:125-8.
5. Albadri S, Chau YS, Jarad F. The use of mineral trioxide aggregate to achieve root-end closure: Three case reports. *Dent Traumatol* 2013;29:469-73.
6. Purra AR, Ahangar FA, Chadgal S, Farooq R. Mineral trioxide aggregate apexification: A novel approach. *J Conserv Dent* 2016;19:377-80.
7. Roberts SC Jr, Brilliant JD. Tricalcium phosphate as an adjunct to apical closure in pulpless permanent teeth. *J Endod* 1975; 1:263-269.
8. Harrison JW. Irrigation of the root canal system. *Dent Clin North Amer* 1984; 4:797-808.
9. Metzger Z, Solomonov M, Mass E: Calcium hydroxide retention in wide root canals with flaring apices, *Dent Traumatol* 2001; 17:86-92.
10. Nicoloso GF, Pötter IG, Rocha RO, Montagner F, Casagrande L. A comparative evaluation of endodontic treatments for immature necrotic permanent teeth based on clinical and radiographic outcomes: A systematic review and meta-analysis. *Int J Paediatr Dent* 2017;27:217-27.
11. Weisenseel JA, Hicks MbL, Pelleu GB Jr. Calcium hydroxide as an apical barrier. *J Endod* 1987;13:1-5.
12. Sheehy EC, Roberts GJ. Use of calcium hydroxide for apical barrier formation and healing in non-vital

- immature permanent teeth: a review. *Br Dent J* 1997; 11:183, 1997.
13. Andreasen JO, Farik B, Munksgaard EC: Long-term calcium hydroxide as a root canal dressing may increase the risk of root fracture, *Dent Traumatol* 2002; 18:134-137, 2002.
 14. Rosenberg B, Murray PE, Namerow, K. The effect of calcium hydroxide root filling on dentin fracture strength. *Dent Traumatol* 2007; 23:26-9.
 15. Kleier DJ, Barr ES. A study of endodontically apexified teeth, *Endod Dent Traumatol* 1991; 17:112-117.
 16. McTigue DJ, Subramanian K, Kumar A. Case series: Management of immature permanent teeth with pulpal necrosis: A case series. *Pediatr Dent* 2013;35:55-60.
 17. Siqueira JF Jr, Lopes HP: Mechanisms of antimicrobial activity of calcium hydroxide: a critical review, *Int Endod J* 1999; 32:361-369.
 18. Fava LR, Saunders WP. Calcium hydroxide pastes: classification and clinical indications, *Int Endod J* 32:257-282, 1999.
 19. Hasselgren G, Olsson B, Cvek M. 1988. Effects of calcium hydroxide and sodium hypochlorite on the dissolution of necrotic porcine muscle tissue. *J Endod* 14:125-7.
 20. Kleier DJ, Barr ES: A study of endodontically apexified teeth, *Endod Dent Traumatol* 1991; 17:112-117, 1991.
 21. Yates JA. Barrier formation time in non-vital teeth with open apices. *Int Endod J* 1999; 21:313-9
 22. Oswald RJ, Friedman CE: Periapical response to dentin fillings. *Oral Surg Oral Med Oral Pathol* 1980;49:344-355.
 23. Clayton RJ: The Periapical Tissue Response to and the Sealing Ability of Apically Packed Dentin Shavings,thesis. Chicago,Loyola University, May 1973.
 24. Kinirons MJ, Srinivasan V, Welbury RR et al: A study in two centers of variations in the time of apical barrier detection and barrier position in nonvital immature permanent incisors, *Int J Paediatr Dent* 2001; 11:447-451.
 25. Englander JA Treatment of non-vital teeth with incompletely formed roots. *J Dent Med* 1956;2:90-96.
 26. Hartsook JT. Pulpal therapy in primary and young permanent teeth. *Dent Clin North Am* 1966, 10:377-389.
 27. Damle SG, Bhattal H, Loomba A. Apexification of anterior teeth: A comparative evaluation of mineral trioxide aggregate and calcium hydroxide paste. *J Clin Pediatr Dent* 2012;36:263-8
 28. Yadav P, Pruthi PJ, Naval RR, Talwar S, Verma M. Novel use of platelet-rich fibrin matrix and MTA as an apical barrier in the management of a failed revascularization case. *Dent Traumatol* 2015;31:328-31.
 29. Bonte E, Beslot A, Boukpepsi T, Lasfargues JJ. MTA versus ca(OH)₂ in apexification of non-vital immature permanent teeth: A randomized clinical trial comparison. *Clin Oral Investig* 2015;19:1381-8.
 30. Giuliani V, Baccetti T, Pace R, et al: The use of MTA in teeth with necrotic pulps and open apices, *Dent Traumatol* 2002; 18:217.
 31. Yeung P, Liewehr FR, Moon PC: A quantitative comparison of the fill density of MTA produced by two placement techniques, *Endod* 2006; 32:456-459,
 32. Mente J, Leo M, Panagidis D, Ohle M, Schneider S, Lorenzo Bermejo J, et al. Treatment outcome of mineral trioxide aggregate in open apex teeth. *J Endod* 2013;39:20-6.
 33. Cvek M. Prognosis of luxated non-vital maxillary incisors treated with calcium hydroxide and filled with gutta-percha. A retrospective study. *Endod Dent Traumatol* 1992; 8:45-55.