

Apexification of immature permanent teeth using biodentine: A case series

Nishana K¹, Prasanth Balan², Jayasree S³, Shabna⁴, Revathy M Nair⁵

^{1,4,5} Junior Resident, Department of Conservative Dentistry and Endodontics. GDC Calicut, Kerala, India

² Associate Professor, Department of Conservative Dentistry and Endodontics. GDC Calicut, Kerala, India

³ Professor and HOD, Department of Conservative Dentistry and Endodontics. GDC Calicut, Kerala, India

Abstract

Management of non-vital teeth with open apices is always a challenge to the dental practitioners. Treatment options comprise conventional apexification procedure with or without apical barriers. One of the disadvantages of conventional apexification using calcium hydroxide is the need for long term therapy to enable barrier formation. In order to overcome that, calcium silicate-based cements like MTA and Biodentine were introduced which enables a single visit apexification. This case series observes apexification and successful healing with the use of Biodentine as an apical barrier matrix in root end apexification procedure.

Keywords: immature tooth, open apex, apical barrier, apexification, biodentine

1. Introduction

Tooth development or odontogenesis is a complex process by which teeth form from embryonic cells, grow and erupt into the mouth. For human teeth to have a healthy oral environment, all parts of the tooth must develop during appropriate stages of development.

The completion of root development and closure of the root apex continues for up to three years following eruption of the tooth. During root formation, if the tooth is affected by caries, trauma or other pulpal pathoses, dentin formation is interrupted and root development will cease. Consequently, the root canal is wide, with thin and weak walls, and the apex remains open^[1].

One of the objective of endodontic treatment is to completely debride and obturate the canal in order to prevent reinfection. But in case of an incomplete root development or the absence of apical constriction it becomes difficult to achieve a three-dimensional adaptation of obturating material within root canal system. Because of lack of apical constriction, an alternative to standard root canal treatment ie. Apexification or Root end closure has been advocated.

Apexification is defined as a method to induce a calcified barrier in a root with an open apex or continued apical development of an incomplete root in a tooth with necrotic pulp^[2].

The use of calcium hydroxide was first introduced by Kaiser in 1964 who proposed that this with camphorated parachlorophenol would induce the formation of a calcified barrier across the apex. Calcium hydroxide can be mixed with a number of different substances (camphorated monochlorophenol, distilled water, saline, anesthetic solution, chlorhexidine and cresatin) to induce apical closure. For many years, calcium hydroxide paste was used to induce a calcified barrier. However, this material requires 5–20 months to form the hard tissue barrier. It has also been shown that the use of calcium hydroxide weakens the resistance of the dentin to fracture^[3].

Among the alternative materials mentioned, Mineral

Trioxide Aggregate (MTA) is currently considered most promising because of its superior biocompatibility and lower cytotoxicity due to its alkaline pH. Moreover, the presence of calcium and phosphate ions result in a capacity to attract blastic cells and hence promote favourable conditions for cementum deposition^[4]. However, MTA has certain disadvantages including high solubility, prolonged setting time (approximately 2 hours and 45 minutes) and difficult handling characteristics.

To overcome the disadvantages of MTA, a new calcium silicate-based material, Biodentine™ (Septodont, Saint-Maur–Des-Fosses, France) has been introduced in 2009.

Biodentine is superior to MTA as its consistency is better suited to clinical use, ensuring better handling and safety, the material does not require a two-step obturation and, as the setting is faster; there is a lower risk of bacterial contamination^[5]

The following case series describes successful management of traumatized permanent anterior teeth with open apex using Biodentine.

2.1 Case 1

An 18-year old male patient reported to the Department of Conservative Dentistry and Endodontics with the chief complaint of a fractured upper central incisors. He confirmed a history of trauma 8 years back. The patient did not recall any history of swelling or pus discharge. The medical and dental histories were uncomplicated. Intraoral examination revealed an Elli's Class III fracture on teeth no. 11 and 21. Palpation and percussion test of the involved teeth did not reveal any tenderness. Both the teeth were not mobile and periodontal probing around them were within physiological limits. Electric pulp testing and thermal tests (Heat and Cold tests) of the involved teeth gave no response, whereas responses were obtained on the adjacent normal teeth.

Detailed radiographic examination of both 11 and 21 revealed a wide canal with an open apex and a marked radiolucency of size $4 \times 7\text{mm}$ periapically (Figure 1a).

Based on the history and the radiographic findings, a provisional diagnosis of chronic periapical abscess was made on 11 and 21. The available treatment options were discussed with, and informed consent was obtained from, the patient. Root canal therapy with calcium hydroxide dressing, followed by apexification with Biodentine was selected. After rubber dam application the pulp cavity was opened to allow access. Endodontic working length was established (Figure 1b). Biomechanical preparation was completed using No 80 stainless steel K- file (MANI, INC., Utsunomiya Tochigi, Japan) under copious irrigation with 5.25% NaOCl (Cmident, India). Irrigation was carried out passively with side-vented irrigation needles, keeping the points 1mm short of the radiographic apex. Calcium hydroxide intracanal medicament (RC Cal, Prime Dental) was placed. The patient was recalled after two weeks and the involved teeth were found to be asymptomatic. The access cavity was reopened, the canal copiously irrigated with 5.25% NaOCl solution and then dried with sterile paper points. Biodentine was mixed according to the manufacturer's protocol and pellets were placed with a plugger until a thickness of 5 mm had been achieved. A sterile cotton ball was placed in the canal for 15 minutes and then the root canal was obturated by the thermo plasticized Gutta-percha technique (Obtura - Spartan) (Figure 1c). The access cavity was then sealed with a composite restoration. Follow up examinations were carried out at one month, three months, six months and one year after apexification. During follow up periods the involved tooth were asymptomatic and the post-operative radiographs taken at one year showed remarkable healing of the osseous lesion. (Figure 1d)

2.2 Case 2

A 16-year-old female patient reported with a chief complaint of pain and swelling in relation to maxillary right central incisor. History revealed that the patient had suffered trauma at the age of 9 years. The vitality of the tooth was determined by the cold pulp test, using dry ice in a "pencil stick" form. It revealed negative response. Radiographic examination revealed an immature tooth with a wide-open apex and a radiolucency of size $4 \times 3\text{mm}$ in proximity of the apex of the tooth (Figure 2a). Endodontic access opening was done, and a periapical radiograph was taken to determine the working length (Figure 2b). Biomechanical preparation was done and root canal debridement was done using alternate irrigation with 2.5% NaOCl and saline. The root canal was then dried with sterile paper points. Calcium hydroxide and iodoform combination (Metapex™, META Biomed Co. Ltd., Korea) was placed in the root canal, and the patient was recalled after 2 weeks. Two week later, the calcium hydroxide dressing was removed by hand instrumentation, and irrigation was done. The root canal was then dried with sterile paper points and Biodentine was pushed using root canal plugger (Figure 2c). After determining that the plug had set, obturation was done and the access cavity sealed using composite resin. IOPA after 6 months revealed inadvertent periapical healing, radiographically and clinically, and the tooth was asymptomatic. (Figure 2d)

3. Discussion

Management of open apex can have multiple treatment options such as apexification, apexogenesis, or

revascularization technique. Apexogenesis is the treatment to preserve vital pulp tissue in the apical part of a root canal to complete formation of root apex [6]. Therefore, apexogenesis is only possible when some vital pulp is remaining. However, it was not possible in our cases, as both teeth had necrotic pulps. Revascularization technique has an advantage of formation of pulp dentin complex. It establishes defense mechanisms of pulp. However, long term follow up and uncertainty of results is a disadvantage. Apexification is defined as a method of inducing a calcified apical barrier or continued apical development of an incompletely formed root in teeth with necrotic pulp. Apexification treatment is supposed to create an environment to permit deposition of cementum, bone and periodontal ligament to continue its function of root development. The goal of this treatment is to obtain an apical barrier to prevent the passage of toxins and bacteria into periapical tissues from root canal. Technically this barrier is necessary to allow compaction of root filling material [7].

Calcium hydroxide has been widely used for apexification. Whilst a higher success rate of apical barrier formation has been reported with the use of calcium hydroxide, long term follow up is essential. Previous studies have described the disadvantages of calcium hydroxide apexification which include failure to control infection, recurrence of infection and cervical fracture [8].

With the discovery of MTA by Torabinejad *et al.*, it has become the material of choice for apexification. Several studies demonstrated its capacity to induce odontoblastic differentiation, good radiopacity, low solubility, high pH, expansion after setting, and antimicrobial activity [9].

There are several disadvantages with MTA, as well. It has shown high solubility, demonstrating 24% loss after 78 days of storage in water. The presence of iron in the grey MTA formulation may darken the tooth. Significant downside to MTA is the prolonged setting time of approximately 2 hours and 45 minutes. Beside a long setting time the major drawbacks of MTA are its relatively low compression and flexural strength, which are lower than those of dentine [10, 11].

Biodentine is a newly introduced (2011) bioactive dentine substitute based on "Active Biosilicate Technology." It is biocompatible, has mechanical properties similar to dentin, and has good sealing ability on dentinal surfaces [12].

Biodentine contains tricalcium silicate, calcium carbonate (filler), zirconium oxide (radiopacifier) and water-based liquid composed of calcium chloride as a water reducing agent for shorter clinical and final setting time, as it also accelerates the rate of early strength development. Biodentine has improved sealing ability, higher compressive strengths, shorter setting time (12 minutes), greater biocompatibility, bioactivity and biomineralization properties than MTA. Moreover, Biodentine® shows improved antibacterial properties compared to MTA, as well as a low cytotoxic effect. Biodentine may have a more prominent biomineralisation ability than MTA [13]. Elumalai *et al.* concluded that MTA and biodentine being bioactive dental materials can be successfully used for various endodontic therapy [14]. Biodentine showed better initial healing while MTA had better long-term effect [15]. Kayahan *et al.* suggested that obturation procedures be postponed at least for 96 hours after mixing MTA to allow the material to achieve its optimum physical properties [16]. However,

Bachoo *et al.* reported that the initial setting reaction of Biodentine takes approximately 12 min and the provision of full maturation takes 2 weeks–1 month. So, that obturation can be done at the same appointment^[17]. On the basis of sealing ability and biocompatibility, apexification treatment with Biodentine was applied in the present case series. The favorable clinical and radiographic outcome in these cases demonstrated that Biodentine may be an efficient alternative to the conventional apexification materials.

4. Conclusion

Single visit apexification with biocompatible materials such as Biodentine and MTA can be considered an effective treatment option for teeth presenting with open apices. The studies are generally in favor of biodentine in terms of physical and clinical aspects despite a few contradictory reports. Though accumulation of further data is necessary, Biodentine holds promise for clinical dental procedures as a biocompatible and easily handled product with short setting time.

5. References

- Bhasker SN. Orban's Oral Histology and Embryology. 11th ed. St. Louis: Mosby-Year Book, 1991, p382.
- American Association of Endodontists. Glossary of Endodontic terms, 10th edition. Chicago: American Association of Endodontists, 2020.
- Andreasen JO, Farik B, Munksgaard EC. Long-term calcium hydroxide as a root canal dressing may increase risk of root fracture. *Dent Traumatol*, 2002; 18:134-7.
- Apexification: a review. *Dent Traumatol*, 2005; 21:1-8.
- Balasubrahmaniam A, Sabna BS, Ramesh Kumar M, *et al.* One visit apexification using a novel dental material, Biodentine – A case report. *IOSR Jnl Dent Med Sci*. 2014; 13(5):90-2.
- Heasman P, McCracken G. Harthy's Dental Dictionary. 3rd ed. London: Churchill Livingstone, Elsevier, 2007.
- Rafter M. Apexification: A Review. *Dent Traumatol*, 2005; 21:1-8.
- Trope M. Treatment of immature teeth with non-vital pulps and apical periodontitis. *Endotopic*, 2007; 14:51-9.
- Songtrakul K, Azarpajouh T, Malek M, Sigurdsson A, Kahler B, Lin LM, *et al.* Modified Apexification Procedure for Immature Permanent Teeth with a Necrotic Pulp/Apical Periodontitis: A Case Series. *J Endod*. 2020; 46(1):116-23.
- Juez M, Ballester ML, Berástegui E. In vitro comparison of apical microleakage by spectrophotometry in simulated apexification using White Mineral Trioxide Aggregate, Total Fill Bioceramic Root Repair material, and BioDentine. *J Conserv Dent*. 2019; (3):237-40.
- Li Chenshuang, *et al.* Apexification Management of Mandibular Second Premolar with a Blunderbuss Apex and Periapical Lesion of an Adult Patient. *Case reports in dentistry*, 2019.
- Parirokh M, Torabinejad M. Mineral trioxide aggregate: A comprehensive literature review – Part III: Clinical applications, drawbacks, and mechanism of action. *J Endod*, 2010; 36:400-13.
- Torabinejad M, Chivian N. Clinical applications of mineral trioxide aggregate. *J Endod*. 1999; 25(3):197-205.
- Elumalai D, *et al.* Comparison of mineral trioxide aggregate and biodentine for management of open apices. *J Interdiscip Dentistry*, 2015; 5:131-5.
- Camilleri J. Staining potential of Neo MTA Plus, MTA Plus, and Biodentine used for pulpotomy procedures. *J Endod*. 2015; 41(7):1139-45.
- Kayahan MB, Nekoofar MH, McCann A, Sunay H, Kaptan RF, Meraji N, *et al.* Effect of acid etching procedures on the compressive strength of 4 calcium silicate-based endodontic cements. *J Endod*. 2013; 39(12):1646-8.
- Bachoo I, Seymour D, Brunton PA. Biocompatible and bioactive replacement for dentin: is this a reality? The properties and uses of a novel calcium-based cement. *Br Dent J*, 2013; 214:E5