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Management of Open Apex in Permanent Teeth with Biodentine

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Abstract: *Biodentine is new calcium silicate based cement that exhibits physical and chemical properties similar to those described for certain Portland cement derivatives. This article demonstrates the use of the newer material, Biodentine as an apical matrix barrier in root end apexification procedure. This case reports present apexification and successful healing with the use of Biodentine as an apical barrier matrix.*
Keywords: *Apexification, apical barrier, Biodentine, periradicular healing*

I. Introduction

Injury to anterior teeth is a common event. Injury to a tooth with immature apex requires a treatment approach that assures a tight seal at apex, which ensures complete biologic and functional restoration of the tooth involved. Orthograde obturation of root canal with blunder-buss apex always poses a challenge.[1] Mineral trioxide aggregate (MTA) is commonly used to create the barrier at the apex in such cases. One of the major problems posed by MTA is handling properties and long time to set.[2,3] Another material with largely improved handling properties, Biodentine (Septodont), was introduced in 2011. It is a calcium silicate-based material, having biocompatibility similar to MTA.[4,5]

Compared to MTA, Biodentine handles easily and needs much less time for setting. Unlike other Portland cement-based products, it is sufficiently stable so that it can be used both for pulp protection and temporary fillings[3,4]. This is why the manufacturer recommends to fill the entire cavity completely with Biodentine in a first step and to reduce it to a base/dentine substitute level in a second visit one week to 6 months later before definitive restoration. For successful capping it is, however, important to seal the cavity against bacterial invasion in a one-stage procedure [3, 4]. While there is extensive evidence documenting that composite fillings are leak-proof, few pertinent data are available for Biodentine.[1,3]

Biodentine has many applications in Dentistry such as crown and root dentine repair treatment, repair of perforations or resorptions, apexification and root-end fillings. The material can also be used in class II fillings as a temporary enamel substitute and as permanent dentine substitute in large carious lesions. The manufacturer claimed about the biocompatibility and the bioactivity of the material, which is important when used as indirect and direct pulp capping and pulpotomy. Furthermore, it preserves pulp vitality and promotes its healing process.[5,6,7] Boidentine has got all the indication where MTA had been indicated. Biodentine can be used for crown and root dentin repair treatment, repair of perforations or resorptions, apexification and root-end fillings. The material can also be used in class II fillings as a tempo rary enamel substitute and as permanent dentine substitute in large carious lesion .[9] Of all the materials available, MTA has been widely used for one-visit apexification. It has attracted considerable attention owing to their superior sealing ability, biocompatibility, regenerative capabilities, and antibacterial properties. Nevertheless, MTA remains subject to some concerns, such as its long setting time, poor handling characteristics, low resistance to compression, low flow capacity, limited resistance to washout before setting, possibility of staining of tooth structure, presence and release of arsenic, and high cost. [10,11]These disadvantages necessitate more ideal restorative materials, with adequate biological and mechanical properties. Recently, a new calcium silicatebased material, Biodentine (Septodont, Saint-Maur-desFossés, France), has been introduced with the intention of preserving the properties and clinical applications of MTA without its negative characteristics.[10,11,12] The present case report highlights the nonsurgical management of symptomatic teeth with immature apices and large periapical radiolucencies using Biodentine.

Case Report

A 14-year-old male patient reported with a chief complaint of pain and swelling in relation to maxillary left lateral incisor. History revealed that the patient had suffered trauma at the age of 11years. The vitality of the tooth was determined by the cold pulp test, using dry ice . It revealed the negative response. Radiographic examination revealed an immature tooth with a wide open apex and a radiolucent area in proximity of the apex of the tooth.

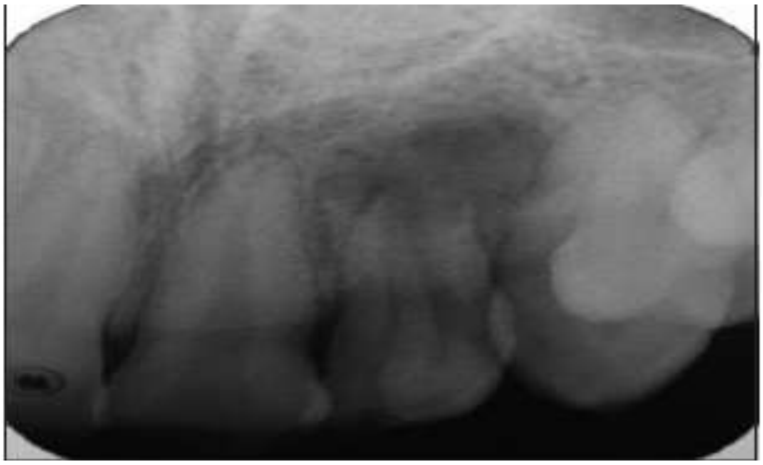

Figure 1: Preoperative radiograph

A dentinal fin was also seen inside the root canal. Endodontic access opening was done under local anesthesia, and a periapical radiograph was taken to determine the working length. Biomechanical preparation was done using no 80 K-file using circumferential filing motion. Root canal debridement was done using alternate irrigation with 2.5% NaOCl and saline. During cleaning and shaping of the canal, the dentinal fin disappeared and merged with the main canal. The root canal was then dried with sterile paper points. Calcium hydroxide and iodoform combination was placed in the root canal, and the patient was recalled after 1 week. One week later, the tooth was again isolated under rubber dam, the calcium hydroxide dressing was removed by hand instrumentation, and irrigation was done with 1.3% NaOCl and 17% liquid EDTA Smear Clear . The root canal was then dried with sterile paper points.

Biodentine capsule was gently tapped on a hard surface (to diffuse powder), five drops of liquid from a single-dose dispenser were poured into the capsule, after which the latter was placed in a triturator for 30 s. The mixture of Biodentine was hence prepared. The first increment of BioDentine was inserted into the canal using a curved needle of the largest diameter fitting into the canal . The material was then delicately pushed towards the apex with a root-canal plugger. Several increments were required to form a plug of adequate thickness (>4 mm)

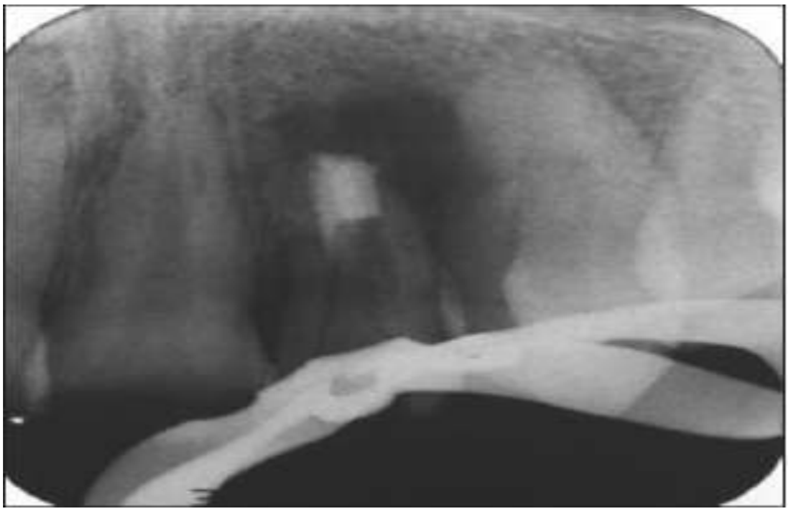

Figure 2: Biodentine plug

The material was adapted to the walls by applying indirect ultrasonic vibration through an ultrasonic tip placed on the plugger touching the material. After verifying that the material was hard-set, and waiting for additional few minutes, Gutta-percha backfill was performed using Obtura II ,and the access cavity was sealed using composite resin. A radiograph confirmed the completion of the endodontic therapy. The clinical follow-up at 24months showed the patient functioning well with no reportable clinical symptoms and the absence of any sinus tract formation. The radiographic follow-up at 24 months showed complete healing of the periapical radiolucency and regeneration of the periradicular tissues.

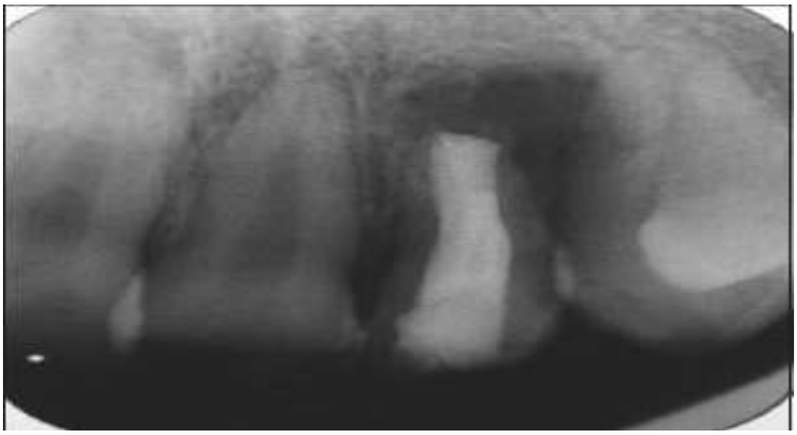

Figure 3: Post obturation radiograph

II. Discussion

Management of cases with open apex poses a problem during management of traumatic injuries involving permanent teeth. Especially, in cases where apex have not been closed up to a level, then conventional root canal can be undertaken. [1]Apical seal with conventional gutta-percha is best when the apical terminus is smallest possible.[2,3] So when the apical terminus is larger due to incomplete root formation, it is advisable either to engage regenerative procedures to reduce the size of it or obtain apical seal with alternative methods.[1,3,4,5]

Regeneration protocol is the procedure to restart the root formation once it has stopped due to any injury. It was not carried out mainly due to decreased success rate in teeth with periapical radiolucency, and more time had lapsed between the traumatic injury and the treatment.[6,7,8]

Clinical applications of ProRoot MTA include the following: Repair of furcal and lateral root perforations, repair of internal root resorption, vital pulp therapy (direct pulp capping, partial pulpotomy and pulpotomy), as an apical plug during apical surgery and as an apical plug in non-vital teeth with open apex.[13]

Figure 4: Healing evident after 24months

Biodentine is a calcium silicate based material used for crown and root dentin repair treatment, repair of perforations or resorptions, apexification and root-end fillings. The material can also be used in class II fillings as a temporary enamel substitute and as permanent dentine substitute in large carious lesions . The manufacturer points out the biocompatibility and the bioactivity of the material, which is important since the use of the material involves indirect and direct pulp capping and pulpotomy. According to the manufacturer, Biodentine preserves pulp vitality and promotes its healing process.[14]

Laurent et al. tested a new Ca_3SiO_5-based material to evaluate its genotoxicity, cytotoxicity and effects on the target cells specific functions. The study concluded that the new material is biocompatible.[15]The material was not found to affect the specific functions of target cells and thus could safely be used in the clinic. About et al. nvestigated Biodentine bioactivity by studying its effects on pulp progenitor cells activation, differentiation and dentine regeneration in human tooth cultures. The study concluded that Biodentine™ is stimulating dentine regeneration by inducing odontoblast differentiation from pulp progenitor cells. [16] Han & Okiji compared calcium and silicon uptake by adjacent root canal dentine in the presence of phosphate buffered saline using Biodentine and ProRoot MTA. The results showed that both materials formed a tag-like structure composed of the material itself or calcium- or phosphate rich crystalline deposits. The thickness of the Ca- and Si-rich layers increased over time, and the thickness of the Ca- and Si-rich layer was significantly larger in Biodentine™ compared to MTA after 30 and 90 days, concluding that the dentine element uptake was greater for Biodentine™ than for MTA.[17] Pérard et al. assessed the biological effects of Biodentine for use in pulp-capping treatment, on pseudo-odontoblastic (MDPC-23) and pulp (Od-21) cells. Secondly, the same authors evaluated the effects of Biodentine and MTA on gene expression in cultured spheroids. They concluded that Biodentine and MTA may modify the proliferation of pulp cell lines. Their effects may fluctuate over time, depending on the cell line considered. The observed similarity between Biodentine and MTA validates the indication for direct pulpcapping claimed by the manufacturers.[18]

Nowicka et al. compared the response of the pulp-dentine complex in human teeth after direct capping Biodentine and MTA. They concluded that Biodentine had a similar efficacy in the clinical setting and may be considered an interesting alternative to MTA in pulp-capping treatment during vital pulp therapy. [19]According to the manufacturer, Biodentine consists of a powder in a capsule and liquid in a pipette. The powder mainly contains tricalcium and dicalcium silicate, the principal component of Portland cement, as well as calcium carbonate. Zirconium dioxide serves as contrast medium. The liquid consists of calcium chloride in aqueous solution with an admixture of polycarboxylate. Once mixed, Biodentine sets in approximately 12 minutes. The consistency of Biodentine is similar to that of phosphate cement.[20] Camilleri et al. characterized and investigated the hydration of Biodentine and laboratory manufactured cement made with a mixture of tricalcium silicate and zirconium oxide and compared their properties to MTA Angelus. They reported that all the cement pastes tested were composed mainly of tricalcium silicate and a radiopacifier. The laboratory manufactured cement contained no other additives. Biodentine included calcium carbonate which together with the additives in the mixing liquid resulted in a material with enhanced chemical properties relative to TCS-20-Z prototype cement. On the other hand MTA Angelus displayed the presence of calcium, aluminum and silicon oxides in the un-hydrated powder. These phases are normally associated with the raw materials indicating that the clinker of MTA Angelus is incompletely sintered leading to a potential important variability in its mineralogy depending on the sintering conditions. As a consequence, the amount of tricalcium silicate is less than in the two other cements leading to a slower reaction rate and more porous microstructure. [21]

Grech et al.investigated the composition of materials and leachate of hydrated prototype cement composed of tricalcium silicate and radiopacifier and compared this to Biodentine and Bioaggregate to assess whether the additives in the proprietary brand cements affect the hydration of the materials. They found that Biodentine and Bioaggregate resulted in the formation of calcium silicate hydrate and calcium hydroxide, which was leached in solution. The hydrated materials were composed of a cementitous phase that was rich in calcium and silicon and a radiopacifying material. Biodentine included calcium carbonate, and Bioaggregate included silica and calcium phosphate in the powders. IRM was composed of zinc oxide interspersed in a matrix of organic material.[22]

Camilleri et al.determined the elemental constitution and investigated the total and leachable arsenic, chromium and lead in Portland cement, pure tricalcium silicate, Biodentine, Bioaggregate and MTA. They concluded that dental materials based on tricalcium silicate cement and MTA release minimal quantities of trace elements when in contact with simulated body fluids. The results of acid extraction could be affected by nonspecific matrix effects by the cement. [23] Shayegan et al. assessed and compared, in primary pig teeth, the pulp response after a pulpotomy using Biodentine, white MTA, or formocresol (FC) and repeat the same after direct pulp capping using Biodentine, white MTA, or calcium hydroxide. They concluded that Biodentine and white MTA are both suitable, biocompatible materials for pulp capping in primary teeth of pigs. [24]

Zhou et al. examined the effect of a Biodentine on the viability of human gingival fibroblasts. They reported that Biodentine caused gingival fibroblast reaction similar to that by MTA. Both materials were less cytotoxic than glass ionomer cement.[25] Firla claimed that during the setting phase of Biodentine, calcium hydroxide ions are released from the cement. This results in a pH of about 12.5 and a basification of the surroundings. This high pH inhibits the growth of microorganisms and can disinfect the dentine.[26] Laurentet al. indicated that thought he interactions between pulp capping materials and the injured pulp tissue are yet unclear, there is growing evidence on the role of growth factors, with TGF-β1 being the most important one. These factors' main role is the signalling of reparative dentinogenesis.In a recently published article,they assessed the reparative dentin synthesis capacity of Biodentine as well as the ability to modulate TGF-β1 secretion by pulp cells which has previously shown to be released from dentine by calcium hydroxide . Using an entire human tooth culture model, they showed that, upon application on the exposed pulp, Biodentine had the potential to significantly increaseTGF-β1secretionfrompulpcellsandinduceanearly form of reparative dentin synthesis . [27]

Zanini et al. also evaluated the biological effect of Biodentine on murine pulp cells by analyzing theexpression of several biomolecular markers after culturing OD-21 cells with or without Biodentine. Their results, consistent with other studies, were in favor of Biodentine, which was found to be bioactive due to its ability to increase OD-21 cell proliferation and biomineralization.[28] Kokate and Pawar conducted a study that compared the microleakage of glass ionomer cement, MTA, and Biodentine™ when used as a retrograde filling material and concluded that Biodentine™ exhibited the least microleakage when compared to other materials used.[29] This case report emphasizes the novel approach of using Biodentine to achieve single visit apexification of the cases with an open apex and large periapical lesion. The use of Biodentine has been demonstrated to induce faster periapical healing for single visit apexification of the cases with large periapical lesions. The material is still under study and many more advancements in its clinical applications are expected in near future. Although the efficacy of BioDentine as a dentin substitute is yet to be clinically proven for its therapeutic indications, it may be a promising material for apexification.

III. Conclusion

Biodentine, a bioactive – biomimetic material, shows promising use for apexification, obturation and reinforcement in management of immature teeth with open apex while serving as a monoblock. However, in such cases, long term follow up is necessary to ensure and evaluate success

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