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Revascularization of Immature Permanent Tooth with Periapical Lesion using a New Biomaterial - A Case Report

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Abstract **Aim:** To describe a case of a necrotic immature mandibular central incisor with sinus tract and periradicular radiolucency that underwent revascularization using Biodentine as coronal sealing material. **Summary:** Revascularization procedures provide a more predicable outcome by rendering continued root development of immature apices. This case report describes the successful revascularization procedure on a mandibular incisor in a 15-year-old patient, with the resolution of the associated periapical pathology within 18 months. The tooth was treated using coronal root irrigation by 6% NaOCl and triple antibiotic paste without instrumentation. This conservative treatment approach combined with a coronal seal of a bioactive material like Biodentine can preserve the vitality of the dental pulp stem cells and create a suitable environment for pulp revascularisation, resulting in the completion of root maturation.

Keywords: *immature apex, revascularization, Biodentine, dental pulp stem cells, stem cells of the apical papilla*

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1. Introduction

The traumatic injury of an immature permanent tooth can lead to the loss of pulp vitality and arrested root development. Cleaning & shaping of the apical portion of the root apex with blunderbuss shape is difficult to achieve as the thin, fragile dentinal walls are prone to fracture during instrumentation or obturation. Traditionally, multiple-visit apexification with calcium hydroxide was the treatment of choice in necrotic immature teeth, which would induce the formation of an apical hard tissue barrier [1]. One-step apexification by the creation of artificial barriers using materials such as MTA, has greatly decreased the number of appointments and time to completion but both the techniques share the same disadvantage of not allowing the continuation of root development leading to fragile root structure.

A recent and different approach involves creating a periapical environment conducive for root maturation after disinfection of the canal space and treatment with antibiotic pastes. Revascularization is a biologically based alternative approach to treat necrotic immature teeth that allows continuation of root development unlike apexification & artificial apical barrier techniques [2,3]. In teeth with open apices and necrotic pulps, it is possible that some vital pulp tissue and Hertwig's epithelial root sheath remain. When the canal is properly disinfected, the inflammatory process reverses and these tissues may proliferate.

The proposed regenerative treatment generally starts with chemical disinfection of the canals by using passive NaOCl [4,5] irrigation without any instrumentation. This is followed by a triple antibiotic dressing (ciprofloxacin + metronidazole + minocycline), as suggested by Hoshino et al [6]. In the absence of clinical signs and symptoms of periradicular disease, the treatment continues with removing the paste and irritating the apical tissues to induce bleeding inside the canal by irritating the apical tissues with a sterile file [7,8], endodontic explorer [9], paper points [10].

After formation of a blood clot, the orifice of the canal is usually sealed with MTA, which allows the regeneration of new tissue adjacent to it [8,9]. Finally, the crown is permanently restored. There is one clinical study that reports successful use of glass ionomer instead of MTA 11. Presence of MTA in the cervical portion of the canal is also reported to cause crown discoloration [8,12,13].

Biodentine™ (Septodont, St. Maur-des-Fossés, France) cement is part of a new approach seeking to simplify clinical procedures. It is a tooth-colored calcium silicate based cement of the same type as MTA®. It has been claimed to be a bioactive dentin substitute for the repair of root perforations, apexification and retrograde root filling by the manufacturers.

This article describes a case of successful revascularization in necrotic immature incisor by using Biodentine, a new endodontic biomaterial for the coronal seal.

2. Case Report

A 15-year-old boy was referred for evaluation on the lower left central incisor. He had a sinus tract in the mandibular area (Figure 1) and slight discomfort since 1 month.

The patient did not have any contributory medical history. On clinical examination, the tooth appeared intact, without caries and a sinus tract was present that traced to the apex of the tooth. Periodontal probings were within normal limits for all teeth in the lower left region. Diagnostic testing was inconclusive on cold and electric pulp testing, with sensitivity on percussion and palpation. Radiographic examination revealed that the tooth had an open apex associated with large radiolucency (Figure 1). The diagnosis of pulp necrosis and chronic apical abscess with a sinus tract was made.

Figure 1. Open Apex Associated with Large Radiolucency and Sinus Tract

Because of the presence of a wide open apex and thin dentinal walls prone to fracture, it was felt that an attempt to achieve regeneration of the pulp should be made by a technique similar to that described by Rule and Winter [14] and Iwaya et al [15]. After extensive explanation of the treatment procedure, risks, and benefits, an informed consent was obtained from the patient's parents.

An access cavity had been made, purulent hemorrhagic drainage obtained, and the necrotic nature of the pulp confirmed. A needle was placed to within 1 mm of the apex, and the canal was slowly flushed with 20 ml of 6% NaOCl. The canal was dried with paper points, and a mixture of ciprofloxacin, metronidazole, and minocycline paste was prepared into a creamy consistency and spun down the canal with a lentulo spiral instrument to a depth of 8 mm into the canal. The access cavity was closed with 4 mm of Cavit (ESPE, Seefeld, Germany).

The patient returned next week, asymptomatic, reporting no pain postoperatively. The sinus tract was not present, and some reduction in the radiolucency was already evident. The access was opened and the canal again flushed with 10 ml of 6% NaOCl. The canal appeared clean and dry, with no signs of inflammation exudate. An endodontic explorer was introduced into the canal and was used to irritate any remaining vital tissue gently to create some bleeding into the canal. The bleeding was stopped and left for 15 min so that the blood clot would form. After 15 min, the presence of the blood clot was confirmed. Biodentine™ (Septodont, St. Maur-des-Fossés, France) was carefully placed over the blood clot, followed by a bonded resin restoration.

The patient was scheduled for recall examination after 2 weeks and advised to call if she was in pain or if swelling or a recurrence of the sinus tract developed.

At the recall appointments (3, 6, 12 and 18 months), the patient was always asymptomatic, the sinus tract over the left central incisor did not reappear. The 6 month recall radiograph showed complete resolution of the radiolucency (Figure 2). At the 18-month (Figure 3) follow-up examination, the patient continued to be asymptomatic, with an indication of continued development of the apex of the tooth and no signs of the sinus tract. Thickening of the dentinal walls was also obvious. The tooth responded positively to the cold test.

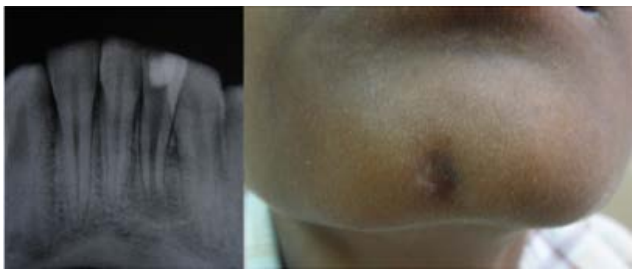

Figure 2. 6 Month Recall Radiograph Showed Complete Resolution of the Radiolucency

Figure 3. 18 Month Follow-up Examination: Continued Development Of The Apex Of The Tooth and No Signs of Sinus Tract

3. Discussion

Revascularization is a novel procedure which exploits the full potential of the pulp for dentine deposition and produces a strong mature root that is better able to withstand the forces than can result in fracture. It has been proposed that in traumatized teeth the crown is usually intact; hence it takes bacteria a long time to advance into the pulp space. If, in this time, the new vital tissue fills the canal space, the ingress of bacteria will be stopped. The necrotic but sterile pulp acts as a matrix into which new tissue can grow.

The infection of the root canal system is considered to be a polymicrobial infection, consisting of both aerobic and anaerobic bacteria [16]. Because of the complexity of the root canal infection it is unlikely that any single antibiotic could result in effective sterilization of the canal. A mixture of ciprofloxacin, metronidazole, and minocycline has been shown to be very effective in eliminating endodontic pathogens in vitro and in situ [6]. This mixture has also been demonstrated to be well tolerated by the vital pulp tissue [17]. After disinfection, the canal should be filled with a resorbable matrix to encourage the in-

growth of new tissue. Finally, the coronal access must be sealed to prevent reinfection.

The importance of a bacteria-tight coronal seal for successful revascularization is well-documented [9]. MTA has been used for coronal sealing in revascularisation cases. The main drawbacks of this class of materials so far have been slow setting kinetics and complicated handling, which rendered these technique sensitive procedures even more difficult and restricted their use to specialists [18].

Thus, an alternative material needs to be explored to overcome these drawbacks. Biodentine™ (Septodont, St. Maur-des-Fossés, France) cement is part of a new approach seeking to simplify clinical procedures. It is a calcium silicate based cement of the same type as MTA®. Its biocompatibility has also been validated experimentally by Laurent et al [19]. They found no evidence of mutagenicity or cytotoxicity with this new material. The percentage of cell mortality with the new cement as performed with the MTT test was similar to that of biocompatible materials such as mineral trioxide aggregate (MTA) and was less than that obtained with Dycal. Also, it did not affect the target cells' specific functions such as mineralization, as well as expression of collagen I, dentin Sialoprotein and Nestin [19]. Based on all its properties, Biodentine™ has been claimed to be a bioactive dentin substitute for the repair of root perforations, apexification and retrograde root filling by the manufacturers. A modified powder composition, the addition of setting accelerators and softeners, and a new predosed capsule formulation for use in a mixing device, largely improved the physical properties of this material making it much more user-friendly [20,21]. Moreover, unlike MTA, Biodentine has the advantage of being tooth-colored and preventing the discoloration caused by the presence of the MTA at the orifice level, which is mentioned in some of the revascularization reports [8,12,18].

Therefore, as depicted by this case, Biodentine is an appropriate sealing biomaterial over the blood clot in revascularization procedure. Biodentine was used in this case study to provide an effective pulpal seal. Although the efficacy of BioDentine as a dentin substitute is yet to be clinically proven for its therapeutic indications, it may be a promising coronal sealing material for revascularization cases.

However, revascularization has certain practical limitations. It is difficult to case select appropriate teeth that clinically test nonvital, but maintain vital apical cells believed to be necessary to successfully perform the procedure. Additional complications such as various systemic health conditions and immunologic problems may offer other obstacles in achieving adequate root maturation in the presence of a periradicular infection. Moreover, because the term *regeneration* is based on clinical and radiographic outcomes and not histologic or biochemically based assessments, one can only make a clinically functional interpretation of the healing process. Nevertheless, using Biodentine as a new endodontic biomaterial over blood clot instead of MTA is an applicable choice.

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