Case Report

Modified single-step apexification and strengthening of thin dentinal walls with Biodentine

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Abstract

Apexification is a technique used to create a mineralized barrier in a root having an open apex or to continue the apical growth of a root that is still not fully developed in teeth with necrotic pulps. Biodentine is a versatile material which can help in achieving apical closure as well as reinforcement of thin dentinal walls, thus improving the overall prognosis and preserving the natural dentition. In the present case, the radiographic evaluation showed thinner dentinal walls and an open apex with periapical radiolucency in relation to the upper right central incisor. The large open root apex and thin dentin walls of immature permanent teeth render them challenging to treat with root canal therapy. This case report describes a modified single-step apexification procedure and strengthening of the dentinal walls of the root canal using Biodentine.

Keywords: Biodentine; immature permanent tooth; modified single-step apexification procedure; open apex

INTRODUCTION

The process of forming mineralized tissue in the apical portion of an immature tooth with an infected necrotic pulp and an incompletely formed root is known as apexification.[1]

Dental traumatic injuries significantly contribute to pulp necrosis and subsequent root canal infection in immature permanent teeth.[2] Before complete root formation at a young age, trauma affects the development of roots, weakened fragile root canals, and it becomes challenging to establish an artificial barrier or apical foramen closure with calcified tissue and treatment for such immature teeth with root reinforcement might become necessary.[3]

Recently, regenerative endodontic procedures (REPs) were introduced for the induction of continued root development and dentin wall thickening of the necrotic immature root that might strengthen the tooth structure.[4] While these techniques can accomplish their biological goals, the results of the treatment are not always predictable, and the strengthening effect of the different healing patterns reported is questionable.[5,6] With unpredictable and questionable outcomes of REPs in everyday practice, more evidence-based definite treatment with better biological outcomes is preferred.[7,8]

The main advantage of a single-step apexification method was that it reduced treatment time and increased patient compliance.[9] Biodentine, a bioactive and biocompatible calcium-based cement, has shown promise in the regeneration of damaged dental tissues during the single-step apexification procedure of traumatized teeth. This method offers a viable alternative to the multi-visit apexification approach.[10]

In the current case report, a symptomatic immature permanent tooth #8 with pulp necrosis and apical periodontitis underwent modified single-step apexification treatment with Biodentine. To promote continued apical root development and strengthening of root structure, a modified apexification technique may be

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used as a replacement to the conventional apexification procedure.[11]

CASE REPORT

A 20-year-old man was reported to the department of endodontics with the chief complaint of pain in the upper front tooth area for the past 2 weeks. During his visit to the department of endodontics, he complained of mild-to-moderate continuous pain and tooth #8 was tender on percussion. The tooth showed mild discoloration with no mobility. The patient was subjected to dental trauma in his childhood, but because there was no tooth fracture or discomfort, neither the patient nor his parent sought dental treatment. No other significant dental or medical history was found. Radiographic examination revealed an immature wide-open apex and periapical radiolucency in relation to tooth #8 [Figure 1a]. Electric pulp test and cold test results were negative and the final diagnosis of the case was made as symptomatic apical periodontitis.

Both apexification and REP were advised to the patient. However, due to the unpredictable outcome of the REP and the longer treatment duration, a more definite treatment, single-step modified apexification procedure with reinforcement of thin dentinal walls with Biodentine, was chosen for tooth #8. The patient was explained about the treatment and informed consent was obtained.

Under local anesthesia with 2% lidocaine containing 1:100,000 epinephrine and rubber dam was placed in the involved tooth. Access opening was done using an Endo-Z bur (Dentsply Maillefer, Ballaigues, Switzerland), and apical patency was obtained with # 15 K-file. Working length was determined using an apex locator (J Morita) and confirmed by an intraoral periapical radiograph [Figure 1b].

The canal was cleaned and shaped with hand K-files (Mani, India) and ProTaper Universal Rotary Files (Dentsply) to an appropriate size to disrupt bacterial biofilm on the canal walls. Root canal irrigation was done with 3% sodium hypochlorite (Hyposol; Prevest DenPro, India) between each instrument, followed by 17% EDTA (NEOEDTA; Orikam, India) and saline. All irrigation was done with two-side vented needles (RC Twents; Prime Dental, India) and the root canal was then carefully dried with sterile paper points (COLTENE, Altstätten, Switzerland). The root canal was disinfected with calcium hydroxide (RC Cal; Prime Dental) for 2 weeks and the access cavity was sealed with sterile cotton pellet and temporary restorative material (Neotemp; Orikam, India).

At the next appointment, the patient was found asymptomatic. Following tooth isolation, calcium hydroxide medicament was removed with copious amount of 3% NaOCl irrigation without the use of EDTA irrigation. After that, sterile paper points were used to dry the root canal. At the same visit, modified apexification procedure was performed for tooth #8 (upper right central incisor). In the apical part of the canal, 1–2 mm from the end of the open apex, a 3-mm thick biocompatible resorbable collagen matrix (Colo Plug; Cologenesis Healthcare, India) was inserted and compacted using an appropriate hand plugger to prevent the Biodentine from extruding into the periapical tissues.

Biodentine was then prepared according to the manufacturer's instructions, carried into the canal with an amalgam carrier, and condensed with hand pluggers to form an apical Biodentine plug of 3–4 mm in thickness. The excess material from the walls was removed with paper points. After 12–15 min, using the vertical condensation technique, the remaining root canal space was filled with warm gutta-percha and composite resin was used to seal the access cavity [Figure 1c].

Follow-up for the treated tooth was done at 6 months, 18 months, and 30 months [Figure 1d-f]. After saving images in JPEG format, these were transferred to Image J software (version 1.53e; National Institutes of Health, USA) and calibrated to calculate the difference in lesion size, dentin thickness, the root length from preoperative and postoperative radiographic images that were done according to the method described in a study by Flake *et al*.[12]

DISCUSSION

Apexification procedures were traditionally performed by calcium hydroxide with unpredictable closure of apex, longer period requirement, compliance of the patient, loss of coronal seal in between appointments, and chances of root fractures because of thin dentinal walls or long-term exposure of calcium hydroxide to root dentin.[13]

Because of these disadvantages, single-step apexification procedures with mineral trioxide aggregate (MTA) have been gained immense popularity and resulted in favorable healing outcomes.[14]

Due to its superior sealing ability and biocompatibility, MTA is being utilized as the material of choice for apexification therapy.[15] MTA is a bioactive material that is suitable for the closure of an open apex root canal because it can stimulate the development of new mineralized tissues.[16]

Recently, Biodentine, a calcium silicate-based cement, has also been used for apical barrier formation. Biodentine, the novel bioactive dentin replacement cement, is made of a powder that includes calcium carbonate, zirconium

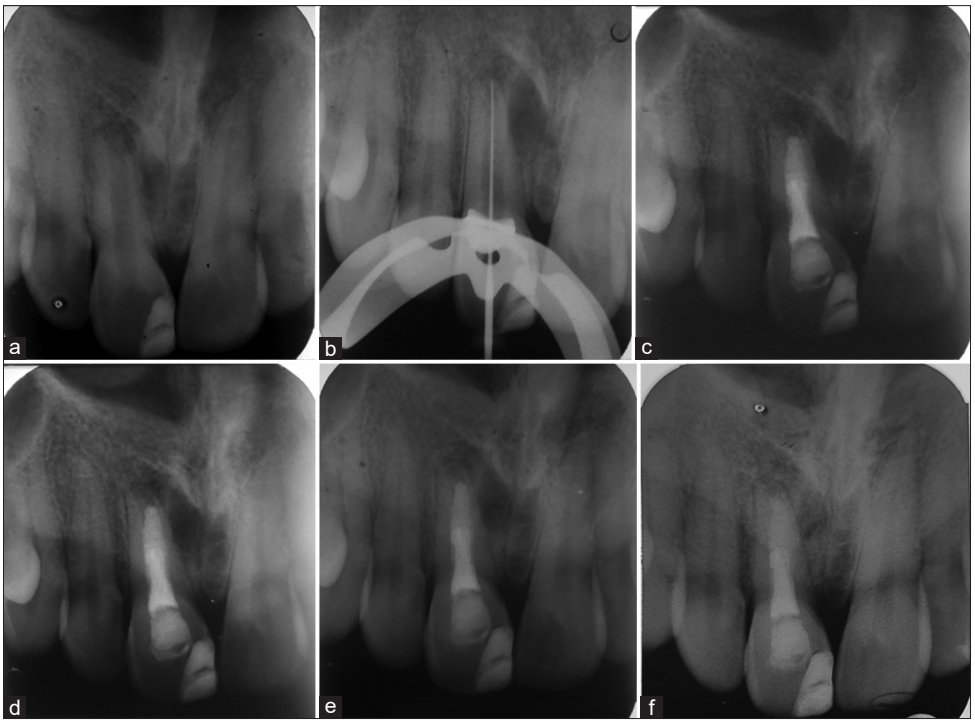

Figure 1: (a) A preoperative periapical radiograph of tooth #8. The tooth has an open apex and a periapical lesion and was diagnosed with necrotic pulp and asymptomatic apical periodontitis (b) working length estimation. (c) A periapical radiograph after biodentine placement, obturation and final restoration. (d) A periapical radiograph after 6-month follow-up. (e) A periapical radiograph after 18 month follow up period showing evidence of apical closure. (f) A periapical radiograph after 30-month follow-up period, showing complete resolution of periapical lesion and apical closure

oxide, tricalcium silicate, dicalcium silicate, and calcium hydroxide. Biodentine is easy to prepare, handle and the time required for setting is shorter than other silicate-based cement. MTA takes 2 h and 45 min to set, while Biodentine sets in 12 min.[17]

In addition, the physical properties of Biodentine have been significantly enhanced, making it far more easy to use, with the introduction of a new predosed capsule formulation designed for use in a mixing device.[18] Biodentine had the highest compressive strength, which is comparable to the compressive strength of natural dentin when compared to MTA and calcium silicate-based cement.[19]

Because of the increased hydroxyapatite apposition on the Biodentine surface during exposure to tissue fluids, its biocompatibility and physical properties were observed better when compared to MTA.[20] Biodentine has been shown to lack cytotoxicity, and it is able to stimulate collagen fiber and fibroblast formation.[21] The good color stability, minimal cytotoxicity, and absence of genotoxicity make it an ideal choice for endodontic procedures.[22-24]

A single-visit apexification procedure of a traumatically injured tooth with Biodentine revealed that this bioactive and biocompatible calcium-based cement can regenerate damaged dental tissues and represents a promising alternative to the multi-visit apexification technique.[10] In this case report, a modified single-step apexification approach was used to treat the tooth, where Biodentine was placed 4 mm coronal to the root apex and separated from periapical tissues using a resorbable collagen barrier.[11]

A plug of resorbable collagen membrane was used in our case for effective condensation of Biodentine to avoid its extrusion into periapical tissue. Absorbable collagen membranes are mechanically malleable, adaptable, and easy to manipulate, which may be beneficial in clinical applications. Additional benefits of collagen include its ability to act as a hemostatic agent, its semi-permeability, which permits the passage of nutrients, its natural enzymatic breakdown, and its chemotactic capability to attract other substances.[25] Furthermore, it adapts easily to the root canal surface and is a weak immunogen which is biodegradable with no need of removing it after the procedure.[26]

The formation of dental roots is critically dependent on the Hertwig epithelial root sheath (HERS) cells.[27] The length of the root, apical closure, and the thickness of the canal walls are all increased by HERS cells. The HERS may be physically

damaged by mechanical irritation during the initiation of periapical bleeding and long-term apical periodontitis that inhibit further root development. Therefore, the modified apexification procedure with Biodentine is simpler to perform than the traditional apexification technique because it avoids the need to place a Biodentine apical plug in proximity to the open apex, which could cause direct harm to the apical papilla cells and HERS cells due to the high pH (12.5) of Biodentin and its extrusion.[11]

Proinflammatory cytokines, such as interleukin-1 (IL-1) and tumor necrosis factor alpha (TNF-α), generated from immunoinflammatory cells are capable of suppressing the biological processes of the HERS cells and the apical papilla cells whenever infection or inflammation affects the pulpal-periapical tissue complex.[28,29]

Therefore, after controlling the inflammation/infection, the physiological function of HERS cells and apical papilla cells can be restored.[30] The present case report showed evidence of continued development of apical roots after 18 and 30 months of follow-up [Figure 1e and f]. This phenomenon might be related to the length of the root, the large diameter of the apical foramen, and the survival of apical papilla cells and HERS cells.[31,32]

CONCLUSION

Within the scope of the present case report, it is possible to conclude that the modified apexification procedure has a favorable treatment outcome equivalent to traditional apexification and possesses the capability to be considered a feasible alternative treatment option for immature permanent teeth with necrotic pulp and apical periodontitis. Furthermore, the additional advantage with this procedure is the continued development of apical roots which enhance the crown/root ratio of the tooth. Future clinical trials are necessary to confirm the outcomes of the current case report before its wide clinical applications in immature necrotic teeth.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patient understands that his name and initials will not be published and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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