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(CASE REPORT)

Apexification of post orthodontic treatment tooth with open apex using bioceramic materials: A case report

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Abstract

Introduction: Treating teeth with open apex might be difficult for clinicians. Advanced apical root resorption can occur following orthodontic treatment and is influenced by biological factors. Although generally minimal and clinically insignificant in most patients, resorption is irreversible and unpredictable. In a small subset, extensive resorption exceeding half the root length may impair function and jeopardize tooth survival. Some studies suggest that teeth with incomplete root development exhibit greater resistance to orthodontically induced resorption.

Case report: A 25-year-old female came to the Department of Conservative Dentistry, Airlangga University Hospital, with a feeling of discomfort in her lower right tooth, with a recurrent fistula. Radiograph showed a post-endodontic treated tooth with a periapical lesion. Tooth 45 was diagnosed with a previously treated tooth with chronic apical abscess. The proposed treatment plan is endodontic retreatment combined with apexification utilizing bioceramic root repair material (Bio-C® Repair) as an apical plug, followed by restoration using a direct composite. Bioceramic materials serve as artificial barriers in the management of open apex, offering multiple advantages, including reduced treatment duration, reinforcement of dentin structure, and bioactive properties that promote healing. The use of bioactive materials may also minimize the risk of complications associated with material extrusion.

Conclusion: Apexification using bioceramic materials offers numerous advantages as an apical barrier and is considered the treatment of choice for managing teeth with open apex, thereby facilitating the long-term preservation of tooth function throughout the patient's lifetime. appointments, increased patient convenience, and reduced inter-appointment contamination risk.

Keywords: Apexification; Bioceramic materials; Endodontic retreatment; Open Apex; Apical end closure

1. Introduction

Dental root development is a highly regulated and intricate process that commences following crown formation and persists for approximately two to three years post-eruption into the oral cavity. Consequently, the processes of root elongation and apical closure are vulnerable to various intrinsic and extrinsic influences, such as traumatic injuries and the application of mechanical forces, which may result in shortened or morphologically altered roots. Root resorption is a potential complication associated with fixed orthodontic treatment, influenced by factors such as treatment duration, force direction and magnitude, and the extent of tooth movement. While this adverse effect is well-documented in fully developed roots, it has also been proposed that similar forces may interfere with the root development process in teeth that are still maturing [1].

Teeth with an open apex lack apical constriction, thereby complicating root canal treatment due to the absence of an apical barrier necessary for effective obturation. The management options for teeth presenting with this condition

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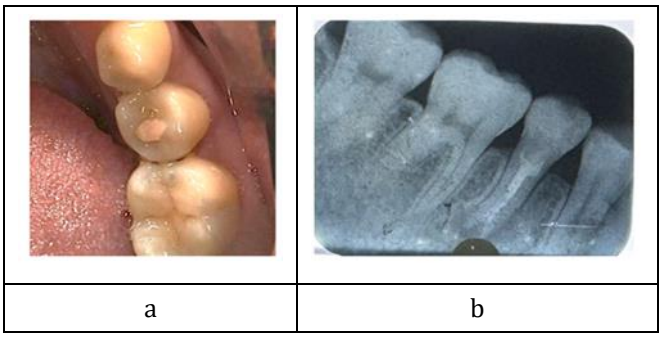
include regenerative endodontic procedures (REP), apexogenesis, and apexification [2]. Apexification refers to a technique aimed at inducing the formation of a calcified barrier at the open apex of an immature, non-vital tooth. This process involves creating favorable conditions within the root canal and surrounding periapical tissues following pulp necrosis, thereby facilitating the development of a calcific barrier at the open apex. An open apex resulting from inadequate root development, which fails to provide the canal with a natural conical taper, is termed a "blunderbuss canal [3].

Inadequate shaping, cleaning, and obturation are the primary causes of endodontic failures; other causes include iatrogenic events or reinfection of the root canal system as a result of a failing coronal seal following endodontic therapy. All of this leads to bacterial contamination and more leaking. Because of the existing thin, fracture-prone radicular walls and the difficulties in creating an apical seal, endodontic retreatment of a tooth with an open apex might be challenging. [4]. Considering the apexification sealing material will come into close contact with the blood clot, it needs to be antibacterial, bioactive, biocompatible, and noncytotoxic. When bioceramic root repair material and MTA are used in RET, apical recovery and root closure occur on average after 54.4 months. Bioceramic root repair material is a good treatment option for apexification, since it promotes apical maturation in 75% of teeth [5]. We present an instance of an endodontic retreatment with an apexification using bioceramic root repair material as the sealing material in an apexification procedure as part of the treatment strategy.

2. Case Report

A 25-year-old female patient presented to Airlangga University Hospital with a complaint concerning her lower right tooth. Although the tooth was asymptomatic in terms of pain, the patient reported occasional discomfort during mastication. She had a history of orthodontic treatment for two years during early adolescence (junior high school) and underwent root canal therapy on the affected tooth approximately four years ago. Over the past month, she has experienced an intermittent salty-tasting discharge from the tooth. She denied any pain but noted persistent chewing discomfort. The patient reported no history of systemic disease or drug allergies.



a b

Figure 1 Initial photograph (a) clinical. (b) periapical radiograph

Intraoral clinical examination revealed that the lower right second premolar (#45) was restored with a temporary filling (Figure 1). A sinus tract was observed adjacent to the tooth, while extraoral examination showed no abnormalities. The tooth exhibited a positive response to percussion, and negative responses to both bite and palpation tests. Salivary analysis indicated a hydration time of 30 seconds (green), a pH of 7.2 (green), and watery viscosity (green), collectively showing a low caries risk. Radiographic examination of tooth #45 revealed a non-hermetic post-endodontic treatment accompanied by a diffuse periapical radiolucency consistent with a periapical lesion (Figure 1).

A diagnosis of previously treated tooth with chronic apical abscess was made based on the clinical and radiographic examination.

The treatment was initiated with informed consent and informed to consent before the procedure. Administration of 2% lidocaine with 1:200000 adrenaline was assessed for tooth #45. The working area was isolated with rubber dam and followed by temporary restoration removal (figure 2a). Proceeded with removal of old gutta percha and sealer using a Hedstrom file (Dentsply Maillefer, Sirona, Switzerland) and retreatment files D3 (Dentsply Maillefer, Sirona, Switzerland)(figure 2b), followed by the measurement of working length using an apex locator (Propex Pixi, Dentsply, Sirona, Switzerland)and obtained a working length of 17 mm (figure 2c), and 110mm was the apical gauging assessed (figure 2e). Irrigation of 1.5% NaOCL using a 30G close end side-vent needle was applied to 2/3 of the root canal length, rinsed with saline then continued with 17% EDTA irrigation followed by saline irrigation and Chlorhexidine 2% in the 1/3 apical and dried using endo suction and sterile paper points (figure 2g). Bioceramic dressing was administered as

intracanal medicament, a moist cotton pellet was placed and temporary restoration (Cavit, 3M ESPE, St. Paul, MN, USA) was applied (figure 2h).

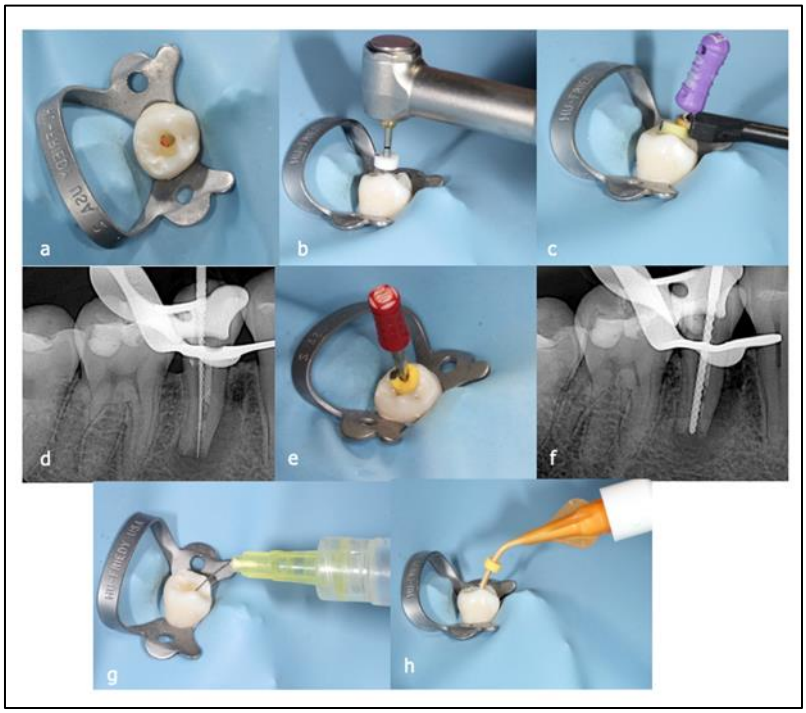


Figure 2 (a) Temporary filling removal, (b)Removal of previous gutta percha and sealer, (c) Working length measure, (d) Periapical radiographic working length confirmation, (e) apical gauging, (f) Periapical radiographic apical gauging confirmation, (g) sequence irrigation, (h) bioceramic dressing application

Two weeks after the first appointment, the patient was called back, the temporary filling was in good condition, and there were no subjective or objective complaints. The tooth was anesthetized, a rubber dam was put in place, the temporary restoration was taken out, and the intracanal dressing was removed using a thorough irrigation procedure. The final irrigant, EDTA 17% (figure 3a), was dried with sterile paper tips and endo suction. A collagen plug was placed initially at the apical to prevent bioceramic extrusions beyond apex. Administration of bioceramic root restoration material for 3 mm using an MTA carrier, the plugger was used to compress it (figure 2b). A temporary restoration was applied together with a moist cotton pellet.

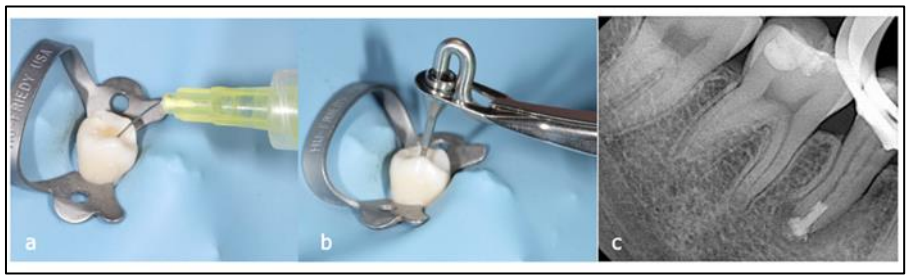


Figure 3 (a) Sequence irrigation, (b)Administration of bioceramic root repair material (c) Apical plug confirmation

A week later, there were no objective or subjective complaints, and the temporary filling was in good shape. The temporary restoration was removed, a rubber dam was placed, and the tooth was anaesthetised. After using a plugger to verify the apical plug, paper points were used to dry the canal. Warm vertical compaction was used for obturation, with resin-based sealer (figure 4a). The cavity was sealed with a temporary restoration, and periapical radiography was used to confirm the obturation (figure 4b).

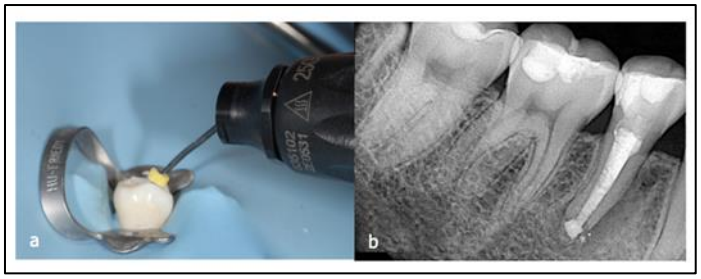


Figure 4 (a) Obturation with warm vertical compaction technique. (b) periapical radiograph confirmation

A week later, subjective and objective assessments indicated that #45 did not have any reported issues and the temporary filling was in satisfactory condition. The working area is isolated with a rubber dam, followed by temporary restoration and cotton pellet removal. The #45 was prepared for direct composite restoration with the addition of fiber-reinforced composite. The tooth was etched with 37% phosphoric acid for 15 seconds, rinsed, and dried with three way syringe until frosted white appearance was formed. Bonding (Universal Bond, 3M, USA) was applied thinly with micro brush then light cured for 20 seconds. The composite restoration procedure begins with application of fiber-reinforced composite (everX Posterior, GC Corp., Tokyo, Japan) with incremental layering technique and light curing for 20 seconds (figure 5a,b). Occlusion and articulation were checked, and finishing and polishing are done with fine finishing bur and polishing disc (Soflex disc, 3M, USA). The restoration are complete (figure 5b).

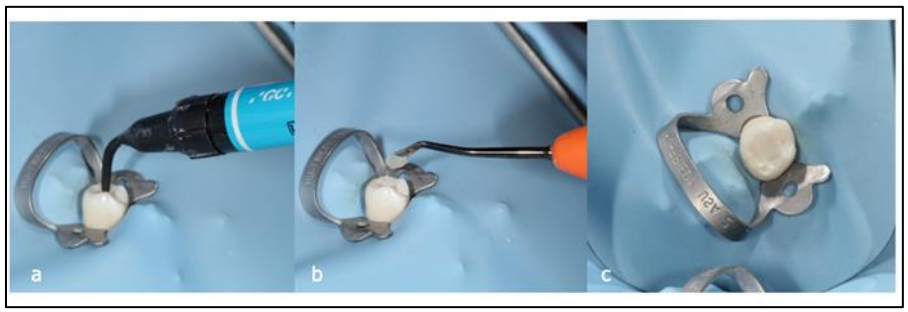


Figure 5 (a,b) Composite restoration application (c) after restoration

Following a week, the tooth showed no symptoms, the restoration was in good shape, the bite and percussion tests were negative, and the gingiva around the tooth was healthy.

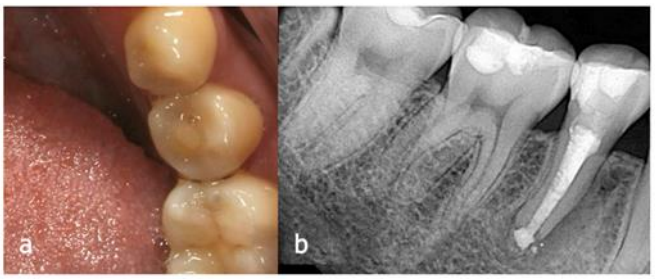


Figure 6 (a,b) Clinical and radiograph after treatment

3. Discussion

Three stages can be distinguished in the root development of an immature necrotic permanent tooth, according to Cvek: stage 1, where less than half of the root formation has an open apex; stage 2, where half of the root formation has an open apex; and stage 3, where two thirds of the root development has an open apex. If the root's apical section is frequently wider than its coronal portion, proper condensation of the gutta-percha cannot be achieved. If the apical part of the root is frequently wider than the coronal part, it is impossible to obtain good condensation of the gutta-percha, which is likely why the prior treatment was not carried out correctly. Selecting the appropriate endodontic treatment for permanent teeth with an open apex remains a clinical challenge. Pulp necrosis occurring during root development

results in arrested root formation, thereby influencing treatment decisions. Additionally, the extent of coronal structure loss must be carefully considered when planning the management of teeth with an open apex. In this case report, apexification using an apical plug with bioceramic root repair material was chosen as the preferred treatment. This approach was deemed appropriate given that the tooth had nearly achieved full root length, although the apical foramen remained widely open [6].

Orthodontic forces applied during the period of root development can compromise pulpal blood flow, increasing the risk of pulpal necrosis and arresting root formation. This pathophysiological mechanism is consistent with the patient's history of undergoing orthodontic treatment for two years during an active root development phase, which likely contributed to the presence of an open apex in this case. [7]

Traditional apexification with calcium hydroxide has demonstrated effectiveness; however, it typically requires multiple visits over an extended period and is associated with reduced root strength and an increased risk of cervical root fractures. In contrast, apexification using bioceramic materials—such as mineral trioxide aggregate (MTA), Biodentine, and newer bioceramic root repair material—offers more predictable outcomes, requires fewer clinical appointments, and minimizes long-term periodontal risks [7]. A recent retrospective study evaluating apexification in immature incisors using bioceramic plugs reported favorable healing rates at 12 months, with success rates of 84% for MTA, 88% for Biodentine, and 92% for TotalFill Putty. These findings highlight the excellent clinical performance of contemporary bioceramic materials and emphasize that the clinician's expertise and case management may play an even more significant role in treatment success than the specific material chosen [8]. In this retreatment case, although the root had nearly achieved full length, the apical foramen remained widely open, necessitating the use of a controlled apexification technique. A bioceramic apical plug was selected due to its favorable biocompatibility, bioactivity, and superior mechanical properties. This approach facilitates the creation of an effective artificial apical barrier, ensuring a hermetic seal that supports periapical healing while reducing the risk of material extrusion and tooth discoloration. [9]

A collagen plug is frequently utilized as an internal matrix or barrier positioned at the apical portion of the root canal, providing a physical scaffold against which bioceramic materials can be compacted. This approach enables precise and controlled placement of the bioceramic apical plug, minimizing the risk of material extrusion into periapical tissues and thereby enhancing the seal's integrity. Due to its biocompatibility and resorbable nature, collagen additionally facilitates tissue regeneration by serving as a scaffold that supports cellular infiltration within the periapical region. The collagen matrix permits the controlled condensation of bioceramic materials, promoting effective apical barrier formation in immature teeth exhibiting open apex. [10]

Long-term follow-up is essential to ensure treatment success. Evidence suggests that periapical healing can continue to progress significantly over time; for example, one study reported an increase in healing rates from 58% at one year to 94% at ten years following apexification. In the present case, periodic radiographic evaluations will be crucial to assess the resolution of the periapical lesion and to monitor the continued maturation and structural integrity of the root. [8]

4. Conclusion

This case demonstrates that endodontic retreatment of an open apex premolar following orthodontic treatment can be successfully managed using a bioceramic apical plug supported by a collagen matrix. Careful disinfection, appropriate material selection, and long-term follow-up are essential to achieve predictable healing and preserve tooth function.

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