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Management of a maxillary central incisor with open apex and strip perforation using full-canal bioceramic putty obturation: A case report

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Abstract
The management of endodontic cases complicated by anatomical alterations such as open apices and root perforations remains a significant clinical challenge. These conditions compromise the establishment of an apical seal, hinder complete disinfection, and increase the risk of treatment failure. Recent advances in bioceramic materials have provided clinicians with bioactive, biocompatible alternatives that offer excellent sealing ability, promote periapical healing, and reinforce weakened root structures.
This case report describes the successful management of a maxillary central incisor in a 30-year-old female patient presenting with discoloration, fracture, and a history of incomplete root canal treatment. Radiographic and cone-beam computed tomographic evaluation revealed the presence of an open apex and a strip perforation along the palatal surface, complicating conventional treatment options. Following careful negotiation, debridement, and disinfection using calcium hydroxide medicament, the entire canal space was obturated with a premixed bioceramic putty, eliminating the need for traditional gutta-percha. The material was placed incrementally to seal the perforation and apex while minimizing the risk of extrusion. Subsequent coronal sealing with glass ionomer cement and composite restoration ensured an effective barrier against reinfection. The tooth was later restored with a lithium disilicate crown to achieve both functional and esthetic rehabilitation.
At follow-up, the patient demonstrated satisfactory healing and absence of postoperative complications, highlighting the clinical potential of bioceramic materials in salvaging structurally compromised teeth. This case emphasizes the importance of advanced imaging, meticulous clinical execution, and material selection in overcoming challenges associated with open apices and perforations. The use of full-canal bioceramic obturation provided an effective and conservative solution, reinforcing the role of bioceramics as a reliable alternative in managing complex endodontic cases.

Keywords: Open apex, strip perforation, bioceramic putty, endodontic obturation

Introduction
The management of complicated root canal cases continues to be one of the most intricate and challenging facets of modern endodontic therapy. These cases frequently present with a myriad of complex clinical and anatomical difficulties that significantly increase the risk of treatment failure if not managed with utmost precision. Teeth exhibiting open apices, longitudinal or horizontal root fractures, internal or external resorption defects, as well as iatrogenic complications such as strip perforations, create an altered root canal environment that complicates every stage of the endodontic procedure. From the initial phase of cleaning and shaping to the final obturation, each step is fraught with obstacles that require a high level of clinical expertise, careful case assessment, and strategic planning. The compromised structural integrity of such teeth combined with unpredictable root canal morphology such as canal obliteration or irregularities poses substantial difficulty in accurately determining working length, effectively disinfecting the canal, and achieving an optimal hermetic seal. Furthermore, the risk of extrusion of materials beyond the apex or perforation site, along with the potential for persistent microbial contamination, further complicates prognosis. Consequently, successful management of these complicated cases demands not only traditional

endodontic skills but also the integration of advanced therapeutic materials and techniques to ensure favorable long-term outcomes while preserving the natural dentition.

In the evolving landscape of endodontics, bioceramic materials have emerged as revolutionary agents that address many of the limitations faced in the treatment of complicated root canal anatomies. These materials, classified broadly under calcium silicate-based cements, are prized for their exceptional bioactivity, biocompatibility, and physicochemical properties that make them highly suitable for a variety of endodontic applications. Bioceramics exhibit excellent sealing ability due to their ability to form hydroxyapatite upon setting, which facilitates a tight, gap-free interface with dentinal walls. Their hydrophilic nature allows them to set and maintain integrity even in the presence of moisture, a critical advantage when managing open apices or perforations where complete drying is not feasible. Moreover, bioceramic materials possess inherent antimicrobial properties that help in reducing residual bacterial load, thereby improving the likelihood of periapical tissue healing. They are also osteoconductive and osteoinductive, promoting regeneration by stimulating the deposition of cementum and new bone formation around the root apex and perforation sites. These combined biological and mechanical advantages have expanded the therapeutic options available to clinicians, allowing for more predictable treatment outcomes in cases that were once considered poor candidates for conservative management. As such, the use of bioceramic materials has become increasingly prevalent in procedures such as apexification, perforation repair, root-end filling, and as an alternative obturation material, ultimately contributing to enhanced preservation of natural teeth and improved patient satisfaction.

This article aims to present a detailed clinical case highlighting the successful management of a complicated root canal case involving an open apex and a strip perforation in the maxillary central incisor. The case demonstrates the application of a novel technique utilizing bioceramic putty for complete canal obturation without the use of traditional gutta-percha. Through this report, we seek to emphasize the practical challenges encountered during the treatment, the rationale behind choosing bioceramic materials, and the step-by-step clinical protocol employed to achieve a favorable outcome. Additionally, the article underscores the importance of careful case selection, precise clinical execution, and patient-centered decision-making in managing complex endodontic cases. By sharing this experience, we hope to contribute valuable insights into the expanding role of bioceramic materials in endodontics and encourage clinicians to consider innovative approaches for preserving natural teeth even in challenging clinical scenarios.

Case Presentation

A 30-year-old female patient presented to the Department of Conservative Dentistry and Endodontics at DA Pandu Memorial RV Dental College, Bangalore, with the chief complaint of discoloration and fracture in the upper front tooth region. The patient reported a history of trauma during her childhood to the anterior teeth and had undergone root canal treatment on the maxillary right central incisor (tooth 11) approximately two years prior. However, the treatment was incomplete, and she experienced persistent discoloration and occasional discomfort in the affected tooth.

Fig 1: Clinical photographs

On clinical examination, tooth 11 exhibited an Ellis Class III fracture. The tooth was notably discolored, presenting a darkened shade compared to adjacent teeth. A pre-existing access cavity was visible on the palatal surface(Fig. 1), and gingival tissue was observed proliferating into the pulp chamber through the access cavity, indicating chronic irritation and possible infection. The tooth was not tender on percussion, and no mobility was detected. Adjacent teeth appeared clinically sound.

Radiographic assessment included periapical radiographs and cone-beam computed tomography (CBCT) imaging. The radiograph revealed an open apex on tooth 11(Fig. 2). Additionally, CBCT imaging revealed a strip perforation on the palatal root surface extending from the palatal wall of the pulp chamber to the middle third of the root canal (Fig. 3). This perforation had led to a communication between the root canal system and the periodontal ligament space, complicating the clinical scenario. The canal appeared obliterated in parts, filled with soft tissue growth.

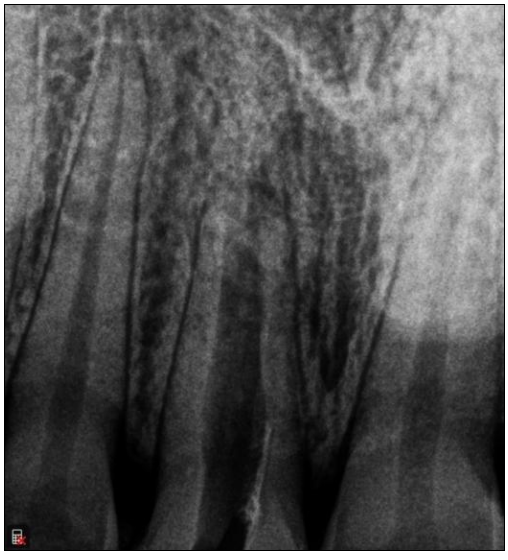

Fig 2: Pre op peri apical radiograph

Fig 3: Pre op CBCT

The patient was thoroughly informed about the complex nature of the case, including the presence of the open apex, strip perforation, and potential complications that could affect the prognosis. Two treatment options were discussed in detail: extraction of the tooth followed by FPD or implant placement, or an attempt at conservative endodontic therapy using advanced materials and techniques to salvage the natural tooth. The patient expressed a strong preference to retain her natural tooth and agreed to proceed with nonsurgical endodontic management.

Under rubber dam isolation, the access cavity was refined to gain optimal visualization and facilitate thorough canal negotiation. Upon exploration, it was noted that the canal was completely obliterated by soft tissue ingrowth extending through the perforation site. The coronal third of this tissue was carefully removed using a sharp spoon excavator, followed by meticulous debridement of the deeper canal portions with hand H-files to minimize trauma and preserve any remaining canal structure. Due to the perforation and open apex, irrigation was performed cautiously using only normal saline and 2% chlorhexidine to avoid potential extrusion of irrigants beyond the apex or through the perforation site.

Working length determination was performed using an electronic apex locator and confirmed radiographically (Fig. 4). Biomechanical preparation was carried out gently to avoid further weakening the root walls, with special attention to maintaining canal patency and controlling debris extrusion. Circumferential filing revealed considerable debris accumulation due to the long-standing exposure of the canal to the oral environment.

To address the persistent microbial challenge, calcium hydroxide paste was placed as an intracanal medicament. This was done over two treatment sessions spaced 15 days apart to ensure effective disinfection and promote healing of the periapical tissues. During this period, the patient was monitored for signs of discomfort, swelling, or other complications.

Considering the clinical challenges posed by the open apex and the strip perforation, a novel obturation technique was planned. Instead of traditional gutta-percha, the entire canal space was obturated with a premixed bioceramic putty material, chosen for its bioactive properties, superior sealing ability, and compatibility with the moist environment of the canal. After drying the canal, the bioceramic putty was introduced incrementally into the canal and gently condensed apically with minimal pressure to prevent extrusion beyond the open apex(Fig. 5). The material was layered until the entire canal was filled up to the cementoenamel junction (Fig. 6), effectively sealing the apex, perforation site, and root canal space in a single obturation phase.

Following obturation, the bioceramic material was allowed to set clinically, after which a protective layer of glass ionomer cement was placed over the canal orifice to safeguard the seal. This was followed by a definitive composite resin restoration to close the access cavity (Fig. 7). The patient was recalled after one week for clinical evaluation, during which no postoperative complications were noted.

Subsequently, the tooth was prepared for prosthetic rehabilitation, and a lithium disilicate crown was fabricated and cemented to restore esthetics, function, and structural integrity (Fig. 8). The patient was advised on oral hygiene measures and scheduled for periodic follow-ups to monitor healing and ensure the long-term success of the treatment.

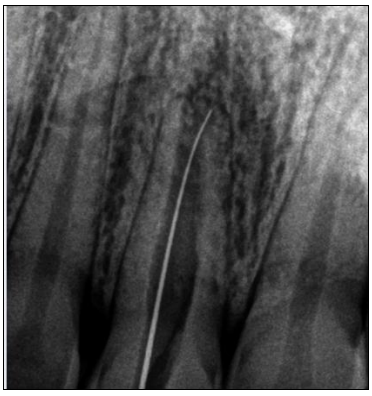

Fig 4: Working length

Fig 5: Incremental placement of bioceramic putty

Fig 6: Post obturation radiograph

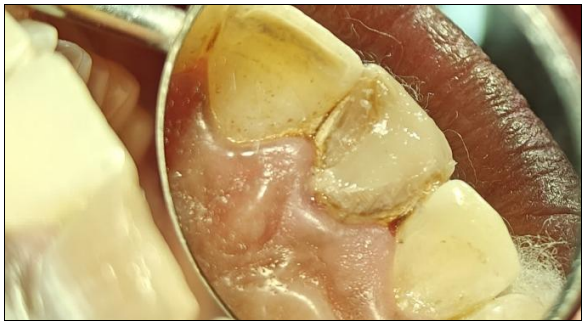

Fig 7: Access restoration

Fig 8: Lithium disilicate crown wrt 11

Discussion

Managing complicated root canal cases involving open apices and root perforations presents a considerable clinical challenge. These conditions complicate the ability to establish an apical seal and maintain asepsis, both of which are critical to endodontic success. Open apices prevent the formation of a natural apical constriction, making conventional obturation techniques difficult and increasing the risk of material extrusion beyond the root canal system. Similarly, root perforations create unnatural communications between the root canal and surrounding periodontal tissues, which can result in persistent infection and potential tooth loss if not properly addressed.

One significant anatomical challenge in open apex or blunderbuss canals is the considerable loss of dentinal walls, which renders the tooth structurally compromised and highly susceptible to fracture. The thin and fragile root dentin fails to provide adequate strength to withstand occlusal forces, increasing the risk of vertical root fractures or catastrophic failure. Therefore, beyond infection control and sealing, reinforcement of the remaining tooth structure becomes a critical treatment objective. Traditional obturation materials like gutta-percha do not contribute to strengthening the root, as they primarily serve as space fillers and lack adhesive or reinforcing properties.

In this context, bioceramic putty offers a unique advantage. Due to its chemical composition and bioactivity, bioceramic materials can bond chemically to dentin and form a monoblock effect within the root canal system. This adhesive interface enhances the fracture resistance of the tooth by providing internal reinforcement that compensates for the minimal dentin thickness. Studies have shown that teeth obturated entirely with bioceramic putty exhibit improved resistance to fracture compared to those filled with conventional gutta-percha and sealer combinations [1]. The bioceramic material's ability to set hard in a moist environment and its dimensional stability make it an ideal candidate for reinforcing structurally compromised teeth with open apices or perforations.

Traditional methods to manage open apex cases have included apexification procedures using calcium hydroxide, which stimulate hard tissue barrier formation over extended treatment periods. However, these techniques require multiple appointments and may weaken dentinal walls due to prolonged medicament use, increasing the risk of root fracture. In contrast, newer bioceramic materials have revolutionized the management of such cases by allowing immediate obturation with a material that not only seals the canal effectively but also promotes tissue healing and regeneration.

Irrigation and intracanal medicaments play a crucial role in the disinfection process, especially in complex cases with open apices and perforations. In this case, irrigation was limited to saline and 2% chlorhexidine, avoiding sodium hypochlorite or other potentially cytotoxic irrigants near the perforation site to prevent extrusion and further tissue damage. Chlorhexidine provides antimicrobial effects without the cytotoxicity associated with some irrigants, making it safer for delicate periapical tissues. Calcium hydroxide was used as an intracanal medicament over two sessions spaced 15 days apart to maximize its antimicrobial efficacy and promote healing. Calcium hydroxide's high pH environment is hostile to residual bacteria and encourages periapical tissue repair, which is especially important when dealing with open apices and perforations [2].

Bioceramic materials, primarily calcium silicate-based cements, have demonstrated excellent biocompatibility and bioactivity. Their ability to form hydroxyapatite crystals upon setting contributes to a strong chemical bond with dentin and a superior seal compared to traditional materials. Moreover, their hydrophilic nature allows them to set in the presence of moisture, a frequent condition in cases with open apices or perforations, where complete drying is impossible. Several studies have reported favorable clinical and radiographic outcomes when bioceramics are used for apexification, perforation repair, and as root canal filling materials in challenging cases [3].

A crucial factor in the successful management of this case was the utilization of advanced imaging technology, specifically Cone-Beam Computed Tomography (CBCT). Unlike traditional two-dimensional radiographs, CBCT provides detailed three-dimensional visualization of root canal morphology, surrounding bone, and pathological defects. In this patient, CBCT allowed precise identification of the strip perforation's location, extent, and relationship to the root canal system and adjacent periodontal tissues. This detailed imaging was invaluable for treatment planning, enabling accurate assessment of the perforation's extent and the degree of canal obliteration, which guided the choice of instrumentation and obturation technique. Additionally, CBCT facilitated monitoring of healing during follow-up by providing volumetric assessment of periapical tissue response. The advent of CBCT has significantly improved diagnostic accuracy and clinical outcomes in complex endodontic cases, making it an indispensable tool in contemporary endodontic practice [4].

In this case, the decision to obturate the entire canal with bioceramic putty without the use of gutta-percha was guided by the need for a biocompatible material that could adapt to the irregular canal anatomy, seal the open apex and perforation simultaneously, and promote periapical healing. The incremental placement technique and gentle apical compaction were essential to avoid extrusion of material beyond the apex, a common concern in open apex scenarios. The successful clinical setting of the material and subsequent restoration with glass ionomer and composite resin ensured a robust coronal seal, critical for preventing reinfection.

The choice of a lithium disilicate crown for the final restoration provided both strength and esthetics, essential for anterior teeth subjected to functional and cosmetic demands. The use of adhesive restorative techniques with ceramic crowns is well-supported in literature to reinforce structurally compromised teeth and enhance longevity [5].

Overall, this case illustrates how modern materials and techniques can overcome the limitations of traditional endodontic treatment in complex cases. The bioactive properties of bioceramics combined with careful clinical execution allowed for the successful retention of a tooth with an otherwise poor prognosis, underscoring the importance of evolving treatment paradigms in conservative dentistry.

Conclusion

The management of complex endodontic cases with open apices and strip perforations demands a thoughtful combination of diagnostic precision, disinfection strategies, and material selection. In this case, CBCT played a vital role in identifying the extent of the defect, while controlled irrigation and intracanal medicament supported microbial control.

The choice to obturate the entire canal with bioceramic putty rather than conventional gutta-percha was pivotal. This technique not only sealed the open apex and perforation but also contributed to reinforcing the thin root structure a necessity in blunderbuss canals where dentin thickness is minimal and the risk of fracture is high. Bioceramic materials, with their exceptional sealing ability, biocompatibility, and mechanical strength, have proven to be a reliable and superior option for managing compromised roots.

Overall, a conservative yet innovative approach allowed for the successful rehabilitation of a tooth with a compromised prognosis, highlighting the growing potential of bioceramic-based endodontics.

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