Case Report

# Apexification Treatment of an Open-Apex Mandibular Central Tooth with Dens Evaginatus using the Novel Root Filling Bioactive Material Cold Ceramic: A Case Report

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**ABSTRACT**
Comprehensive knowledge of canal morphology and its variations is essential for successful endodontic treatment. Mandibular incisors frequently present with two canals, with Vertucci Type III being the most common configuration. Dens evaginatus is a developmental anomaly that may lead to pulp exposure and subsequent necrosis. The present case describes the management of a mandibular incisor with dens evaginatus, pulpal necrosis, open apex, and Vertucci Type III canal configuration. We established the diagnosis through clinical examination and periapical radiography. After chemo-mechanical preparation using standard instrumentation and irrigation protocols, cold ceramic was used as an apical barrier material to induce apexification. We placed the material after the sinus tract had resolved, and treatment was completed in three appointments. Clinical and radiographic follow-ups at 6 and 12 months demonstrated healing of the periapical lesion, absence of symptoms, and satisfactory apical closure. This case suggests that cold ceramic may be a suitable bioactive material for apexification in anatomically complex immature teeth.

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## Introduction

The first step to a successful endodontic treatment is a thorough understanding of the tooth's root canal morphology and its potential variations. This aim can be established by taking radiographs at different horizontal angles, or cone beam computed tomography (CBCT) may be recommended if there is greater concern about the anatomy [1]. In the literature on the anatomy of mandibular incisors across different populations, it has been reported that the frequency of two-canal mandibular incisors ranged from 26.2% to 68% [2-4].

Three-dimensional studies of mandibular incisors with two canals have indicated that Vertucci Type III is the most frequent [5-6]. This canal type is defined as a single canal exiting the pulp chamber, splitting into two canals within the root, and then merging to exit as a single canal [3]. This configuration may have variations being observed in CBCT images [5].

Cold ceramic (CC) is a novel root filling material which was first presented by Modaresi [7]. This calcium silicate-based material has demonstrated features competitive with or superior to mineral trioxide aggregate (MTA) material across several aspects, including low cytotoxicity [8-9], biocompatibility [10-11], and most importantly, high sealability even in the presence of moisture [12]. This material showed promising results in various endodontic applications, including root-end filling material, repair material for root perforations, pulp-capping material, filling material for root canal obturation, and apical barrier in open-apex teeth [13-14].

Dens evaginatus is characterized as a cusp-like tubercle comprised of an enamel layer and a dentinal core, which extends to the pulpal tissue [15]. The prevalence of this developmental anomaly is reported to range from 0.1% to 15% among different populations [16]. In patients undergoing regular dental examinations, prophylactic reduction of this cusp may be beneficial before occlusal forces cause fracture. The risk of pulp exposure resulting from abrasion or fracture of this tubercle makes such intervention clinically significant. Over time, a pulp-periapical lesion may result from this extension into the periapical tissues [17]. This tooth might not show any symptoms for an extended period, as was the case presented in the current study.

The appropriate treatment for a tooth with dens evaginatus and irreversible pulpitis depends on the stage of apex closure. In closed-apex teeth, root canal therapy is performed. If the root is underdeveloped, treatment is selected based on Moorrees' classification [18]. In this classification, the underdeveloped tooth is categorized into 6 types based on the degree of root maturation (I-VI, from least to most developed) [18]. In types I–III of immature teeth, regenerative treatments are prescribed to induce root development [18]. In types IV-VI of this classification, therapies based on induction of apexogenesis using bioceramic cements is recommended [18]. The present report describes the management of an immature mandibular incisor with dens evaginatus, pulpal necrosis, an open apex, and Vertucci Type III canal configuration treated with apexification using cold ceramic.

## Case Presentation

A 14-year-old male presented to a private endodontics clinic with a chief complaint of a non-healing spot on his chin that had appeared 2 weeks ago. After clinical examination, we detected an intraoral sinus tract apical to the left mandibular incisor (tooth #31). The mentioned tooth also had dens evaginatus at the incisal surface. The tooth underwent a cold test, which showed the pulpal tissue was necrotic. Periodontal probing depths were within normal limits (≤3 mm) with no evidence of periodontal involvement. The other mandibular anterior teeth were vital. We prescribed an intra-oral radiograph of the lower incisors (Figure 1). The radiograph revealed that the left mandibular incisor was underdeveloped and had a periapical lesion associated with the apex, which measured approximately 3×3 mm. As there were signs of double lamina dura, and the canal morphology

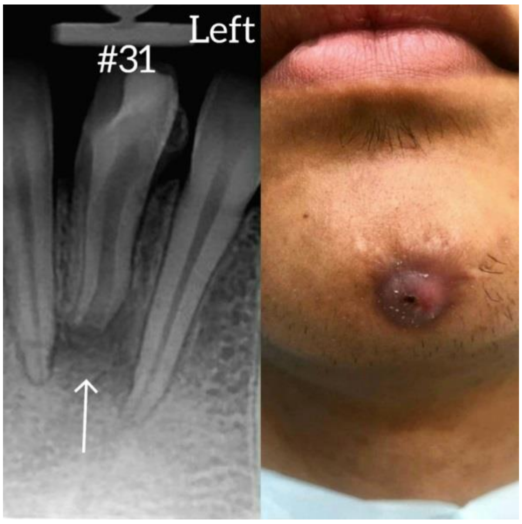


**Figure 1:** Preoperative periapical radiograph of tooth #31 demonstrating an immature open apex and a well-defined periapical radiolucency (white arrow). The adjacent teeth exhibit normal periapical structures

was questionable, we prescribed a CBCT with a field of view of the left mandibular incisors. The CBCT radiograph revealed one canal leaving the pulp chamber, which was then divided into two canals in the root, finally merging and exiting as one canal in the apical portion (Figure 2). This canal configuration is classified as Vertucci Type III.

We scheduled three appointments for the patient's treatment. In the first appointment, after administration of local anesthetics (Lidocaine 2% & epinephrine 1/100 000) and rubber dam isolation, we prepared an access cavity using a surgical operating microscope (Mediworks, China). Then we determined the canal length

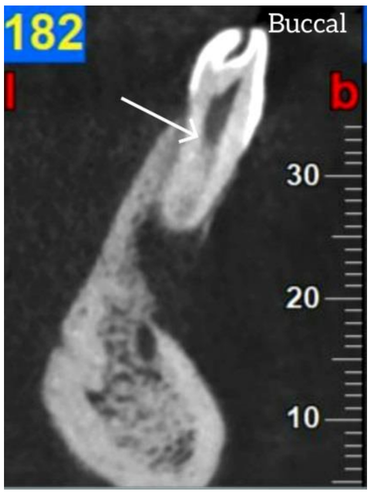


**Figure 2:** Cone beam computed tomography (CBCT) sagittal section of tooth #31 revealing Vertucci's Type III canal configuration, characterized by one canal leaving the pulp chamber, bifurcating within the root (white arrow), and merging apically into a single canal

using both a periapical radiograph and an apex locator (Root ZX- Japan). After that, the canal debridement was performed using an M3 rotary file (China). Next, the canal was irrigated with 5.25% sodium hypochlorite and activated using ultrasonic technology (Dentsply). After inserting intra canal medicament, calcium hydroxide was placed into the canal using a Lentulo spiral, a light-cure cobalt temporary filling was applied.

Two weeks later, the sinus tract size had shrunk by the time of the first visit. This time, 5.25% sodium hypochlorite was used for irrigation, and ultrasonic activation was performed. Once more, we placed a temporary filling after inserting calcium hydroxide with Lentulo inside the canal.

The sinus tract was fully healed at the third visit, which took place a month after the first. We removed the temporary filling. Irrigation with 5.25% sodium hypochlorite was performed, with ultrasonic activation. Additionally, a final irrigation with 17% ethylenediaminetetraacetic acid (EDTA) was performed, followed by ultrasonic activation. After drying the canal with paper points, CC was delivered into the canal using a carrier to obturate the canal. We mixed the CC powder with its specific liquid according to the manufacturer's instructions to achieve a putty-like consistency. The material was carried into the canal using an appropriate carrier and gently condensed apically with hand pluggers to form an apical barrier. After ensuring proper placement, the remaining canal space was obturated with CC using the incremental condensation technique to achieve a homogenous fill. Care was taken to avoid overextension beyond the apex.

Then, we temporarily filled the access cavity with temporary light-cured filling (Cobalt Iran). The next day, we returned to ensure the patient was pain-free and that the CC was set. Composite resin was used for the final restoration. The recall visit was conducted 6 and 12 months after the initial visit. No sinus tract was observed clinically. Additionally, the intra-oral radiograph revealed that the periapical lesion had healed, indicating a successful root canal treatment (Figure 3).


**Figure 3:** Immediate postoperative radiograph showing obturation with cold ceramic (CC) and apical barrier formation

**Discussion**

In contemporary endodontics, biocompatibility is not the only feature required in treatments. Materials with high bioactivity and biocompatibility are preferred in modern endodontics [19]. Bioactive material is defined as having the capacity to form apatite in human body fluids [20]. The use of bioactive materials in endodontics began when calcium hydroxide was first presented to induce dentinal bridge formation in exposed pulp tissues [13]. After that, MTA was proposed by Torabinejad as a bioactive material [21]. The mechanism of bioactivity in MTA is based on its ability to induce hydroxyapatite crystal formation in the moist environment of the pulp [22]. Other MTA-type bioactive materials have been widely available on the market in recent years and have been effectively used for a variety of tasks, such as pulp capping, pulpotomy, apexogenesis, apexification, perforation repair, root canal filling, or as a sealer with gutta-percha [23].

CC is a bioactive material composed of fine hydrophilic particles set in the presence of moisture [12]. When the ceramic surface comes into contact with body fluids, ions within the ceramic structure are exchanged with ions in the surrounding environment, promoting calcium phosphate deposition. The calcium and phosphate ions released from the gel layer then precipitate to form a hydroxyapatite layer, a mineral naturally found in bone. This newly formed hydroxyapatite layer acts as a bridge, allowing bone cells to adhere to and grow on the ceramic surface, promoting tissue integration [24].

The key feature of a substance used for root filling is its ability to seal the canals' pathways. Several studies using the electrochemical method, dye penetration, and scanning electron microscopy have reported high sealability of CC [12-13, 25-26]. Hwang *et al.* [27], reported that CC demonstrated performance comparable to that of MTA. Also, Hasheminia *et al.* [25] compared the sealability of CC and MTA under different environmental conditions. Their results demonstrated that sealability of CC is better than MTA in blood-contaminated conditions and similar to MTA in dry and saliva-contaminated conditions, as assessed by the dye penetration test. Furthermore, Modaresi *et al.* [12, 26] compared the sealability of CC with glass ionomer and calcium hydroxide. They indicated that CC provides better sealability than both glass ionomer and calcium hydroxide.

Another critical feature of root-filling material is its nontoxicity and biocompatibility [28]. A number of studies have been carried out in order to compare these characteristics between the CC and MTA [8,10,13,28]. Bodrumlu *et al.* [8] demonstrated CC as low cytotoxicity material. Mozayeni. *et al.* [10] revealed that CC is a viable option and biocompatible root filling material competitive with MTA and having superior cell viability to intermediate restorative material as a traditional root-end filling material.

The other criteria compared between CC and MTA were marginal adaptation and setting time. Mokhtari *et al.* [13] evaluated the marginal adaptation by scanning electron microscopy. It has been shown that these two materials have similar marginal adaptation to retrograde materials. Setting time has also been compared between CC and MTA, revealing that the primary setting time is shorter in CC than in MTA (about 15 min in CC and about 165 min in MTA) [28].

Vertucci Type III canal configuration is characterized by one canal leaving the pulp chamber, dividing within the root, and merging again before exiting at a single apical foramen. This anatomical complexity increases the risk of incomplete debridement and inadequate obturation, as bifurcation areas may harbor residual debris and microorganisms.

In complex canal configurations, such as Vertucci Type III, a material with favorable flow properties and sealing ability is particularly important for adapting to bifurcation areas and irregular canal walls. The use of CC in this case may have contributed to adequate sealing of the canal system, including the bifurcated segment.

Although MTA is considered the gold standard bioactive material in apexification procedures, CC was selected in the present case due to its previously reported bioactivity and sealability, shorter setting time, favorable handling properties, and lower cost [12,13,25-26,28]. The significantly shorter initial setting time of CC reduces chair time and minimizes the risk of material displacement in open-apex teeth. Furthermore, previous studies have demonstrated reliable sealing ability even in moist or blood-contaminated environments [25], which is clinically relevant in immature teeth with periapical lesions.

The successful clinical and radiographic outcomes observed in this case suggest that CC may be a suitable material for anatomically complex canal systems; however, further studies are required to validate this observation.

## Conclusion

In this case of an immature tooth with Vertucci Type III canal configuration, CC was successfully used as a root canal filling material, resulting in favorable clinical and radiographic outcomes during follow-up. The material's reported bioactivity, sealing ability, and shorter setting time may have contributed to adequate adaptation within the complex canal anatomy. However, as this report describes a single case without long-term comparative evaluation, further clinical studies are required to confirm its effectiveness.

## Declarations

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**Author Contributions**

All authors contributed to the study conception and design. All authors read and approved of the final manuscript.

## Conflicts of Interest

The authors declare that they have no conflict of interest.

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