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Apexification as an endodontic treatment alternative for a traumatized tooth with incomplete root formation: a case report

Apicificação, uma alternativa de tratamento endodôntico para dente com rizogênese incompleta traumatizado: um relato de caso

Apecificación, um tratamento endodôntico alternativo para dientes com rizogénesis icompleta y trauma: reporte de um caso

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ABSTRACT

Objective: To report a clinical case in which the apexification technique was employed for the management of a traumatized tooth with incomplete root development. **Case description:** A 9-year-old male patient (T.G.M.) presented to the Ana Lúcia Fecury Dental Clinic, CEUMA University, Imperatriz-MA campus, with a history of dental trauma. Comprehensive assessment, including medical history, extraoral and intraoral examinations, and radiographic analysis, was performed. The initial diagnosis was an uncomplicated crown fracture involving enamel and dentin of tooth #11. Following a subsequent traumatic episode, the diagnosis evolved to a complicated crown fracture involving enamel, dentin, and pulp tissue. Endodontic management was undertaken through apexification with calcium hydroxide. The treatment required a 10-month period of intracanal medication replacement until the formation of a complete artificial mineralized barrier at the apical third, after which follow-up was conducted. **Final considerations:** This case report demonstrates the clinical efficacy of apexification in the management of traumatized teeth with incomplete root development and reinforces the role of calcium hydroxide as the gold standard material for this procedure.

Keywords: Dental trauma, Incomplete root development, Apexification.

RESUMO

Objetivo: Descrever um relato de caso clínico a partir da técnica de apicificação em dente com rizogênese incompleta traumatizado **Detalhamento do caso:** Paciente TGM, 09 anos, sexo masculino, procurou atendimento na clínica odontológica Ana Lúcia Fecury da Universidade CEUMA, campus Imperatriz-MA, com diagnostico de traumatismo dentário. Foram realizados anamnese, exames extra e intraorais e exames radiográficos. Inicialmente o diagnóstico foi de fratura não complicada envolvendo esmalte e dentina para o dente 11, porém após nova queda, o novo diagnóstico foi de fratura complicada envolvendo esmalte, dentina e tecido pulpar. Optou-se pelo tratamento endodôntico de apicificação com hidróxido de cálcio, totalizando um tempo clínico de 10 meses de troca de medicação intracanal para formação completa da barreira mineralizada artificial no terço apical com proservação. **Considerações finais:** O relato de caso pode ressaltar a eficácia clínica da técnica de apicificação em dentes traumatizados com rizogênese incompleta e contribuir para a literatura quanta a efetividade do uso do hidróxido de cálcio como material padrão ouro.

Palavras-chave: Traumatismos dentários, Rizogênese incompleta, Apicificação.

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RESUMEN

Objetivo: Describir un reporte de caso clínico utilizando la técnica de apicificación en un diente traumatizado con rizogénesis incompleta. **Descripción del caso:** Paciente masculino de 9 años (TGM) acudió a la clínica odontológica Ana Lúcia Fecury de la Universidad CEUMA, campus Imperatriz-MA, con diagnóstico de traumatismo dentario. Se realizaron anamnesis, exámenes extra e intraorales y estudios radiográficos. Inicialmente, el diagnóstico fue de fractura no complicada que comprometía esmalte y dentina en el diente 11. Sin embargo, tras una nueva caída, el nuevo diagnóstico fue de fractura complicada con compromiso de esmalte, dentina y tejido pulpar. Se optó por el tratamiento endodóntico de apicificación con hidróxido de calcio, con un tiempo clínico total de 10 meses de recambio de medicación intraconducto, hasta la formación completa de la barrera mineralizada artificial en el tercio apical, seguida de proservación. **Consideraciones finales:** Este reporte de caso resalta la eficacia clínica de la técnica de apicificación en dientes traumatizados con rizogénesis incompleta y contribuye a la literatura respecto a la efectividad del hidróxido de calcio como material estándar de oro.

Palabras clave: Traumatismos dentários, Rizogénesis incompleta, Apicificación.

INTRODUCTION

The practice of sports, often associated with a healthy lifestyle, provides several benefits; however, traumatic injuries are also part of this context Majeswski et al. (2022); Tewari N, et al. (2023), including dental trauma, which affects nearly one billion people worldwide (RICHARDS D, 2018). Dental trauma may occur in both primary dentition (11–30%) and permanent dentition (2.6–50%) Levin et al. (2020); Majeswski et al. (2022), potentially involving supporting and soft tissues. Consequently, it can result in pain, loss of function, psychological impact, and the need for specific dental treatments, such as endodontic therapy (BOURGUIGNON et al., 2020; TEWARI et al., 2021).

When endodontic treatment is required due to irreversible pulp damage, the success rate may vary in young permanent teeth affected by trauma, as root apex closure occurs only about three years after eruption (MURRAY, 2023; SHAIK et al. 2021). Therefore, immature permanent teeth require additional care, especially when treatment planning considers differential diagnosis based on the patient's general health, root development stage, and pulp status of the immature tooth (MAJESWISKI et al., 2022). This is due to their fragile physiology and root anatomy, which pose greater diagnostic and clinical challenges (HARLAMB, 2016; SHAIK et al., 2021).

Recent systematic reviews have suggested that apexification is the accepted nonsurgical treatment of choice for necrotic immature permanent teeth (SHAIK et al., 2021; WIKSTROM et al., 2021; PANDA et al., 2022; STEFANIDOU et al., 2024). Apexification promotes the formation of a mineralized tissue barrier during root development, showing favorable success rates when properly performed (PANDA et al., 2022; STEFANIDOU et al., 2024).

The apexification technique can be carried out with the use of bioactive materials that assist in apical closure of immature permanent teeth subjected to trauma, such as calcium hydroxide and bioceramics, including Mineral Trioxide Aggregate (MTA) and Biodentine (AN et al., 2024; SILVA et al., 2025; ZHANG et al., 2025). However, due to its low cost and satisfactory clinical outcomes, calcium hydroxide remains a viable alternative for this procedure (LAVÔR et al., 2017).

Given the above, the aim of this study was to report a clinical case of apexification in an immature permanent tooth treated with pulpectomy and calcium hydroxide, associated with direct composite resin restoration, supported by the use of available technological tools and updated multidisciplinary scientific knowledge. The hypotheses of this case report are: Null hypothesis (H0): No mineralized barrier formation was radiographically observed after successive calcium hydroxide medication replacements. Alternative hypothesis (H1): Mineralized barrier formation was radiographically observed after successive calcium hydroxide medication replacements. This study was approved by the Research Ethics Committee involving human subjects (CAAE:87090425.3.0000.5084 / No. 7.652.604) and informed consent was obtained from all participants.

CASE REPORT

A 9-year-old male patient, leucoderm, presented to the clinic, with the chief complaint of “trauma to the maxillary central incisors” following a fall while playing soccer on a court. The patient sought care one week after the incident. Medical history, extraoral and intraoral examinations, and radiographic assessments were performed.

Radiographic and clinical examinations revealed an uncomplicated crown fracture involving enamel and dentin in teeth #11 and #21, and an enamel fracture in tooth #12 (Figure 1A and 1B). After establishing the diagnosis of dental trauma, direct restorations with composite resin (Figure 1D) (Forma, Ultradent, São Paulo, SP, Brazil) were performed on the affected teeth. Radiographic examination (Figure 1C) showed that the apices of teeth #11 and #21 presented incomplete root development.

Figure 1: (A) Initial clinical presentation. **(B)** Occlusal view of the fractures. **(C)** Periapical radiographic examination. **(D)** Clinical aspect after composite resin restoration of teeth 11 and 21.



Source: Soares NF, et al., 2025.

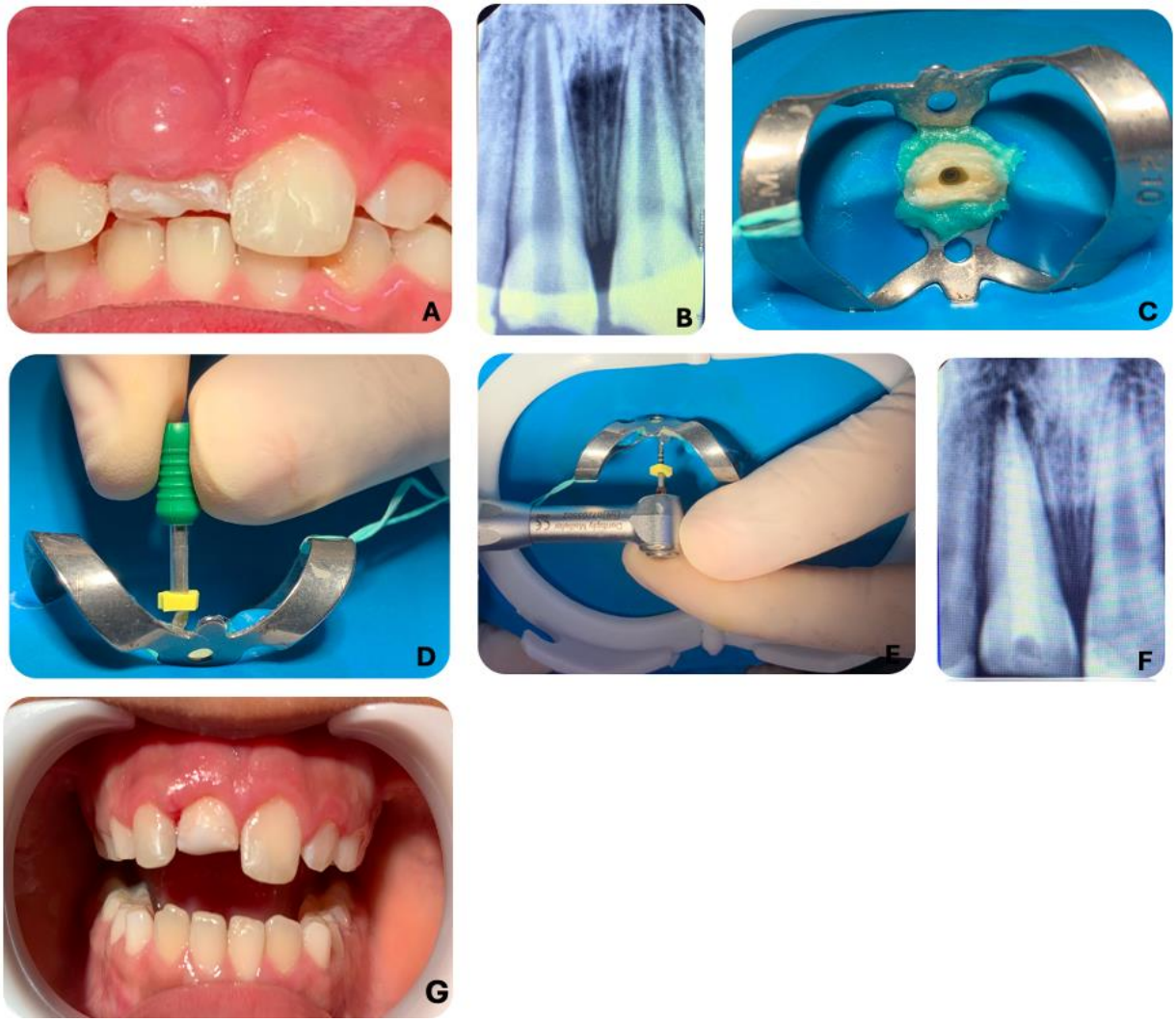
On September 11, 2024, the patient returned to the dental school clinic, twenty days later, after suffering another fall that resulted in a complicated crown fracture of tooth #11, involving enamel, dentin, and pulp tissue) Figure 2 (A and B). Given the clinical condition, endodontic treatment of tooth #11 was initiated. Following anesthetic calculation, the patient was anesthetized with 2% lidocaine containing 1:100,000 epinephrine (DFL Indústria e Comércio S.A., Rio de Janeiro, RJ, Brazil), using two carpules of the anesthetic solution.

Absolute isolation of the tooth was achieved with clamp #211, and access cavity preparation was performed using a 1012HL diamond round bur, followed by exploration with second-series K-files and catheterization. The canal was then cleaned and abundantly irrigated with 2.5% sodium hypochlorite. At the end of the session, intracanal medication with calcium hydroxide paste (Ultracal XS) was placed, and the canal was sealed with a light-cured glass ionomer cement (Ionglass Photo Liner – Maquira, Maringá, PR, Brazil) as a temporary restoration Figure 2 (C, D and E).

Additionally, composite resins were selected for definitive restorations. Modified absolute isolation of teeth #11, #12, and #21 was performed, and a bevel was prepared on teeth #11 and #21 using a 2135F conical diamond bur. Selective enamel etching with 37% phosphoric acid was followed by application of an adhesive system (3M Single Bond Universal – Solventum, 3M, Blumenau, SC, Brazil).

Subsequently, the incremental composite resin technique was performed: palatal surface (A1E resin; 3M, Blumenau, SC, Brazil), interproximal surfaces (A1E resin; 3M, Blumenau, SC, Brazil), dentin (EB1 resin, Opallis; FGM Dental Group, Joinville, SC, Brazil), and buccal surface (A2E resin, Forma; Ultradent, São Paulo, SP, Brazil). Finally, finishing was performed with F and FF burs, and polishing was carried out using polishing paste and the Ultra-gloss polishing kit (American Burrs, Palhoça, SC, Brazil) (CONCEIÇÃO, 2018) (Figure 2 G).

Figure 2 - Endodontic treatment following a new dental trauma. Clinical and radiographic aspects **(A** and **B)**; Chemical–mechanical preparation **(C–E)**; Intracanal medication **(F)**; Provisional restora**tion** with glass ionomer cement **(G)**.



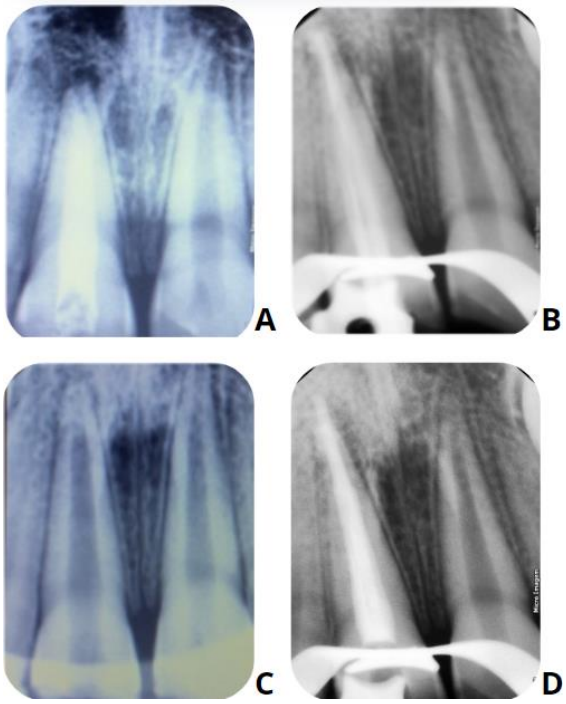
Source: Soares NF, et al., 2025.

On November 29, 2024, the patient was re-evaluated and reported no symptoms. Local anesthesia was administered with 2% lidocaine containing 1:100,000 epinephrine, followed by absolute isolation of tooth #11 with clamp #211. The provisional restoration was removed using a 1012HL diamond round bur. The intracanal calcium hydroxide medication (Ultracal XS; Ultradent Products Inc., Utah, USA) was removed by copious irrigation with 2.5% sodium hypochlorite and aspiration, assisted by an endodontic file. A periapical radiograph was then obtained, and working length was determined with an electronic apex locator, establishing a measurement of 19 mm.

The root canal was instrumented using a mechanized technique with reciprocating file Reciproc R50 (VDW GmbH, Munich, Germany). Canal cleaning was performed with abundant irrigation using 2.5% sodium hypochlorite. At the end of the session, calcium hydroxide paste (Ultracal XS) was reapplied as intracanal medication, and the access cavity was sealed with light-cured glass ionomer cement (Ionglass Photo Liner; Maquira, Maringá, PR, Brazil) as a temporary restoration.

This protocol was maintained until August 5, 2025, with intracanal medication replaced every 30–45 days to stimulate apical closure (completion of root development), totaling a clinical period of 10 months to achieve apexification **Figure 3 (A-D)**.

Figure 3 - Periapical radiographs illustrating the intervals of intracanal medication replacement at 3 months **(A)**; 4 and 6 months **(B)**; 10 months **(C)**. Root canal obturation **(D)**.



Source: Soares NF, et al., 2025.

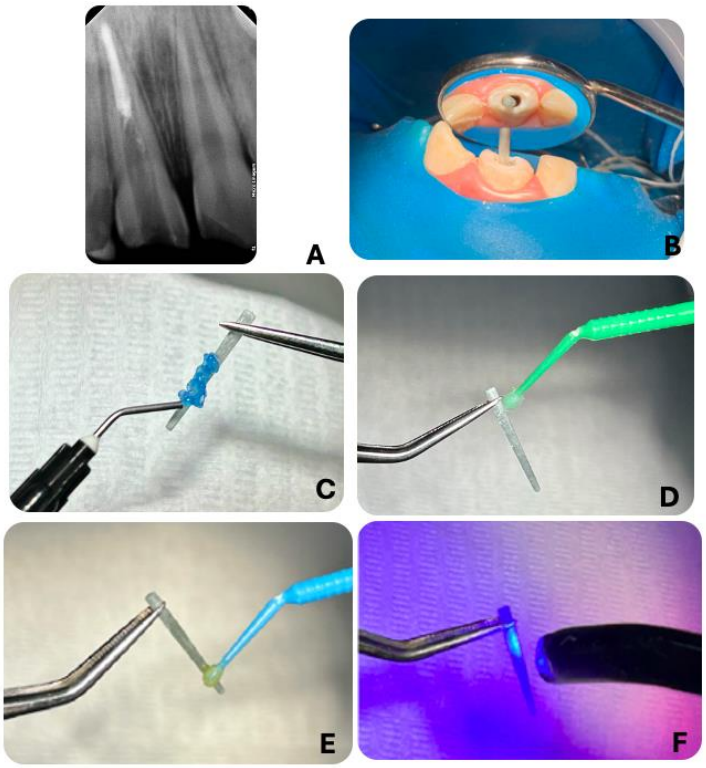
On August 13, 2025, the obturation and subsequent partial removal of the root canal filling were performed, followed by fiber post cementation and fabrication of a composite resin crown. Local anesthesia was achieved with 2% lidocaine containing 1:100,000 epinephrine. Relative isolation was applied to teeth #11, #12, and #21, with clamps adapted to teeth #16 and #26 using clamps #203 and #205. The provisional restoration was removed with a 1012HL diamond round bur.

For canal obturation and partial removal of the filling, Largo burs #1, #2, and #3 were used to remove gutta-percha and to shape the canal walls adequately (Figure 4A). A portion of the root canal filling was preserved up to half of the canal length to allow proper fiber post adaptation, as recommended by Pegoraro (2013). The fiber post cementation stage required conditioning of the post surface.

The post was disinfected and conditioned with 37% phosphoric acid (Allprime, São José, SC, Brazil), rinsed for 30 seconds, and dried. Silane was then applied in two layers, allowing solvent evaporation between applications. Next, an adhesive system (Adper Single Bond 2; 3M, Blumenau, SC, Brazil) was applied and light-cured for 40 seconds Figure 4 (B-F).

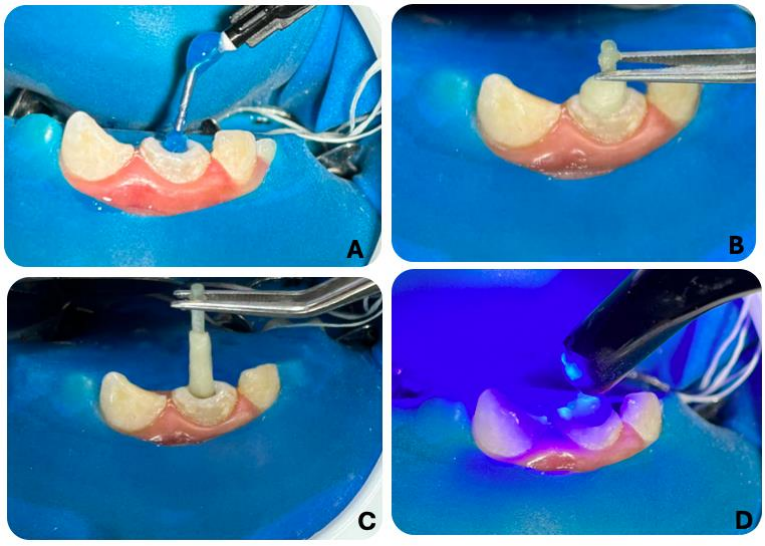
The fiber post was anatomized with composite resin to ensure complete adaptation inside the canal, followed by light curing for 10 seconds in two stages. Dual-cure resin cement (Fill Magic Dual Cement; Vigodent Indústria e Comércio Ltda., Rio de Janeiro, RJ, Brazil) was then applied to both the root canal dentin substrate and the anatomized post, which was subsequently light-cured in situ. Finally, a composite resin core build-up and definitive composite resin restoration were completed (PEGORARO, 2014) Figure 5 (A-D).

Figure 4 - Root canal desobturation **(A)** and fabrication of a fiber post **(B–F)**.



Source: Soares NF, et al., 2025.

Figure 5 - Etching and cementation of the fiber post (A–D).



Source: Soares NF, et al., 2025.

For the final restoration, based on the previously selected composite resin shades, modified absolute isolation was performed on teeth #11, #12, and #21. Composite resin was adapted over the core build-up with 2 mm incremental insertions on teeth #11 and #21. A bevel was prepared using a 2135F conical diamond bur. Selective enamel etching was performed with 37% phosphoric acid (Allprime, São José, SC, Brazil).

Subsequently, a universal adhesive system (3M, Blumenau, SC, Brazil) was applied. Incremental layering of composite resin was then carried out in the following sequence: palatal surface (A1E resin; 3M, Blumenau, SC, Brazil), interproximal surfaces (A1E resin; 3M, Blumenau, SC, Brazil), dentin (EB1 resin, Opallis; FGM Dental Group, Joinville, SC, Brazil), and buccal surface (A2E resin, Forma; Ultradent, São Paulo, SP, Brazil). Finishing was performed with F and FF burs, and polishing was completed using polishing paste and the Ultra-gloss polishing kit (CONCEIÇÃO, 2018) Figure 6 (A e B).

Figure 6 - Final radiograph (A) and composite resin restoration of teeth 11 and 21 (B).



Source: Soares NF, et al., 2025.

DISCUSSION

Dental trauma is common in children and adolescents and is considered a public health problem due to its high prevalence. It primarily affects young permanent anterior teeth in individuals between eight and twelve years of age, with a higher incidence in males than in females, and is associated with aesthetic, functional, and psychosocial consequences, as evidenced in the present case report (ALAN et al., 2023; LOPES & SIQUEIRA, 2020; SAIKIRAN et al., 2022).

In this study, the maxillary central incisor with incomplete root development was affected by trauma, resulting in a complicated crown fracture. Previous studies have shown that the most commonly affected teeth are the maxillary central and lateral incisors and the mandibular incisors due to their prominent position in the dental arch, as observed in Figures 1A and 1B of the present report (SWAIKAT et al., 2023; VICTORINO et al., 2025). In cases of incomplete root development, the likelihood of pulp inflammation or necrosis is higher, as observed radiographically in this case (Figure 1C), with an extremely wide canal, absent apical third, large apical foramen, and thin, fragile canal walls (ALOBAID et al., 2014; SAIKIRAN et al., 2022; VICTORINO et al., 2025).

A clinically well-established regenerative therapy supported by the literature is apexification (GUERRERO et al., 2018; WIKSTROM et al., 2021; SHAIK et al., 2021; PANDA et al., 2022; STEFANIDOU et al., 2024). In this case report, apexification was performed using calcium hydroxide as the bioactive material due to its broad contact-based antimicrobial action, mineralizing ability, and biocompatibility, which play a fundamental role in the therapy of the dentin-pulp complex and periapical periodontium (MALAKAR et al., 2024). Periodic placement and replacement of calcium hydroxide as intracanal medication stimulated the formation of mineralized tissue over several months, as reported in the literature (JITARU et al., 2016; ADNAN & ULAH, 2018). Therefore, the alternative hypothesis of the study was accepted.

Although Mineral Trioxide Aggregate (MTA) offers significant advantages over calcium hydroxide, such as faster and more efficient apexification Bonte et al. (2015) ; Koyuncuoglu & Aren (2025), calcium hydroxide

remains the gold standard due to its proven efficacy, success rates ranging from 79% to 96%, low cost, and ease of application (KUMAR et al., 2011; LIN et al., 2014; JITARU et al., 2016; MALAKAR et al., 2024). This justified its use in the present case, as mineralized barrier formation was observed radiographically after successive medication changes (Figure 3A–D).

Due to the fragile anatomical structure of tooth #11 and the endodontic treatment performed, the use of intracanal retainers was necessary to reinforce tooth strength and prosthetic retention (KUMAR et al., 2011; LINSUWANONT et al., 2018). However, studies indicate that intracanal posts cannot fully restore the strength of immature teeth with wide canals, increasing the risk of root fractures (KUMAR et al., 2011; LINSUWANONT et al., 2018). Therefore, an anatomically shaped fiber post was used, providing greater mechanical strength and clinical performance for both direct and indirect restorations (GULDENER et al., 2017; LINSUWANONT et al., 2018; KUIJIPER et al., 2020).

The use of absolute isolation during composite resin restorations is essential for achieving proper adhesion between tooth and resin, thus increasing restoration longevity (KEYS & CARSON et al., 2017; KUMAR et al., 2011; LIN et al., 2014). In specific situations, such as pediatric dental care, clinical practicality, esthetic considerations, and clamp adaptation, modified absolute isolation can be employed, as observed in Figures 4B–C, 5C–F, and 6A (CONCEIÇÃO, 2018; GOEL & BARJATYA, 2023).

Endodontically treated teeth require reliable restorations to minimize failures, such as root fractures, reduced endodontic longevity, crown detachment, or post fracture (PANITIWAT & SALIMEE, 2017; ALHAMDAN et al., 2024). Indirect composite restorations are generally preferred over direct restorations in endodontically treated teeth due to their greater durability and minimal intervention (MARIO et al., 2022; KUIJIPER et al., 2023). However, a direct restoration was chosen in this case for reduced treatment time and cost. Although direct comparison with literature reports is limited, the technique effectively prevented fluid percolation into the root canal and restored tooth form and function.

This case report highlights the clinical relevance of apexification as an effective approach for managing traumatized teeth with incomplete root development and pulp necrosis in a maxillary central incisor. The technique enabled apical closure through mineralized barrier formation, as observed radiographically, preserving root structure and allowing a favorable long-term prognosis (GUERRERO et al., 2018). Clinically, this procedure is essential to prevent early tooth loss, particularly in young patients (PANDA et al., 2022; STEFANIDOU et al., 2024). Subsequent rehabilitation using an intracanal post and direct restoration restored function and esthetics while positively impacting psychosocial aspects often affected by dental trauma (SAIKIRAN et al., 2022; KUIJIPER et al., 2023). This case underscores the importance of early diagnosis and careful application of conservative techniques, demonstrating their key role in endodontic and restorative dentistry.

In summary, the multidisciplinary treatment approach, involving multiple dental specialties, was successful. Apexification of the root canal was achieved over a ten-month period, allowing complete apical closure. Subsequently, endodontic treatment was finalized, followed by rehabilitation using an anatomically shaped fiber post, which enabled the fabrication of a direct restoration that effectively restored both function and esthetics for the patient.

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