

Long-term bone preservation following mid-root fractures: a 12-year follow-up case report

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Case Report

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Abstract

Background

Horizontal root fractures are uncommon traumatic injuries involving dentin, cementum, the periodontal ligament, and frequently the dental pulp. Long-term management is particularly challenging in growing patients when displacement of the coronal fragment, pulpal complications, and the need to preserve the natural dentition coexist. This report describes the 12-year clinical and radiographic course of bilateral middle-third root fractures managed after delayed referral.

Methods

A healthy 10-year-old girl sustained a bicycle accident resulting in uncomplicated enamel-dentin crown fractures of the maxillary lateral incisors and horizontal middle-third root fractures of both maxillary central incisors, with displacement and mobility of the coronal fragments. Emergency semi-rigid splinting was performed. Eight months later, persistent displacement and mobility of the coronal fragments and absent pulp sensibility responses were identified. The coronal fragments were mobilized and repositioned under local anesthesia and stabilized with a flexible splint. Following the development of findings compatible with pulp necrosis in the coronal fragments, endodontic treatment was restricted to these fragments, while the apical segments remained untreated. After intracanal calcium hydroxide medication, the coronal fragments were obturated with mineral trioxide aggregate, and the anterior teeth were restored with composite resin. Clinical and radiographic follow-up was performed for 12 years.

Results

At the 12-year evaluation, the traumatized teeth remained functional and aesthetically acceptable. Localized bone rarefaction adjacent to the fracture line and slight-to-moderate tooth mobility persisted. However, no progressive inflammatory root resorption, extensive periapical lesion, pain, or functional complaints were observed, supporting long-term retention of the affected teeth.

Conclusion

This case documents long-term retention of bilateral mid-root-fractured maxillary central incisors throughout craniofacial growth after individualized management and endodontic treatment restricted to the coronal fragments. The stable 12-year clinical and radiographic findings, despite residual mobility and localized bone rarefaction, emphasize the importance of preserving tooth structure when feasible and maintaining prolonged follow-up in growing patients with complex root fractures.

1 | Introduction

Horizontal root fractures are traumatic injuries that simultaneously affect the dental hard tissues (dentin and cementum), periodontal ligament, and often the dental pulp [1, 2]. These fractures involve transverse separation of the tooth into coronal and apical segments. Although relatively uncommon, they account for 0.5%–7% of all traumatic injuries in permanent teeth and are less frequent than other types of trauma, such as crown fractures or luxations [1, 2]. Maxillary central incisors are the teeth most frequently affected, and children and adolescents are particularly susceptible, usually as a result of falls, sports accidents, or collisions [2]. The intensity, direction, and point of impact determine the fracture pattern and the extent of damage to adjacent tissues [2].

Fractures may occur in the cervical, middle, or apical third of the root, with the middle third being the most frequently involved, likely due to its thinner anatomy and greater susceptibility to impact forces [3]. The clinical presentation depends on the fracture location and mobility of the coronal fragment. In middle-third fractures, the coronal segment may exhibit significant displacement, resulting in mobility, gingival sulcus bleeding, and, in some cases, altered tooth position, whereas the apical fragment usually remains stable, anchored to the alveolar bone [3].

The prognosis of horizontal root fractures depends on several factors, including fracture location, coronal fragment mobility, pulp vitality, and preservation of the alveolar bone [4, 5]. Conservative approaches, such as flexible splinting and periodic pulp vitality monitoring, have proven effective in most cases, particularly when coronal fragment mobility is minimal and there are no signs of necrosis [4, 5]. Even when endodontic treatment is required, intervention limited to the coronal fragment may be sufficient, provided that there is no significant periodontal compromise [6, 7]. Healing mechanisms include the formation of hard tissue, connective tissue, bone associated with soft tissue, or, in some cases, granulation tissue, the latter being associated with an unfavorable prognosis [2].

Although the short- and medium-term outcomes of horizontal root fractures are well documented, few studies have provided long-term clinical and radiographic follow-up, particularly regarding the maintenance of periradicular bone integrity [9]. Documenting cases with follow-up exceeding a decade provides valuable insights into the biological behavior of root fractures over time and reinforces the importance of conservative management in young patients, allowing the preservation of natural teeth, functional stability, and alveolar bone until skeletal maturity enables definitive rehabilitation [8].

2 | Case Report

This case report was prepared in accordance with the CARE guidelines and the Preferred Reporting Items for Case Reports in Endodontics (PRICE 2020) guidelines [10]. A clinical timeline summarizing the sequence of events, treatment decisions, and follow-up evaluations is presented in Fig. 1. Written informed consent for publication of the clinical information and accompanying images was obtained from the patient's legal guardian

A healthy 10-year-old girl sustained a bicycle accident while returning home from a nearby store. According to her guardian, she abruptly applied the front brake while riding at high speed, was thrown

forward, and struck her face directly against the ground. Emergency treatment was provided within a few hours after the injury at Hospital de Base de Brasília.

The initial clinical and radiographic examination revealed uncomplicated enamel-dentin crown fractures of the maxillary lateral incisors (teeth 12 and 22) and horizontal root fractures located in the middle third of both maxillary central incisors (teeth 11 and 21), associated with displacement and mobility of the coronal fragments. Emergency management consisted of stabilization of the traumatized teeth with a semi-rigid splint to promote periodontal healing, according to the protocol adopted at the treating institution.

Eight months after the trauma, the patient was referred to the University of Brasília Extension Program Dental Trauma: Prevention and Treatment for specialized management. At presentation, the original semi-rigid splint remained in place (Fig. 2A). A comprehensive clinical and radiographic reassessment was performed, including standardized photographic documentation. Periapical radiographs confirmed horizontal root fractures involving the middle third of both central incisors, with persistent separation and displacement of the coronal fragments (Fig. 2B).

Figure 2. Clinical and radiographic findings eight months after the traumatic injury. (A) Clinical appearance at presentation to the specialized dental trauma service, with the initial semi-rigid splint still in place. (B) Periapical radiographs showing horizontal root fractures in the middle third of the maxillary central incisors (teeth 11 and 21), with persistent separation and displacement of the coronal fragments.

Clinical examination revealed persistent mobility of the coronal fragments of teeth 11 and 21, without spontaneous pain, swelling, or signs of acute periodontal inflammation. Occlusion remained stable, and the lateral incisors showed satisfactory periodontal conditions. Pulp sensibility testing elicited no response in teeth 11 and 21, whereas teeth 12 and 22 responded within normal limits. The available clinical record did not specify the sensibility-testing method; therefore, no additional test details are reported here.

Considering the prolonged displacement of the coronal fragments, the absence of pulp sensibility responses, and the patient's stage of craniofacial growth, an individualized tooth-preserving treatment plan was established. The objectives were to maintain the natural teeth and alveolar ridge during skeletal development and to postpone definitive prosthetic rehabilitation, if ultimately required, until skeletal maturity. Because spontaneous fragment realignment was no longer expected after eight months, mobilization and delayed repositioning of the coronal fragments were selected to improve fragment adaptation and periodontal stability.

Under local infiltrative anesthesia with 2% lidocaine containing 1:100,000 epinephrine (Alphacaine 100®, DFL, Rio de Janeiro, Brazil), the coronal fragments of teeth 11 and 21 were carefully mobilized and repositioned to achieve the closest possible adaptation to the apical fragments while minimizing manipulation of the periodontal ligament. After repositioning, the teeth were stabilized with a flexible splint using a 0.4-mm stainless steel orthodontic wire (Morelli®, Sorocaba, SP, Brazil).

During follow-up after repositioning, both central incisors remained unresponsive to pulp sensibility testing and subsequently developed clinical and radiographic findings compatible with pulp necrosis confined to the coronal fragments. Because the available manuscript record does not provide the complete set of diagnostic findings beyond those reported, no additional diagnostic criteria are inferred. Clinical appearance during endodontic treatment, with the flexible splint maintained and temporary restorations in place, is shown in Fig. 3A.

Root canal preparation was limited to the fracture line using 2.5% sodium hypochlorite (Fórmula & Ação®, São Paulo, Brazil) as the irrigating solution. Calcium hydroxide paste (Ultracal XS®, Ultradent, South Jordan, UT, USA) was used as an intracanal medicament for approximately 30 days. Subsequently, the coronal fragments were obturated with mineral trioxide aggregate (ProRoot MTA®, Dentsply Sirona, Tulsa, OK, USA), achieving an adequate seal without instrumentation of the apical segments (Fig. 3B). Three weeks later, the flexible splint was removed (Fig. 3C), and definitive direct composite resin restorations (Filtek Z350 XT®, 3M ESPE, St. Paul, MN, USA) were placed in teeth 11, 12, 21, and 22 to restore function and esthetics.

Following completion of treatment, the patient was enrolled in a long-term follow-up program involving periodic clinical and radiographic examinations. The source manuscript does not specify all intermediate follow-up intervals; therefore, only documented time points are reported. At the 12-year evaluation, standardized clinical photographs and periapical radiographs were obtained.

The facial clinical view demonstrated satisfactory maintenance of the natural dentition and composite resin restorations (Fig. 4A), whereas the palatal view showed acceptable marginal adaptation and integrity of the restorations (Fig. 4B). Periapical radiographic examination demonstrated maintenance of the relationship between the coronal and apical fragments, with a localized area of bone rarefaction adjacent to the fracture line that remained stable over time and showed no evidence of progressive inflammatory root resorption or extensive periapical lesions (Fig. 4C). The lateral clinical view demonstrated preservation of the alveolar ridge contour throughout the follow-up period (Fig. 4D).

Slight mobility persisted in teeth 12, 21, and 22, whereas tooth 11 exhibited moderate mobility. Despite these findings, the patient reported no pain or functional complaints throughout follow-up. Overall, the natural dentition was maintained throughout craniofacial growth, with acceptable function and esthetics at the 12-year evaluation.

3 | Discussion

Horizontal root fractures affecting the middle third of the root represent a therapeutic challenge because the prognosis depends on multiple biological and mechanical factors, including the degree of displacement of the coronal fragment, pulp status, root development, and the quality of periodontal healing. Among these variables, fragment displacement and mobility are consistently reported as important predictors of healing, since they directly influence the re-establishment of periodontal ligament integrity and hard tissue repair [11–13]. In the present case, despite the prolonged interval

between the initial trauma and specialist management, long-term retention of both central incisors was achieved, demonstrating that favorable outcomes may still be obtained when treatment is carefully planned according to biological principles.

Current International Association of Dental Traumatology (IADT) guidelines recommend immediate repositioning and flexible splinting whenever displacement of the coronal fragment is present [5]. In the present case, however, the patient was referred approximately eight months after the initial trauma, when spontaneous realignment was no longer expected. Persistent displacement and mobility of the coronal fragments raised concerns regarding periodontal stability and the long-term maintenance of the teeth. Therefore, surgical repositioning was selected as an attempt to improve fragment adaptation and create more favorable conditions for periodontal healing and long-term tooth retention. Although this approach is not routinely indicated, it represented a conservative alternative to extraction in a growing patient, in whom implant-supported rehabilitation was contraindicated because of ongoing craniofacial development.

Another important aspect was the decision to perform endodontic treatment exclusively in the coronal fragments while preserving the apical segments. Healing of horizontal root fractures is strongly associated with maintenance of the vitality of the apical fragment, which preserves its neurovascular supply and regenerative potential [12]. Previous studies have demonstrated that treatment limited to the coronal segment is sufficient in most cases of pulp necrosis following horizontal root fracture and avoids unnecessary intervention in the apical fragment [6, 7]. The favorable clinical and radiographic findings observed throughout the 12-year follow-up support this biological approach.

The long-term outcome observed in this patient should also be interpreted with caution. Although the teeth remained functional and aesthetically acceptable throughout follow-up, slight to moderate mobility persisted, and localized bone rarefaction adjacent to the fracture line was observed radiographically. These findings indicate that complete biological healing was not achieved and reinforce that successful management of horizontal root fractures does not necessarily imply complete restitution of the original periodontal architecture. Nevertheless, the radiographic appearance remained stable throughout follow-up, with no evidence of progressive inflammatory root resorption, extensive periapical lesions, or tooth loss. Therefore, rather than suggesting complete periodontal regeneration or preservation of alveolar bone volume, this case demonstrates the long-term maintenance of the natural dentition under clinically acceptable conditions.

The preservation of natural teeth during craniofacial growth represents one of the main clinical implications of this report. Premature extraction of traumatized anterior teeth in children is frequently associated with progressive alveolar ridge resorption, esthetic impairment, and the need for future bone augmentation procedures before implant placement [14]. In the present case, maintenance of both central incisors until adulthood allowed preservation of the alveolar ridge morphology and delayed definitive rehabilitation until skeletal maturity, which is consistent with current recommendations for the management of traumatic dental injuries in growing patients.

Only a limited number of reports have described follow-up periods exceeding ten years after horizontal root fractures [7–9]. Consequently, the present case contributes additional evidence regarding the long-term behavior of middle-third root fractures managed using a conservative multidisciplinary approach. Nevertheless, the findings should be interpreted within the inherent limitations of a single case report. Clinical outcomes may have been influenced by patient-related factors, including young age, periodontal healing capacity, oral hygiene, compliance with follow-up, and the absence of additional traumatic episodes. Furthermore, objective outcome measures, such as cone-beam computed tomography, standardized periodontal indices, or patient-reported outcome measures, were not available throughout the entire follow-up period. Therefore, causal relationships between the intervention and the favorable outcome cannot be definitively established.

Overall, this case supports conservative management as a viable treatment strategy for selected horizontal root fractures in growing patients. Rather than advocating surgical repositioning as a routine procedure, the present report illustrates that individualized treatment planning, preservation of the apical fragment, and long-term clinical monitoring may allow prolonged retention of natural teeth until definitive rehabilitation becomes biologically appropriate.

4 | Conclusion

This 12-year follow-up case report demonstrates that middle-third horizontal root fractures may achieve favorable long-term clinical outcomes when managed using an individualized conservative approach, even when definitive treatment is not performed immediately after the traumatic injury. In the present case, the combination of surgical repositioning of the coronal fragments, endodontic treatment restricted to the coronal segment, and long-term clinical and radiographic follow-up allowed the maintenance of the natural teeth with acceptable function and esthetics throughout the patient's craniofacial growth.

Although slight tooth mobility and localized bone rarefaction were observed at the final follow-up, these findings remained clinically stable over time and did not compromise tooth retention or function. This case highlights the importance of individualized treatment planning and long-term follow-up in the management of horizontal root fractures in growing patients, supporting the potential of conservative strategies to maintain the natural dentition until definitive rehabilitation becomes biologically appropriate.

Abbreviations

IADT: International Association of Dental Traumatology

MTA: Mineral trioxide aggregate

PRICE: Preferred Reporting Items for Case Reports in Endodontics

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Written informed consent for publication of the patient's clinical details and accompanying clinical images was obtained from the patient's legal guardian.

Availability of data and materials

All data supporting the findings of this case report are included in the article. Additional patient-level data are not publicly available to protect patient confidentiality.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

All authors contributed to the conception and development of the case report, interpretation of the clinical findings, and critical revision of the manuscript. All authors read and approved the final manuscript.

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Figures

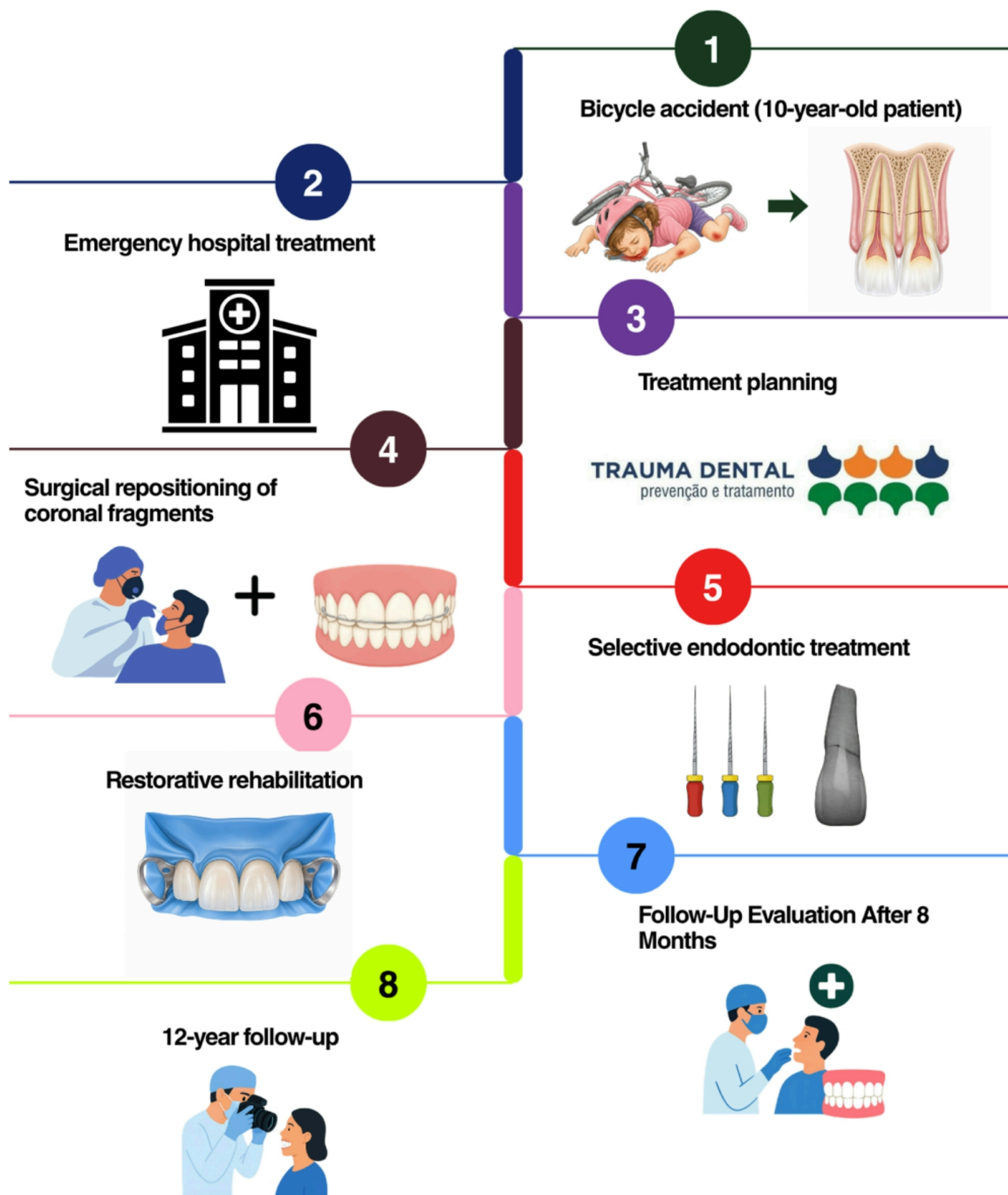


Figure 1

Clinical timeline summarizing the sequence of traumatic injury, treatment procedures, and follow-up evaluations.

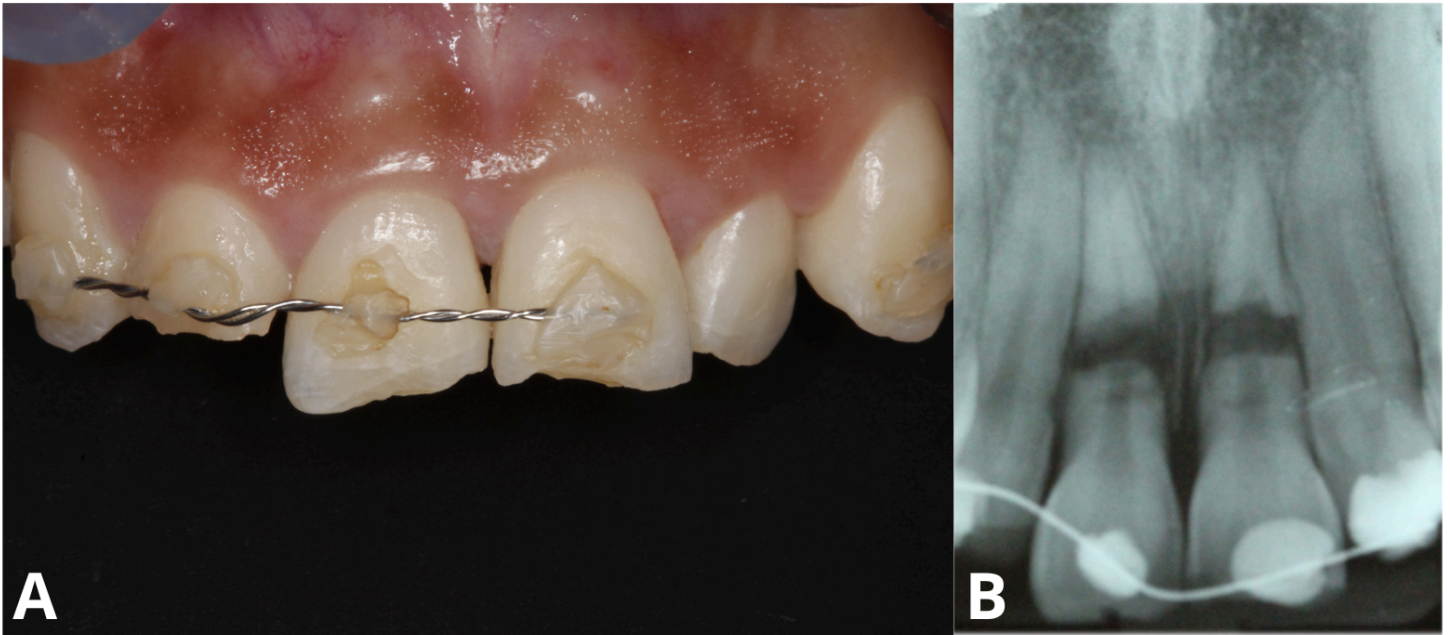


Figure 2

Clinical and radiographic findings eight months after the traumatic injury. (A) Clinical appearance at presentation to the specialized dental trauma service, with the initial semi-rigid splint still in place. (B) Periapical radiographs showing horizontal root fractures in the middle third of the maxillary central incisors (teeth 11 and 21), with persistent separation and displacement of the coronal fragments.

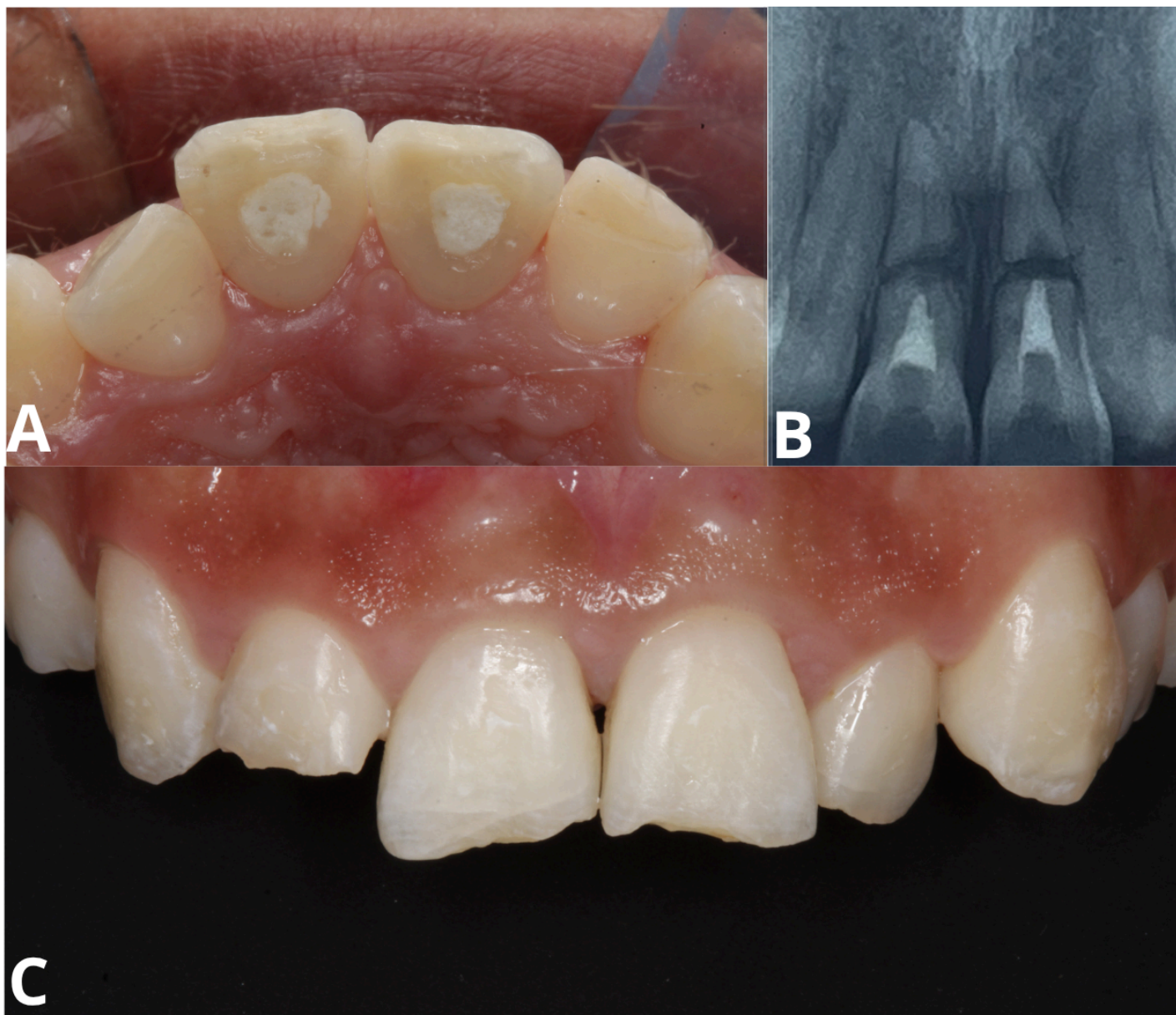


Figure 3

Endodontic management of the fractured maxillary central incisors. (A) Clinical appearance during endodontic treatment of teeth 11 and 21, with the flexible splint maintained and temporary restorations in place. (B) Periapical radiographs after endodontic treatment restricted to the coronal fragments, showing obturation with mineral trioxide aggregate (MTA) up to the fracture line and preservation of the untreated apical segments. (C) Clinical appearance after removal of the flexible splint, three weeks after completion of endodontic treatment.



Figure 4

Clinical and radiographic findings at the 12-year follow-up. (A) Facial clinical view showing maintenance of the natural dentition and composite resin restorations. (B) Palatal clinical view showing the integrity and marginal adaptation of the restorations. (C) Periapical radiographs showing maintenance of the relationship between the coronal and apical fragments, with localized bone rarefaction adjacent to the fracture line and no evidence of progressive inflammatory root resorption or extensive periapical lesions. (D) Lateral clinical view showing preservation of the alveolar ridge contour at the 12-year follow-up.