

# Delayed tooth replantation after dry storage: Preservation of function and aesthetics for a decade

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## ABSTRACT

**Introduction:** Currently, determining therapeutic strategies for improving prognosis of delayed replantation of teeth that have been inadvertently stored in a dry environment is a challenge. A 22-year-old patient sought dental care three days after avulsion of tooth #8. Mechanically, the root surface was carefully scraped with periodontal curettes and chemically treated with 5.25% sodium hypochlorite followed by 17% EDTA. Following extraoral treatment and chemomechanical preparation, the root canal was filled with calcium hydroxide paste. The patient did not attend all follow-ups. After 102 months, maxillary right central incisor was clinically functional, but ankylosed. There was palatal periodontal pocket measuring 5 mm in depth and purulent exudate.

Radiography revealed advanced external root resorption. After periodontal treatment, the root canal was dressed with calcium hydroxide paste and subsequently filled with MTA. At follow-up after 18 months, root resorption had stabilized. Experimentally, an extracted tooth stored under identical conditions received similar root surface treatment. With scanning electron microscopy, the root surface showed a high degree of cleanliness with patent dentinal tubules, suggesting favorable root permeability. Root surface treatment and intracanal dressing enabled preservation of the avulsed tooth after delayed replantation, with satisfactory function and aesthetics for approximately a decade.

**Keywords:** Maxillofacial injuries. Tooth avulsion. Dental injuries. Tooth resorption.

» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

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## Introduction

Incidence of complete avulsion ranges from 1% to 16% of all traumatic injuries caused to the permanent dentition.<sup>1,2</sup> Immediate reimplantation has been widely accepted as an effective treatment modality for biological reasons relative to maintaining the vitality of periodontal ligament cells.<sup>2,3</sup> Physiologically, the pre-cementum protects the root from the immune system, which prevents cementum and dentin from being recognized as antigens and triggers root resorption mechanisms.<sup>4,5</sup> The remaining epithelial cell rests of Malassez play a crucial role in preventing dentoalveolar ankylosis.<sup>6</sup>

In contrast, in delayed tooth replantation, irreversible damage to the periodontal ligament and pulp necrosis associated with microbiological contamination of the root surface and root canal are challenges to the longevity of avulsed teeth.<sup>2-8</sup> In previous cases of replantation, necrotic tissue adhering to the root was mechanically removed, followed by antimicrobial treatment of the root surface.<sup>2,3,8-10</sup> After replantation, the root surface was first colonized by osteoblasts rather than cementoblasts,<sup>10</sup> leading to ankylosis.<sup>2-10</sup> Additionally, microbes on the root surface and in dentinal tubules as well as the root canal can activate inflammatory root resorption.<sup>11,12</sup> Therefore, the outcomes of avulsed teeth in cases of delayed replantation and non-physiological storage have shown low rates of survival representing a significant challenge for dentists.<sup>4,5,13,14</sup>

This clinical case report describes a tooth avulsed and stored for three days in a dry environment and was visibly contaminated. The tooth underwent extraoral treatment and was replanted, and it has functioned satisfactorily in the oral cavity for approximately a decade.

## Case report

In December 2004, a 22-year-old male patient arrived at the Endodontics Clinic at Universidade Federal dos Vales do Jequitinhonha e Mucur, Brazil, requesting replantation of an avulsed tooth. The patient reported suffering a physical assault three days earlier, and complained of pain in the maxillary anterior region without presenting any signs or symptoms of a neurological disorder. His tetanus vaccination was up to date, and his medical record was

non-contributory. The avulsed maxillary right central incisor was wrapped in dirty gauze with residual clotted blood, and it was visibly dry. Extraoral examination revealed several scabs on the patient's face. Intraorally, there were blood clots in the anterior region, lacerations of the inner surfaces of the lips, and horizontal coronal fractures affecting the enamel and dentin of the maxillary left and right lateral and left central incisors (Fig 1A). The maxillary anterior region was cleaned with gauze soaked in physiological saline solution. Palpation of the alveolar process did not suggest any fractures. The maxillary left and right lateral and left central incisors presented with normal mobility and responded positively to cold sensitivity tests (Endo-ice – The Hygenic Corp, Akron, OH, USA). Radiographic examination revealed no foreign bodies in the lips, and periapical radiographs excluded the presence of bone or root fractures (Fig 1B). Avulsed maxillary right central incisor (Fig 1C) presented incisal fracture and root integrity. The patient was informed that replantation had an unfavorable prognosis, but he chose to proceed with this treatment option and agreed to the treatment by signing a free and informed consent.

Extraoral preparation consisted of meticulous root scaling performed with a Gracey curette under irrigation with saline solution, assisted by an operating microscope. Chemical treatment consisted of immersion in a flask with 20 mL of 5.25% sodium hypochlorite solution for 10 minutes, followed by immersion in 5 mL of 17% EDTA for three minutes. Finally, the tooth was washed with 10 mL of saline solution. After crown access and pulpectomy apical patency was achieved with a #15 file at 26-mm working length. The root canal was chemomechanically prepared under frequent irrigation with 5.25% NaOCl solution. After smear layer removal with 17% EDTA, the canal was dried with absorbent paper cones and filled with calcium hydroxide paste (Calen, SS. White Artigos Dentários Ltda, São Paulo, Brazil). Crown restoration was achieved with light-cured resin (Z100; 3M ESPE, Sumaré, Brazil).

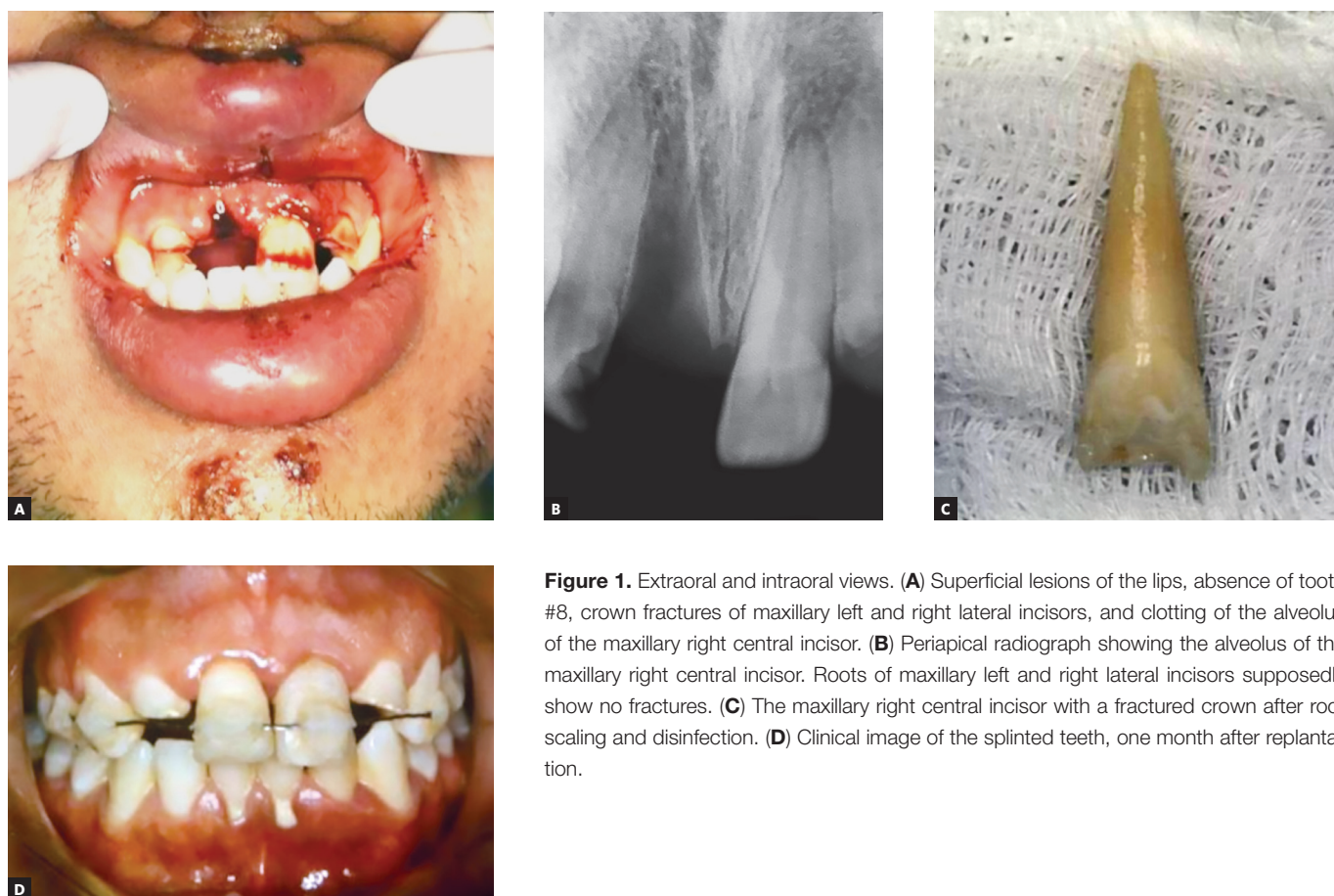
Subsequently, after antisepsis of the face, oral prophylaxis was followed by mouthwash with 0.12% chlorhexidine gluconate solution (Periogard – Colgate/Palmolive, São Paulo, Brazil). After local infiltrative anesthesia, the clot and granulation tissue in the

alveolus of the maxillary right central incisor were gently removed with Lucas curettes under irrigation with saline solution. The maxillary right central incisor was replanted using light pressure, and after occlusion was checked, a semi-rigid splint made of 0.5-mm-diameter steel wire was bonded in place with Z100 resin. The patient was instructed regarding proper brushing and dental flossing techniques and was told to mouthwash with 0.12% chlorhexidine gluconate solution daily for one week. The patient received antibiotics (500 mg amoxicillin, 3 times per day for one week) and anti-inflammatory (600 mg ibuprofen, three times per day for three days). Additionally, he was instructed to eat soft food while healing and to avoid biting with the splinted teeth.

For maxillary right and left lateral incisors, pulp-ectomies were performed as urgent treatment, followed by restoration with light-cured resin. When the patient returned after the fifth week, he was as-

ymptomatic and presented with a high degree of visible dental biofilm and gingivitis (Fig 1D). The splint was removed, and it was confirmed that the maxillary right central incisor was firmly attached to the alveolus. Under absolute isolation, calcium hydroxide paste was removed, and the patient was scheduled to have this medication replaced every three months. Maxillary right and left lateral incisors were endodontically treated and restored with intraradicular pins and resin-based crowns. After 24 months, periapical radiographs showed that maxillary right central incisor presented with incipient apical replacement resorption and cervical bone loss (Fig 2A). Reassessments continued, and every six months, the intracanal dressing was renewed over the following six years. The periodontal condition remained radiographically stable over the next 48 months (Fig 2B).

Nevertheless, the patient then failed to appear for assessments for 30 consecutive months, and when

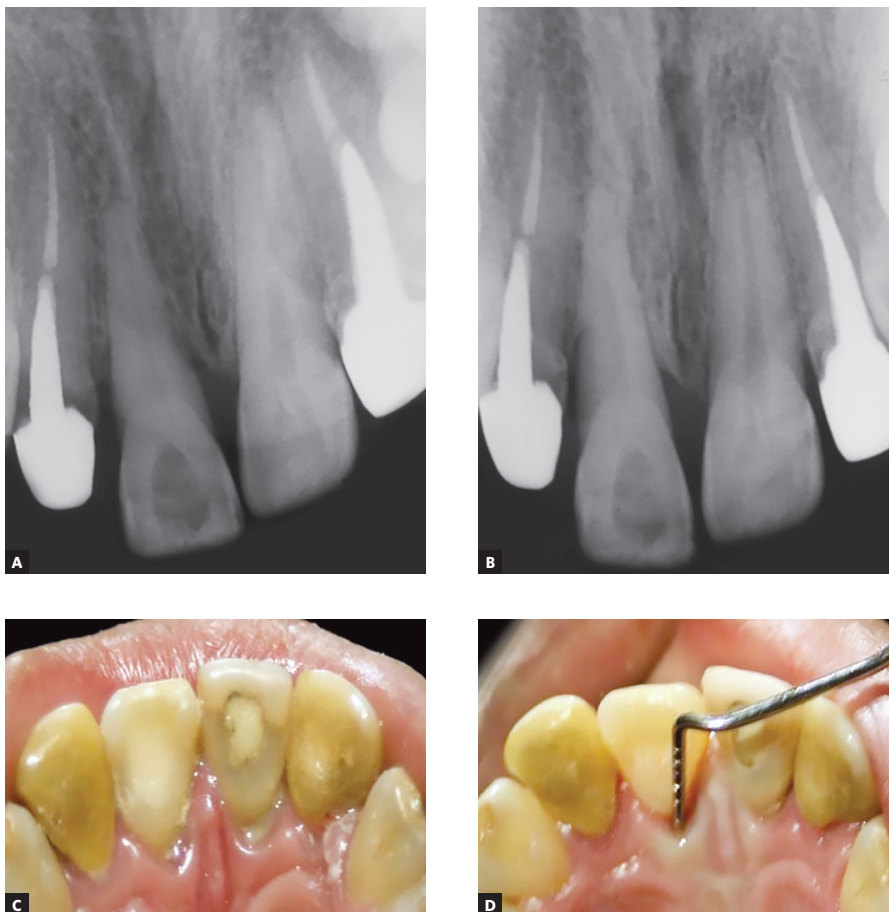


**Figure 1.** Extraoral and intraoral views. **(A)** Superficial lesions of the lips, absence of tooth #8, crown fractures of maxillary left and right lateral incisors, and clotting of the alveolus of the maxillary right central incisor. **(B)** Periapical radiograph showing the alveolus of the maxillary right central incisor. Roots of maxillary left and right lateral incisors supposedly show no fractures. **(C)** The maxillary right central incisor with a fractured crown after root scaling and disinfection. **(D)** Clinical image of the splinted teeth, one month after replantation.

he finally returned, he presented with a symptomatic acute periapical abscess in the maxillary left central incisor. Clinically, maxillary right central incisor was functional and asymptomatic, and it lacked mobility; however, it had a high-pitched percussion sound suggestive of ankylosis. Periodontal examination of maxillary left and right central incisors revealed purulent exudate on the palatal surface and probing depths of 5 mm (Figs 2C, D). Radiographs revealed external root resorption of the maxillary right central incisor in the apical third and advanced inflammatory resorption in the cervical segment, involving mesial and distal surfaces. The maxillary left central incisor presented external root resorption in the middle third and periapical radiolucency (Fig 3A). One week after urgent treatment, root canals were prepared, dressed

with calcium hydroxide for 60 days and conventionally filled with gutta-percha and sealer. In addition, the maxillary right central incisor underwent debridement with 5.25% NaOCl aided by a K-file (Fig 3B), and the tooth was filled with MTA White (Angelus Indústria de Produtos Odontológicos S/A, Londrina, Brazil) and restored with Z100 resin. Then, subgingival scaling was performed with Gracey curettes and irrigation with saline solution. A 0.12% chlorhexidine gluconate mouthwash was prescribed daily for one week.

Clinically, 120 months after replantation, the patient maintained effective dental biofilm control, and maxillary right central incisor showed signs of ankylosis. Radiographically, root resorption of maxillary right central incisor remained stable, and maxillary left central incisor presented with normal periapex



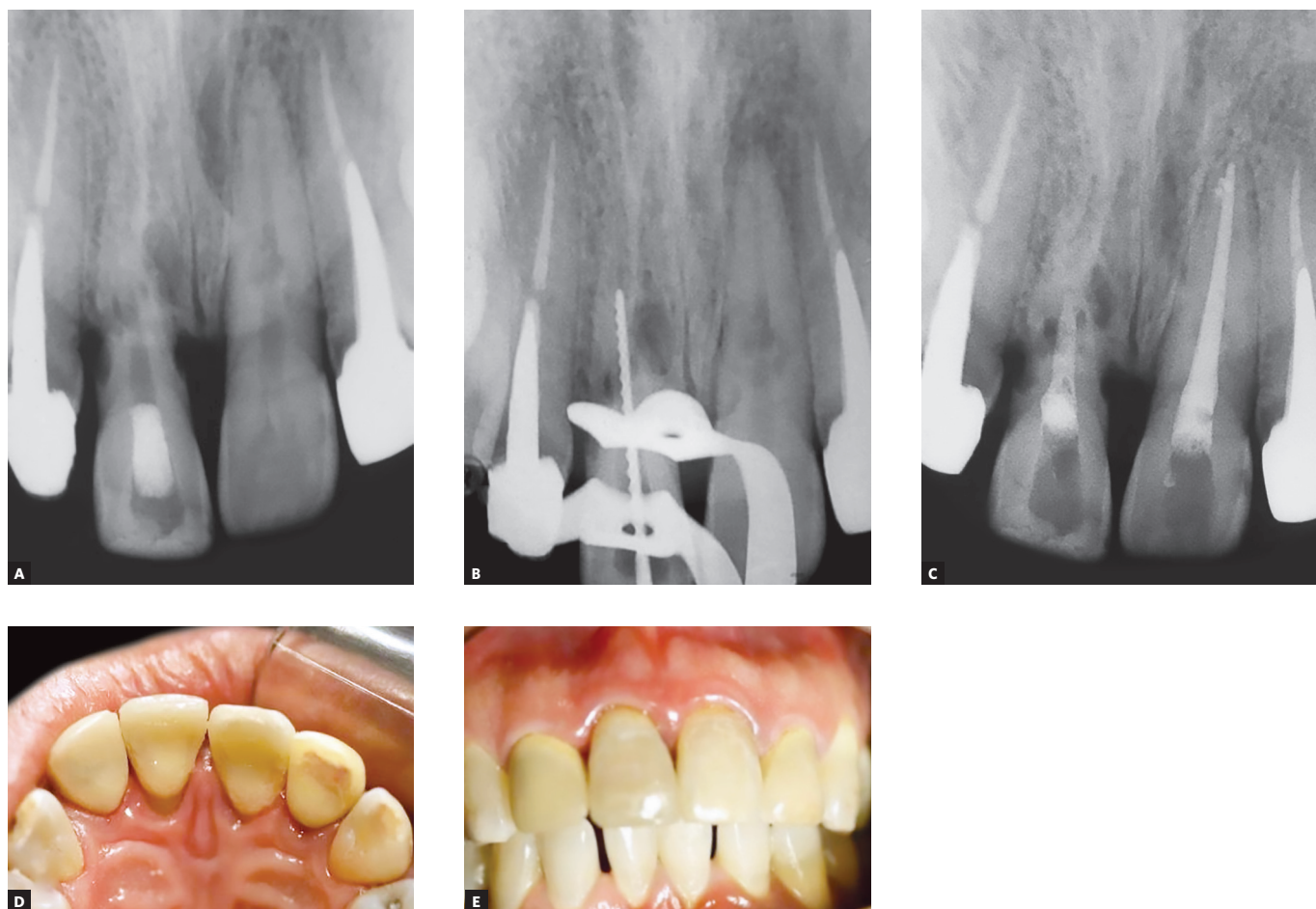
**Figure 2.** **A)** Follow-up at 24 months. Root canal of the maxillary right central incisor filled with calcium hydroxide paste. Note cervical bone loss and incipient external apical root resorption. **(B)** After 48 months, periodontal bone loss shows discrete progression. **(C)** and **(D)** Clinical picture at 8.5 years: gingival exudate and periodontal pocketing depth in maxillary left and right central incisors.



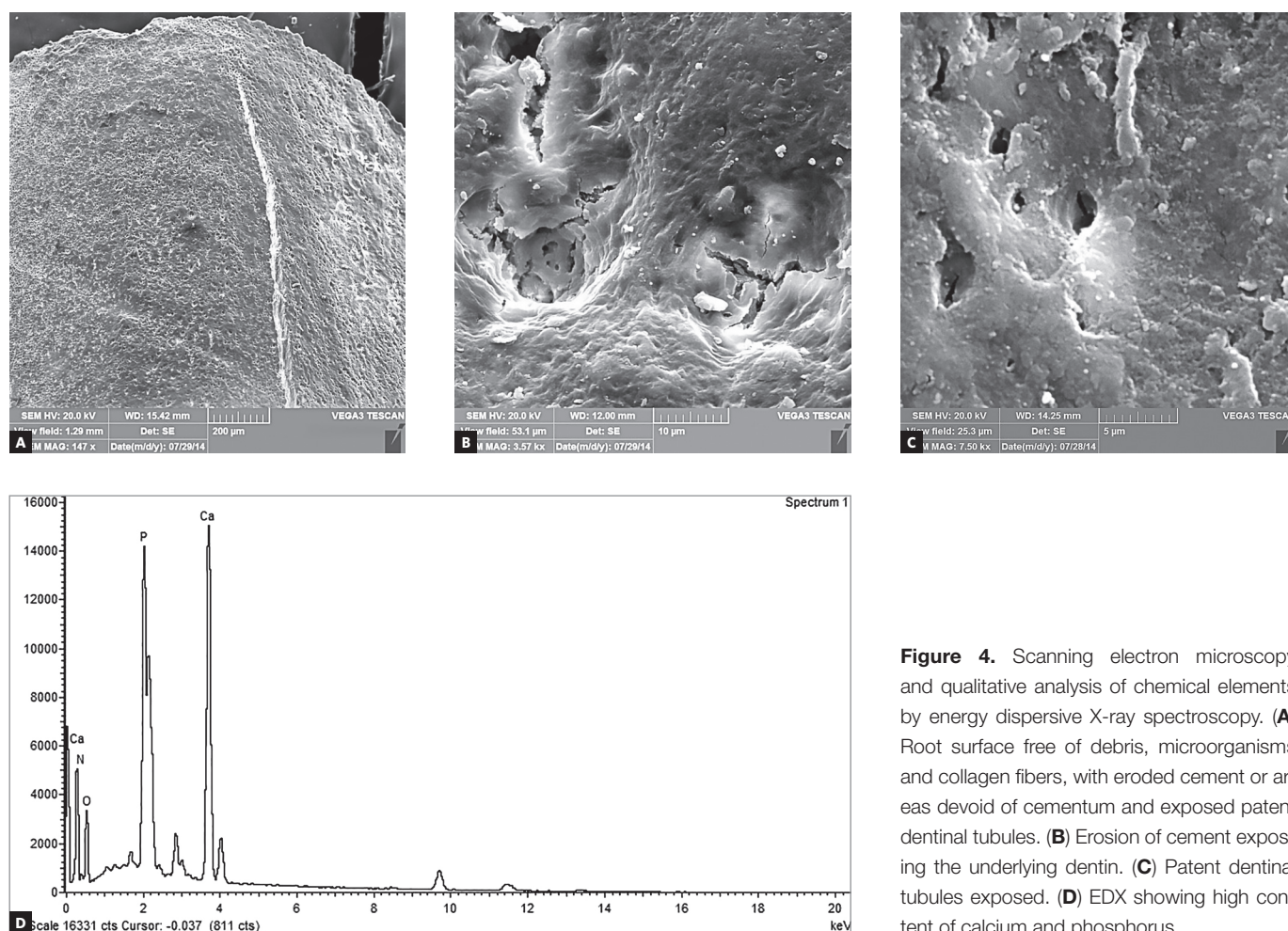
and periodontium (Fig 3C). Maxillary right and left central incisors were functional and asymptomatic, and the patient was satisfied with aesthetics and overall outcome of the treatment. Probing depths decreased to 2 mm, and gingival exudate was eliminated (Figs 3D, E).

To investigate the structural aspects of the reimplanted avulsed tooth root surface, a maxillary right central incisor extracted for advanced periodontal disease from a 26-year-old patient received identical

mechanical and chemical treatment of root surface and was processed for analysis by scanning electron microscopy (SEM) and qualitative analysis of chemical elements by energy dispersive X-ray spectroscopy (EDX). The overall root surface was very clean and free of debris, microorganisms and collagen fibers, with eroded cement exposing the dentinal tubules (Figs 4A-C). EDS showed high peaks of phosphorus and calcium, which are the constituents of hydroxyapatite (Fig4D).



**Figure 3.** **A)** Radiographic aspect at 102 months after replantation. Advanced cervical root resorption of maxillary right central incisor, periapical lesion and external root resorption of maxillary left central incisor. **B)** Filling of the maxillary right central incisor with MTA and conventional filling of maxillary left central incisor. **C)** and **D)** Favorable clinical picture at 120 months after replantation.



**Figure 4.** Scanning electron microscopy and qualitative analysis of chemical elements by energy dispersive X-ray spectroscopy. **(A)** Root surface free of debris, microorganisms and collagen fibers, with eroded cement or areas devoid of cementum and exposed patent dentinal tubules. **(B)** Erosion of cement exposing the underlying dentin. **(C)** Patent dentinal tubules exposed. **(D)** EDX showing high content of calcium and phosphorus.

## Discussion

Avulsed permanent teeth with extraoral dry time longer than 60 minutes have poor long-term prognoses with delayed replantation.<sup>2,3</sup> Inflammatory response increases with increasing extraoral dry time.<sup>14</sup> In addition to restoring the tooth for aesthetic, functional and psychological reasons, the aim in delayed replantation is to maintain alveolar bone contours. However, the expected eventual outcome is ankylosis and resorption of the root, and the tooth will eventually be lost.<sup>2</sup>

The therapeutic approach should be based on the prevention or arrest of inflammatory resorption by neutralizing contamination with endodontic treat-

ment, systemic antibiotic therapy and root surface treatment.<sup>2,13</sup> In this clinical case report, surprising clinical and radiographic success was achieved with delayed replantation after extended dry storage of a tooth that was supposedly contaminated. The positive results could be attributed to treatments performed on the surface of the root, which resulted in adequate removal of debris, necrotic tissue and microorganisms and caused erosion of the cementum and exposure of adjacent dentinal tubules. This condition might have increased root permeability to intracanal calcium hydroxide, resulting in stable alkalinity and possibly delaying root resorption.

Scaling of the periodontal ligament was performed with curettes under irrigation with saline solution in order to remove the necrotic layer of cementum and reduce the likelihood of external inflammatory resorption.<sup>9,10</sup> The efficacy of cleaning was determined using a surgical microscope. Then, the root was decontaminated because it was visibly unclean. It has been suggested that 2% sodium fluoride could be used to treat the root surface.<sup>2</sup> However, 5.25% sodium hypochlorite was chosen for two reasons: its bactericidal action<sup>15</sup> and its ability to dissolve organic material.<sup>16</sup> Using this solution can aid in the removal of necrotic residual tissue. Indeed, on SEM, a high degree of cleanliness was observed throughout the root surface. The effects of NaOCl treatment on demineralized roots caused no marked changes in the elemental composition or ultrastructure of the dentin,<sup>17</sup> which was confirmed by EDX and SEM analysis.

Extraoral endodontic treatment was followed by a traditional procedure: after chemomechanical preparation and smear layer removal, the root canal was filled with calcium hydroxide paste.<sup>18,19</sup> Although controversial, antibiotics, corticosteroids, and calcium hydroxide have been recommended as intracanal dressing.<sup>7</sup> The continual diffusion of hydroxyl ions from calcium hydroxide alkalizes the root structure, inducing bactericidal action and inhibiting or delaying external inflammatory root resorption.<sup>20,21</sup> Temporary application of intracanal calcium hydroxide is recommended for mature teeth; however, the ideal duration of treatment has not been defined.<sup>7,21</sup> In this case study, the extended use of calcium hydroxide was chosen due to its biological and antibacterial properties.<sup>22,23</sup> Its periodic renewal was planned because of intracanal calcium hydroxide solubility.<sup>7,18,22,23</sup>

At the two-year follow-up appointment, incipient apical root resorption was observed in addition to cervical bone loss. The patient was instructed to maintain meticulous oral hygiene, and intracanal medication was maintained due to its beneficial effects on root resorption.<sup>2,3,7</sup> In cases of external infection-related root resorption, calcium hydroxide can arrest 98% of infection-related resorption in luxated teeth and 90% in avulsed and later replanted teeth.<sup>2,3,7,18,19</sup> From SEM, we hypothesized that patent's dentinal tu-

bules must have facilitated satisfactory diffusion of intracanal calcium hydroxide to the root surface and contributed to delay root resorption.

After 102 months, the periodontal status declined. Lack of oral hygiene contributed to the formation of periodontal pockets on maxillary right and left central incisors, contributing to the development of inflammatory resorption, mainly of the reimplanted tooth. Because of the progressive solubility of intracanal calcium hydroxide at the site of resorption, it was replaced with MTA, which can be considered a viable option for root canal filling in delayed tooth replantation due to its biocompatibility,<sup>23</sup> diffusion<sup>24</sup> and satisfactory clinical results with a short follow-up in cases of severe inflammatory root resorption.<sup>25</sup> Periodontal treatment successfully resolved probing depths and gingival exudate.

One flaw of this case was that the patient was not compliant with the scheduled follow-up visits, which could have negatively influenced treatment outcomes because intracanal dressings were not replaced regularly. Additionally, oral hygiene was poor. These two factors might have contributed to the development of periodontal pocketing and cervical root resorption because these symptoms stabilized as soon as periodontal treatment was provided. Thus, treatment of the root surface associated with renewed intracanal treatment with calcium hydroxide after a long interval were pivotal to the success of the procedure. One decade after performing unreliable delayed dry replantation, the tooth presented with stable root resorption, and no additional periodontal attachment loss was observed. The tooth is fully functional and is aesthetically acceptable, and the patient is engaged in maintaining his periodontal health. The patient is aware of the possibility of losing the tooth in the future, and he understands that if this happens, he will need to consider placement of an osseointegrated implant or fixed bridge.

## Conclusion

In conclusion, clinical and radiographic results were achieved with delayed and potentially contaminated dry dental replantation. However, more case studies are needed to confirm the efficacy of this therapeutic strategy.



## References

1. Fountain SB, Camp JH. Traumatic injuries. In: Cohen S, Burns RC, editors. *Pathways of the pulp*. 7th ed. St Louis: CV Mosby; 1998.
2. Andersson L, Andreasen JO, Day P, Heithersay G, Trope M, Diangelis AJ, et al. International association of dental traumatology guidelines for the management of traumatic dental injuries. 2. Avulsion of permanent teeth. *Dent Traumatol*. 2012 Apr;28(2):88-96.
3. Andreasen JO, Borum MK, Jacobsen HL, Andreasen FM. Replantation of 400 avulsed permanent incisors. 1. Diagnosis of healing complications. *Endod Dent Traumatol*. 1995 Apr;11(2):51-8.
4. Pohl Y, Wahl G, Filippi A, Kirschner H. Results after replantation of avulsed permanent teeth. III. Tooth loss and survival analysis. *Dent Traumatol*. 2005 Apr;21(2):102-10.
5. Trope M. Clinical management of the avulsed tooth: present strategies and future directions. *Dent Traumatol*. 2002 Feb;18(1):1-11.
6. Keinan D, Cohen RE. The significance of epithelial rests of Malassez in the periodontal ligament. *J Endod*. 2013 May;39(5):582-7.
7. Panzarini SR, Trevisan CL, Brandini DA, Poi WR, Sonoda CK, Luvizuto ER, et al. Intracanal dressing and root canal filling materials in tooth replantation: a literature review. *Dent Traumatol*. 2012 Feb;28(1):42-8.
8. Andreasen JO, Hjorting-Hansen E. Replantation of teeth. I. Radiographic and clinical study of 110 human teeth replanted after accidental loss. *Acta Odontol Scand*. 1966 Nov;24(3):263-86.
9. Esper HR, Panzarini SR, Poi WR, Sonoda CK, Casatti CA. Mechanical removal of necrotic periodontal ligament by either Robinson brittle brush with pumice or scapel blade. Histomorphometric analysis and scanning electron microscopy. *Dent Traumatol*. 2007 Dec;23(6):333-9.
10. Hupp JG, Mesaros SV, Aukhil I, Trope M. Periodontal ligament vitality and histologic healing of teeth stored for extended periods before transplantation. *Endod Dent Traumatol*. 1998 Apr;14(2):79-83.
11. Ehnevid H, Lindskog S, Jansson L, Blomlöf L. Tissue formation on cementum surfaces in vivo. *Swed Dent J*. 1993;17(1-2):1-8.
12. Hammarström L, Blomlöf L, Lindskog S. Dynamics of dentoalveolar ankylosis and associated root resorption. *Endod Dent Traumatol*. 1989 Aug;5(4):163-75.
13. Andreasen JO. Effect of extra-alveolar period and storage media upon periodontal and pulpal healing after replantation of mature permanent incisors in monkeys. *Int J Oral Surg*. 1981 Feb;10(1):43-53.
14. Andreasen JO. A time-related study of periodontal healing and root resorption activity after replantation of mature permanent incisors in monkeys. *Swed Dent J*. 1980;4(3):101-10.
15. Soares JA, Carvalho MAR, Santos SMC, Mendonça RM, Ribeiro-Sobrinho AP, Brito-Júnior M, et al. Effectiveness of chemomechanical preparation with alternating use of sodium hypochlorite and EDTA in eliminating intracanal *Enterococcus faecalis* biofilm. *J Endod*. 2010 May;36(5):894-8.
16. Cobankara FK, Ozkan HB, Terlemez A. Comparison of organic tissue dissolution capacities of sodium hypochlorite and chlorine dioxide. *J Endod*. 2010 Feb;36(2):272-4.
17. Inaba D, Duschner H, Jongebloed W, Odelius H, Takagi O, Arends J. The effects of a sodium hypochlorite treatment on demineralized root dentin. *Eur J Oral Sci*. 1995 Dec;103(6):368-74.
18. Cvek M. Treatment on non-vital permanent incisors with calcium hydroxide. II. Effect on external root resorption in luxated teeth compared with effect of root filling with gutta percha. *Odontol Revy*. 1973;24:343-54.
19. Cvek M, Granath L, Hollander L. Treatment of non-vital permanent incisors with calcium hydroxide. III. Variation of occurrence of ankylosis of reimplanted teeth with duration of extra-alveolar period and storage environment. *Odontol Revy*. 1974;25:43-56.
20. Mohammadi Z, Dummer PMH. Properties and applications of calcium hydroxide in Endodontics and dental traumatology. *Int Endod J*. 2011 Aug;44(8):697-730.
21. Barrett EJ, Kenny DJ. Avulsed permanent teeth: a review of the literature and treatment guidelines. *Endod Dent Traumatol*. 1997 Aug;13(4):153-63.
22. Estrela C, Sydney GB, Bammann LL, Felipe O Júnior. Mechanism of action of calcium and hydroxyl ions of calcium hydroxide on tissue and bacteria. *Braz Dent J*. 1995;6(2):85-90.
23. Marão HF, Panzarini SR, Aranega AM, Sonoda CK, Poi WR, Esteves JC, et al. Periapical tissue reactions to calcium hydroxide and MTA after external root resorption as a sequela of delayed tooth replantation. *Dent Traumatol*. 2012 Aug;28(4):306-13.
24. Ozdemir HO, Özçelik B, Karabucak B, Cehreli ZC. Calcium ion diffusion from mineral trioxide aggregate through simulated root resorption defects. *Dent Traumatol*. 2008 Feb;24(1):70-3.
25. Güzeler I, Uysal S, Cehreli ZC. Management of trauma-induced inflammatory root resorption using mineral trioxide aggregate obturation: two-year follow up. *Dent Traumatol*. 2010 Dec;26(6):501-4.