Available online at www.giornaleitalianoendodonzia.it

CASE REPORT

Late re-implantation (48 hours) of an avulsed upper central incisor to preserve function, esthetics and alveolar bone for eleven years

ABSTRACT

Aim: *To describe the clinical management of a tooth re-implanted late to maintain functionality, esthetics and alveolar bone preservation.*

Summary: *A healthy 11-year-old female patient presented 48 hours after avulsion of the left upper central incisor, which was carried in a paper napkin. The tooth was rinsed with physiological solution, conditioned with sodium fluoride and root canal treatment was performed extra-orally. The tooth was immersed in distilled water mixed with MTA, the blood clot was removed from the socket and the tooth was re-implanted and splinted. The patient had a prescription for antibiotics, analgesics and a tetanus vaccination. After 8 days, the patient was asymptomatic with no mobility and mild gingival inflammation. The splint was removed 2 months later. At 8 months, resorption by substitution began and was followed for 1 to 7 years, at which time resorption by substitution occupied approximately 95% of the root, but without mobility. After 11 years of re-implantation, the remains of the crown and the gutta-percha were removed from the alveolus. The re-implanted tooth served to preserve the bone without the need for bone grafting, as alveolar bone was formed as the tooth resorbed.*

Key Learning points:

- *The avulsed and re-implanted tooth, even late, maintains masticatory function and prevents psychological distress for the patient.*
- *Late re-implantation of the avulsed tooth allows alveolar preservation with functional bone and provides better support for the placement of an osseointegrated implant.*

Norberto Broon[1]

Alvaro Cruz[1, 2*]

Gerardo Gascón[1]

Itzel Estefania Hernández-Meza[3, 4]

Clovis Monteiro Bramante[5]

[1]*Endodontics Dept, University Center of Health Sciences, University of Guadalajara, Mexico*

[2]*Institute for Research in Biomedical Sciences, University Center of Health Sciences, University of Guadalajara, Mexico*

[3]*University Center from Altos, University of Guadalajara, Mexico*

[4]*Endodontics Dept. at UTEG, Mexico*

[5]*Faculty of Dentistry of Bauru, University of São Paulo, Brazil*

Received 2024, July 25

Accepted 2024, September 13

KEYWORDS *Dental reimplantation, avulsion, dental trauma, alveolar preservation, endodontics.*

Corresponding Author

Dr. Alvaro Cruz | University Center of Health Sciences, Sierra Mojada 950, Col. Independencia, C.P. 44340, Guadalajara, Jalisco | México.

E-mail: endoacruz@yahoo.com | Tel. +523336159804

Peer review under responsibility of Società Italiana di Endodonzia

10.32067/GIE.2024.38.01.16

Introduction

The oral region represents 1% of a person's body surface area, but receives 5% of all physical injuries (1-3), with a high incidence of anterior dental trauma in people aged 7-12 years (4-6), with a prevalence in the permanent dentition that varies from 0.5% to 16.0% (7,8). In addition, the loss of an anterior tooth at a young age, can lead to bullying, embarrassment when laughing, exclusion from peers at school (9,10) which can cause shyness in some people, affecting their self-esteem and even their social interaction and economy (11).
The World Health Organization classification of trauma (7) divides them into injuries that affect hard tissues, such as teeth, periodontium, bone or a combination of these anatomical structures (1). These injuries require specific and immediate treatment (1). One of the most serious traumas is tooth avulsion, which is the complete displacement of a tooth from its original position in the mouth. This trauma is of such magnitude that it causes rupture of both the periodontal ligament and the pulp tissue (12). Reimplantation is the ideal treatment for the avulsed tooth, defined as the return of the tooth to its socket (13), preferably as soon as possible and especially in patients in the dental development phase (14).
Avulsion results in pulp necrosis due to pulp rupture and damage to periodontal ligament cells. Damage to the periodontal ligament is related to the extra-oral time and extra-oral storage conditions of the avulsed tooth. The most recommended liquids to keep teeth out of the socket are Hank's balanced solution or milk (12); more recently, storage and transport boxes have been suggested (1). The advantage of milk is that it is easy to obtain, unlike transport boxes or Hank's solution. Other factors that influence the prognosis of the pulp tissue and periodontal ligament are apical foramen diameter, root canal length and proper handling (15).
Unfortunately, in some cases reimplantation is not performed immediately and the tooth is stored in an inadequate medium or in a dry medium prior to reimplantation (12). These situations result in the absence of viable cells in the periodontal ligament attached to the root surface (7). The lack of viable cells and the denatured collagen in the root surface promote an inflammatory process upon reimplantation, followed by alveolar remodelling, in which clastic cells are formed and deposited on the root surface, initiating superficial root resorption (12,16), which may progress to resorption by substitution or ankylosis (12).
There is a low level of knowledge in the population and in the educational sector about the best actions to take after dental trauma (17,18), which may be due to inadequate attention in medical institutions (2) or to the knowledge barrier between dentists, physicians, teachers, coaches, etc. (3). This is observed because the avulsed teeth arrive at hospital centers or dental offices in dry storage or reimplantation is not considered. A person who has had an accident should be treated with first aid to save his life, but the initial treatment of an avulsion is not so complex, it only consists of reimplanting the avulsed tooth at the site of the accident (1).
Another important aspect of the loss of a front tooth in young patients who are still growing and developing, is that the avulsed tooth cannot be replaced by an implant, as this would give an unaesthetic result as the person's jaw grows. If the avulsed tooth is not repositioned, the alveolar ridge will collapse due to the lack of masticatory stimulus and when the patient is an adult, he/she will require bone grafting to achieve a stable alveolar process for an implant (1).
The purpose of this clinical case is to describe the clinical management of an avulsed tooth that was reimplanted 48 hours after avulsion to preserve tooth function and preserve the alveolar process, for placement of an osseointegrated implant in adult stage.

Case report

An 11-year-old female patient presented to the dental service of the Regional Military Hospital of Guadalajara, Mexico, with an

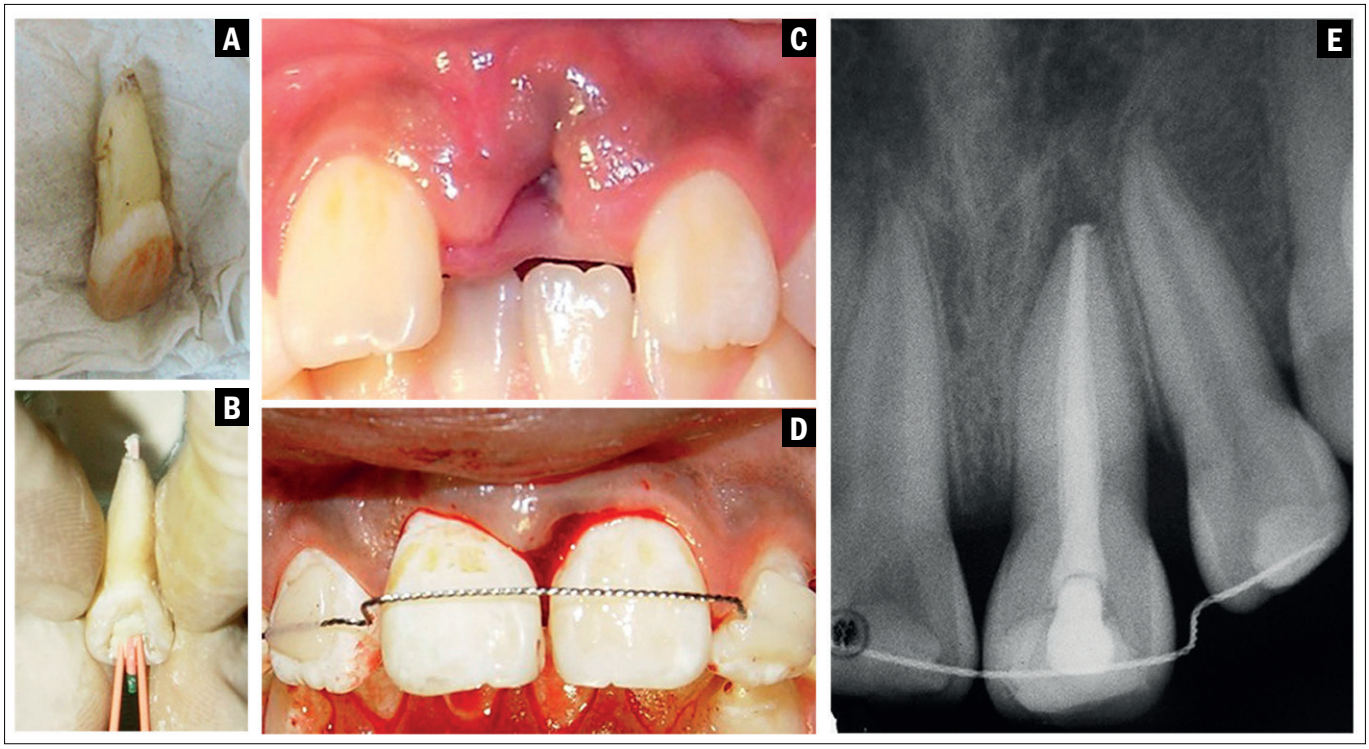

Figure 1
A) Avulsed tooth #21 transported in a paper napkin; **B)** extraoral root canal treatment; **C)** partial collapse of the socket after avulsion; **D)** replantation of tooth #21; **E)** radiographic aspect of the replanted tooth.

avulsion of the left upper central incisor (tooth #21) caused by a fall from a mechanical toy. The tooth was found at the scene of the accident after 24 hours; the parents kept the tooth in a dry paper napkin for a further 24 hours and it was then taken to the Endodontic Clinic (Figure 1A).

Clinical examination revealed a collapsed alveolar space (Figure 1B), healing, minimal swelling and mild pain. A conversation was held with the parents about the therapeutic options and their future prospects, which were to wait for the alveolar space to heal and to fabricate a temporary prosthesis. This option has the disadvantages of chewing, aesthetic and psychological impairment and in the absence of chewing stimulus for the development of the premaxilla, the alveolar process would collapse and bone grafting may be necessary in the future if an implant is considered in this area.

The other therapeutic option proposed was to re-implant the tooth, informing the patient and her parents that the tooth would be resorbed by root replacement due to the extraoral dry period. The advantage of this procedure is that the patient would regain masticatory stimulus in the region and the bone would maintain the normal thickness of the alveolar process by replacing the root, making it more receptive to a future implant. Aesthetically, the patient would retain her own natural appearance. It was explained to them that, with appropriate treatment, the tooth could remain in the mouth for several years, but that the prognosis was that sooner or later it would be resorbed. Both the patient and her parents decided to have the tooth re-implanted.

The tooth was examined and found to be free of fractures, fissures or debris; it was washed with 0.9% sodium chloride solution (Lab. Pisa, Guadalajara, México). The tooth was placed in 2.5% sodium hypochlorite solution for three minutes to remove necrotic tissue from the periodontal ligament and to disinfect it. It was conditioned with 2% sodium fluoride (Fluordent, Lab. Altamirano, México City, México) for 20 minutes.

Root canal treatment was performed extraorally (Figure 1C). Palatal access to the root canal was obtained using a #2 tungsten carbide bur at high speed and water spray irrigation. The cervical and middle thirds were enlarged with Gates-Glidden 2-4 drills (Maillefer/Dentsply, Ballaigues, Switzer-

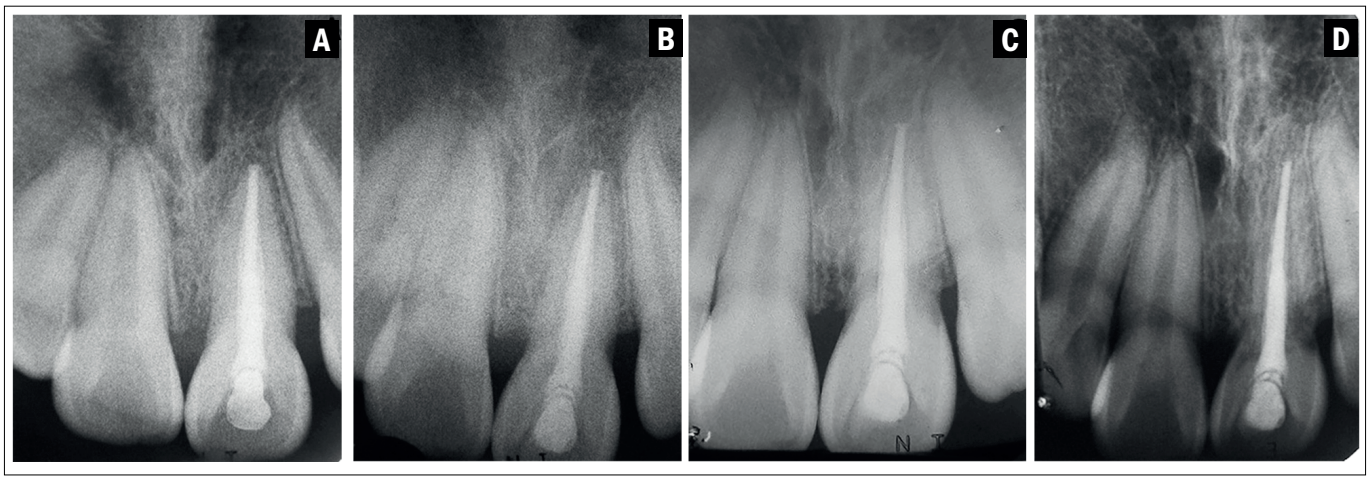

Figure 2
Radiographic controls of reimplanted tooth #21. **A)** 6 months - adequate evolution; **B)** 1 year - minimal areas of resorption; **C)** 2 years - larger areas of resorption; **D)** 3 years - resorption of approximately 50% of the root surface.

land) under copious irrigation with 2.5% NaOCl (Clorox, CDMX, Mexico). The root canal length was obtained by subtracting 1 mm from the length of a #20 K-file when its tip was visualised in the foramen. Chemomechanical preparation was performed with K files (Maillefer/Dentsply) up to file 50, irrigated with 2.5% sodium hypochlorite. The canal was dried with sterile coarse paper tips (Kerr, Glendora, USA). White MTA cement (Angelus, Londrina, Brazil) was prepared and delivered to the canal with a #40 Lentulo spiral 40 and gutta-percha cones (Hygenic, Akron, USA) were placed. Excess cones and cement were hot trimmed and the pulp chamber was irrigated with water. The coronal access was sealed with light-curing composite (3M Filtek, 3M Espe, St Paul, USA).

To alkalinise the root surface, the tooth was placed in a solution of distilled water mixed with MTA (Angelus) for 20 minutes while the alveolus to receive the reimplanted tooth was prepared. The patient was regionally anaesthetised with 3% mepivacaine without vasoconstrictor (Septodont, Saint-Maur-des-Fossés, France) and the clot present in the socket was gently removed with a curette (Septodont, Saint-Maur-des-Fossés, France) and the clot present in the alveolus was gently removed with a Lucas curette and rinsed with 0.9% saline solution, without carving the walls of the alveolus. The tooth was gently reimplanted in its own socket, its proper occlusion was verified and it was fixed with a semi-rigid splint made of 0.18 twisted orthodontic wire ligature (Dentaurum, Ispringen, Germany) from the right maxillary lateral incisor (tooth #12) to the left maxillary lateral incisor (tooth #22) with light-curing resin buttons (3M Filtek). Gentle digital compression was applied to the gingival tissues with moist sterile gauze for three minutes, to bring them as close to the root surface as possible (Figure1D). An analogue periapical radiograph (Kodak, Guadalajara, Mexico) was taken to verify adequate root position (Figure 1E). Amoxicillin 250 mg every 8 hours for 7 days and acetaminophen 150 mg every 8 hours for 5 days were prescribed, along with tetanus vaccination. After 8 days, the patient was asymptomatic, no mobility of tooth #21, and good stability of the splint; the gingival tissue showed mild inflammation.

After 2 months, tooth #21 had no mobility and the splint was removed. The gingival tissues were with no inflammation; radiographically there was no evidence of resorption or apical pathology, but slight widening of the periodontal ligament. At the 6-month control, radiographic absence of periodontal ligament space in the mesial root wall was observed, but no evidence of resorption (Figure 2A). Clinically, the gingival tissues were healthy and the tooth was immobile. At 8 months, radiographic resorption by substitution was observed in the distal wall of the middle third of the root, absence of periodontal space in the mesial wall, periapical area without radiolucent zone, as well as the beginning of resorption of the root apex.

At the clinical-radiographic control 1 year after reimplantation, the patient was as-

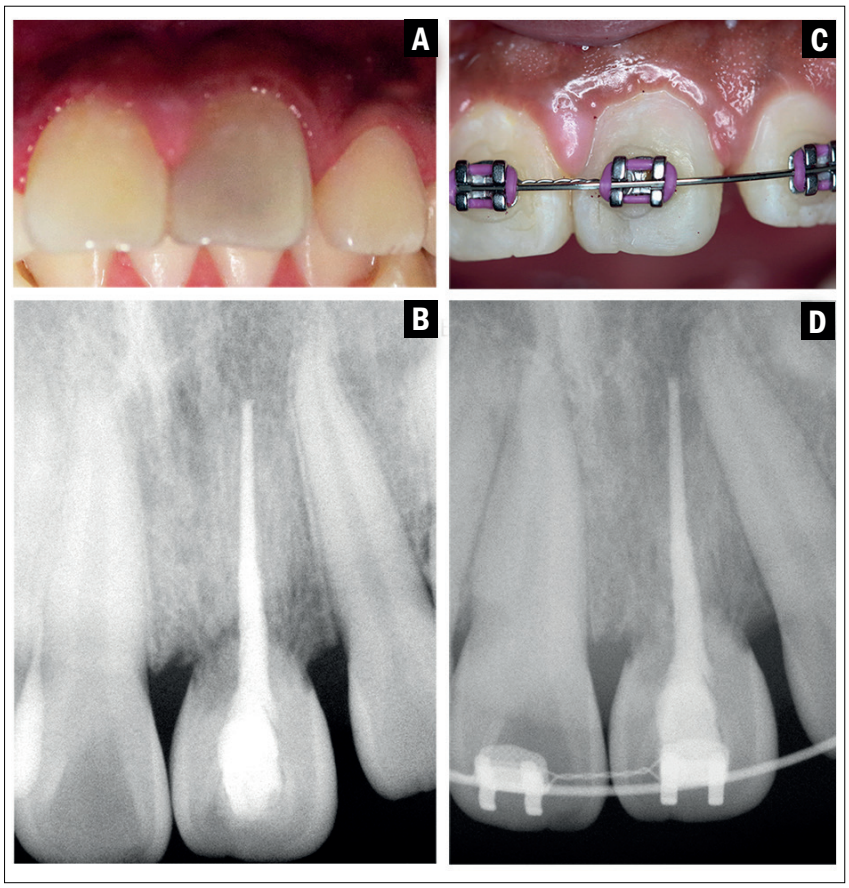

Figure 3
Clinical radiographic controls of tooth #21 after reimplantation. **A)** moderate darkening of tooth #21 (4 years); **B)** replacement resorption of more than 50% of the root surface (4 years); **C)** inflammation of the marginal gingiva of tooth #21 (5 years); **D)** replacement resorption of about 75% of the root surface (5 years).

ymptomatic, with no tooth mobility and adequate gingival tissue attachment. It was decided to change the composite because of the colour change caused by filtration. Radiographs showed loss of periodontal ligament space throughout the root, minimal areas of root resorption in the middle and apical third, absence of radiolucent zone, and loss of apical tooth structure (Figure 2B).

Two years after reimplantation, the patient remains asymptomatic in her clinical-radiographic control, with good tissue attachment, absence of inflammation, no sinus tract, and minimal inflammation of the marginal gingiva. Radiographically, there were more areas of apical root resorption, no visualisation of the radicular periodontal ligament space, and small radiolucent areas at the cervical level in the distal wall of tooth #21 (Figure 2C).

At the 3-year clinical and radiographic follow-up, the patient was asymptomatic with adequate gingival attachment, lack of mobility, and inflammation in the marginal gingiva of tooth #21. Radiographically, resorption by replacement of approximately 50% of the radicular surface was observed, with the presence of a radiolucent area in the distal and mesial wall at the level of the amelocemental junction (Figure 2D).

Four years after reimplantation, the patient was still asymptomatic, clinically there was a change in crown colour due to composite filtration and slight inflammation at the marginal gingival level in both incisors (Figure 3A). Radiographically, there was resorption due to replacement of more than 50% of the root surface, but areas of the root were still visible. Bone ingrowth was observed in the crown, as well as minimal radiolucent areas. (Figure 3B).

Four and a half years after the reimplantation, the patient began orthodontic treatment. Five years after the reimplantation, at the clinical-radiographic control and 6 months after the start of orthodontic treatment, there was inflammation of the marginal gingiva in both incisors, with no change in colour, no mobility, no pain and no sinuous tract (Figure 3C). The radiograph showed resorption by substitution in more than 80% of the root surface, as well as free gutta-percha in the alveolar space (without radiolucent areas), and small radiolucent areas in the clinical crown, however, but with the appearance of bone invagination in tooth #21 (Figure 3D).

6 years later, the patient was asymptomatic, without mobility, and continued with orthodontic treatment (minor movements). Dyschromia of the clinical crown of tooth #21, mild inflammation and minimal gingival invagination on the vestibular surface of tooth #21 was observed (Figure 4A). Radiographs showed resorption of approximately 90% of the root surface, no alveolar bone loss and minimal radiolucent areas in the clinical crown (Figure 4B).

Seven years after the reimplantation, the patient remained asymptomatic and compliant with her orthodontic treatment. Gingival inflammation and invagination in the marginal zone of tooth #21, dyschromia, and grade 1 mobility were observed (Figure 4C). The radiograph showed replacement resorption of approximately 95%

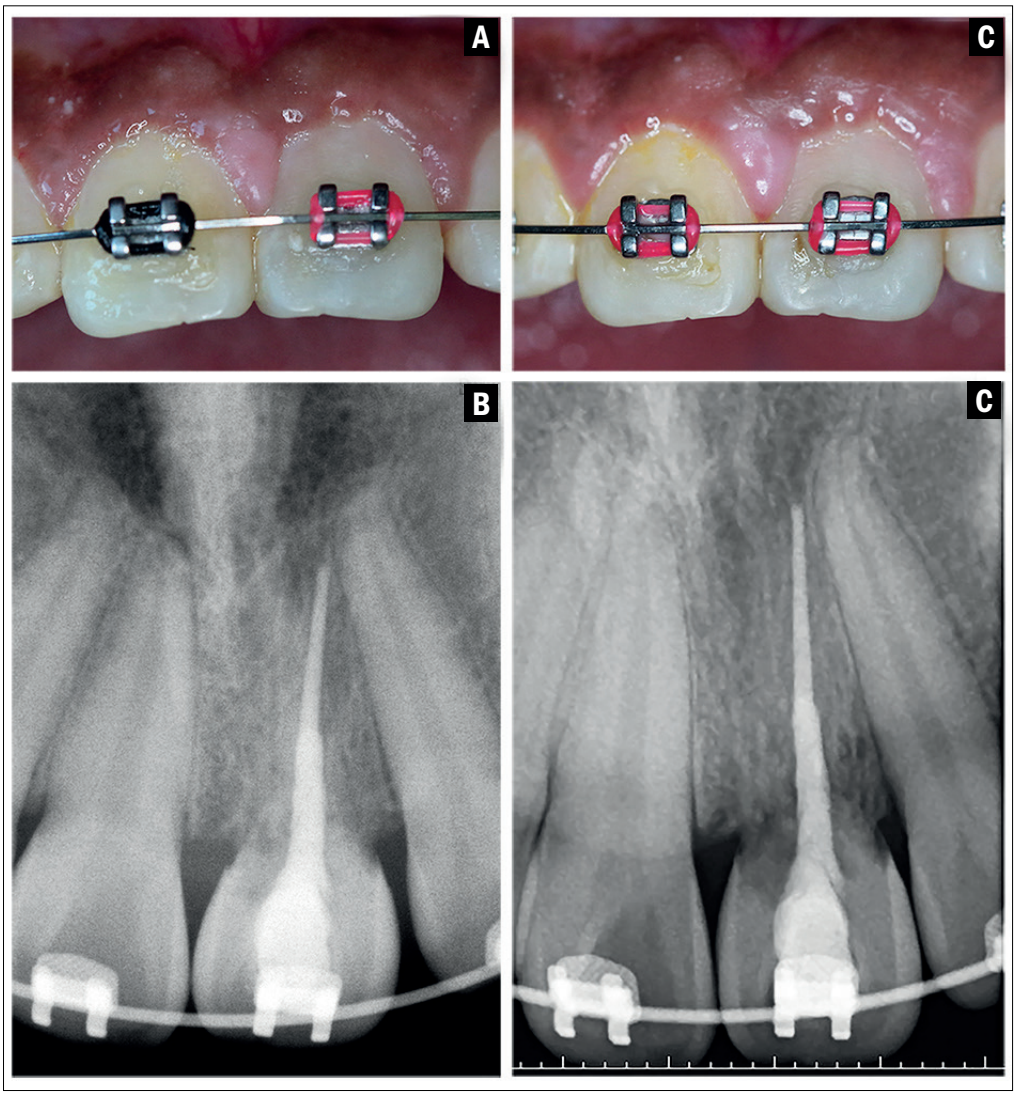

Figure 4
A) Moderate darkening of tooth #21 and marginal gingival inflammation (6-year control); **B)** replacement resorption of approximately 85% of the root surface (6 years); **C)** crown discolouration and increased marginal gingival inflammation (7 years); **D)** replacement resorption of approximately 95% of the root surface (7 years).

of the root surface, with bone ingrowth in the crown and radiolucent areas in the mesial and distal walls, suggesting intense osteoclastic activity on the reimplanted tooth (Figure 4D). At this appointment, it was recommended that the tooth be extracted and an implant placed. However, the patient did not accept this and preferred to keep the tooth.

The patient returned **11 years after reimplantation** with exaggerated mobility of tooth #21. On examination, the clinical crown was pinkish with gingival invagination on the vestibular surface and inflammation in both central incisors, more pronounced in tooth #21. The patient was without brackets as she had discontinued orthodontic treatment. Tooth #21 was in infraocclusion. It was painless but with intrusive mobility (Figure 5A); radiographically, no root structure is observed, as well as separation of the crown from the bone and minimal union with the gutta-percha, good level of the alveolar bone, absence of radiolucent areas and no adjacent pathology (Figure 5B). A CBCT was obtained and the sagittal and axial slices showed adequate bone formation with sufficient thickness for implant placement (Figures 5C and 5D). It was explained to the patient that it would be necessary to remove the coronary portion, the remaining gutta-percha and place an osseointegrated implant (Hiossen, Englewood Cliffs, USA) with an acrylic temporary (Figures 5C-5F). The patient consented and the procedure was completed.

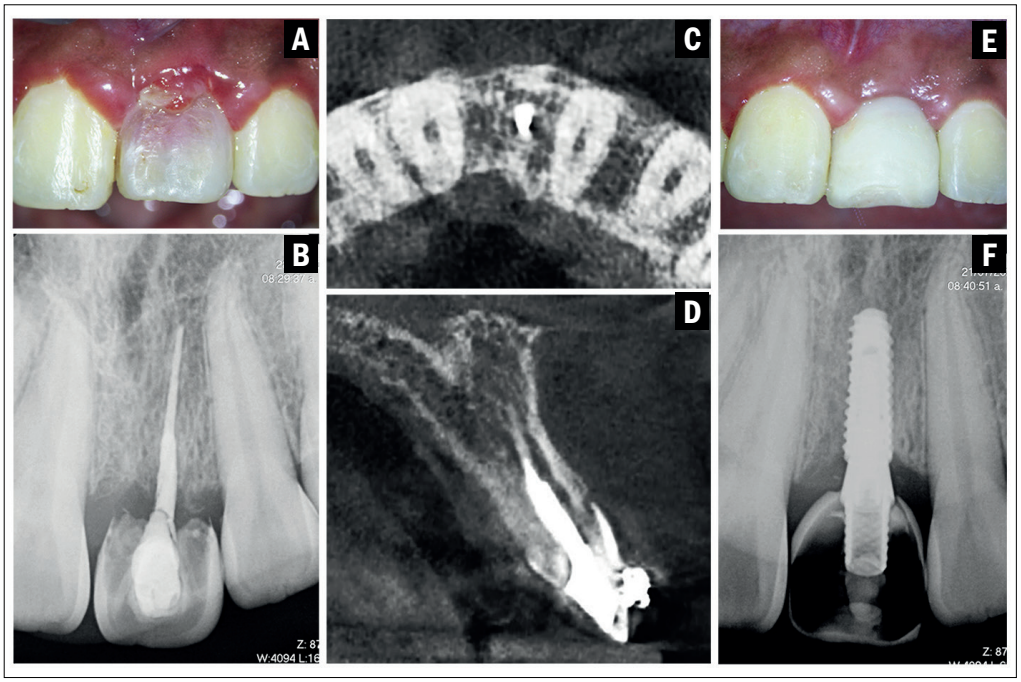

Figure 5
Control at 11 years. **A)** pink staining of the clinical crown of tooth #21 and inflammation with bleeding of the marginal gingiva; **B)** total resorption of the root; gutta-percha can be seen in the alveolar bone; **C)** axial CBCT section showing how the bone has replaced the root; **D)** sagittal CBCT section showing preservation of the vestibular and palatal alveolar bone; **E)** clinical aspect of the acrylic temporary on the implant (6 months); **F)** radiographic aspect of the osseointegrated implant in the space of tooth #21.

Discussion

According to the guidelines of the International Association of Dental Traumatology (IADT), avulsed teeth should preferably be reimplanted at the site of the accident (19, 20), and if this is not possible, it is recommended that they be taken immediately to the dentist and transported in saline solution. Other solutions such as Hank's solution (21), Viaspan, Dentosafe, contact lens solution, milk, Gatorade, saliva or drinking water can also be used (22, 23). In this case, the avulsed tooth had been dry for 48 hours prior to treatment, so it is assumed that necrosis of the periodontal ligament cells had occurred. For this reason, it was decided to perform the extraoral root canal treatment in the same session prior to reimplantation, taking into account the IADT protocol for post-trauma reimplantation (19, 20), which states that if the teeth are dry outside the socket for more than 60 minutes, the root canal treatment can be performed extraorally prior to reimplantation, since there is no possibility of revascularisation of the pulp tissue and the periodontal ligament is necrotic.
Despite the prognosis of root resorption, it was decided to reimplant the tooth, mainly because she was a young patient and because she met the three requirements of late reimplantation after trauma, which are to preserve the aesthetic, functional and psychological aspects of the patient (19), since the loss of the tooth could provoke bullying and unpleasant situations in her social environment. Similarly, due to her age, the purpose of reimplantation was to preserve the natural soft tissues, to allow bone formation as the tooth resorbed and to preserve the alveolus for an implant when the patient reached adulthood.
When a tooth is reimplanted late, it is clear that inflammatory resorption and ankylosis, characterised by fusion of the alveolar bone and cementum, will occur. Soares et al (2015) (24), in a retrospective study, found that replacement resorption was present in 87.2% of cases following late reimplantation. This is due to the absence of a viable periodontal ligament (25, 26). To prevent or delay the process of ankylosis and inhibit root resorption (27, 28), three aspects should be considered: first, root surface treatment, second, root canal treatment, and third, antibiotic therapy (29). Regarding the use of medication, tetracycline is considered the indicated antibiotic as it reaches adequate levels in the gingival crevicular fluid and can help to control resorption (27, 28), however, it could in-

crease tooth colour change in patients aged 12 years or younger (30), and as the patient was 11 years old, amoxicillin was preferred as the antibiotic of choice.
It has been reported that one of the main factors in external root resorption is the presence of necrotic remnants of the periodontal ligament (29), but this is a controversial aspect as different techniques and procedures have been recommended to clean the root surface, such as periodontal curettes, scalpel blades, diamond burs, sodium hypochlorite and even pumice stone to clean the root surface (31). In the present case, the tooth was first immersed in NaOCl and then in 2% sodium fluoride for 20 minutes to avoid mechanical damage to the root cementum by the instruments. Sauro et al (32) showed that dental hard tissues, when immersed in 5 to 10% sodium fluoride solutions, have the ability to become fluoride-containing biocrystals similar to hydroxyapatite.
Other studies have suggested sodium fluoride, stannous fluoride, tetracycline, citric acid, hypochlorous acid, calcium hydroxide, formalin, alcohol, bisphosphonates and even indomethacin to prevent root resorption (7). Fluoride is thought to act on the cement, converting hydroxyapatite to fluorapatite (32), which is harder, inhibits bacterial growth, and may delay osteoclast metabolism and activity (29).
However, there is no consensus on the fluoride, concentration and timing of application in late reimplantation. Zuhal (31) reported that a reimplanted tooth remained in the mouth for 16 years without external root resorption. They used a topical gel of 1.23% acid fluoride phosphate for 15 minutes followed by rinsing with saline. The tooth was kept in distilled water mixed with MTA cement and obturated in the same session with gutta-percha+MTA cement to alkalinise the external and internal root surfaces prior to reimplantation (33). Krug et al (35) describe the survival of an upper central incisor reimplanted for 18.5 years, in which the tooth was kept dry for 1 hour and in physiological solution for 3 hours. Prior to reimplantation, the tooth was immersed in 2% sodium fluoride for 20 minutes; root canal treatment was started at 14 days, medicated with calcium hydroxide and obturated at 3 months. Two years after reimplantation, resorption and ankylosis were observed clinically and radiographically, which progressed slowly, allowing functional retention of the teeth with favourable esthetics. Savas et al (25) treated two patients aged 8 and 10 years with avulsion of the maxillary central incisors; the teeth were outside the alveolus for 27 and 7 hours respectively, so endodontic treatment was performed extraorally, followed by reimplantation.
Clinical radiographic controls were performed at 18 months for the 8-year-old patient and at 12 months for the 10-year-old patient. During these control periods the teeth were stable, but with resorption by substitution and ankylosis. They consider that despite the long time out of the socket in an unsuitable (dry) environment, the teeth should be reimplanted, especially in patients in the growth and development phase.
Tattullo et al (34) state that the recruitment of bone stem cells and bone growth molecular factors to the area provides a means for tissue remodelling. It is possible that this management during tooth reimplantation may have favoured the 11-year permanence and alveolar bone preservation in the present case. The tooth was used to maintain the surrounding bone for the years required for the patient to receive an implant.
The long-term prognosis of late reimplanted teeth is poor and their survival uncertain, despite IDT guidelines on reimplantation. Currently there is no clear guidance on the treatment protocol for severe external root resorption due to a lack of clinical and scientific evidence. Sometimes it is based on personal judgments, as most of the available treatment options are in case series or individual reports. Therefore, the treatment plan should be based on clinical judgment of each individual case. The opinion of orthodontic, prosthodontic and endodontic specialists is usually required (37).
The progression of external resorption

depends on the conditions of each patient, including age and systemic factors that regulate bone remodelling. In adult patients their bone remodelling is slower, whereas younger people have a rapid bone metabolism. This means that the prognosis of a late reimplanted tooth is better in adult patients than in young patients (35).
The clinical advantage of reimplantation, even at a late stage, is that the alveolar ridge bone is preserved, allowing subsequent implant placement without the need for bone grafting, as in this case. In addition to the age of the patient, the immune response should be considered, which plays an important role in the outcome of reimplanted teeth after avulsion (36). Atopic patients have less tooth loss, whereas non-atopic patients have more root resorption during the first 5 years after trauma, although in this case the atopic or non-atopic status of the patient was not considered (38).
Regarding the long-term survival of reimplanted teeth, Sangiovanni et al. (39) carried out a systematic review of the literature and found a success rate of 87.2% of reimplanted teeth, confirmed a high degree of reproducibility of the treatment, and considered that the success of the treatment is favoured by the reduced extra-alveolar storage time of the reimplanted tooth.
They consider it to be a viable therapeutic option, with an adequate success rate and high predictability. The overall survival expectancy of a late replanted tooth is 50% after 5.5 years (7), similar to the 4.7 years reported by Pohl et al (40). However, Petrovic et al (41) reported it to be 2.5 to 5.5 years in immature teeth, but Wang et al (42) reported that it can last up to 11 years in fully developed roots, as reported in this case.
However, the present case was out of the mouth for 48 hours and yet the tooth was retained for 11 years before extraction and placement of an implant, although the tooth had already been resorbed for 7 years and had no mobility, the patient decided to wait until she had severe mobility, knowing that her tooth would have to be extracted.

Conclusion

Late reimplantation of the avulsed tooth allowed the tooth to remain functional for 11 years and provided a positive psychological impact to the patient while the tooth was in the mouth, in addition to preserving the alveolar bone for placement of an osseointegrated implant.

Clinical Relevance

Re-implantation of an avulsed tooth after a long period of dryness allows the child or adolescent to maintain their chewing physiology and grow without psychological problems, and although the tooth is resorbed after a while, the root space is occupied by physiological bone, allowing the placement of an implant in better biological conditions.

Conflict of Interest

None.

Acknowledgements

Grants PROSNII 2024 University of Guadalajara to NB and AC.

References

1 *Brüllmann D, Schulze RK, D'Hoedt B. The treatment of anterior dental trauma. Dtsch Arztebl Int. 2011;108:565–70.*
2 *Emerich K, Kaczmarek J. First aid for dental trauma caused by sports activities: state of knowledge, treatment and prevention. Sports Med. 2010;40:361–6.*
3 *Emerich K, Gazda E. Review of recommendations for the management of dental trauma presented in first-aid textbooks and manuals. Dent Traumatol. 2010; 26:212–6.*
4 *Day P, Duggal M. Interventions for treating traumatised permanent front teeth: avulsed (knocked out) and replanted. Cochrane Database Syst Rev 2010; 20: CD006542.*
5 *Naidoo S, Sheiham A, Tsakos G. Traumatic dental injuries of permanent incisors in 11- to 13-year-old South African school children. Dent Traumatol. 2009; 25:224–8.*
6 *Navabazam A, Farahani SS. Prevalence of traumatic injuries to maxillary permanent teeth in 9- to 14-year-old school children in Yazd, Iran Dent Traumatol. 2010;26:154–7.*
7 *Andreasen JO, Andreasen FM, Andersson L. Textbook and color atlas of traumatic injuries to the teeth. Oxford, UK: Blackwell Munksgaard; 2007.*

8 Trope M. Avulsion of permanent teeth: theory to practice. Dent Traumatol. 2011;27:281–94.
9 Rodd HD, Barker C, Baker SR, Marshman Z, Robinson PG. Social judgements made by children in relation to visible incisor trauma. Dent Traumatol. 2010; 26:2–8.
10 Fakhruddin KS, Lawrence HP, Kenny DJ, Locker D. Impact of treated and untreated dental injuries on the quality of life of Ontario school children. Dent Traumatol. 2008;24:309–13.
11 Lars A. Epidemiology of traumatic dental injuries. J Endod. 2013;39:S2–S5
12 Shaul Lin, Dvorah Schwarz-Arad, Malka Ashkenazi. Alveolar bone width preservation after decoronation of ankylosed anterior incisors. J Endod. 2013;39:1542–4.
13 American Association of Endodontics (AAE). Glossary of Endodontics terms. IX ed, 2016.
14 Coste SC, Silva EF, Machado LCS, Barbato DAF, Souza MLC, Colosimo EA, Bastos JV. Survival of replanted permanent teeth after traumatic avulsion. J Endod. 2020;46:370–5.
15 Krastl G, Weiger R, Filippi A, Van Waes H, Ebeleseder K, Ree M, Connert T, Widbiller M, Tjderhane L, Dummer PMH, Galler K. Endodontic management of traumatized permanent teeth: a comprehensive review. Int Endod J. 2021;54:1221–45.
16 Fuss Z, Tsesis I, Lin S. Root resorption - Diagnosis, classification and treatment choices based on stimulation factors. Dent Traumatol. 2003; 19:175-82.
17 Tewari N, Sultan F, Mathur VP, Rahul M, Goel S, Bansal K, Chawla A, Haldar P, Pandey RM. Global status of knowledge for prevention and emergency management of traumatic dental injuries in dental professionals: systematic review and meta-analysis. Dent Traumat. 2021;37:161–176.
18 Tewari N, Goel S, Srivastav S, Mathur VP, Rahul M, Haldar P, Ritwik P, Bansal K. Global status of knowledge of parents for emergency management of traumatic dental injuries: a systematic review and meta-analysis. Evid Based Dent. 2023;24:91.
19 Andersson L, Andreasen JO, Day P, et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries. 2. Avulsion of permanent teeth. Dent Traumatol. 2012; 28:88-96.
20 Bakland L. Dental Trauma Guidelines. J Endod. 2013;39:S6–S8
21 Fouad AF, Abbott PV, Tsilingaridis G, Cohenca N, Lauridsen E, Bourguignon C, et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 2. avulsion of permanent teeth. Dent Traumatol. 2020;36:33142
22 Trope M. Clinical management of the avulsed tooth: present strategies and future directions. Dent Traumatol. 2002;18:1-11.
23 Gopikrishna V, Baweja PS, Venkateshbabu N, Thomas T, Kandaswamy D. Comparison of coconut water, propolis, HBSS, and milk on PDL cell survival. J Endod. 2008;34:587-9.
24 Soares AJ, Souza GA, Pereira AC, Vargas-Neto J, Zaia AA, Silva EJ. Frequency of root resorption following trauma to permanent teeth. J Oral Sci. 2015;57:73–8.
25 Savas S, Kucukyilmaz E, Akcay M, Koseoglu S. Delayed replantation of avulsed teeth: two case reports. Case Rep Dent. 2015;2015:197202.
26 Karayilmaz H, Kirzioglu Z, Gungor OE. Aetiology, treatment patterns and long-term outcomes of tooth avulsion in children and adolescents. Pak J Med Sci. 2013; 29:464-8.
27 Lavda M, Clausnitzer CE, Walters JD. Distribution of systemic ciprofloxacin and doxycycline to gingiva and gingival crevicular fluid. J Periodontol. 2004;75: 1663-7.
28 Sae-Lim V, Wang CY, Choi GW, Trope M. The effect of systemic tetracycline on resorption of dried replanted dogs' teeth. Endod Dent Traumatol. 1998;14:127-32.
29 Panzarini SR, Gulinelli JL, Poi WR, Sonoda CK, Pedrini D, Brandini DA. Treatment of root surface in delayed tooth replantation: a review of literature. Dent Traumatol. 2008; 24:277–82.
30 Sanchez AR, Rogers RS 3rd, Sheridan PJ. Tetracycline and other tetracycline-derivative staining of the teeth and oral cavity. Int J Dermatol. 2004; 43: 709-15.
31 Kırzıoglu Z, Güngör OE, Erdogan Y. 16-Year follow-up of an avulsed maxillary central incisor after replantation following 10-h storage: An unusual case. Spec Care Dentist. 2017;37:199-203.
32 Sauro S, Spagnuolo G, Giudice C, Andrade Neto DM, Fechine PBA, Chen X, Rengo S, Chen X, Feitosa VP. Chemical, structural and cytotoxicity characterisation of experimental fluoride-doped calcium phosphates as promising remineralising materials for dental applications. Dent Mater. 2023; 39:391-401.
33 D'Anto V, Di Caprio MP, Ametrano G, Simeone M, Rengo S, Spagnuolo G. Effect of mineral trioxide aggregate on mesenchymal stem cells. J Endod. 2010; 361:1839-43.
34 Tatullo M, Riccitiello F, Rengo S, Marrelli B, Valleta R, Spagnuolo G. Management of endodontic and periodontal lesions: the role of regenerative dentistry and biomaterials. Dent J. 2020;32:1-5.
35 Krug R, Kremeier K, Krast G. Long-term retention of avulsed maxillary permanent incisors replanted after prolonged non-physiological storage. Dent Traumatol. 2019;35:147–52.
36 Mathews DP, Spear FM. Long-term management of avulsed "hopeless" teeth in the adult dentition. J Esthet Restor Dent. 2021;33:127–34.
37 Patel S, Saberi N, Pimental T, Teng PH. Present status and future directions: Root resorption. Int Endod J. 2022;55(Suppl.4):892–921.
38 Roskamp L, Silva Neto UX, Carneiro E, Fariniuk LF, Westphalen VPD. Influence of atopy the outcome of avulsed and replanted Teeth during 5 Years of Follow-up. J Endod. 2017;43:25–8.
39 Sangiovanni G, Scelza G, Giordano F, Chiacchio A, Ferrigno R, Rengo C, Pisano M. Intentional replantation in endodontics: review of literature. Giornale Italiano di Endodonzia. 2021;35:151-62.
40 Pohl Y, Wahl G, Filippi A, Kirschner H. Results after replantation of avulsed permanent teeth: III—tooth loss and survival analysis. Dent Traumatol. 2005;21:102–10.
41 Petrovic B, Markovic D, Peric T, Blagojevic d. Factors related to treatment and outcomes of avulsed teeth. Dent Traumatol. 2010;26:52–9.
42 Wang G, Wang C, Qin M. A retrospective study of survival of 196 replanted permanent teeth in children. Dent Traumatol. 2019;35:251–8.