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## What can we do with a dental avulsion? A multidisciplinary Clinical Protocol

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### Abstract

**Purpose:** The aim of this case report was to explain a multidisciplinary and conservative approach carrying out the replantation of an avulsed closed apex central incisor stored in dry conditions for a 16-hour period from the moment of trauma.

**Case report:** This report describes a case of a 28 year-old male who suffered contusion of the upper lip, avulsion of right upper central incisor, enamel cracks after trauma of left upper central incisor and upper left lateral incisor crown fracture due to an accident. Avulsed tooth was dry stored and it was replanted 16h after the trauma. The root was disinfected and the necrotic periodontal tissue removed, the endodontic treatment was done before replantation and a flexible splint was applied to tooth 13 to tooth 23. Two months later a contralateral tooth presented crown discoloration occurred due to pulp necrosis an endodontic treatment as well as bleaching were carried out. An esthetic restoration for lateral incisor crown fracture was also done. In the one year review the patient remains asymptomatic, with no signs of root resorption or ankylosis of the damaged teeth.

**Conclusions:** A conservative approach of tooth with delayed reimplantation can be a stable and functional with the appropriate treatment procedures. A clinical protocol for patients and professionals for the treatment of the avulsed tooth is proposed.

**Key words:** Endodontics, dental avulsion, avulsed tooth protocol.

## 01 Introduction

02 Dental avulsion is described as a complete displacement  
03 of a tooth from its socket in the alveolar bone, and it is  
04 one of the most traumatic dental injuries which origi-  
05 nates exposure of the cells of the periodontal ligament  
06 to the external environment as well as disruption of the  
07 blood supply to the pulp (1-6); resulting in a ischemic  
08 damage to the pulp tissue and periodontal ligament tis-  
09 sue (7,8). Avulsion of permanent teeth is seen in 0.5% to  
10 3% (9,10) or 1-11% (11,12) of all dental injuries depen-  
11 ding on the studies, being maxillary central incisors the  
12 most frequently affected tooth (13,14).

13 The factors that most influence the prognosis and out-  
14 come of replantation of the avulsed tooth are tooth de-  
15 velopment as well as extra-alveolar storage time and  
16 medium type (15). An appropriate storage medium as  
17 Hank's balanced salt solution, saline, milk or saliva en-  
18 sures the viability of the periodontal ligament cells pre-  
19 sent on the root surface (6).

20 If the avulsed tooth has closed apices, it is recommen-  
21 ded an elective root canal treatment if it is replanted  
22 (9,10,16-19). The treatment of choice is usually as fol-  
23 lows: in most cases endodontic treatment is performed  
24 (10, 20) and antibiotic is normally prescribed. The pa-  
25 tient is also instructed in diet, recommending soft food,  
26 and oral hygiene (10). Once the tooth has been reposi-  
27 tioned in the socket, it is normally splinted and occlusion  
28 relieved to prevent root resorption (10,21).

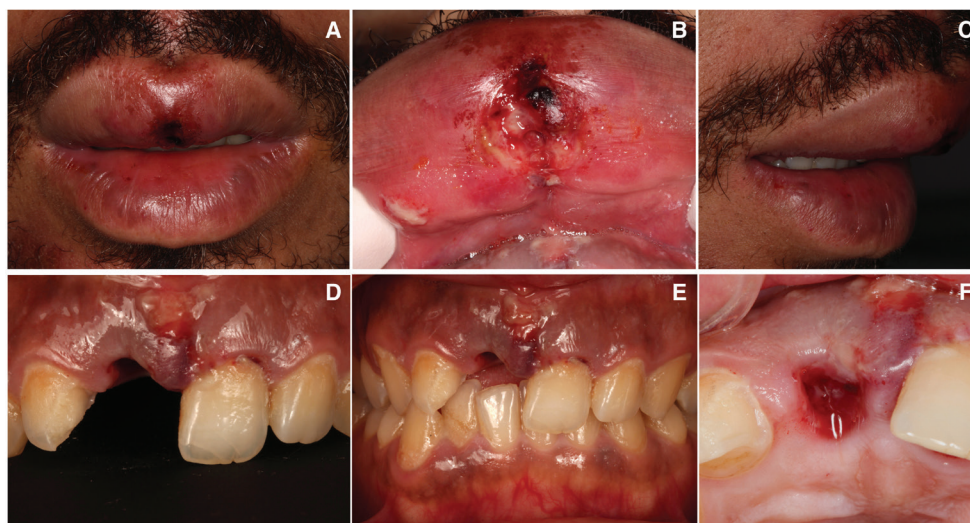
29 Post-traumatic complications can occur deferred over  
30 time and can affect not only the tooth but also the su-  
31 pporting structures. Those ones could be: root resorp-  
32 tion, pulp canal obliteration or pulp necrosis as well as  
33 soft tissue injuries or bone fractures, being pulp necrosis  
34 the most common post-traumatic complication (22,23).

This case report explains a multidisciplinary and con-  
servative approach carrying out the replantation of an  
avulsed closed apex central incisor stored in dry condi-  
tions for a 16-hour period from the moment of trauma,  
avoiding more complex and less immediate treatments  
such as implants, and giving conservative solution to  
complications that can occur deferred over time.

## Case Report

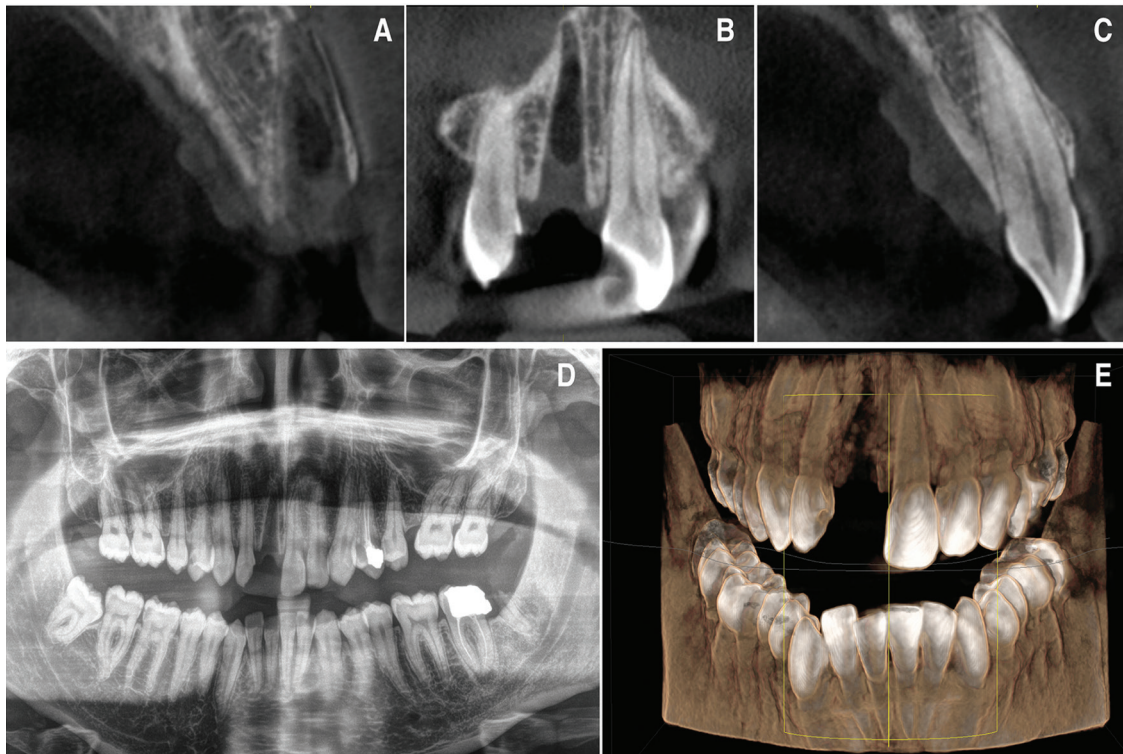
A healthy 28-year-old man visited the dental clinic with  
the upper right central incisor avulsed 16 hours after an  
accidental fall. The patient went to the hospital's medical  
emergency services and there his soft tissues and mucous  
membranes were disinfected, but did not reposition the  
avulsed tooth. The tooth had been kept in milk, except for  
the two hours prior to the clinical visit. The patient delive-  
red it on a paper napkin and completely dehydrated. After  
the clinical examination, photos and Cone Beam Compu-  
ted Tomography (CBCT) scan it was observed contusion  
of the upper lip (Fig. 1A-C), avulsion of the right upper  
central incisor (Fig. 1D-F), enamel cracks after trauma  
of left upper central incisor and upper left lateral incisor  
crown fracture, according to Andreasen's classification  
which was also confirmed by the X- ray periapical study,  
CBCT scan (WhiteFox, Acteón Médico-Dental Ibérica  
S.A.U.-Satelec, Merignac, France) with the following ex-  
posure parameters: 105.0 kilovolt peak, 8.0 milliamperes,  
7.20 s, and a field of view of 15 × 13 mm. (Fig. 2) and  
both thermal (Endo-Ice; Coltène/Whaledent, Lezennes,  
France) and electrical pulp tests (Parkell; Edgewood, NY,  
USA). As for the alveolar classification was a type 1, pre-  
senting all the bone plate preserved.

Initially, the avulsed tooth was cleaned carefully with  
sterile saline serum (Braun, Jaén, Spain) (Fig. 3A). Du-

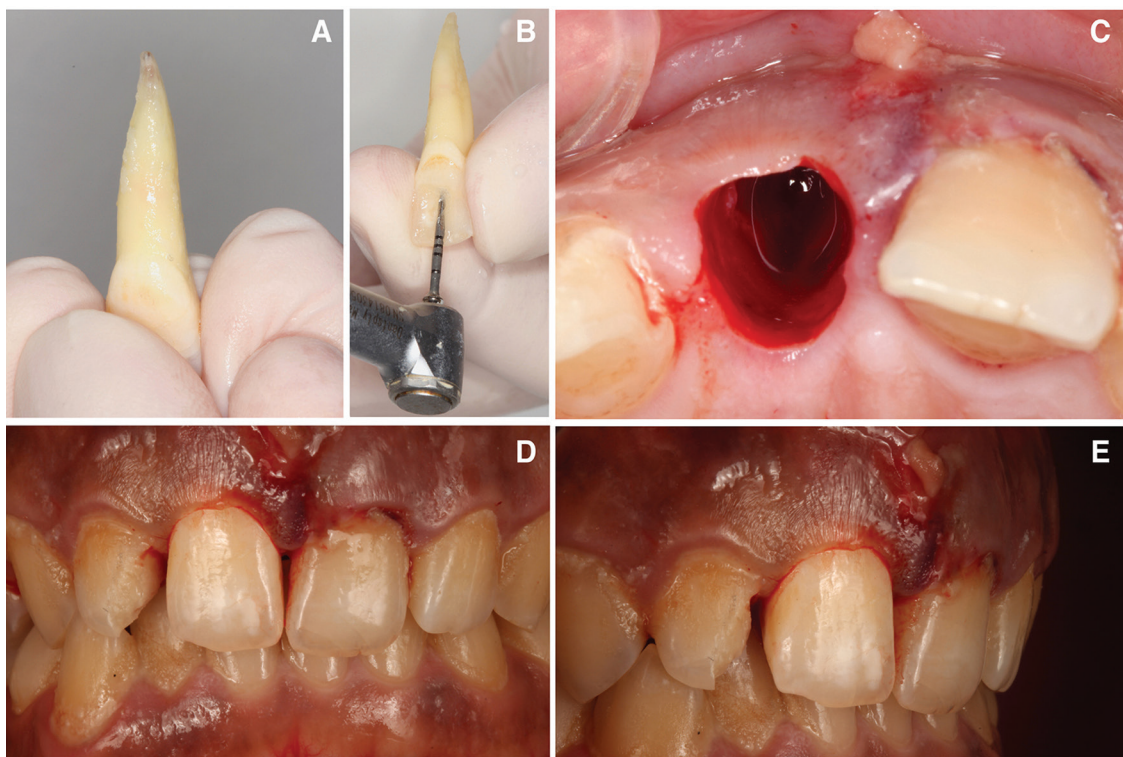


**Fig. 1:** A,B,C) Upper lip contusion from different points of view. D,E) Avulsion of right upper central incisor. F) Socket healing after dental avulsion.





**Fig. 2:** Pre-treatment radiographic study. A) Axial tomographic cut of the socket after the avulsion of the right upper incisor. B) Coronal view of the socket after the avulsion. C) Axial tomographic cut of the upper left incisor. D) Initial orthopantomography after tooth avulsion. E) 3D reconstruction of the patient's bone jaws and teeth following dental trauma.

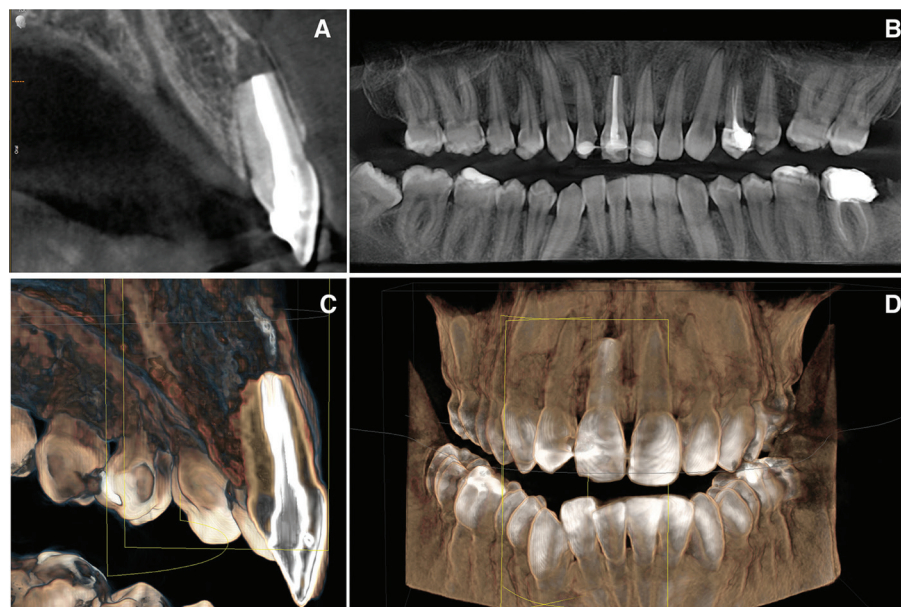


**Fig. 3:** A) Avulsed tooth cleaned. B) Extraoral endodontic treatment. Access cavity preparation. C) Socket activated causing bleeding before intentional replantation. D,E) Tooth placed into his socket and splinted temporarily with orthodontic wire.

ring the clinical procedure the tooth was taken by its anatomical crown to prevent root surface damage. Subsequently, the endodontic access cavity was performed to allow a straight access to the root canal system. The working length of the root canal was established using a direct method, by subtracting 1mm from the actual root length determined by introducing a 10/02 K-file (Dentsply Maillefer, Ballaigues, Switzerland) until it was visible through the apical foramen. Subsequently, extraoral root canal treatment was performed using a R25 reciprocating endodontic file (Reciproc; VDW, Munich, Germany) and irrigated with 5 ml of 5.25% sodium hypochlorite (NaOCl) (Clorox; Oakland, CA, USA), 5 ml of 17% ethylenediaminetetraacetic acid (EDTA) (Smear-Clear; SybronEndo, CA, USA), and 5 ml of sterile saline solution (Braun, Jaén, Spain) using an endodontic needle (Miraject Endo Luer; Hager & Werken, Duisburg, Germany) with a diameter of 0.3 mm inserted 1 mm into the working length (Fig. 3B). The contact between the irrigating solution and the surface of the root canal walls was enhanced by using an ultrasonic tip (IRRI S, VDW®, Munich, Germany). Afterwards, the root canal system was dried with sterile paper points (Dentsply Maillefer, Ballaigues, Switzerland) and finally, each root canal system was sealed using a warm gutta-percha system (Calamus, Dentsply Maillefer, Ballaigues, Switzerland) and an epoxy-amine resin-based sealer (AH Plus, Dentsply DeTrey, Konstanz, Germany) until the cemento-enamel junction. Furthermore, the access cavity was filled with a direct composite resin restoration (Filtek Supreme XTE, 3M™, MN, USA). Then, an apicectomy

were carried out, removing the apical 3mm from the apex. A 3mm retrocavity was designed by means of an ultrasonic diamond tip (Ref.: PUSURG #2, ProUltra®, Dentsply Maillefer®, Ballaigues, Switzerland). and the retrocavity preparation was sealed with mineral trioxide aggregate as root-end filling material (ProRoot® MTA white, Dentsply Tulsa Dental®, Tulsa, UK).

Replanted tooth was performed using infiltrative anaesthesia with lidocaine 2% and 1:100000 epinephrine (Artinibsa; Inibsa, Lliça de Vall, Barcelona, Spain). The alveolar socket was activated causing bleeding (Fig. 3C) before intentional replantation. The activation of the socket was carried out because the clot had already been established. The tooth was replaced into his alveolar socket (Fig. 3D,E) and splinted for 15 days with an orthodontic wire from 13 to 23 (Onlyorto, S.L., Barcelona, Spain) and composite resin (Filtek Supreme XTE, 3M™, MN, USA). Occlusal stops were also placed in tooth 4.6 and 3.6 to prevent occlusal contacts due to patient overbite. Antibiotic treatment was prescribed (Augmentine®, GSK, 80 G, Brentford, United Kingdom) with analgesics (Dexketoprofen 25 mg, Menarini S.A., Barcelona, Spain), for one week. The patient was instructed in oral hygiene accompanied by chlorhexidine rinses and soft diet. The patient was scheduled for follow-up appointments at 1, 3, 6, 12 months in order to assess the clinical and radiographic evaluation of the treatment. At the 12 months follow-up visit, the patient remained asymptomatic and CBCT scan (WhiteFox, Acteón Médico-Dental Ibérica S.A.U.-Satelec, Merignac, France) was performed (Fig. 4).

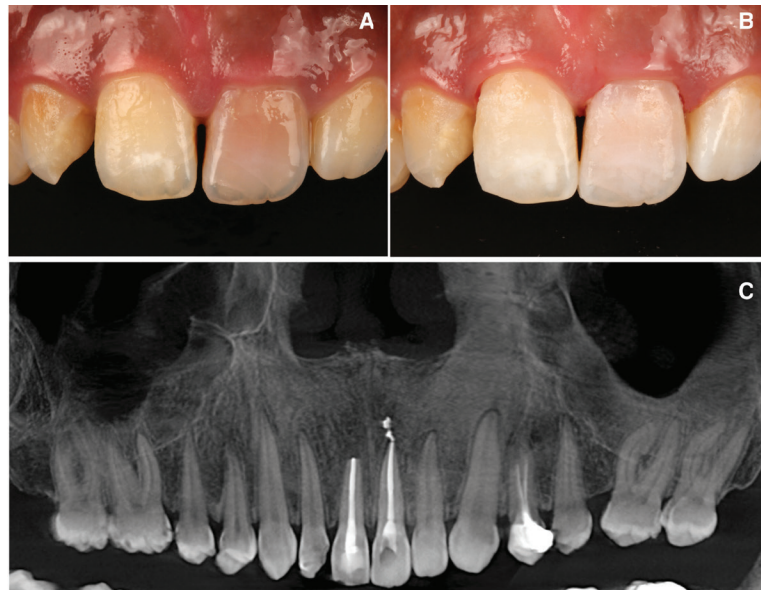


**Fig. 4:** Radiographic study after replantation of the avulsed tooth. A) Axial tomographic cut of the upper right incisor replanted in the socket. B) Orthopantomography after tooth replantation. C) 3D axial reconstruction of the right upper incisor replanted. D) 3D reconstruction of the patient's bone jaws and teeth after tooth replantation.



Three months after the replanted tooth, the upper left central incisor presented crown discoloration (Fig. 5A). The tooth was non-sensitive to both thermal (Endo-Ice; Coltène/Whaledent, Lezennes, France) and electrical pulp tests (Parkell; Edgewood, NY, USA). Periapical radiographs were taken to confirm the diagnosis of pulp necrosis. Root canal treatment was performed using infiltrative anaesthesia with lidocaine 2% and

mm inserted 1 mm into the working length. The contact between the irrigating solution and the surface of the root canal walls was enhanced by using an ultrasonic tip (IRRI S, VDW®, Munich, Germany). Afterwards, the root canal system was dried with sterile paper points (Dentsply Maillefer, Ballaigues, Switzerland) and finally, each root canal system was sealed using a warm gutta-percha system (Calamus, Dentsply Maillefer, Ba-



**Fig. 5:** A) Contralateral tooth crown discoloration due to pulp necrosis. B) Contralateral crown bleaching due to crown discoloration after a pulp necrosis. C) Post treatment orthopantomography.

1:100000 epinephrine (Artinibsa; Inibsa, Lliça de Vall, Barcelona, Spain). Rubber dam (Hygenic Dental Dam; Coltene Whaldent Gruppe, Altstätten, Switzerland) was disinfected with a povidone-iodine solution (Betadine; Meda, Solna, Sweden). Subsequently, the pulp chamber was opened to enable access to the root canal system. Root canal system instrumentation was performed with a 10/.02 K-file (Dentsply Maillefer, Ballaigues, Switzerland), and 1 ml of sterile saline solution (Braun, Jaén, Spain) was used to irrigate the canal and detach any bacteria adhered to dentin. The working length of the root canal system was determined using an electronic apex locator (Raypex 6; VDW, Munich, Germany) and verified with a working length radiograph using a 20/.02 K-file (Dentsply Maillefer, Ballaigues, Switzerland). The root canal system was prepared using an R25 reciprocating endodontic file (Reciproc; VDW, Munich, Germany) and irrigated with 5 ml of 5.25% NaOCl, 5 ml of 17% EDTA (SmearClear; SybronEndo, CA, USA), and 5 ml of sterile saline solution (Braun, Jaén, Spain) using an endodontic needle (Miraject Endo Luer; Hager & Werken, Duisburg, Germany) with a diameter of 0.3

mm inserted 1 mm into the working length. The contact between the irrigating solution and the surface of the root canal walls was enhanced by using an ultrasonic tip (IRRI S, VDW®, Munich, Germany) until the cemento-enamel junction.

Furthermore, the access cavity was filled with a temporary restoration (Fermi, Liechtenstein, Ivoclar Vivadent). An internal-external bleaching of that tooth was subsequently carried out using 35% hydrogen peroxide (Philips Zoom WhiteSpeed, Royal Philips, Amsterdam, Holanda) combining with photoactivation using a LED lamp (Lamp Philips Zoom WhiteSpeed, Royal Philips), lasting 15 minutes in three applications. At the end of the first clinical session sodium perborate (Endoperox, Septodont) was placed inside the pulp chamber and it was sealed with the same provisional seal. Between clinical sessions had to pass 14 days and a second clinical session was held again, also of three photoactivated applications for fifteen minutes. Again sodium perborate was placed inside the pulp chamber for seven days and the temporary seal was put back (Fig. 5B,C). A week later it was checked if an harmonic tooth color had been reached with adjacent teeth and since this had been achieved, sodium perborate was removed again. In addition, a

01 piece of cotton was placed inside the pulp chamber and  
 02 a new temporary seal was made. Furthermore, the access  
 03 cavity was filled with a direct composite resin restora-  
 04 tion (Filtek Supreme XTE, 3M™, MN, USA). The pa-  
 05 tient was scheduled for follow-up appointments at 1, 3,  
 06 6 and 12 months in order to assess the evaluation of the  
 07 treatment. At the 12 months follow-up visit, the patient  
 08 remained asymptomatic and periapical radiograph and  
 09 CBCT scan (WhiteFox, Acteon Médico-Dental Ibérica  
 10 S.A.U.-Satelec, Merignac, France) was performed. Six  
 11 months after the intentional replantation the occlusal  
 12 stops were removed (Fig. 6).

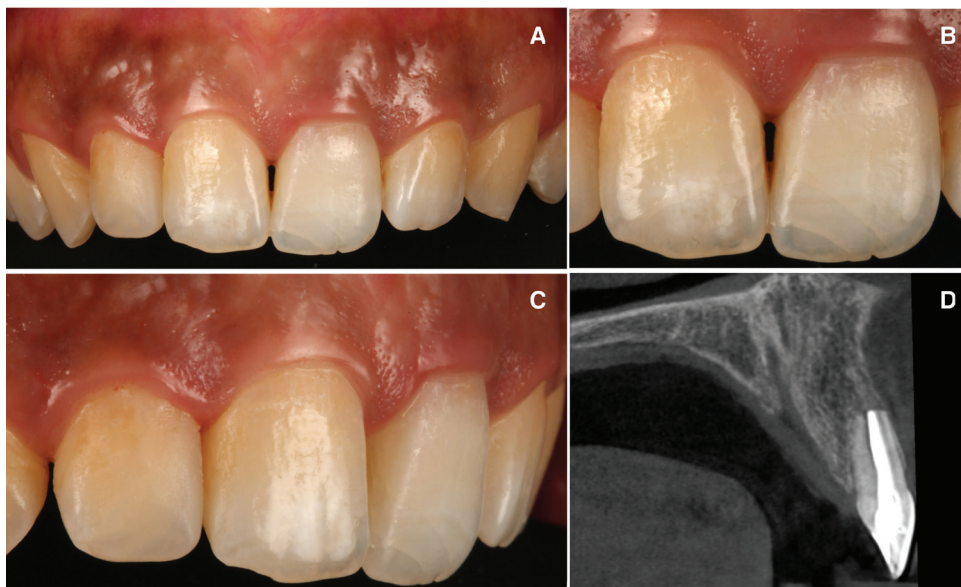


Fig. 6: A,B,C) Post treatment clinical image. D) Axial tomographic cut of the upper right incisor in the bone socket after 1 year of treatment.

## Discussion

01 Dental avulsion treatment is complex (6), due to the fact  
 02 that it is influenced by many different factors. The most  
 03 influential factor is the periodontal ligament cells con-  
 04 dition at the moment of the replantation, which in many  
 05 cases are nonviable and are not expected to heal.  
 06 Unfortunately when such a traumatic accident occurs,  
 07 an avulsed tooth manage is usually unknown (15). In  
 08 this case patient was treated on the hospital's medical  
 09 emergency services but he did not receive any dental  
 10 treatment, so the tooth was replanted 16h after trauma.  
 11 Due to the amount of hours passed and the inadequa-  
 12 te treatment of the root surface and excessive dehydra-  
 13 tion, the attached nonviable soft tissue was removed  
 14 carefully (6,25). Thus, given the long delay in the re-  
 15 plantation and the unfavorable storage conditions, this  
 16 was a bad prognosis case. This is due to changes that  
 17 occur in both the pulp and periodontal ligament, which  
 18 will be decisive in the preservation or loss of the avulsed  
 19 tooth. There are different clinical factors on which the  
 20 treatment to be performed will depend: 1) time of tooth

out of the mouth (extraoral period), 2) state of the perio-  
 dontal ligament (conservation medium) and 3) degree of  
 root development.

In this case, revascularization was not expected due to  
 the closed apex. Extraoral root canal treatment is recom-  
 mended in the International Association of Dental Trau-  
 matology (IADT) guidelines prior to the replantation of  
 the tooth (6,25,26), and this is exactly what was done.  
 Then, the apicoectomy was carried out and the root end  
 was obturated with mineral trioxide aggregate (Proroot  
 MTA, Dentsply Sirona, Bensheim, Deutschland), the  
 socket was activated and the incisor replanted.

In these kinds of pathologies root resorption is consi-  
 dered a risk (10,16,17,27). Added to this is the increa-  
 sed risk from the bleaching treatment performed (28).  
 Further risks include abscess formation, pulp necrosis  
 and ankylosis. Complications can be deferred over time  
 and other teeth that have been able to receive trauma  
 may show pathological signs long after the accident, so  
 they should be examined. Two months after the initial  
 treatment contralateral tooth presented crown discolora-  
 tion due to pulp necrosis. A conservative treatment was  
 carried out, endodontic treatment as well as internal and  
 external whitening were performed. In this way more  
 invasive treatments such as veneers or crowns were  
 avoided, respecting the dental structure to the fullest.  
 Although in this case they have not been observed,  
 ankylosis of the root to the alveolar bone as well as root  
 resorption are the most common complications after  
 replantation (6,28,29). It should be considered that in  
 adults, ankylosed teeth are able to remain functional for  
 many years due, in particular, to the slow rate of bone re-  
 modeling (28,30-33). This is why it was decided to take

the risk of ankylosis before performing a more invasive treatment such as implant replacement of the tooth.

Therefore, on the basis of the present clinical case, a conservative treatment protocol for the avulsed tooth is presented, depending on the extraoral time elapsed and the amount of root development:

If the extraoral time is short, less than one hour there can be cellular vitality, so treatment will depend on root development. The tooth must be manipulated by the crown to avoid further injuring the periodontal ligament, as well as it must be continuously moist. Only if the root surface appears contaminated should it be cleaned with physiological serum.

•When the apex is open, revascularization and apical closure are possible. Therefore, immature teeth with extraoral period less than one hour should be inserted into a doxycycline solution before being immediately replanted, which could improve revascularization.

•Although in teeth with closed apex there is no possibility of revascularization, if extraoral time is short, the chances of periodontal healing are acceptable. The steps to be performed are as follows: Cleaning the root surface with

physiological serum, replant with slight pressure, because if it is strong it could affect the cells of the periodontal ligament and increase the probabilities of ankylosis.

When the tooth spends an extraoral time longer than sixty minutes, cell necrosis occurs. That is why in all cases endodontic treatment should be performed.

•If the tooth has an open apex when avulsion occurs a gentle cleansing of the periodontal ligament should be carried out. Subsequently performing an apexification treatment and a reimplantation.

•Instead if the avulsed tooth has the apex closed, after a gentle cleansing of the periodontal ligament it should be done an extraoral endodontic treatment and apicectomy using MTA and the consequent replantation (34).

In all cases if there is bone fracture, it should be attempted to reduce. As well as if there are lesions in the soft tissues, they should be sutured, especially in the cervical margin.

In the same way in all cases oral hygiene instructions, chlorhexidine rinses, soft diet recommendations should be given. Antibiotic and analgesic treatment must also be provided. And ferulization of the avulsed tooth should be performed to prevent ankylosis (Table 1).

**Table 1:** Avulsed tooth. Protocol. Guidelines for dentist and patient.

Professional			
Possible wounds to the soft tissues (face, lips and oral mucosa) should be checked. It should be analyzed if there is mandibular rupture at the level of the condyles. The socket should avoid tampering. It should only be irrigated with physiological serum.			
SHORT extraoral period (less than 60min)		LONG extraoral period (more than 60min)	
Open apex	Closed apex	Open apex	Closed apex
Root surface clean with physiological serum	Root surface clean with physiological serum	Gentle cleansing of the periodontal ligament	Gentle cleansing of the periodontal ligament
Reimplantation	Reimplantation (endodontic treatment after 7-10 days of avulsion if it was necessary)	Apexification treatment and subsequent endodontic treatment	Extraoral endodontic treatment and apicectomy using MTA
Control Rx and revision	Control Rx and revision	Reimplantation	Reimplantation
		Control Rx and revision	Control Rx and revision
Oral hygiene instructions +chlorhexidine rinses + soft diet Antibiotic and analgesic treatment Ferulization			
Patient			
<input type="checkbox"/> Locate and collect the tooth from the surface where it is located. <input type="checkbox"/> Hold the tooth by the anatomical crown avoiding contact with the root surface. <input type="checkbox"/> Wash with water, physiological serum or saliva. <input type="checkbox"/> Try to reposition the piece inside the socket (the repositioning of the tooth will only be done on definitive teeth). Go to the dentist as soon as possible.  <input type="checkbox"/> If the previous step is not possible, the part can be transported immediately in a wet environment: - 1st option -> Milk. - 2nd option -> Physiological serum. - 3rd option -> Saliva (between the lip and vestibular of the teeth or between the cheek and vestibular faces). - 4th option -> Water.			
It is vitally important to note that the time of action is decisive when it comes to dental reimplantation after an avulsion, since after 2 hours the failure rate is very high.			



## 01 Conclusions

02 In conclusion, despite a prolonged extra-alveolar dry  
03 storage time a conservative approach of tooth with de-  
04 layed reimplantation can be a stable and functional with  
05 the appropriate treatment procedures. It is proposed a  
06 clinical protocol for patients and professionals for the  
07 treatment of the avulsed tooth.

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### Conflict of interest

Non declared.