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Traumatic dental injures on maxillary incisors and its sequelae after 22-years follow-up: a case report

Injúrias dentais traumáticas nos incisivos superiores e suas sequelas após 22 anos de acompanhamento: um relato de caso

Lesiones dentales traumáticas en incisivos superiores y sus secuelas después de 22 años de seguimiento: reporte de un caso

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Abstract

Avulsion of a permanent tooth is a serious condition and a true dental emergency that can be associated with other traumatic injuries. In addition, in reimplanted avulsed teeth, ankylosis and external replacement resorption (ERR) are two typical biological responses, with long-term progression and outcome associated with the patient's growth stage. The purpose of this report is to present the long-term outcome of an 18-year-old patient who was the victim of a motor vehicle traffic accident that resulted in traumatic injury to the maxillary incisors, including an avulsed central incisor with extensive external replacement resorption (tooth 11). Twenty-two years later, due to the continuous effect of the ERR process on the reimplanted tooth and favorable bone weight, it was decided to perform rehabilitation with immediate guided implant by a simplified method (KEA-TECH system). In young patients, the decision to maintain the tooth even under unfavorable conditions may delay rehabilitation with implants.

Keywords: Tooth avulsion; Dental implants; Root resorption; Prognosis.

Resumo

A avulsão de dentes permanentes é uma séria condição e uma verdadeira emergência odontológica que pode estar associada à outras injúrias traumáticas. Além disso, em dentes avulsionados reimplantados, anquilose e reabsorção radicular externa por substituição (RES) são duas respostas biológicas típicas, com progressão e desfecho a longo prazo associados ao estágio de crescimento do paciente. Esse relato de caso descreve o desfecho à longo prazo de um paciente de 18 anos de idade, que foi vítima de um acidente de automobilístico que resultou na injúria traumática dos incisivos superiores, incluindo um incisivo central avulsionado com extensa RES (dente 11). Após 22 anos, devido ao efeito contínuo do processo de RES do dente reimplantado, realizou-se a extração do elemento dental, seguido pela reabilitação imediata com implante por meio de cirurgia guiada através de um método simplificado (sistema KEA-TECH). Conclui-se que em pacientes jovens, a decisão de manter o dente mesmo em condições desfavoráveis, pode postergar a reabilitação com implantes.

Palavras-chave: Avulsão dentária; Implantes dentários, Reabsorção da raiz, Prognóstico.

Resumen

La avulsión de los dientes permanentes es una afección grave y una verdadera emergencia dental que puede estar asociada con otras lesiones traumáticas. Además, en los dientes

avulsionados reimplantados, la anquilosis y la reabsorción radicular externa por sustitución (RES) son dos respuestas biológicas típicas, con progresión a largo plazo y resultados asociados con la etapa de crecimiento del paciente. Este informe de caso describe el resultado a largo plazo de un paciente de 18 años que fue víctima de un accidente automovilístico que resultó en una lesión traumática en los incisivos superiores, incluido un incisivo central avulsionado con RES extenso (diente 11). A los 22 años, debido al efecto continuo del proceso RES del diente reimplantado, se realizó la extracción del elemento dental, seguida de la rehabilitación inmediata con implantación mediante cirugía guiada mediante un método simplificado (sistema KEA-TECH). Se concluye que en pacientes jóvenes, la decisión de mantener el diente incluso en condiciones desfavorables, puede posponer la rehabilitación con implantes.

Palabras clave: Avulsión de diente; Implantes dentales; Resorción radicular; Pronóstico.

1. Introduction

Traffic accidents are responsible for 0.5-24% of dentoalveolar injuries (Azami-Aghdash et al., 2015). Among these injuries, dental avulsion, characterized by complete displacement of the tooth from its alveolus, is considered the most severe type of dental trauma (Andreasen, Borum, Jacobsen & Andreasen 1995; Andersson et al., 2016). Due to severe damage to supporting tissues, the prognosis is sometimes unfavorable (Andersson et al., 2016). The incidence of root resorption in reimplanted teeth is high (Andreasen et al., 1995; Souza et al., 2018), and external replacement resorption (ERR) is the most frequently occurring event (Andreasen et al., 1995). This type of resorption is related to injuries in which the periodontal ligament (PL) remained dry or was removed from the root surface, damaging the protective cement layer (Andreasen 1985; Trope 2012).

Many factors can affect periodontal healing, including the stage of root development, extraoral dry storage time, storage medium, extent of damage to PL cells, and presence of visible contamination (Andersson et al., 2016; Trope 2011; Petrovic, Marković, Peric & Blagojevic 2010). However, most patients affected with dental avulsion are children and adolescents (Andersson 2013), which contraindicates the use of radical or definitive rehabilitation treatments, even in situations in which the tooth was maintained under unfavorable conditions. Mainly in cases where the patient has not yet achieved complete facial development, temporary measures are required to maintain the tooth and surrounding bone until the patient's facial growth is completed (Trope 2011).

Radiographic establishment of visible tooth resorption can vary over months or years, and its progress is substantially influenced by factors specific to the individual, such as the patient's metabolism and age (Ebeleseder et al., 1998). Therefore, long-term follow-up is essential as this complication can potentially culminate in tooth loss. However, many patients do not attend the follow-up sessions consistently, making long-term rehabilitation planning difficult.

2. Methodology

This is a descriptive observational study of a case report that describes the endodontic approach for traumatized maxillary incisors, including an avulsed central incisor with extensive ERR, in an 18-year-old patient. After a period of 22 years, due to the continuous effects of the ERR process on reimplanted teeth, we opted for extraction and immediate guided implant rehabilitation with a simplified method. With regard to ethical aspects, explanations about the risks, benefits and prognosis of the treatment performed were provided to the patient and he consented to the disclosure of data and the display of images of his case by signing the Informed Consent Form.

3. Case Report

An 18-year-old male patient attended a private dental office in the city of Uberlândia, MG, Brazil for emergency treatment of dentoalveolar injuries after a traffic injury. Intraoral examination revealed laterally luxated maxillary left central (tooth 21) and maxillary right lateral (tooth 12) incisors; coronal fracture with extensive pulp involvement and middle-third horizontal root fracture in the maxillary left lateral incisor (tooth 22); and empty socket of the maxillary right central incisor (tooth 11). The avulsed tooth was stored in filtered water for approximately 60 minutes.

Considering the large number of affected teeth, after a preliminary anamnesis, it was decided to start reimplantation on tooth 11. The clot was suctioned out of the socket, and no alveolar bone wall fracture was detected. Reimplantation of tooth 11 and repositioning of teeth 12 and 21 were performed under local anesthesia with slight digital pressure. Direct pulp protection was performed with calcium hydroxide ($Ca(OH)_2$) materials and temporary restoration was performed using zinc oxide-based material (IRM temporary sealer, Dentsply Sirona, York, Pennsylvania, USA) on tooth 22. A semirigid splint with orthodontic wire (0.4

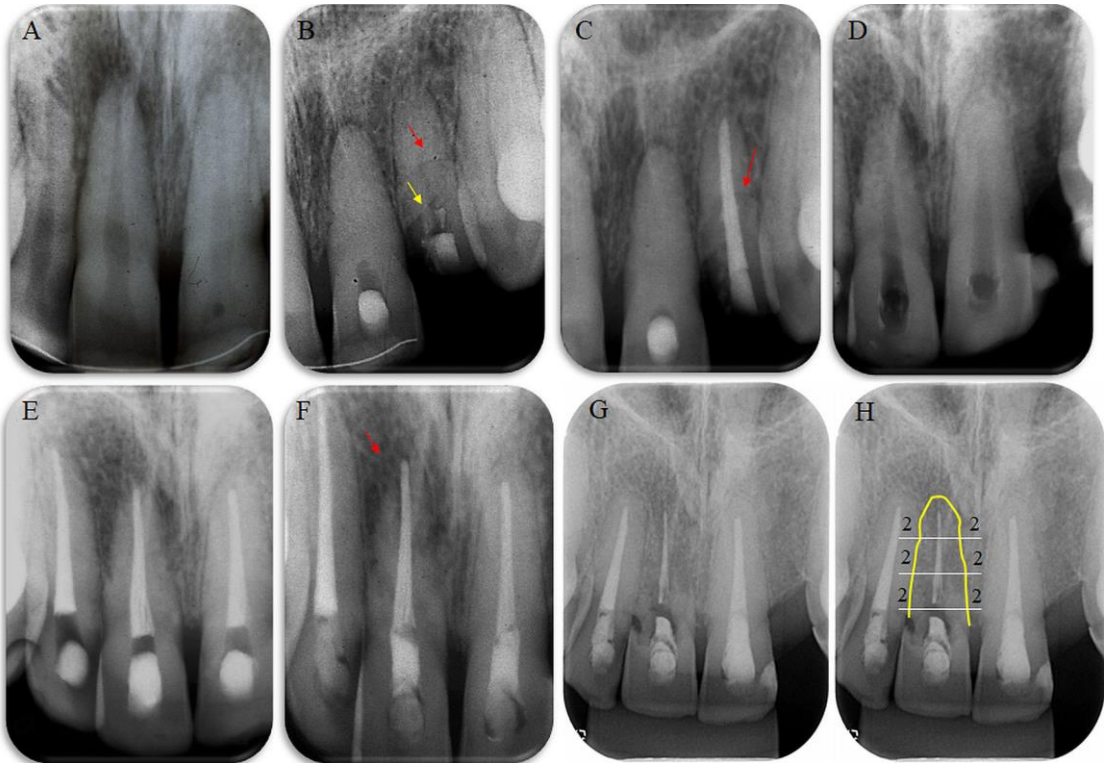
mm) and composite resin surrounding teeth 13, 12, 11 and 21 was applied for 15 days (Figure 1A). Systemic antibiotic therapy (500 mg amoxicillin for a period of 7 days) was administered. No tetanus vaccine administration was necessary.

Fifteen days after the accident, the splint was removed. Endodontic access and chemomechanical preparation of the cervical and middle thirds of teeth 21 and 22 were also performed after the use of $Ca(OH)_2$ paste with polyethylene glycol (PEG) as an initial root canal dressing (Figure 1B). On the 21st day, the apical chemomechanical preparation of teeth 21 and 22 was completed, and the intracanal medicament was changed.

After 30 days, tooth 22 was obturated (Figure 1C). Teeth 12 and 11 showed no response to thermal sensitivity tests and were tender to percussion. Endodontic treatment of the reimplanted tooth (Andersson, Bodin & Sörensen 1989) was initiated, and on the next day, treatment was initiated for tooth 12, which had a slight color change. To establish a rational schedule for changing the intracanal medication, on this day, the intracanal dressing for teeth 11, 12 and 21 was replaced, and the dressing was changed every 60 days thereafter.

Approximately 90 days after tooth 22 was filled, while still in treatment, the patient returned to the office with the tooth missing (Figure 1D). According to him, the tooth was extracted in the emergency department of the Federal University of Uberlândia due to increased mobility and associated pain. At that time, a new evaluation of the teeth under treatment was performed, and the intracanal dressing was changed for teeth 11, 12 and 21. Approximately 180 days after initial treatment, clinical assessments were updated. A decision was made to fill tooth 12, and filling of tooth 21 was postponed due to the presence of pain to percussion. Teeth 11 and 21 were filled 270 days after the beginning of treatment (Figure 1E).

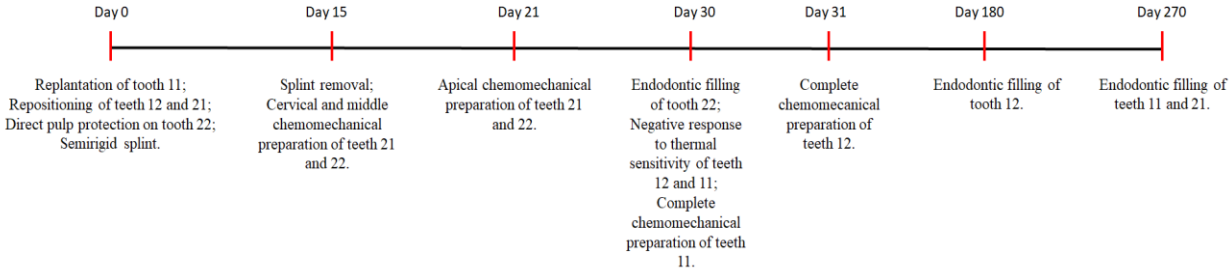
Figure 1: Radiographs of the endodontic treatment sequence of the traumatized maxillary incisors. Initial radiograph: (A) Teeth 12, 11 and 21; (B) Tooth 22. Image suggestive of horizontal root fracture (red arrow) and crown root fracture (yellow arrow); (C) Final radiograph of tooth 22. Image suggestive of horizontal root fracture (red arrow); (D) Absence of tooth 22; (E) Final radiograph of teeth 12, 11 and 2; (F) 27-month follow-up, with radiographic signs of external replacement resorption on tooth 11; (G) Follow-up after 22 years of the trauma; (H) Root resorption index.



Source: Authors, 2020.

All teeth were treated under absolute isolation, necrotic pulp tissue was removed using Hedstroem files (Maillefer, Dentsply), and the root canals were irrigated with 1% sodium hypochlorite. $Ca(OH)_2$ paste with PEG was used as the root canal dressing in all sessions. Chemomechanical preparation was performed with manual type K stainless steel files (Maillefer, Dentsply) up to the master apical diameter of ISO 55 for teeth 12 and 22 and ISO 50 for teeth 11 and 21. The root canals were obturated using the lateral compaction technique with gutta-percha points and zinc oxide- and eugenol-based endodontic sealers (EndoFill, Dentsply Sirona, York, Pennsylvania, USA). The access cavities were restored with composite resin one week later. Figure 2 shows a timeline of the sequence of treatments performed.

Figure 2: Summary of the sequence of treatments performed displayed on a timeline.



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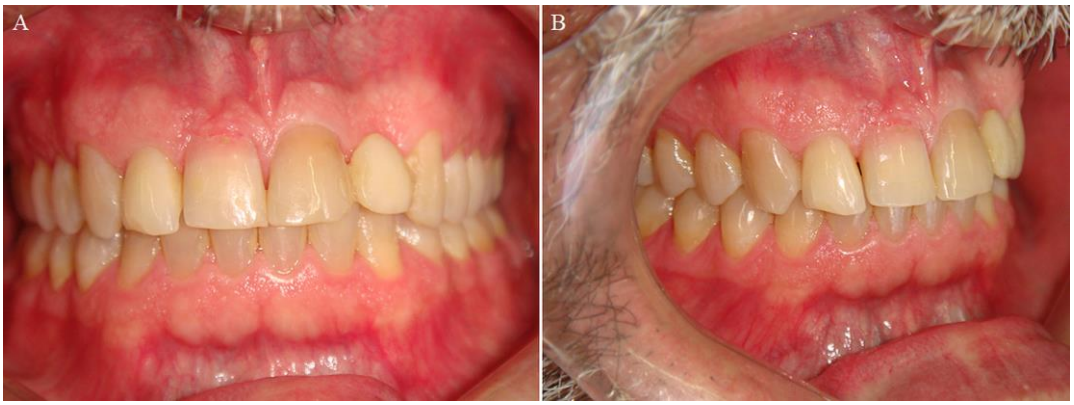
After all endodontic treatments were completed, the patient was instructed on the need for periodic follow-up; however, he did not attend the scheduled visits for a period of 2 years and 3 months. Upon returning to the office, a metallic percussion sound was observed in tooth 11, indicating ankylosis, which was confirmed by radiographic signs of ERR (Figure 1F). Periapical radiographs suggested the presence of bone directly attached to the root and the absence of the PL space, and the lamina dura around the root could not be determined. Teeth 12 and 21 did not show any clinical or radiographic signs of developing periapical pathology or root resorption.

The patient was again warned of the need to continue clinical and radiographic monitoring of all teeth involved in the trauma, the ankylosis involving tooth 11 and possible related complications. However, after successive telephone calls, he continued not to attend the follow-up sessions. Twenty-two years after reimplantation, he visited the clinic with esthetic complaints regarding the cervical region of tooth 11 (Figure 3A and 3B). The endodontically treated teeth were asymptomatic, with no dental mobility. In the periapical radiographic examination, extensive ERR was identified in tooth 11 (Figure 1G), with a root resorption index of 12 (Figure 1H) according to Andersson, Bodin & Sörensen (1989). Teeth 12 and 21 did not show any radiological evidence of resorption.

Figure 3: Clinical analysis 22 years after trauma. (A) Frontal view; (B) lateral view.



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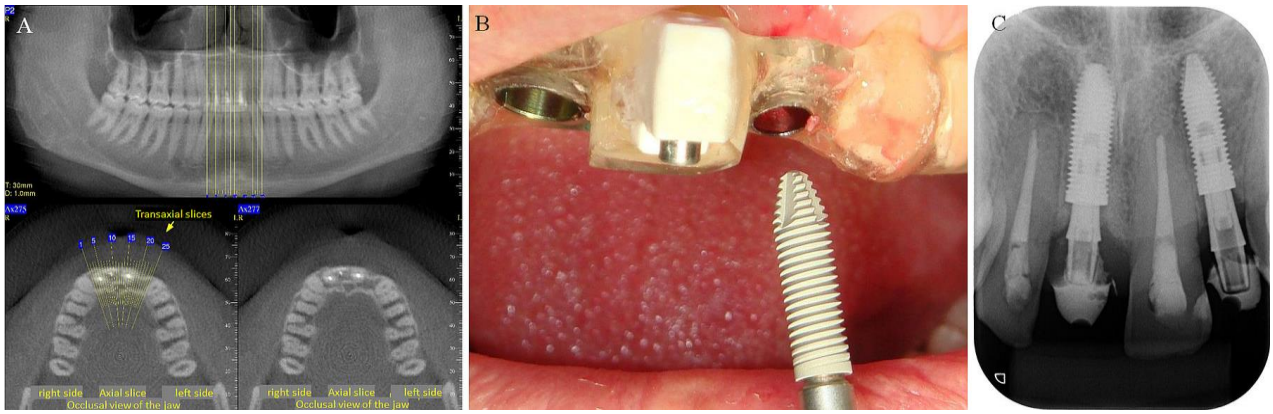
Rehabilitation with implants for teeth 11 and 22 was proposed, and cone beam computed tomography (CBCT) was requested for case planning (Figure 4A). Tooth 11 was extracted, and guided implant installation with immediate loading in the region of teeth 11 and 22 was performed (Figure 4B and C). KEA-TECH software and the Pross Guide system (KEA-TECH, Uberlândia, MG, Brazil) were used in the planning and execution of the tomographic-surgical guide for implant placement.

Figure 4: Guided surgery to install implants in the area of teeth 11 and 22. (A) Cone beam computed tomography was used to plan the installation of implants; (B) Conducting guided surgery; (C) Radiographic aspect of the implant installation.



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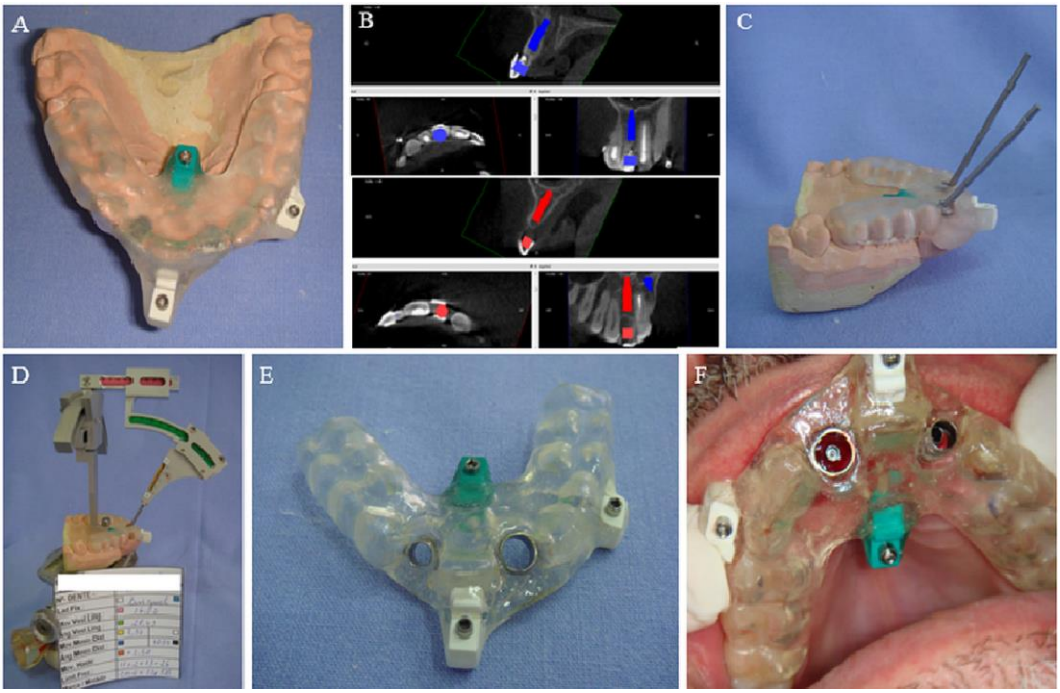
Briefly, for this procedure, a single guide was used in all stages, starting with the tomographic guide, which was transferred to a surgical guide without deformations (Figure 5). For this purpose, the guide was duplicated in a muffle with hypodense material. Three metallic references and a total of five reference points were placed on the buccal and palatal faces. The guide was fixed with acrylic resin on the replica from the muffle, resulting in a tomographic guide (Figure 5A). With the tomographic guide positioned in the mouth, the patient underwent a new CBCT (Figure 5B) scan. The captured images were converted by the KEA-TECH system, and the coordinates and linear data for installing the guide tubes were produced (Figure 5C). After the image conversion and the inclusion of the data for the installation of tubes in the tomographic guide, it becomes a surgical guide (Figure 5D) intended to direct anchoring of the implants during surgery (Figure 5E). This device developed by the authors does not require prototyping to create the surgical guide, thus reducing costs and maintaining accuracy during surgery (Figure 5F).

Figure 5: Creating the tomographic guide and surgical guide. (A) Tomographic guide completed; (B) Conversion of the images obtained by computed tomography, with the tomographic guide in position, using the KEA-TECH system; (C) Installation of guide tubes; (D) Obtaining coordinates and linear data for installing the tubes; (E) Completed surgical guide; (F) Adaptation of implant installation after the surgical procedure was performed using the guide.



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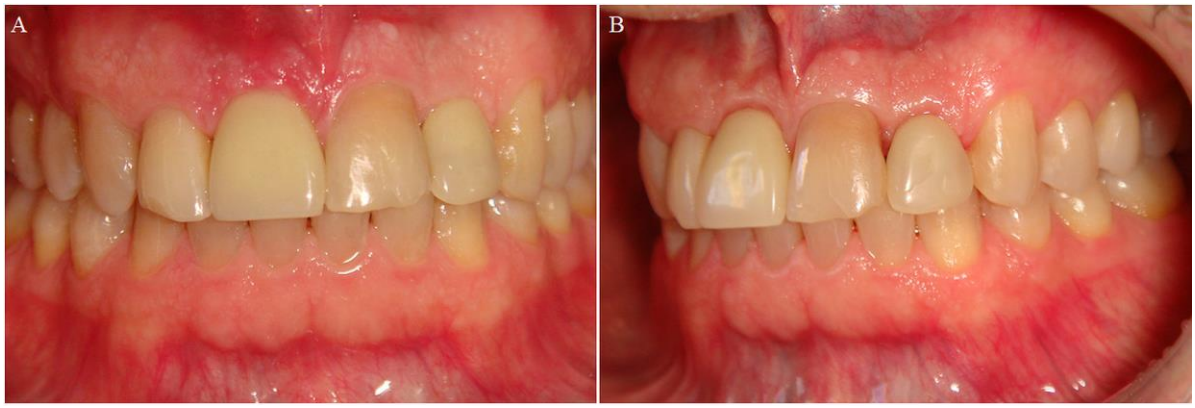
After a temporary prosthesis was placed (Figure 6A and 6B), the patient did not return for the installation of a permanent crown. The low cooperation of the patient prevented the completion and monitoring of the definitive prosthetic crowns.

Figure 6: Clinical aspect 4 months after the installation of implants for teeth 11 and 22. (A) Front view; (B) Three quarter view.



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4. Discussion

In most cases of dental avulsion, immediate reimplantation is not possible. In such situations, the tooth must be placed in a storage medium and taken to the dentist as quickly as possible until it can be reimplanted; this is a crucial step for a good prognosis (Is Khinda, Kaur, S Brar, Kallar & Khurana 2017). In particular, the present case was challenging because in addition to the avulsion, the patient had other traumatized teeth. The clinical approach taken in cases of dental trauma depends primarily on the tissues affected and the extent of the damage caused by the injury to these tissues (Breik 2008).

Emergency care was initiated for the avulsed tooth, which was stored for 60 minutes in water. The characteristics of water, such as a pH between 7.4 and 7.79 and an osmolarity of 30 mOsm/kg (Is Khinda *et al.*, 2017), make it unsuitable for use as a storage medium as it favors cell lysis (Blomlöf 1981; Pileggi, Dumsha & Nor 2002). In addition, the use of water as a storage medium has been associated with ankylosis and ERR (Udoye, Jafarzadeh & Abbott 2012) and may have contributed to the evolution of resorption. Contrary to the recommendations of the literature (Andersson *et al.*, 2016), endodontic treatment of the avulsed tooth began 30 days after the trauma with the aim of achieving greater clinical stability after this period with a dental splint. Although the ideal is to perform the endodontic

treatment 7 to 10 days after reimplantation (Andersson *et al.*, 2016), the decision to postpone treatment has been made clinically (Krug, Kremeier & Krastl 2019).

The intracanal medication with $Ca(OH)_2$ was replaced for a total of 270 days until tooth 11 was filled. The findings in the literature regarding the duration of $Ca(OH)_2$ therapy before definitive filling are controversial (Andreasen & Andreasen. 1992; Trope, Yesilsoy, Koren, Moshonov & Friedman 1992). In general, there is a consensus that before definitive filling, the sequelae of reimplantation must be under control, and the periapical tissues must be completely repaired (Panzarini *et al.*, 2012). The long-term use of $Ca(OH)_2$ medication should be avoided in teeth with damage to the root surface, since $Ca(OH)_2$ can lead to dentin fragility (Naseri, Eftekhar, Gholami, Atai & Dianat 2019) and favor the appearance of ankylosis with external root resorption (Lengheden, Blomlö, & Lindskog 1991). However, $Ca(OH)_2$ remains the most widely used dressing due to its biological properties (Panzarini *et al.*, 2012; Mohammadi & Dummer 2011) being usually prepared by agglutination with an aqueous or viscous vehicle. Although other alternatives currently exist, such as ready-to-use calcium hydroxide pastes and bioceramic materials (Day *et al.*, 2012), within the limitations imposed at the time, the use of calcium hydroxide associated with PEG was widespread.

In the case presented, 2 years and 3 months after the accident, the reimplanted tooth was diagnosed with ankylosis and ERR. However, considering that the patient was absent from all subsequent follow-up sessions, it is not possible to determine when the ERR process began. The incidence of ERR in reimplanted teeth is 51% (Souza *et al.*, 2018), and the loss of the tooth within a 10-year period occurs in approximately 50% of situations (Andreasen *et al.*, 1995). However, tooth 11 differed from this statistic, having remained in function for 22 years. Systemic factors and patient age influence the progression of ERR (25–27), which is slower in adult patients (Andersson *et al.*, 1989; Andersson 1988; Yu & Abbott 2016). According to the scale proposed by Andersson et al. (Andersson *et al.*, 1989), the severity of root resorption in the present case reached level 12, which corresponds to the highest possible degree of resorption. Although it is not possible to determine when resorption occurred, this fact suggests that the resorption occurred slowly and intermittently, as it was reincorporated into the normal process of remodeling the alveolar bone. Therefore, it is important to monitor and establish the opportune moment for replacing the tooth with an implant considering individual characteristics to avoid compromising the esthetics of the region.

Tooth 22 showed radiographic signs of crown-root fracture, with the line of fracture appearing to meet another fracture line on the middle third. However, this radiographic sign was not confirmed by tomographic examination or additional radiographs at different angles.

The absence of adequate complementary imaging exams may have contributed to the unfavorable prognosis and resulted in the presence of mobility and pain that led to tooth extraction. The communication between the fracture line and the oral environment may have a significant influence on the healing process (Hovland 1992), promoting contamination with bacteria present in the gingival sulcus (Hovland 1992, Andreasen 1989). Currently, the indicated clinical management for preserving the tooth would be the maintenance of a semirigid splint for 4 weeks in cases of root fracture and the endodontic treatment of the coronal tooth segment to the fracture line (Diangelis *et al.*, 2017). Despite the use of several approaches in the present case that could currently be considered questionable, conservative management of avulsed teeth in young patients should always be prioritized since implants installed early in young patients will undergo saucerization, which compromises esthetics, since human longevity is increasing.

Regarding the final implant-supported rehabilitation, the presence of a bone crest and cortical bone with sufficient width, which was confirmed by CBCT, are essential for the installation of the implant and esthetic rehabilitation of the anterior incisor area (Braut, Bornstein, Belser & Buser 2011). After delayed reimplantation with subsequent ankylosis, morphological changes in the alveolar bone are common, with vestibular bone reduction over time and no significant palatal bone resorption (Tsukiboshi & Tsukiboshi 2014). This may result in dental infraposition due to vertical maxillary growth, which was not observed in the present case. Most likely, because the patient was outside the peak period of growth (Malmgren & Malmgren 2002), the bone apposition that occurred allowed successful rehabilitation with immediate loading.

In general, guided surgeries are performed without a flap, aiming to reduce trauma and postoperative pain while allowing surgical precision (Nickenig, Eitner, Rothamel, Wichmann, & Zöller 2012). However, for the extraction of the coronary remnant of tooth 11, it was necessary to remove bone tissue due to ankylosis, generating substantial trauma. Otherwise, in the region of tooth 22, such precepts of guided surgery were applied, which was fundamental due to the lower bone thickness in this region as a result of a tooth extraction more than 20 years ago. For this purpose, the Pross Guide system and KEA-TECH software were used in the planning and execution of the tomographic-surgical guide. Compared to other systems, this system is easier to use and has a lower cost because the guide can be made directly on the patient model without a need for prototyping technology (Ramos *et al.*, 2016).

5. Final Considerations

In the present report, which involved several teeth in the anterior region with different types of trauma, the reimplanted tooth was functional for a period of 22 years. This demonstrates that in cases of mature tooth avulsion in young patients, tooth maintenance should be prioritized to postpone the need for implant-supported rehabilitation, and guided surgery is a safe option at the time of installation.

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