

Management of Avulsed Permanent Maxillary Incisor Tooth with 11 Hours of Extraoral Time: A Case Report

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ABSTRACT

Aim: This study describes the management of a replanted and endodontically treated avulsed permanent maxillary incisor tooth with 11 hours of extraoral time.

Background: Avulsion is one of the most common and severe dental injuries occurring in young children and has an unreliable prognosis. Immediate avulsion treatment is essential to maintain the tooth's vitality and minimize complications. A successful outcome is determined by adequate preservation and early replantation.

Case description: A nine-year-old boy reported to the advanced dental care clinic with an avulsed tooth #21 due to a bicycle fall. The boy's mother attempted to preserve the tooth by storing it in the refrigerator for 11 hours immediately after the trauma. The tooth was replanted and splinted; however, the tooth showed pulpal necrosis after 2 weeks, suggesting replantation failure that necessitated further intervention. Accordingly, an apexification procedure employing mineral trioxide aggregate and gutta-percha was performed to treat the tooth's open apex and promote continued root development. The patient remained asymptomatic during the follow-up periods of 6 and 12 months.

Conclusion: This case report demonstrates the effective treatment of an open apex avulsed tooth through an apexification procedure despite the unusual tooth preservation attempt by the patient's mother.

Clinical significance: Although delayed replantation of an avulsed tooth is accompanied by few complications, it might inadvertently preserve the alveolar bone and provide psychological advantages to the patient, making it a viable alternative to dental prosthesis.

Keywords: Apexification, Avulsion, Case report, Dental injuries, Pulp necrosis, Replantation, Splint, Trauma.

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INTRODUCTION

Damage to teeth and associated orofacial structures can be highly distressing for both young children and parents because of their significance to appearance and the resulting psychological implications.^{1,2} In this context, tooth avulsion—occurring primarily in pediatric children—is an extremely traumatic dental injury. It is a dental trauma that refers to a tooth being completely displaced or knocked out from its alveolar socket.³ Owing to its infrequency and severity, permanent tooth avulsions contribute to 0.5–16% of all traumatic injuries, with a male predominance (male 3:female 1) and in the age-group of 7–14 years.⁴ The teeth most commonly affected by avulsion are the maxillary central incisors due to their exposed positioning within the dental arch.⁵ Furthermore, low stability against extrusive stresses due to the relatively elastic alveolar bone and incompletely formed root contributes to the trauma occurring more commonly in the younger population.⁴

The majority of avulsions occur during the preadolescent and adolescent years. Hence, it is imperative to maintain the tooth and the surrounding bone until facial growth is completed.⁶ The actions taken at the site of the injury determine the prognosis of an avulsed tooth. Although it is not always possible to do the procedure (placing the tooth back) at the injured site, replantation is typically the preferred course of treatment.⁷ Swift and effective intervention is necessary to manage and improve the likelihood of favorable long-term outcomes of an avulsed tooth.⁶ Despite the fact that a tooth may be saved via replantation, it is crucial to observe that some teeth have a poor chance of surviving over time and could eventually be lost or extracted.⁷

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The prognosis, effectiveness of therapy, and likelihood of survival of the avulsed tooth are all significantly impacted by the possible risks of infection and root resorption that may occur at any stage during avulsion and replantation.⁸ The dentoalveolar ligament rupturing following tooth avulsion exposes the majority



Figs 1A to C: (A) Pretreatment IOPA radiograph showing empty alveolar socket in relation to tooth #21; (B) Splinting of the replanted avulsed tooth #21 from 12 to 22; and (C) Postsplinting IOPA radiograph showing replanted and splinted tooth # 21

of periodontal ligament cells that remain on the root surface; these cells need to be hydrated to maintain the tooth's longevity while reducing resorption problems and accelerating recovery. On the contrary, inflammatory resorption occurs when the extraoral duration of the avulsed tooth is increased, which may lead to drying of the periodontal ligament.⁵ However, the risk of external root resorption (inflammatory/replacement) is still high even when tooth replantation is adequately managed.⁹

In a retrospective analysis of avulsed tooth cases, the complications were found in 8% of the 125 cases. It was observed that 70% of replanted teeth had external root resorption, 10% presented with surface resorption, 10% had replantation resorption, and 10% showed ankylosis.¹⁰ In terms of pulp-related issues, pulp necrosis was reported after 4 weeks, while internal root resorption was demonstrated at the one-year follow-up.¹⁰ However, the rates of ankylosis and resorption vary significantly and often can be unpredictable.⁷ Furthermore, it has also been reported that replanted teeth that follow the International Association of Dental Traumatology's (IADT) treatment guidelines have a higher probability of long-term survival.¹¹

Immature teeth with open apices are a significant determinant of the avulsed tooth's outcome. The prognosis is generally poorer for immature roots (open apex) than for mature roots (closed apex), which have a higher survival probability.⁹ The main objective when managing immature teeth with open apices is to promote continued root development and apical closure (apexification).⁷

This case study aims to demonstrate the effective treatment of an avulsed permanent maxillary incisor tooth with an open apex and 11 hours of extraoral time in a nine-year-old boy who had suffered trauma due to a bicycle fall. The tooth showed signs of necrosis after replantation, thereby requiring further intervention. Apexification was performed to promote continued root development.

CASE DESCRIPTION

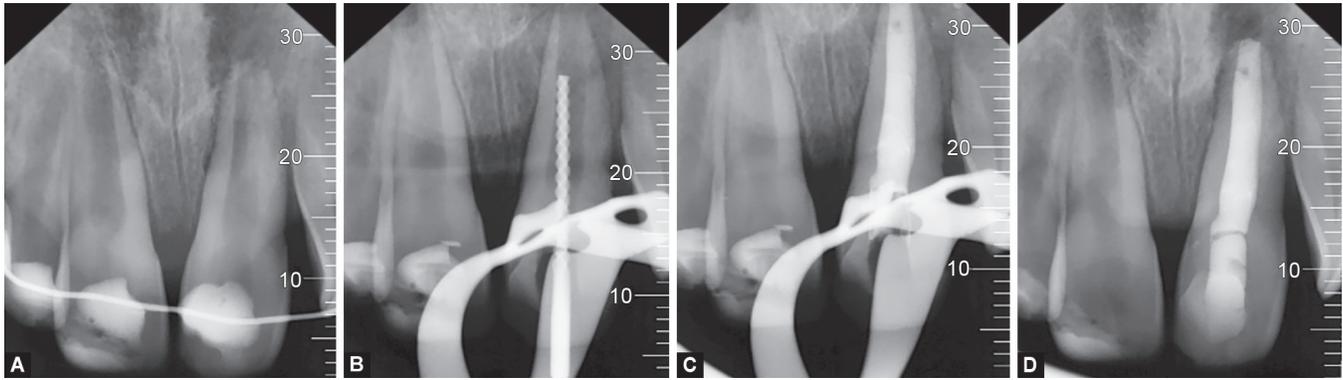
A nine-year-old boy reported to the advanced dental care clinic, Ministry of Health hospital, Hail city, Saudi Arabia, in September 2023 at 9 a.m. with a main complaint of a knocked-out front tooth. He had experienced dental trauma resulting from a bicycle fall the previous night, around 10 p.m. Immediately after the trauma, the

patient's mother retrieved the tooth from the ground, wrapped it in a plastic bag, and stored it in the refrigerator till their visit to the clinic (approximately 11 hours, from 10 p.m. to 9 a.m.). The tooth was received from the patient's mother and stored in saline until further use.

The patient's history and extraoral examination for swelling and facial asymmetry were insignificant. He had received his tetanus shot eight months before. The intra-oral examination revealed an avulsed permanent maxillary left central incisor (#21) with minor gingival lacerations. The examination of the alveolar socket showed no indication of bony wall fracture or the presence of tooth fragments, which was further confirmed by an intra-oral periapical (IOPA) radiograph (Fig. 1A). The avulsed tooth had immature roots (open apex) but was noncarious and intact except for the slight mesioincisal chipping, so it was determined to replant the tooth, followed by splinting. The patient's mother was explained about the treatment process, any resultant complications, and further interventions. The patient's mother consented to the treatment process and signed the consent form.

The socket was irrigated, and the tooth was delicately and thoroughly cleaned to remove debris by holding the crown using copious saline solution. Under local anesthesia, the tooth was gently placed inside the socket in line with the adjacent right central incisor. A canine-to-canine splint was placed from the palatal surface using a flexible and passive multistranded wire (Fig. 1B). The patient's occlusion was examined to rule out occlusal interference during biting and prevent further injury to the periodontal tissues. A post-splinting IOPA radiograph (Fig. 1C) verified the precise placement of the replanted tooth. The patient was advised to avoid sports that require contact, use a mouthwash with 0.12% chlorhexidine twice a day, brush their teeth with a soft toothbrush after each meal, and maintain a soft diet.⁷ The patient was informed to follow the postoperative instructions for 2 weeks. Following treatment and postoperative instructions, the patient was discharged and recalled after 2 weeks.

At 2-week follow-up, the tooth showed signs of necrosis. The IOPA radiograph of tooth #21 at 2 weeks showed radiolucency near the middle 3rd and widening of periodontal ligament space at the mesial aspect (Fig. 2A). Clinical investigations via pulp-vitality tests of tooth #21 demonstrated a delayed response. The adjacent and

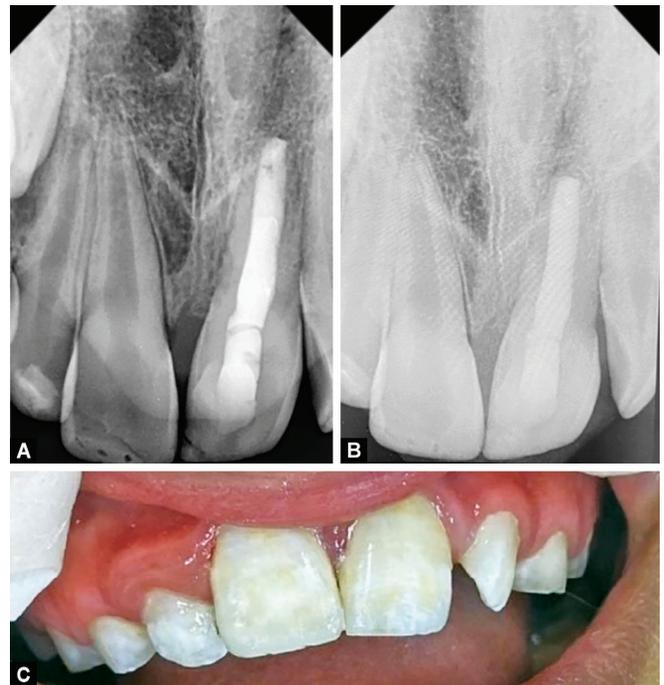


Figs 2A to D: (A) Intra-oral periapical radiograph of tooth #21 at 2 weeks showing radiolucency near the middle 3rd and widening of periodontal ligament space at the mesial aspect of tooth #21; (B) Working length determination IOPA for tooth #21; (C) IOPA of tooth #21 immediately after obturation; and (D) IOPA of tooth #21 after obturation and final restoration

opposing teeth were used as controls and showed positive pulp response. The tooth was kept under observation for an additional 2 weeks, and the patient's mother was instructed to monitor and report any unusual signs or symptoms. At the subsequent visit, the patient was clinically asymptomatic, and the tooth mobility was reduced to grade I. The oral hygiene was good at both follow-up visits. The tooth had an open apex as confirmed by IOPA radiograph, indicating incomplete root development. Pulp-vitality tests still revealed a negative response of tooth #21. Therefore, it was decided to revise the treatment plan to include a procedure (apexification) aimed at promoting continued root development. The patient's mother was explained regarding the revised plan and any possible complications, and consent was obtained.

The splint was removed, and a rubber dam was used to isolate the concerned tooth (#21), followed by a traditional access cavity preparation to determine the working length, which was confirmed radiographically (Fig. 2B). The canal was mechano-chemically cleaned by a combination of intracanal instruments and copious irrigation (0.5% sodium hypochlorite; NaOCl) followed by drying of the instrumented canal with sterile paper points. Mineral trioxide aggregate (MTA; MTA Plus, Avalon Biomed, Tulsa, Bradenton, USA) was mixed as per the manufacturer's instructions, and approximately 4 mm of the mixed material was meticulously placed at the apical end of the canal using an MTA carrier and was condensed using a pre-fitted plugger to establish an apical plug. Any excess MTA was removed, and the access cavity was temporarily sealed using a sterile cotton pellet moistened with distilled water. The proper positioning and apical plug were confirmed by an IOPA radiograph (Fig. 2C). The patient was prescribed oral antibiotics and analgesics (Amoxicillin 250 mg tablet or 5 mL syrup thrice daily for five days and Paracetamol 125 mg tablet or 5 mL syrup twice daily for three days). On the following day, the access cavity was opened, the cotton pellet was removed, and the MTA plug's hard set was confirmed using an endo file. Warm gutta-percha was used to obturate the remaining root canal length, and resin composite was used to seal the access opening that same day (Fig. 2D). The patient was discharged in a safe and sturdy condition after providing oral and written postoperative instructions and was scheduled for a follow-up appointment at 3 and 6 months. However, the patient missed the 3-month appointment but returned for the next appointment.

At six-month follow-up, the patient was asymptomatic, and the radiographic findings were insignificant (Fig. 3A). At 1-year



Figs 3A to C: (A) Intra-oral periapical radiograph of tooth #21 at 6-month follow-up; (B) IOPA radiograph of tooth #21 at one-year follow-up showing completion of root formation; (C) Intra-oral image of the replanted and endodontically treated avulsed tooth #21 at one-year follow-up

follow-up, the IOPA radiograph showed complete healing with completion of the root formation (Fig. 3B). The patient and the mother were happy and satisfied with the treatment outcome (Fig. 3C).

DISCUSSION

Traumatic dental injuries are the 2nd most prevalent dental condition after caries and constitute a significant cause of oral and dental emergencies. Avulsion, which is defined as the complete removal of the tooth from its socket, is the most serious of all traumatic dental injuries.¹² Children between the ages of 7 and 9, when permanent incisors begin to erupt, have the highest occurrence. The surrounding bone is less mineralized, the roots

are still growing, and the periodontal ligament is softer at this time, which reduces its resistance to extrusive forces.¹³ The current case report describes the successful treatment of an immature avulsed tooth in a 9-year-old male patient with 11 hours of extraoral time. The tooth was replanted inside its socket, splinted, and then treated by apexification, the outcome of which was last assessed at a one-year follow-up.

The decision not to replant the avulsed tooth is irrevocable, and conserving it is imperative.⁷ The pulp tissue, periodontal ligament, and alveolar bone of the tooth socket are the three tissues that aid in the healing process following the replantation of an avulsed tooth. The pulp survival, obliteration, or necrosis are the three healing methods the pulp may exhibit after trauma.¹⁴ Tooth avulsions necessitate prompt medical care due to the possibility of tooth loss.¹² The periodontal ligament sustains severe damage when a tooth is forcibly knocked out, which ruptures the neurovascular bundle and results in pulp necrosis.¹²

An avulsed tooth can be transported via milk, Hank's balanced salt solution, the patient's own saliva, water, saline, coconut water, and propolis.¹⁵ Water may not be the best medium, but it is better than having a dry tooth.⁷ In this study, the patient's mother wrapped the tooth in a plastic bag and refrigerated it for 11 hours. While the tooth ultimately became necrotic over time, the mother's proactive response is noteworthy. This highlights the unusual attempt by the patient's mother to preserve the avulsed tooth by storing it in the refrigerator.

Successful outcomes and a good prognosis for dental trauma cases depend largely on the execution of an appropriate emergency care and treatment plan. Unfortunately, the proper emergency treatment in tooth avulsion is frequently not provided because of the lack of expertise among non-experts, who usually provide initial care before the child receives dental therapy.¹⁶ Increased understanding of how to deal with avulsed teeth at the location of the injury reduces the likelihood of experiencing future negative impacts. As reiterated earlier, the peak age for dental traumatic injuries has been between 7 and 14 years, which is when the children spend the majority of their time at school. Thus, it is claimed that schoolchildren are more prone to such injuries, primarily as a result of falls and accidents during competitive sports. It is, consequently, critical that school teachers are prepared to intervene when such circumstances occur.¹⁷ Numerous studies have found that there is a lack of awareness regarding dental trauma treatment and first aid; yet, coaches, teachers, and the general public must all be adequately informed about it, and school-based interventions can be utilized to raise awareness of dental trauma management, especially in terms of storing and transporting the avulsed tooth.¹⁸

The periodontal ligament cells may sustain more damage in the absence of an appropriate storage medium, which would be detrimental to the replanted tooth's prognosis.¹⁵ The periodontal ligament's rate of healing is dependent on how long the avulsed tooth has been kept dry outside the alveolar socket and whether or not it was contaminated by the surrounding environment (such as soil) during the injury.⁷ If the tooth is replaced right away, the periodontal ligament is typically in acceptable condition; if it has been dry for less than 60 minutes and has some dead cells, the condition is fair. Most cells will die if the tooth is kept dry for over 60 minutes and the periodontal ligament is in bad condition.⁷ Replanting the tooth into the alveolar socket immediately is therefore vital.¹⁹ The long-term prospects for delayed replantation

are not favorable. Replantation attempts to restore function and appearance, at least temporarily, while maintaining the alveolar bone's height, width, and shape in cases with pulpal necrosis. Therefore, even if the dry or extraoral period exceeds the ideal 60 minutes, replacing a permanent tooth is almost always the best option.⁷

In this case, the patient was 9 years old, and the avulsed tooth had an open apex but was complicated by 11 hours' extraoral time. The immature avulsed tooth, if replanted as soon as possible, has an open apex's ample blood supply, which increases the possibility of revascularization, which allows roots to grow and mature continuously.¹² Therefore, unless follow-up visits clearly demonstrate infection or pulpal necrosis of the root canal system, it is not recommended to start endodontic therapy. The risk of infection-related root resorption, which occurs at a rapid pace in youngsters, should be weighed against the possibility of pulp space revascularization.⁷ However, in the current study, the tooth showed signs of necrosis at 2-week follow-up, but we followed a wait-and-watch method for another 2 weeks before proceeding with the treatment. Since there was no improvement at subsequent follow-up, root canal treatment was initiated.

In the present study, apexification, a conventional technique for treating pulpal necrosis in teeth with immature roots, was applied. This technique permits further root development and provides an appropriate setting for the placement of a permanent restoration by establishing an artificial barrier at the root end. Apexification can be categorized based on the material type: MTA apexification and calcium hydroxide [Ca(OH)₂] apexification. There are various drawbacks to Ca(OH)₂ apexification. The patient must be very cooperative because they must visit the clinic multiple times for material replacement. Secondly, Ca(OH)₂ placement over time may weaken the root structure.²⁰ Apexification in the present report was accomplished with MTA, which is a biocompatible and hydrophilic endodontic cement that sets in contact with humidity. Furthermore, MTA stimulates osteogenesis and healing and has demonstrated better outcomes compared to calcium hydroxide.^{21,22} The canal was irrigated with a low concentration of NaOCl (0.5%) solution compared to 2.5% concentration because of a greater risk of NaOCl seeping through the apex of young teeth.²³ However, a copious amount of irrigation compensated for the lower concentration of NaOCl.

Replantation will maintain the availability of future therapeutic options. If necessary, and after a timely inter-disciplinary evaluation, the tooth can be extracted eventually and at a suitable time. Parents should be informed that if the replanted tooth becomes ankylosed and infra-positioned, decoronation or other therapies like auto transplantation may be necessary, depending on the risk of tooth loss and the patient's growth pattern.⁷

CONCLUSION

The presented case demonstrates the successful management of an avulsed immature tooth through an apexification procedure, which showed completed root formation at a one-year follow-up. The case also highlights the unusual attempt by the patient's mother to preserve the avulsed tooth by storing it in the refrigerator. This necessitates that the general public should be made aware of the information regarding the storage and transportation of the avulsed tooth.

ORCIDHaia M Alanazi  <https://orcid.org/0009-0000-4212-8895>**REFERENCES**

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