CASE REPORTS

A Treatment Method for Inflammatory External Root Resorption Based on Calcium Hydroxide and X-Ray Imaging Findings: A Case Report Study

Raheleh Zarei Lemraski [1, 2*]

[1] *Research Center for Prevention of Oral and Dental Diseases, Baqiyatallah University of Medical Sciences, Tehran, Iran*

[2] *Department of Endodontics, School of Dentistry, Baqiyatallah University of Medical Sciences, Tehran, Iran*

*Corresponding Author: Raheleh Zarei Lemraski
Email: zareirahel25@gmail.com

Received: 08 August 2024 / Accepted: 24 September 2024

Abstract

Purpose: This case report aims to describe a new treatment for severe inflammatory external Root Resorption (RR) using calcium hydroxide at different intervals, supplemented by X-ray imaging follow-up.

Materials and Methods: A 13-year-old boy reported the avulsion of his upper left central incisor. The tooth had been avulsed four months prior and was replanted forty minutes later by an emergency service. The canal was thoroughly irrigated with 2% sodium hypochlorite and then filled with calcium hydroxide of a creamy consistency as an intracanal medication due to its antimicrobial properties, using lentulo spirals. The calcium hydroxide was left inside the canal for a month. Following the diagnosis, treatment involved conventional endodontic therapy with calcium hydroxide dressings, and the root canal was definitively filled after radiographic control of the resorption.

Results: At the 6- and 12-month follow-ups, clinical and radiographic examinations revealed no signs or symptoms of any abnormalities. The resorption process had halted, and the radiograph showed the reappearance of the normal lamina dura, indicating successful therapy.

Conclusion: We demonstrated that our method, which involves using calcium hydroxide as an antimicrobial and anti-resorptive agent with X-ray imaging follow-up, can effectively result in complete treatment.

Keywords: Inflammatory; Teeth; X-Ray; Case Report.

DOI:

1. Introduction

Tooth avulsion can cause severe injury to the pulp of the injured tooth and Periodontal Ligament (PDL), and the prognosis and success of the treatment depend on several factors, such as the time interval between avulsion and replantation of the avulsed tooth and the environment in which the tooth is kept until it can be replanted [1]. The best treatment option in such cases is replanting the avulsed tooth, but this may not always be possible immediately. Good emergency management and an appropriate treatment plan are important for a favorable prognosis [2].

It has been reported that the prevalence of tooth avulsion can be as high as 16% in children and adolescents aged 11 to 16, frequently occurring in the maxillary central incisor [3]. Root Resorption (RR) is an adverse consequence after the replantation of avulsed tooth and is classified into two kinds: internal and external RR, in which external RR is more prevalent than internal RR [4]. Avulsion can cause damage to the pulp and PDL, with pulp necrosis almost always occurring after avulsion [5, 6]. The tooth detaches from the socket mainly due to the rupture of the PDL, leaving viable PDL cells on most of the root surface. Additionally, small localized cementum damage occurs as a consequence of the tooth being crushed or scratched against its socket [7]. Thus, after avulsion and replantation, infection and RR may occur, affecting the treatment outcome and survival rate [8]. Keeping the PDL hydrated while the tooth is out after avulsion minimizes the consequences of this trauma. Hydrated PDL cells can survive, leading to healing and regeneration without further inflammation after replantation [2]. However, excessive desiccation of PDL cells before replantation causes an inflammatory response over a diffuse area on the root surface [2]. In cases where only a small area needs repair after the initial inflammatory response, healing is more straightforward. However, when a large portion of the root surface is damaged and requires new tissue, there's a greater risk of replacement resorption. In this process, the entire root surface may be gradually replaced by bone due to the body's natural bone remodeling [7]. Traumatic dental injuries can also cause another type of resorption, external inflammatory resorption, which can occur after avulsion and replantation [6].

The process of external inflammatory resorption has not been completely explained. However, it is reported that the essential factor causing external resorption is a denuded root surface due to cementoblast necrosis and destruction of the precementum layer, along with pulp necrosis and infected dentinal tubules [9]. Dentinal tubules, along with the main apical foramen and lateral canals, act as conduits for intracanal stimuli to penetrate the periodontium through the exposed root surface [6, 10].

Pulp necrosis is a definite consequence of avulsion [11]. While the only consequence of necrotic pulp may be the lack of continuity in root development, necrotic tissue can strongly contribute to bacterial contamination. Root canal infection will inevitably occur if adequate root canal treatment is not performed or the tooth is not vascularized again [11]. In other words, the etiology of external inflammatory RR is the presence of root canal infection combined with damage to the cementum on the root surface, which can be very aggressive. The resorption process will arrest when the bacteria are removed from the canal space. Otherwise, the RR will continue, potentially resulting in tooth loss [12].

The external RR can be diagnosed through radiographic evaluation, which shows loss of tooth structure and radiolucency of bone and the PDL [13]. The loss of cementum allows bacteria and their endotoxins to infiltrate the PDL, accelerating the inflammatory resorption process. If left untreated, external inflammatory resorption can ultimately result in tooth loss [11]. The recommended treatment for external inflammatory RR involves thoroughly cleaning the root canal and applying calcium hydroxide [14]. Removing the underlying causes is crucial for managing this condition, and proper root canal treatment can significantly impact the progression of the inflammatory resorptive process. The use of intracanal medication is often suggested in endodontic treatment for such cases, with calcium hydroxide being considered one of the important agent, particularly for treating avulsed teeth. Its chemical formula, $Ca(OH)_2$, gives it several beneficial properties, including inhibiting microbial enzymes, exhibiting antimicrobial effects, activating tissue enzymes such as alkaline phosphatase, and stimulating mineralization [4]. Calcium hydroxide paste is an alkaline material that significantly increases the pH on

the external root surface by releasing calcium and hydroxyl ions. This increased pH can halt the resorptive process by neutralizing the acidic pH of the area and inhibiting clastic activity as a consequence [5].

Several studies have been reported on the treatment of inflammatory RR; however, it remains a challenging condition to manage. We applied a new method using calcium hydroxide as an antimicrobial and anti-resorptive agent, with X-ray imaging follow-up, to treat a 13-year-old boy. This method, along with the follow-up imaging results, is presented in this report for potential future investigation.

2. Case Report

A healthy 13-year-old boy referred to the endodontics department at Baqiyatallah University of Medical Sciences (Tehran, Iran) with a complaint of avulsion of his maxillary left central incisor. During the medical history review, it was revealed that the tooth had been avulsed four months earlier and replanted approximately 40 minutes later by an emergency service. Following the avulsion, the tooth was stored in milk, as instructed by a dentist [15]. Upon clinical examination, a dental splint was observed on the buccal surface of the central incisors. This splint had been placed on the day of the trauma and had remained in place since (Figure 1a).

Pulp vitality testing, including a cold test (Endo-Ice, Coltene/Whaledent, Inc.) and electric pulp test, showed negative responses, indicating pulp necrosis. The patient was asymptomatic, with normal tooth mobility and no abnormal response to percussion. Unfortunately, the patient and his parents had not been informed of the need to remove the splint or seek further treatment, resulting in the splint remaining on the tooth for approximately four months.

Radiographic examination (Schick CDR system, Schick Technologies, Long Island, NY, USA) revealed significant external RR in the maxillary left central incisor (Figure 1b). After explaining the treatment options and prognosis to the patient and his parents, a Cone-Beam Computed Tomography (CBCT) scan (Kodak 9000 3D, Kodak Dental Systems, Carestream Health, USA) was prescribed for a more detailed evaluation of the resorption's progression (Figure 2), which confirmed that no canal perforation had occurred.

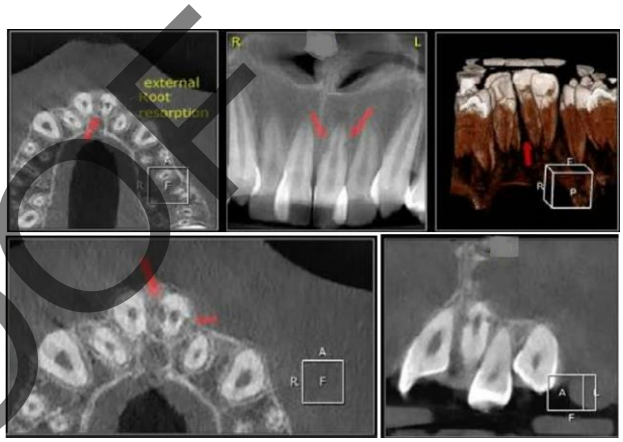

Figure 2. CBCT sacn, indicating extension of resorption

At the first visit, local anesthesia was administered using an infiltration of 2% lidocaine with 1:100,000 epinephrine, and rubber dam isolation was applied. An access cavity was prepared with a fissure bur, and the canal was thoroughly irrigated with 2% sodium hypochlorite. Using the ProTaper system, the canal was debrided with rotary files up to file F2 (6%). The

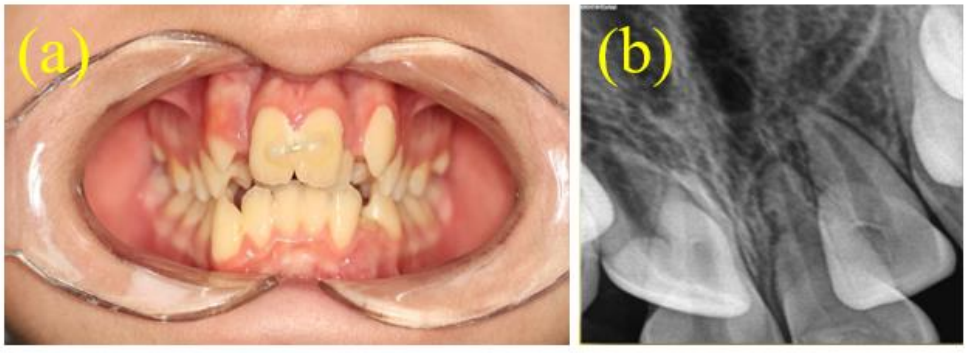

Figure 1. Patient with splinted teeth (a), and initial radiograph indicating external root resorption in the maxillary left central incisor (b)

working length was determined with an apex locator (Root ZX, J. Morita) (Figure 3a). After drying the canal, calcium hydroxide was applied in a creamy consistency as an intracanal medication for its antimicrobial properties, using lentulo spirals. The cavity was then sealed with composite, and the splint was removed.

The calcium hydroxide remained in the canal for one month before being replaced with a densely packed form of calcium hydroxide, chosen for its anti-resorptive effects, and left in place for three months (Figure 3b). After this period, radiographic evaluation revealed that the resorptive process had stopped (Figure 3c), and clinical examination showed no signs or symptoms of periapical or periodontal disease.

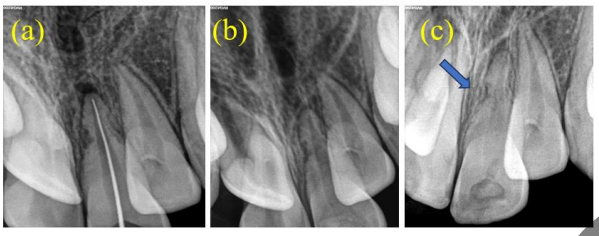

Figure 3. Working length determination, apical radiolucency is obvious (a), calcium hydroxide densely packed (b), and radiographic evidence of healing of resorption side (c)

We did not obturate the canal because the patient's orthodontist planned to begin treatment with a removable appliance. According to established guidelines [16], orthodontic movement can be initiated once resorption and infection are under control, as was the case here. Six months later, after completing active orthodontic movement, the patient was recalled for assessment, which showed no further root resorption. The root canal was then filled using a size 50 gutta-percha master cone (Dentsply Maillefer) and bioceramic sealer (DIA_ROOT, BIO Sealer) with the lateral condensation technique (Figure 4a). At both the 6- and 12-month follow-ups, clinical and radiographic examinations revealed no signs or symptoms of any complications (Figure 4b and 4c). The resorption process had completely stopped, and radiographs showed reestablishment of the normal lamina dura, confirming the success of the treatment.

Figure 4. Final radiograph after endodontic therapy (a), follow up radiography after 6 months (b), and 12 months (c)

3. Discussion

We introduced a novel approach to treating inflammatory external RR by utilizing calcium hydroxide, supplemented by regular follow-up through X-ray imaging. The prognosis and treatment of a tooth following avulsion and replantation are influenced by several critical factors. These include the extent of physical damage to the cementum and PDL cells on the root surface, the time elapsed between avulsion and replantation, the storage medium used for the tooth, and the stage of root development at the time of avulsion. Treatment decisions largely depend on whether the root has an open or closed apex and on the viability of the PDL cells [11].

The viability of PDL cells plays a pivotal role in the success of replantation. The choice of storage medium and the time before replantation are crucial for maintaining PDL cell viability. No PDL cells are expected to survive after 60 minutes or more of extraoral dry time [17, 18]. However, teeth stored in mediums such as Hank's Balanced Salt Solution (HBSS), saline, or milk, which provide balanced osmolality, demonstrate better outcomes in terms of replantation success, as these mediums help preserve PDL cell viability [19].

Root canal therapy is effective in arresting the resorption process and facilitating tooth repair [11]. This treatment is essential for eliminating necrotic tissue. However, in cases of replacement resorption, the tooth is gradually replaced by bone, regardless of the treatment applied [5]. The use of intracanal medication, particularly calcium hydroxide, is critical. In our study, we employed calcium hydroxide both as an antimicrobial agent and as a means to inhibit resorption [20]. Our findings demonstrate that the

prevention of external inflammatory resorption following trauma is feasible and that ongoing resorption can be halted with timely intervention. Preventing root canal infection, or eradicating bacteria from an already infected canal, is central to managing external inflammatory resorption. This objective is achieved through thorough root canal treatment, adherence to fundamental treatment principles, and the use of appropriate intracanal medicaments that positively influence the PDL cells and control bacterial presence [20]. According to the International Association of Dental Traumatology guidelines, any luxated tooth with necrotic pulp post-injury should be treated with calcium hydroxide as an intracanal medicament until definitive root canal therapy is completed [20]. In our case, we employed calcium hydroxide both to eliminate bacterial infection and to inhibit the resorption process, while also monitoring the patient's response to the treatment through periodic X-ray imaging.

It is well known that orthodontic treatment applied to teeth with a history of trauma can lead to negative pulpal and periodontal outcomes [21]. Thus, it is essential to thoroughly investigate any history of trauma when assessing new orthodontic patients. Teeth with a prior history of RR due to trauma exhibit an increased susceptibility to further resorption when subjected to orthodontic forces. Although there remains debate over whether orthodontic movement directly leads to pulp necrosis in traumatized teeth [16]. In our case, resorption had already begun before orthodontic treatment. This made the tooth more vulnerable to additional resorption from orthodontic forces. Consequently, we elected to delay the orthodontic intervention until the resorption was halted and the infection was controlled in accordance with established guidelines [16].

4. Conclusion

This case report outlines the treatment of severe external inflammatory RR in a tooth requiring orthodontic intervention. We demonstrated that our method, using calcium hydroxide as an antimicrobial and anti-resorptive agent with X-ray imaging follow-up, can effectively result in complete treatment. We propose further investigation of calcium hydroxide treatment with X-ray imaging follow-up in larger patient samples.

References

1- Jaradat M, Rahhal A. "Orthodontic considerations for traumatized permanent teeth". Br *J Med Med Res*. Vo. 15, pp.1-8, (2016).

2- Flores MT, Andersson L, Andreasen JO, Bakland LK, Malmgren B, Barnett F, et al. "Guidelines for the management of traumatic dental injuries. II. Avulsion of permanent teeth". *Dental Traumatology*. Vo. 23(No. 3), pp. 130-6, (2007).

3- Çalışkan MK, Türkün M, Gökay N. "Delayed replantation of avulsed mature teeth with calcium hydroxide treatment". *J Endod*. Vo. 26(No. 8), pp. 472–6, (2000).

4- Jahromi MZ, Motamedi MRK. "Effect of calcium hydroxide on inflammatory root resorption and ankylosis in replanted teeth compared with other intracanal materials: a review". *Restorative Dentistry & Endodontics*. Vo. 44 (No. 3), (2019).

5- Cunha RS, Abe FC, Araujo RA, Fregnani ER, Bueno C. "Treatment of inflammatory external root resorption resulting from dental avulsion and pulp necrosis: clinical case report". *General Dentistry*. Vo. 59(No. 3), pp. 101-4, (2011).

6- Finucane D, Kinirons MJ. "External inflammatory and replacement resorption of luxated, and avulsed replanted permanent incisors: a review and case presentation". *Dental Traumatology*. Vo. 19(No. 3), pp. 170-4, (2003).

7- Trope M. "Avulsion of permanent teeth: theory to practice". *Dental Traumatology*. Vo. 27(No. 4), pp. 281-9, (2011).

8- Souza BDM, Dutra KL, Kuntze MM, Bortoluzzi EA, Flores-Mir C, Reyes-Carmona J, et al. "Incidence of root resorption after the replantation of avulsed teeth: a meta-analysis. *Journal of Endodontics*". Vo. 44(No. 8), pp.1216-27, (2018).

9- Trope M, Yesilsoy C, Koren L, Moshonov J, Friedman S. "Effect of different endodontic treatment protocols on periodontal repair and root resorption of replanted dog teeth". *Journal of Endodontics*. Vo. 18(No. 18), pp, 492-6, (1992).

10- Andreasen JO. "A time-related study of periodontal healing and root resorption activity after replantation of mature permanent incisors in monkeys". *Swedish Dental Journal*. Vo. 4(No. 3), pp. 101-1, (1980).

11- Abbott PV. "Prevention and management of external inflammatory resorption following trauma to teeth". *Australian Dental Journal*. Vo. 61, pp. 82-94, (2016).

12- Tronstad L. "Root resorption—etiology, terminology and clinical manifestations". *Dental Traumatology*. Vo. 4(No. 6), pp. 241-52, (1988).

13- Yi J, Sun Y, Li Y, Li C, Li X, Zhao Z. "Cone-beam computed tomography versus periapical radiograph for diagnosing external root resorption: a systematic review and meta-analysis". *Angle Orthod*. Vo. 87(No. 2), pp. 328–37, (2017).

14- Ahangari Z, Nasser M, Mahdian M, Fedorowicz Z, Marchesan MA. "Interventions for the management of external root resorption". *Cochrane Database Syst Rev*. Vo. 11 (No. CD008003), (2015).

15- Blomlöf L, Lindskog S, Andersson L, Hedström KG, Hammarström L. "Storage of Experimentally Avulsed Teeth in Milk Prior to Replantation". *J Dent Res*. Vo. 62(No. 8), pp. 912–6, (1983).

16. Sandler C, Al-Musfir T, Barry S, Duggal MS, Kindelan S, Kindelan J, et al. "Guidelines for the orthodontic management of the traumatised tooth". *Journal of Orthodontics*. Vo. 48(No. 1), pp. 74-81, (2021).

17- Sato K, Muramatsu T, Tsuchiya Y, Masaoka T, Enokiya Y, Hashimoto S, et al. "Proliferation, migration and apoptosis of periodontal ligament cells after tooth replantation". *Oral Dis*. Vo. 16(No. 3), pp. 263–8, (2010).

18- Deshpande NM, Shah D, Wadekar S. "Maintenance of cell viability in extraoral conditions for a case of intentional replantation to retrieve a separated endodontic instrument". *J Conserv Dent*. Vo. 22(No. 2), pp. 207–12, (2019).

19- Nene KS, Bendgude V. "Prognosis of replanted avulsed permanent incisors: A systematic review". *Int J Pedod Rehabil*. Vo. 3, pp. 87-9, (2018).

20- Mohammadi Z, Dummer PMH. "Properties and applications of calcium hydroxide in endodontics and dental traumatology". *International Endodontic Journal*. Vo. 44(No. 8), pp. 697-730, (2011).

21- Kindelan SA, Day PF, Kindelan JD, Spencer JR, Duggal MS. "Dental trauma: an overview of its influence on the management of orthodontic treatment". *Part 1. J Orthod*. Vo. 35(No. 2), pp. 68–78, (2008).