Khalij Libya Journal of Dental and Medical Research. 2026;10(2):226-230
https://doi.org/10.47705/kjdmr.26306
eISSN:*2708-888X*

Original article

Treatment of External Root Resorption by Intentional Replantation Using Calcium Silicate-Based Cements

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Abstract
Intentional replantation is a clinical technique that involves the extraction of the tooth and reinserting it into the socket after endodontic manipulation and restoring the defect of root resorption with a suitable biocompatible material. The procedure is typically performed as a last resort when other treatment options, such as root canal therapy or apical surgery, are not feasible or have failed. The aim and objective of this search were to show the success rate of intentional replantation as a treatment for teeth with root resorption. Using the PubMed, ResearchGate, and Google Scholar electronic databases. The keywords were as follows: intentional replantation, root resorption, and Biodentine. The results showed that intentional replantation is a reliable and predictable procedure; when indicated, with a very high success rate if it is done correctly, promptly, and the periodontal ligament integrity is preserved as much as possible. When standard protocols of intentional replantation are followed, clinical and radiological success is expected. From this point of view, intentional replantation should be considered as a viable therapeutic option and not as a procedure of last resort
Keywords: Root Resorption, Endodontic Replantation Interface, Endodontics, Calcium Silicate-Based Cements.

Received: 09/05/26
Accepted: 07/07/26
Published: 15/07/26

Introduction

Resorption occurs due to reactions involving odontoclasts that affect the hard tissues of teeth (1). Additionally, tooth structure resorption can happen because of physiological, pathological, or idiopathic reasons. Timely diagnosis and proper treatment can help avoid severe complications (2). The resorption process is categorized into external and internal types depending on where the resorption begins, and it is also classified into apical and cervical types based on their location on the root surface. Additionally, another classification is made based on the factors that contribute to it. Internal resorption may be triggered by the persistent presence of inflammatory factors, such as necrotic pulp tissues or iatrogenic factors (like internal bleaching) (3). In contrast, external resorption is typically caused by chronic periodontal inflammation, whitening procedures, and orthodontic movements. In some cases, resorption may occur without any known cause (4).

The etiology of various types of root resorption involves two phases: mechanical or chemical injury to protective tissues and subsequent stimulation by infection or pressure. The nature of the injury can be similar across different types of root resorption (4). There is no standard protocol for treating external resorption. Treatment is suggested based on the pattern and location of resorption: internal access, external access, and intentional replantation (5). The external access is performed by a surgical access that allows for the repair of the defect by using biocompatible materials, such the one based on calcium silicate. These materials are a “dentinal substitute” and are characterized by easy manipulation, resistance to compression, radiopacity, excellent biocompatibility and color stability (6,7). Since ERR is a deteriorating lesion and could end in the gradual destruction of dental structure and subsequent tooth loss (8). It should be diagnosed immediately, managed properly, and treated effectively. Therefore, the treatment of EIRR varies according to the cause, severity of resorption, and its impact on the pulpal tissue (9).

Several studies have introduced calcium silicate-based cements, including mineral trioxide aggregate (MTA), calcium-enriched mixture (CEM) cement, Biodentine, and bioactive glass, as the most common bioactive materials for endodontic applications (10). Due to its sealing characteristic, resistance to compression, biocompatibility, and ability to regenerate hard tissue as cement and dentin. (11,12). Successful management of the root resorption involves an accurate diagnosis and in-depth knowledge of the various etiological factors and the pathological processes involved (13). A conventional intraoral radiograph produces images that have objects superimposed upon each other. The observer has to make three-dimensional decisions on the basis of a two-dimensional image. Cone beam computed tomography (CBCT) is an innovative technology that provides crucial information not obtainable from traditional X-rays. It allows clinicians to evaluate the area of interest in three different planes, effectively eliminating the superimposition commonly found in conventional radiographic imaging. CBCT has high sensitivity and specificity in the detection of resorption lesions, and it performs significantly better than digital intraoral radiographs (14).

External root resorption is considered a condition that results in a dramatic loss of tooth structure. The treatment of external resorption varies according to the vitality of the pulp. removal of the etiologic factor in cases where the corresponding tooth pulp is vital is the first treatment option (15) Also, Damage to the periodontal ligament and cementum triggers an

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inflammatory cascade which may lead to aggressive resorption if left untreated While endodontic management is the cornerstone in controlling resorption of pulpal origin, surgical intervention or alternative strategies, including Intentional replantation may be necessary when dental lesions are extensive or difficult to access. Previous reports have documented successful outcomes from intentional replantation in cases of external resorption. These studies highlight the importance of minimizing extraoral time and utilizing bioactive materials to enhance the healing process (16).

Intentional replantation (IR) is a conservative and cost-effective treatment option for managing post-treatment apical periodontitis when orthograde retreatment or apical microsurgery is not feasible, has failed, or carries unacceptable risks for the patient (17,18). IR consists of the deliberate extraction of the affected tooth and its reinsertion into the alveolus after sequential root resection, preparation, and hermetic sealing with a biocompatible root-end filling material (19). The ultimate goal of this procedure is to enable tooth survival (20)

The IR technique has been progressively modified and refined. Currently, the process includes atraumatic tooth extraction techniques, root resection, and preparation using piezoelectric systems, with extraoral handling minimized to ensure the shortest possible duration in an environment that maintains cell viability; and root-end filling with different biomaterials, performed under illumination and magnification. A survival rate of 88% at 2 years has been reported. Pre- and perioperative factors can significantly influence prognosis. When performed according to modern apical microsurgery principles and the biological understanding of dental trauma, this technique enhances healing potential and minimizes the risk of complications. Ankylosis, root resorption, the expansion of apical radiolucency, the persistence or intensification of symptoms, and increased probing depth are the main complications described within the literature (21). This systematic review aimed to show the success rate of intentional replantation as treatment of teeth with external root resorption when orthograde retreatment or apical microsurgery is unfeasible. also, to evaluate the effectiveness of interventions that can be used in the management of external root resorption in teeth and to identify and summarize published articles that assess the efficacy of calcium silicate-based cements as a restoration material.

Methods

A literature search was conducted using the Medline/PubMed and Google Scholar electronic databases. The search was focused on original papers related to the subject of the thesis. The keywords used for the search included: endodontic-replantation interface, root resorption and surgical replantation, endodontics, calcium silicate-based cements, Biodentine, and cone-beam computerized tomography. After conducting a systematic review, a total of 34 references were included. This review aims to show the success rate of intentional replantation as treatment of teeth with external root resorption when orthograde retreatment or apical microsurgery is unfeasible. The titles and abstracts of the articles resulting from the electronic searches were carefully screened. Afterwards, full-text articles were examined and selected based on the inclusion criteria.

Results

The search identified 6 publications that satisfied the inclusion criteria (Table 1). summarizes the included articles that addressed the calcium silicate-based cements as restoration filling materials used for the treatment of external root resorption by intentional replantation. According to 6 studies from (2015 - 2025) show the applicability of intentional replantation to successfully solve complicated cases of root resorption to restore the teeth that would be difficult or not possible to treat by conventional root canal treatment. treatment of the cases as a combination of intentional replantation and Root canal treatment and material which restore the defect of resorption.

The standard treatment protocol for inflammatory root resorption involves several key steps. First, the root canal system is prepared using a chemo-mechanical approach and irrigated with sodium chloride (NaCl). During the treatment, an interappointment dressing is placed in the canal with calcium hydroxide (cH) to maintain an alkaline pH in the dentinal tubules. This helps to eliminate bacteria and inactivate their byproducts (22). Additionally, it is crucial to insert an appropriate restoration into the resorption cavity. Mineral Trioxide Aggregate (MTA), a calcium-silicate-based material, is recommended for perforation repair because of its bioactivity and biocompatibility (23), allowing it to form a close and permanent contact with the periradicular tissue.

Intentional replantation is defined as the deliberate extraction of a tooth to repair a defect or address a treatment failure, followed by the replacement of the tooth into its original socket (24). Intentional replantation is recommended as a last resort when other treatment options fail due to concerns about the additional damage it may cause to the periodontal ligament (PDL)(25). However, this technique has advantages, including shorter application time, ease of manipulation, and lower economic costs (26). The prognosis for a replanted tooth depends significantly on how long it has been out of the mouth; if it is reinserted within 30 minutes, the risk of resorption is minimized. Although this procedure is suggested only for specific cases, reports indicate a success rate of up to 95% when performed according to established guidelines. In this case, all relevant parameters were carefully evaluated before proceeding with intentional replantation. When case selection is done correctly, the ease of the treatment and its prognosis improve. Follow-ups at 3 and 12 months confirmed the successful management of this case (27,28).

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Table 1: Comparative summary of related work, highlighting studies that used calcium silicate-based cements as restorative filling materials for the treatment of external root resorption through intentional replantation.

Author/ Year	Age/Gender	Tooth	Radiograph	Material Used	Result
Pruthi , et al ,2015	28y/male	11	CBCT	RCT, IR Biodentine	Clinically and radiographically showed satisfactory results, no pain on percussion
Funda et al, 2017	46y / male	11	IOPA	RCT, IR MTA	absence of pain/tenderness to percussion/palpation, as well as the absence of tooth mobility and inflammation.
Wolters et al,2019	27y/male	23	CBCT	RCT, IR Biodentine	Clinically and radiographically showed a Tooth healing, no signs of inflammation or mobility
Messina et al. (2021)	14y/ male	21	CBCT	RCT, IR Biodentine	Clinically and radiographically showed a tooth in good healing, without clinical or radiographic signs of inflammation. The tooth maintains a physiological mobility; this demonstrates the presence of a functional support tissue without the appearance of ankyloses
Pereira et al, 2022	37y/ male	25	CBCT	RCT, IR MTA	Clinically and radiographically showed a Tooth healing, no signs of inflammation or mobility
Le HV, et al, 2025	11y/ female	36	Panoramic biograph, CBCT	RCT, IR Biodentine	Follow-up over 24 months showed resolution of clinical symptoms, arrest of root resorption, healing of periapical lesions, and complete apical closure

• *RCT =root canal treatment, IR =intentional replantation.*

Discussion

As global life expectancy increases, it is essential to assess all effective treatment options to prolong the lifespan of natural teeth (29,30). Intentional replantation has often been regarded as an unreliable method in endodontics (24). It is frequently overlooked as a viable treatment choice, especially in light of the high success rate associated with dental implants (31). The procedure of intentional replantation has been practiced since the 18th century (32), and its indications have evolved over time (33). Recent studies have developed treatment protocols that focus on managing root resorption and splinting methods, showing that this procedure is more reliable than previously believed. This makes intentional replantation a viable treatment option in select cases. These studies report successful applications of intentional replantation in saving otherwise hopeless teeth affected by root resorption. However, there are no clear guidelines for cases involving root resorption, so treatment decisions are based on the clinical condition of each case, the patient's needs, and the experience of the operator (34). Intentional replantation is recommended when conventional endodontic treatment is ineffective or difficult to perform. This is particularly true when other therapies have failed or when periradicular surgery is not a viable option (35). Historically, various materials have been used to restore the resorption cavity, including glass ionomer, light-cured resin composite, and amalgam. However, these materials do not promote periodontal reattachment. Therefore, newer calcium silicate-based substances, such as Mineral Trioxide Aggregate (MTA), Calcium Enriched Mixture (CEM), and Biodentine, can be utilized. MTA and Biodentine are considered the gold standard in this clinical context, as they are bioactive materials that support the development of periodontal attachment (36,37). A new calcium silicate-based material has been proposed as an effective option for repairing perforations. This substance can be placed in direct and lasting contact with periradicular tissue due to its bioactivity and biocompatibility. It possesses mechanical properties similar to those of dentin, making it suitable as a dent in substitute for crowns and roots (38).

Filippi et al. (2006) examined the outcomes of intentional replantation involving the resection of ankylosed areas. Their findings indicated that this approach can prevent or delay the recurrence of ankylosis in 7 out of 15 treated teeth (39). Additionally, Tang et al. (1996) reported a successful case of intentional replantation for a mandibular molar that had significant periodontal damage due to iatrogenic perforation of the furcation. They proposed a viable surgical technique for a situation that is typically considered hopeless (40). Filho et al. (2004) concluded that intentional replantation can be a

suitable alternative treatment in cases where conservative endodontic therapy or surgical techniques are not feasible (41). While this procedure is recommended only for specific cases, it has been reported to have a success rate of up to 95% when executed according to established guidelines. In the field of interventional radiology (IR), numerous studies on success and failure rates have been conducted. These studies indicate that success rates can range from 50% to 95%, with an average retention period of 3 to 5 years. Furthermore, some research suggests that the tooth can last up to 20 years, and in extremely rare circumstances, even up to 41 years (42,43).

Conclusions

Intentional replantation procedures are an alternative when nonsurgical or surgical endodontic treatment is not feasible. ER is always a challenge for the clinician. In some cases, the standard procedures are difficult to implement. Intentional replantation after treating the tooth extra-oral could be an option, in cases where it is feasible, to improve the prognosis of a tooth that otherwise would be hopeless. On the other hand, Intentional replantation may be considered a suitable option to successfully maintain those that were once deemed untreatable through conventional endodontic procedures, especially considering the favourable prognosis and outcomes recently reported in the literature. Additionally, cost-effectiveness and predictable outcomes using calcium silicate biomaterials, Biomaterials can foster angiogenesis activation and bone cells proliferation, which are contributory factors in tissue regeneration, assisting the patient in keeping their natural dentition.

Conflict of interest. **Nil**

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