

## REVIEW



# The current status of intentional replantation: a narrative review

Musliana Mustaffa<sup>1\*</sup>, Sobrina Mohamed Khazin<sup>1</sup>, Nurul Ain Ramlan<sup>2</sup>, Huwaina Abd Ghani<sup>3</sup>

<sup>1</sup> Department of Restorative Dentistry, Kulliyah of Dentistry, International Islamic University Malaysia, Jalan Sultan Ahmad Shah, Bandar Indera Mahkota, 25200 Kuantan, Pahang, Malaysia.

<sup>2</sup> Centre of Studies, Comprehensive Care Dentistry, Faculty of Dentistry, Universiti Teknologi MARA, Sungai Buloh Campus, Selangor Branch, 47000 Jalan Hospital, Sungai Buloh, Selangor, Malaysia.

<sup>3</sup> Conservative Dentistry Unit, School of Dental Sciences, University of Science Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia.

## Abstract

Intentional replantation which has been practiced since the 1940s has evolved from its initial position as a final course of treatment to a viable alternative for managing failed root canal treatment. This review provides an overview of the current status of intentional replantation, clinical considerations prior to intentional replantation procedure, treatment outcomes and to explore future direction in this field. A literature search was conducted via Google Scholar using the search terms 'tooth reimplantation' and 'intentional replantation', and PubMed using the search terms 'tooth reimplantation AND endodontics', and 'intentional replantation' AND endodontics' for English language publications from January 2000 to December 2024. Additional relevant articles were identified through manual review of reference list from selected publications. Findings from this review indicate that favourable treatment outcomes can be achieved depending on several critical factors such as the access and understanding of current intentional replantation protocols, meticulous preoperative assessments, careful case selection criteria, adherence to established extra-oral manipulation time limitations during the procedure, and implementation of atraumatic tooth extraction techniques to prevent root damage.

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## \*Corresponding author

## Address:

Kulliyah of Dentistry, International Islamic University Malaysia, Jalan Sultan Ahmad Shah, Bandar Indera Mahkota, 25200 Kuantan, Pahang, Malaysia.

**Telephone:** +6095705500

## Email address:

[muslianamustaffa@iium.edu.my](mailto:muslianamustaffa@iium.edu.my), [drmusliana@gmail.com](mailto:drmusliana@gmail.com)

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## Introduction

Intentional replantation, also known as tooth reimplantation has been documented in dental practice since the 1940s. Intentional replantation has been regarded as a final course of treatment when other treatment options such as nonsurgical root canal retreatment or endodontic surgery are not feasible. However, current dental practice has repositioned intentional replantation as an alternative to failed root

canal treatment rather than as a last resort intervention (Marouane *et al.*, 2017). This procedure is a viable option in various clinical cases, as it is associated with fewer complications and superior cost-effectiveness at preserving the natural tooth compared to other treatment modalities (Asgary *et al.*, 2014; Javed *et al.*, 2020; Plotino *et al.*, 2022; Lin *et al.*, 2024) provided appropriate case selection criteria are met.

Intentional replantation is the planned extraction of a tooth, followed by extra-oral

root-end surgery or other necessary repairs, and subsequent replacement of the tooth into the original tooth socket. This procedure offers clinicians the distinct advantage of comprehensive tooth surface examination under the magnification, allowing detailed assessment of anatomical

variations, portals of exit, fracture lines, and otherwise inaccessible areas. This facilitates repair or root-end surgery without damaging the supporting tooth structures, thus promoting the reestablishment of healthy periradicular tissues (Plotino *et al.*, 2020; Plotino *et al.*, 2022).



Figure 1. Flow diagram of tooth replantation procedure.

The indications and techniques for intentional replantation protocols are clearly outlined in the literature to facilitate clinicians providing this treatment to patients (Kratchman, 2018; Plotino *et al.*, 2021; Plotino *et al.*, 2022; Pisano *et al.*, 2023) (Figure 1). Despite established clinical protocols, variations in the techniques with

regards to the prescription of preoperative antibiotics, number of clinicians involved in the procedure, tooth extraction method and tooth handling post extraction, socket manipulation/curettage, root resection method, root-end preparation method, root-end filling material, extra-oral manipulation time, and tooth splinting have been

documented (Becker, 2018). It has been suggested that the prophylactic antibiotics should only be prescribed under certain medical conditions, including complex congenital heart defects, prosthetic cardiac valves, history of infective endocarditis, ongoing intravenous bisphosphonate therapy, and recent joint surgery (within first 3 months) (Segura-Egea *et al.*, 2018). Despite a viable alternative to retain the natural tooth, clinicians should have a thorough understanding with regards to the indications, clinical procedures and possible complications because the affected tooth is usually compromised and is susceptible to fracture during the tooth extraction process, which can affect its long-term success (Lin *et al.*, 2024).

The majority of complications following intentional replantation are persistent periapical inflammation, external root resorption, ankylosis, periodontal pocket formation and potential tooth loss manifest within the first year, although delayed complications remain possible (Cho *et al.*, 2016). Despite these complications, improved healing outcomes were observed in cases where replanted is completed within 15 minutes (Cho *et al.*, 2016). The primary complication following intentional replantation is ankylosis, which is frequently associated with excessive splinting. When sufficient tooth stability is achieved following intentional replantation, postoperative fixation on the replanted tooth may be accomplished using a crossed suture suspended above the occlusal surface with optional resin composite reinforcement at the tooth surface (Plotino *et al.*, 2020). However, in cases of inadequate tooth stability, a flexible splint with a steel wire not exceeding 0.3-0.4mm is applied for 2 weeks to allow physiologic tooth mobility and minimise the risk of ankylosis (Plotino *et al.*, 2020).

The article aims to provide an overview of the current status of intentional replantation, clinical considerations prior to intentional replantation procedure, treatment outcomes and to explore future direction in this field.

## Materials and Method

A literature search was carried out using Google Scholar with the search terms 'tooth reimplantation' and 'intentional replantation'. Another database was PubMed with the search terms 'tooth reimplantation AND endodontics', and 'intentional replantation' AND endodontics'. The search included English language publications from January 2000 to December 2024. Two independent assessors reviewed the scientific contents of the identified articles. Additional relevant studies were selected through manual review of the reference lists of selected articles. Disagreement between two assessors was resolved through consensus discussion. This review included 23 articles related to intentional replantation and it is worth noting that original research articles on this topic were limited, with the majority of articles predominantly comprising review articles, case reports/series and other study designs including systematic reviews (Table 1).

## Discussion

Intentional replantation demonstrates a viable alternative across various clinical cases (Table 2), contingent upon careful case selection criteria (Figure 2). Based on reported data, the survival of intentionally replanted teeth, defined as tooth retention across varying follow-up periods was 88% (95% CI, 81%-94%) (Torabinejad *et al.*, 2015). Additional study revealed 90% survival rates at less than 6 months follow-up with slight decline observed in cases followed up beyond 36 months (Wang *et al.*, 2020). In another study, the mean survival rate of 85.9% for approximately 12 months observation period was observed (Javed *et al.*, 2020). A recent study reported a survival rate of approximately 89% and 86% for single rooted and multi rooted teeth respectively (Pisano *et al.*, 2023).

Table 1. Articles on intentional replantation.

Type of study	Number of article (s)	Area of studies
Systematic review	5	<ul style="list-style-type: none"> <li>• Tooth survival after intentional replantation (Torabinejad <i>et al.</i>, 2015; Pisano <i>et al.</i>, 2023)</li> <li>• Clinical outcomes involving the survival and success of intentionally replanted teeth (Wang <i>et al.</i>, 2020)</li> <li>• Clinical outcomes (Javed <i>et al.</i>, 2020)</li> <li>• Effectiveness of intentional replantation (Plotino <i>et al.</i>, 2023)</li> </ul>
Prospective study	2	<ul style="list-style-type: none"> <li>• Tooth retention and healing after intentional replantation and outcome predictors (Cho <i>et al.</i>, 2016)</li> <li>• Clinical outcomes and bone changes determined using cone beam computed tomography (Park <i>et al.</i>, 2023)</li> </ul>
Retrospective study	1	<ul style="list-style-type: none"> <li>• Clinical outcomes of intentionally replanted teeth in terms of tooth survival and periradicular healing and investigation of their prognostic factors (Choi <i>et al.</i>, 2014)</li> </ul>
Case report/series	4	<ul style="list-style-type: none"> <li>• Indication and case selection (Asgary <i>et al.</i>, 2014)</li> <li>• Viable treatment option when a dental implant, nonsurgical retreatment or surgical treatment is not possible (Cotter &amp; Panzarino, 2006)</li> <li>• Clinical procedure and outcomes (Alves <i>et al.</i>, 2020)</li> <li>• Clinical outcomes and bone changes before and after intentional replantation (Santos <i>et al.</i>, 2022)</li> </ul>
Position statement	1	<ul style="list-style-type: none"> <li>• Evidence on clinical guidance to undergraduate and postgraduate students, dental practitioners, clinical teachers and researchers (Plotino <i>et al.</i>, 2021)</li> </ul>
Review article	10	<ul style="list-style-type: none"> <li>• Case selection (Unver <i>et al.</i>, 2011)</li> <li>• Clinical procedures, indications, outcomes (Marouane <i>et al.</i>, 2017)</li> <li>• Indication (Kratchman, 2018)</li> <li>• Clinical procedures including variations in the techniques (Becker, 2018)</li> <li>• Concepts and techniques (Kratchman, 2019; Plotino <i>et al.</i>, 2020)</li> <li>• Rationale and indications, treatment protocols, treatment outcomes (Plotino <i>et al.</i>, 2022)</li> </ul>

- Clinical procedures and outcomes (Sangiovanni *et al.*, 2021; Kumar *et al.*, 2024)
- Case selection, preoperative assessment, clinical procedures, post-operative management and follow-up, treatment outcomes, prognosis and complications (Lin *et al.*, 2024)

Meanwhile, the success, characterised by absence of clinical symptoms, improvement in the periodontal probing depth and radiographic evidence of bone regeneration was 70% to 90% (Wang *et al.*, 2020). In another study, the success rate was 77.23% for approximately 12 months observation

period was also reported (Javed *et al.*, 2020). Although tooth survival is the most commonly reported outcome in existing literature, success and failure rates of intentional replantation have also been reported.

Table 2. Considerations for choosing intentional replantation over intra-oral surgery.

	Considerations	Relevance
Tooth-related	Lingually inclined mandibular second molar (Kratchman, 2019)	Thick buccal cortical bone removal is required to access the roots ridge causing excessive bone removal due to the external oblique ridge
	Mandibular teeth in proximity with the inferior dental canal or mental nerve (Kratchman, 2019)	Risk of paraesthesia from potential nerve injury
	Roots of maxillary molar in proximity with maxillary sinus floor (Kratchman, 2019; Plotino <i>et al.</i> , 2022)	Risk of perforating maxillary sinus floor, risking post-operative sinus infection
	Palatally positioned maxillary molars (Kratchman, 2019)	Buccal access will require unnecessary bone removal. Palatal access will risk injury to greater palatine artery
	Difficult access to sites requiring repair (perforations/ resorption/ palatogingival groove/ vertical root fracture) (Plotino <i>et al.</i> , 2022)	Unnecessary bone removal will jeopardize periodontal support
	Periodontally compromised tooth (Park <i>et al.</i> , 2022)	Apical bone removal will reduce periodontal support to access the root
General	Patients who cannot tolerate surgical procedures (Kratchman, 2019)	Tooth replantation procedures are performed extra-orally
	Patients with tremor (Kratchman, 2019)	Risk of iatrogenic injury during surgical procedures due to patient movement, especially during incision, bone removal, and root-end cavity preparation. Intra-orally surgery might be difficult due to loss of focus from “moving” surgical site



Figure 2. Periapical radiograph of endodontically treated molars. A and B: straight roots with interseptal bone, good candidate for intentional replantation without splinting. C: Fused root, easy removal, but requires splinting after intentional replantation.

In cases presenting with complicated root structure and high risk of fracture during tooth extraction, teeth with repeated nonsurgical root canal treatments, large root canal with minimal root dentine thickness, and insufficient coronal tooth structure for forceps engagement, preoperative orthodontic extrusion (Figure 3A, 3B) for 2-3 weeks prior to intention increase tooth mobility and volume of periodontal ligament

to facilitate atraumatic tooth extraction, thus minimising the risk of complications such as root resorption and ankylosis (Choi *et al.*, 2014), ultimately improving tooth survival (Torabinejad *et al.*, 2015). Alternatively, the use of orthodontic separators (Figure 3C) at the inter-proximal regions approximately 10-14 days prior to tooth extraction may also facilitate the tooth extraction process (Kratchman, 2019).



Figure 3. A and B: Clinical photographs of maxillary second premolar with minimal coronal tooth structure undergoing orthodontic extrusion (Photos courtesy of Lt. Colonel Dr. Muhammad Khiratti Bin Mat Zainal). C: Orthodontic separators placed interproximally prior to tooth removal.

Systematic reviews have documented the success and survival rates, along with prognostic indicators that support the effectiveness of intentional replantation procedure (Torabinejad *et al.*, 2015; Wang *et al.*, 2020; Pisano *et al.*, 2023). Critical prognostic indicator includes preoperative orthodontic extrusion, which can reduce the risk of root resorption and increase tooth survival (Torabinejad *et al.*, 2015).

Additional significant indicators identified in literature include minimised extra-oral manipulation time, reductions in

periodontal pocket depth, type of tooth, type of root-end filling material, prevention of atraumatic tooth root damage during extraction (Wang *et al.*, 2020), and careful case selection criteria (Pisano *et al.*, 2023).

Treatment outcomes are considered as favourable in the absence of clinical signs and symptoms, radiographic evidence of resolution and return of the tooth to normal function (Asgary *et al.*, 2014). Although existing data demonstrates the predictability of the procedure, several consideration warrant consideration such as

the predominance of case reports and/or case series (Pisano *et al.*, 2023), retrospective studies (Wang *et al.*, 2020), combined retrospective and other study designs (Torabinejad *et al.*, 2015) and lack of comparative data between intentional replantation and other treatment modalities (Plotino *et al.*, 2023), underscoring the need for more rigorous prospective clinical studies.

In general, the outcomes of intentional replantation is dependent on multiples critical factors such as implementation of atraumatic tooth extraction, adherence to less than 15 minutes extra-oral manipulation time, copious irrigation with sterile saline solution or Hank's balanced salt solution to prevent drying out of the root surface, meticulous instrumentation steps, and patient compliance post procedure (Cotter & Panzarino, 2006). The success of intentional replantation carries various opportunities for technical mishaps and is highly dependent on the clinicians (Sangiovanni *et al.*, 2022). While there is a lack of evaluation regarding the skillset and experience of clinicians in literature, available evidence suggests that careful case selection and adequate procedural training may positively impact treatment outcomes (Asgary *et al.*, 2014). Future research into the impact of this variable on treatment outcomes represents an important direction for future research.

The integration of intentional replantation into dental school curricula is a crucial step towards preparing future clinicians for this treatment modality. Additionally, the development of comprehensive educational initiatives encompassing both theoretical knowledge and clinical competencies are fundamental for dental educators, practicing clinicians, graduates and students. This ongoing lifelong educational process is essential to ensure continuous update on intentional replantation and optimal patient care to offering this procedure as a treatment option.

## Conclusion

Favourable treatment outcomes of intentional replantation can be achieved through access to updated knowledge, comprehensive preoperative assessments, careful case selection criteria, adherence to extra-oral manipulation time, and implementation of atraumatic tooth extraction to prevent root damage. Although higher levels of evidence for the procedure such as randomised clinical trials are lacking, current evidence suggests promising results, subject to the clinicians following standardised protocol aligned with evidence-based recommendations.

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## Conflict of Interest

None

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