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The Success Rate of Intentional Replantation in Permanent Teeth: An Umbrella Review

Dr. Dhanashree Kamble[1], Dr. Ashish Jain[2], Dr. Rahul Rao[3], Dr. Sanpreet Singh[4], Dr. Ritvi Arvind[5], Dr. Apurva Patil[6]

[1]Department of Conservative Dentistry and Endodontics, Institute: Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Navi Mumbai
[2]Department of Conservative Dentistry and Endodontics, Institute: Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Navi Mumbai
[3]Bharati Vidyapeeth Dental College and Hospital, Navi Mumbai
[4]Department of Oral Pathology and Microbiology, Institute: Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Navi Mumbai
[5]Bharati Vidyapeeth Dental College and Hospital, Navi Mumbai
[6]Bharati Vidyapeeth Dental College and Hospital, Navi Mumbai

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Abstract

Background: *Tooth replantation is known to be a precise and predictable procedure. Although the success of this procedure is dependent on multiple variables, there is still not enough literature that documents the replantation process precisely describing the outcomes of intentional reimplantation. Therefore, this umbrella review aims to analyze the outcomes of intentional reimplantation, both patient and treatment-related, and assess the operative factors that would affect the same. The study evaluates and critically appraises the evidence for the outcomes of intentional reimplantation, both patient and treatment-related, and assesses the operative factors that would affect the same.*

Materials and Methods: *PubMed, Google Scholar, Cochrane, Scopus, and Embase were used to search the literature published in the English language without any restrictions for the date of publication. Any systematic review describing the procedure of intentional reimplantation with or without meta-analysis was included. Reported details of Intentional reimplantation were extracted from the selected articles.*

Results: *A total of n=7 systematic reviews were included in the final data analysis. The mean survival rate of intentional replantation is 84.02 on 12-month follow-up.*

Conclusion: *Intentional replantation is a viable treatment option that can be chosen over tooth extraction and implantation. This procedure has a high success rate and is also cost-effective when other conventional treatments.*

Keywords: *Avulsion, Tooth Replantation, Dental Extraction.*

Introduction

The aim of a successful endodontic and restorative treatment is to preserve the natural dentition, in function and aesthetics, in its pristine form. Age-old non-surgical endodontic treatments have given a high success rate. Complications arising from them have been managed by root canal re-treatment or surgical endodontics. However, in some cases, endodontic re-treatment or apical surgery is not feasible or impractical. In cases where conventional treatment fails, Intentional replantation (IR) can be considered as a viable option.[1] Intentional replantation is described as "the intentional removal of offending tooth, its visual inspection and insertion of the same into the periosteum after it has been removed for executing an endodontic procedure (root-end filling or root repair) outside the oral cavity.[2]

The ingress of better modes of atraumatic extraction with elevators, luxators, and periotomes has led to the popularity of this cost-effective method of IR. It is indicated in cases where root canal treatment has failed or where the damage is not repairable intra-orally. It can be considered a favorable treatment modality in cases of apical periodontitis in clinically inaccessible areas. A simple root anatomy facilitates atraumatic extraction and thus successful IR.[3] Similarly, in cases of iatrogenic damage like perforation, calcified canals, overextension of obturating material, close proximity to vital bodies (such as the mental nerve), and in teeth not indicated for apical microsurgery, IR can be done.[4,5] Recently, IR has achieved a greater dimension with its use with new-age biomaterials and periodontal regenerative agents. Numerous studies suggest that the survival rate of IR is as high as 90%, making it a viable option for treatment.[6] When traditional endodontic and implant treatment plans have questionable prognosis or they are not cost-effective, IR can be considered as a predictable and economical alternative treatment.[7]

The longevity of a tooth intentionally retransplanted is multifactorial. Therefore, it is imperative clinicians have established clinical protocols in hand to facilitate decision-making for a successful IR outcome. The objective of the study was to evaluate the outcomes of intentional replantation of teeth and their success rate. The objectives of this study are to evaluate and critically appraise the evidence for the outcomes of intentional reimplantation, both patient and treatment-related, and assess the operative factors that would affect the same.

Material and Methods

The review was conducted in accordance with the Preferred Reporting Items for Overviews of Reviews (PRIOR) guidelines PICOS framework was used to design research questions. (Table 1).[9] The study was registered under PROSPERO Registration number: CRD42023410591. The questions of the review were designed for patients undergoing Intentional Replantation. They were as follows

a. What percentage of treatment done using IR survive or succeed (Outcome)?

b. What are the factors (Intervention and Comparison) that impact or impede the rates of success and survival of IR (Outcome)?

c. In comparison to other procedures like implants, how successful is IR (comparison and outcome)?

A systematic approach was adopted for this umbrella review. As the literature review in this area was limited, restrictions on the follow-up time frame, language, procedure, and publication year were not imposed. Five databases PubMed, Cochrane, Embase, Google Scholar, and Scopus were used to acquire data using keywords 'tooth replantation' OR 'intentional replantation.'

Reviewers were designated before the study commencement. The screening was carried out independently by the authors (DK & AJ) against the predefined inclusion criteria, following which two authors retrieved and reviewed full-text manuscripts. Any potential disagreement or discrepancies was resolved by a 3rd author (RR). The data was extracted independently by two calibrated reviewers using standardized pre-tested electronic

collection forms. In case of missing and unclear data, attempts were made to contact the corresponding author of the article and bridge the missing information.[5]

The description of success and survival were also defined. Success included favorable periodontal healing, negative evidence of external root resorption, treatment of resorbed teeth with endodontic intervention, absence of ankylosis, and healthy alveolar bone growth around the replanted tooth. Survival was indicated by the presence of the transplanted tooth at all follow-up visits of the patient irrespective of the clinical and radiographic outcomes. Failures were defined as cases wherein the transplanted tooth was indicated for extraction.

Two reviewers (DK and SSS) independently assessed the quality of review articles using AMSTAR 2.[9] The rating for all literature inputs was categorized as high, moderate, and low respectively. Any disagreements between the two reviewers were concluded with a discussion with a third author (RR). The score for every article was calculated by consensus of the three reviewers. The Corrected Covered Area Analysis (CCA) was performed to evaluate the degree of overlap between primary studies in a meta-review using the GROOVE TOOL.[10]

Results

Through keywords, 4860 articles were related to the subject. Out of this, 10 articles were available at PubMed/ MEDLINE, 4850 articles by Google Scholar. 4829 were considered irrelevant by consensus. After thorough revision, 20 studies were selected. Based on the full text of the articles,9 articles were excluded due to duplication, 2 articles were based on animal study, and 2 articles were based on reimplantation of avulsed teeth 7 systematic reviews were eventually included in the present umbrella review (Figure 1).[1,6,7,11-14]

The primary characteristic data includes the details related to the study designs, samples, and outcomes are listed in Table 2. Four out of seven studies mentioned the survival rate of intentional replantation. The mean survival rate of intentional replantation was calculated to be 84.02 on 12 months follow-up.

The CCA index was used to measure the degree of overlap among all the included systematic reviews (Table 3). Excel spreadsheet was used for citation matrices. The overall CCA for the study was found to be 4.64% conferring it to be slightly overlapped. GROOVE tool (Graphical Representation of Overlap for Overviews) was used to represent the overlapping evidence between the studies. (Figure 2)

Table 4 shows the quality appraisal of the 7 studies included in the umbrella review. These systematic reviews/meta-analyses were conducted in the period Inception–2022. According to the AMSTAR-2 tool, no study was categorized as high risk, 2 as moderate risk, and 5 were considered low risk. Two systematic reviews did not specify heterogeneity among their analyzed original studies, 5 SRs reported heterogeneity, out of which 2 SRs reported high heterogeneity, 1 SR reported low heterogeneity and the remaining 2 SRs were considered as having variable heterogeneity depending on the specific characteristics of the included original studies.

The risk of bias was moderate in 2 studies and low in 2 studies (28.57%). Four studies did not clarify quality assessment procedures in terms of the instrument used. One study used the JBI (Joanna Briggs Institute) Critical Appraisal Tool in different versions. The Newcastle Ottawa Scale (NOS) was used in one systematic review, and finally, one systematic review used The National Institutes of Health (NIH) Quality Assessment Tool quality assessment procedures.

Discussion:

The above literature describes the factors involved preoperatively, during, and post-operatively that affect the intentional reimplantation of permanent teeth in various individuals. In addition to this, patient satisfaction levels and aesthetics were also gauged in comparison to the conventional treatment plans. A wide range of

systematic reviews were analyzed to corroborate the information on IRs. The percentage of overlap of the included systematic reviews was evaluated and calculated using the CCA index, thus widening the research base. Therefore, this umbrella review is a thorough insight into the predictability of IR as a treatment plan.

A study conducted by Gianluca Plotino et al. to compare IR with conventional endodontic treatment or retreatment for the treatment of permanent teeth with endodontic etiology suggests that IR can be considered as an alternative procedure to save teeth. However, the lack of literature review from the SRs, makes clinical application of the concept tedious and requires clinician's experience to ensure predictability. Four systematic reviews included in this study evaluated the success of IR pragmatically and it was elicited that the survival rate of IR ranges from 84.02 to 88 percent. The higher survival rate was seen to be directly proportional to the amount of time taken to replant the tooth as it affected the health of periodontal cells.[7,13]

Wang et al. suggested that if the teeth to be reimplanted predispose with apical abscess (acute or chronic), the IR may fail. The failure risk in such cases is 2.7 times more than usual. The reason behind the failure is attributed to the destruction, inflammation caused by periodontal bone and PDL cells.[8] The survival rates of IR between teeth that are single-rooted and the teeth that are multi-rooted teeth are statistically the same. Therefore, it can be concluded that intentional reimplantation is unaffected by the number of roots of the selected tooth. CBCT proves itself as a quick and predictable guide to plan and support IR planning in diagnosis and treatment planning.[11]

Mahmoud Torabinejad et al. compared intentional replantation with Implant with single crown (ISC) and they concluded that the mean survival rate of ISCs was 97% which was significantly higher than that of IR teeth 88%.[14] In another study conducted by Anshul Mainkar et al. they concluded that intentional replantation is an economical treatment modality even when custom post/core and crown are needed.[13] The study also concluded that intentional replantation was more economical than implant treatment. Hence, it can be discussed as a treatment option. It was suggested that even if IR failed, implants could still be considered as a treatment option, thus, delaying the need for replacement.

Dry time outside the oral cavity is considered a crucial factor in the procedure of intentional replantation and its subsequent success. Most authors have stated the requirement of keeping the extracted tooth extra-orally below a time interval of 15 min to maintain the viability of periodontal ligament cells. Normal saline is graded as the most common medium for storage of extracted teeth to prevent desiccation of periodontal ligament for successful replantation. Studies have demonstrated superiority of Hank's Balanced Salt Solution in preserving the periodontal ligament of extracted and avulsed teeth.[15] Storage of root involves covering the tooth in a cotton gauze soaked in saline/HBSS or immersing the tooth in the liquid.[12,13]

Finances play a big role for a patient to choose any treatment plan, irrespective of the prognosis of the treatment. Intentional reimplantation has been seen to be more cost-effective than implants or even post and core which is done in order to save the tooth.[16] Clinicians have a tendency to choose treatment plans with higher prognosis. However, it is important that first more cost-effective treatment is tried and thereafter treatment with the highest prognosis is done entailing the fact that conventional treatments like apicoectomy, endodontic retreatment, and partial dentures for repairing a failed root canal–treated molar should be done first than single-tooth implants which are less economical.[17,18]

It is noted that the quality of life of a patient reduces significantly once RPDs are used. Therefore, the agenda of any clinician should be to withhold or prevent from reaching such a stage. It is suggested that intentional replantation should be considered before extraction of the offending tooth or immediate implant placement even when single-tooth implant can be done. The success of intentional replantation reduces the need for implant

placement substantially. Further, even if the procedure fails the preserved periosteum allows easy placement of a dental implant. Thereby, delaying the probability of the patient using a removable denture.[19,20]
The inclusion of only systematic reviews relates to the positive findings of IR over implant treatments. However, there are low evidence and inconclusive protocols for preserving teeth, in an environment, outside the oral cavity after tooth removal. Also, the preservation of alveolar bone and the follow-up periods alter the success and survival rate of IR, which have been not included in the study.

Conclusion:

Intentional replantation can be considered as a viable treatment option that can be chosen over tooth extraction and implantation. This procedure has a high success rate and is also cost-effective when other conventional treatments like nonsurgical treatments and surgical retreatments have yielded negative results or are bound to have poor prognosis. Therefore, in such cases, intentional replantation can be considered as a practical alternative. Moreover, this study elicits the fact that IR is successful irrespective the number of roots of the tooth to be reimplanted. IR is considered safe as long as the procedure is performed with utmost care to preserve periodontal cells of the corresponding tooth.

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Table 1: PICOS Criteria used for the selection of systematic reviews in the present umbrella review

PICOS Framework	Criteria
Definition Population	Patient undergoing tooth intentional-replantation No defined gender, age, and medical history of the patient No defined tooth type used for replantation (single rooted /multi-rooted)
Intervention	Intentional reimplantation of teeth No defined tooth type or root development stage. No established reasons for intentional replantation. No defined quadrant or tooth number for receiving IR and subsequent follow-up duration
Comparison	Not applicable
Outcome	Primary: • survival rates • success rate • factors affecting the same • Periodontal health Secondary:

	• Patient acceptance • Aesthetic outcome • Cost analysis • Adverse effects if any
Study Design	Systematic review With/without meta-analysis No limitation on language, publication year, Follow up time

Table 2: Characteristics of samples and outcomes of the systematic reviews in the present umbrella review

Author/ year	**Included primary studies in systematic review**	**Study designs included in the analysis**	**Age Range**	**Total Teeth (primary studies, n=)**	**Teeth Type**	**Follow-up Duration**	**Main Outcome**	**Risk of Bias Assessment Tool used**	**Meta-analys conduc d**
Massimo Pisano et al Italy 2022 [1]	n=60 January 1996 to 1 July 2022;	Clinical trials, case reports, case series, analytical observational studies,	7yrs-76yrs	106 n=60	Multi-rooted -50 Single rooted - 56	3months-15years	Survival rate of 86.7% was currently estimated for intentional replantation, and no statistically significant difference was found between single-rooted and multi-rooted replanted teeth survival rate of single-root implanted teeth was 89.3% while for multi-rooted reimplanted teeth it was 84%.	JBI (Joanna Briggs Institute) Critical Appraisal Tool	No
Gianluca Plotino et al Italy 2022 [7]	n=0 inception to November 2021	Clinical trials, longitudinal observational studies (retrospective and prospective comparative cohort and case–control studies)	NM	n=0	NM	NM	NM	NM	No

Faizan Javed Pakistan 2022 [11]	n=13 1965 to December 2021	Clinical trials, cohort studies and case series.	10yrs - 56yrs	1317 n=13	NM	6months-22 years	Intentional replantation has acceptable long-term success (77.23%) and survival (85.9%).	Newcastle–Ottawa scale	Yes
Teng Kai Ong Malaysia. 2022 [12]	n=14 1950-2020	Observational studies, prospective cohort study retrospective cohort studies	NM	1263 n=14	Multi-rooted - 979 Single rooted- 62 NR-222	1Day-22years	Within the limitations of this study, IR presented with a good overall healing rate of 80.2% with a complication rate of 21.7%.	The National Institutes of Health (NIH) Quality Assessment Tool	Yes
Lin Wang et al China 2020 [6]	n=12 January 2000 - October 2017	case series, RCTs, prospective or retrospective study	11years-77years	905 n=12	NM	6 months-12years	At 6–12-month follow-up, the survival rate in 5 studies was 80–90%. At 12–36-month follow-up, the survival rates in 2 studies were reduced between 65% and 80%. One study reported that the survival rate of 83.3% at 12 months	NM	No
Anshul Mainkar United Staes 2017 [13]	n=6 January 1966 and February 2017	NM	NM	n=551	NM	2years-12 years	Compared with a single-tooth implant, intentional replantation was more cost-effective even when custom post/ core and crown are also	NM	Yes

							needed.		
Mahmoud Torabinejad et al USA 2015 [14]	n= 8 January 1966 to April 2014	case series , case report	NM	n=838	NM	2-6 years	A systematic review and meta-analysis found that the mean survival of ISCs (97%) was significantly higher than that of IR teeth (88%).	NM	Yes

Table 3: Corrected covered area analysis for measuring the degree of overlap among the included systematic reviews

Overall results		
Number of columns / reviews	c	8
Number of rows / index publications	r	80
Number of primary studies/ including double counting	N	106
Covered area	N/(rc)	16.56%
Corrected covered area	(N-r)/(rc-r)	4.64%
Interpretation of overlap	**Slight overlap**	
Structural Zeros	X	534
Corrected covered area (adjusting by structural zeros)	(N-r)/(rc-r-X)	100.00%
**entire list of 80 studies provided as supplementary material*		

N° of non-overlapped primary studies	SR 1	67
Number of overlapped primary studies	SRs 2	4
	SRs 3	6
	SRs 4	2
	SRs 5	1
	SRs 6	0
	SRs 7	0
	SRs 8	0
	SRs 9	0
	SRs 10	0
	SRs 11	0
	SRs 12	0
	SRs 13	0
	SRs 14	0
	In 15 or more SRs	0

Table 4: AMSTAR analysis of the systematic reviews included in the present umbrella review

References	Question & inclusion (1)	Protocol (2)	Study design (3)	Comprehensive search (4)	Study selection (5)	Data exclusion (6)	Exclude study justification (7)	Include study details (8)	Risk of bias (RoB) (9)	Fu sou (10
Massimo Pisano et al. 2022	YES	YES	YES	YES	YES	YES	YES	YES	YES	YE
Gianluca Plotino et al. 2022	YES	PY	YES	YES	YES	YES	YES	PY	NO	NC
Faizan Javed et al. 2022	YES	YES	YES	YES	YES	YES	PY	YES	YES	NC
Teng Kai Ong et al. 2022	PY	YES	YES	PY	YES	YES	YES	YES	YES	YE
Lin Wang et al. (2020)	NO	YES	YES	YES	YES	YES	YES	YES	NO	YE
Anshul Mainkar et al. (2017)	NO	NO	NO	PY	NO	NO	NO	YES	NO	NC
Mahmoud Torabinejad et al. (2015)	YES	YES	YES	YES	YES	NO	YES	YES	NO	NC
Y: yes; N: no; PY: partial yes; NMC: no meta-analysis conducted.										

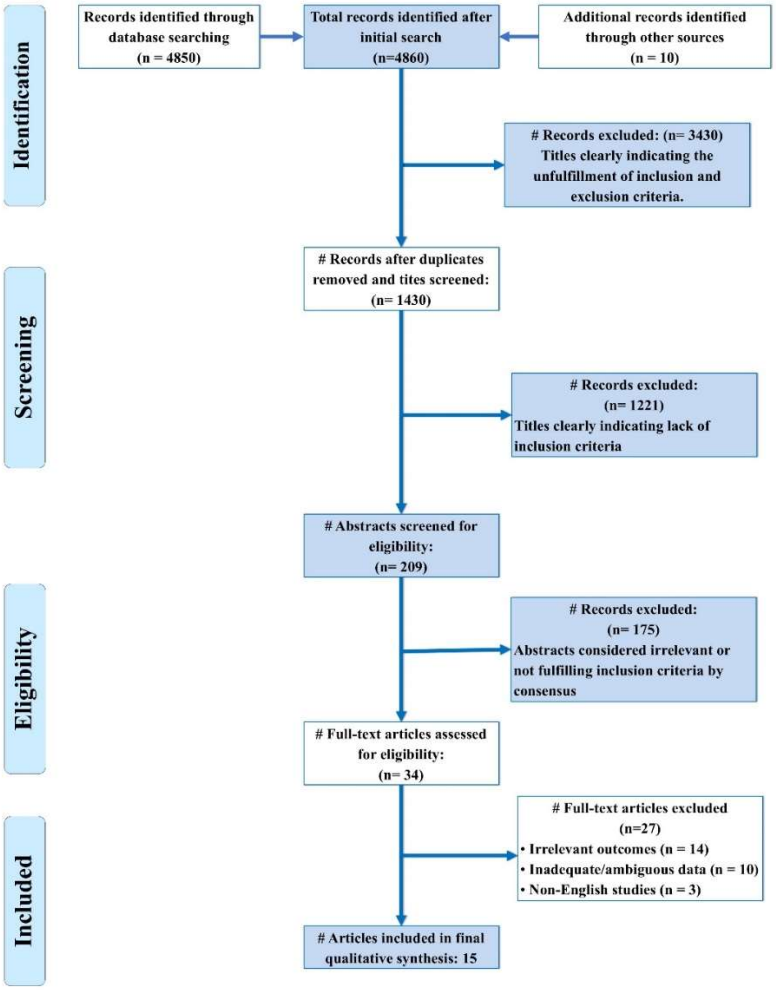

Figure 1: PRIOR Flow diagram indicating the selection process of the systematic review in the present umbrella review

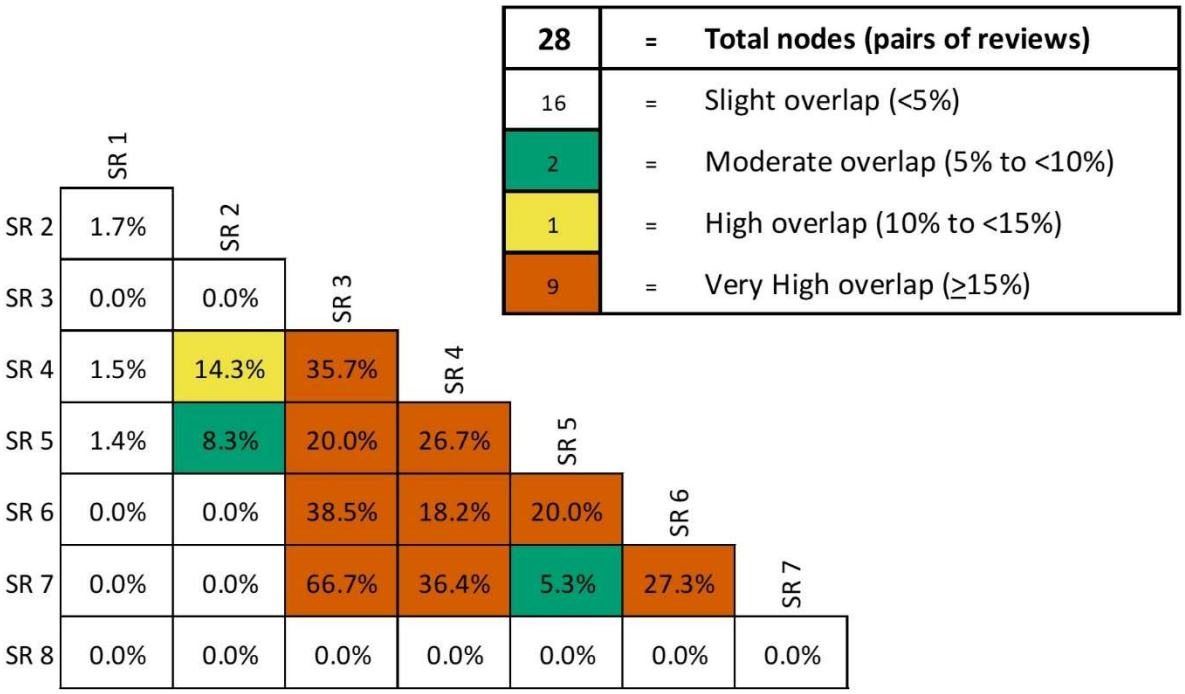

Figure 2: Graphical Representation of Overlap for OVERviews (GROOVE)