Available online at www.giornaleitalianoendodonzia.it

REVIEW ARTICLE

Intentional replantation in Endodontics: review of literature

ABSTRACT

Intentional replantation (IR) is a surgical approach consisting of a tooth's controlled extraction. The latter is repositioned in its original alveolar socket after being endodontically treated extra-orally.
The present work was conducted to assess the Intentional replantation by reviewing the literature of articles presenting case reports treated with the IR technique.
The current literature search was conducted through PubMed, Scopus, EMBASE, and Google Scholar. Articles updated from 1996 to December 1st 2021, have been included. Each reviewed article was evaluated using a ten-question data extraction form to identify the type of study, the sex and age of the patients, the teeth treated, the extra-alveolar time of the teeth, the techniques used and the time of follow up.
Modern technologies recently introduced in dentistry aided in achieving encouraging results; in particular, it has been highlighted that surgical interventions are shorter and less invasive and with a lower percentage of failures.
In conclusion, this work aimed to analyze and discuss the surgical procedures of IR described in the literature by different authors through a review of the literature. Furthermore, a clinical case using the intentional reimplantation technique was also reported.

Giuseppe Sangiovanni[1*]
Giuseppe Scelza[1]
Francesco Giordano[2]
Andrea Chiacchio[1]
Roberto Ferrigno[1]
Carlo Rengo[1]
Massimo Pisano[1]

[1]*Department of Medicine and Surgery, University of Salerno, Salerno, Italy*

[2]*Independent dentist in Salerno, Italy*

Received 2021, December 15
Accepted 2022, February 10

KEYWORDS *Intentional replantation, intentional replantation procedure, intentional replantation techniques, intentional replantation case-report*

Corresponding Author
Giuseppe Sangiovanni | University of Salerno, Salerno | Italy
Phone number: 00393295465284 | Email gsangiovanni7@gmail.com

Peer review under responsibility of Società Italiana di Endodonzia
10.32067/GIE.2021.35.02.49

Introduction

Intentional replantation (IR) is a surgical technique that consists of the controlled extraction of a tooth and repositioning the latter in its original alveolus. This procedure is done in order to allow, in an extraoral environment, the evaluation of root surfaces and endodontic treatment when the orthograde treatment or apical surgery cannot be made (1). The intentional re-implant is indicated: in cases of persistent symptomatic apical periodontitis after orthograde endodontic therapy for teeth in which the orthograde path is either complex or blocked (2-4). Also, IR can be applied in cases with improper endodontic therapy with overfilling material beyond the apex with the persistence of the lesion even after periapical surgery was done (3). Moreover, it can be applied when a surgical endodontic flap retraction is contraindicated due to anatomical or accessibility limitations (5). In addition, in conditions of inaccessible external root resorption (6), or in special cases of root perforations,(7) and in cases of complex root or root-crown fractures (7-9), the IR can be recommended. Furthermore, IR can be beneficial for treating teeth presented with development anomalies such as fused teeth or with canal configuration type C (10-12).

In summary, the IR can be the last resort when all the possible orthograde and periapical surgery approaches have failed or are contraindicated.

The intentional re-implant can represent a therapeutic choice even when the alveolar bone level is required to be preserved for subsequent implant insertion (13-14).

The surgical phase in IR must be performed with extreme precision to improve the results and the percentage of success. The extraction tactic must be the least traumatic to avoid tooth fractures and damage to the periodontal ligament (PDL), which can comprehend a critical role in the treatment's healing and success (15). Some authors consider the extraction part the most technically sensitive phase of the procedure (16). Once extraction is done, the extracted tooth is then analyzed in order to underline the presence or absence of fractures or anatomical characteristics that require attentiveness, for example, the presence of additional or accessory canals or multiple foramina (17). Subsequently, based on the case, the decision to proceed to extra-oral endodontic treatment can be developed (18-21).

Of fundamental importance for the treatment success is the management and the conservation of the PDL and, in particular, the extra-alveolar environment conditions (22, 23). It was established that an extra-alveolar time greater than 15 minutes in a dry environment compromises the vitality of the PDL by increasing the possibility of replacement and ankylotic reabsorption (24). Therefore, the extra-alveolar time must be minimized, and the conservation of the tooth occurs in a humid environment to render the surgical procedure more predictable (25, 26).

Removing any cystic or granulomatous tissue residues in the alveolar socket (alveolar curettage) aiming to initiate alveolar healing is very debated in the literature as the main objective is to avoid removing or damaging the PDL attached to the alveolar walls (27). Some authors have advocated a healing technique of the apical portion implicating removing the lesion without affecting the pocket walls (28). Removing the cystic tissue in the latter technique involves using the laser to reduce inflammation and speed up the healing (29).

Once the alveolar socket is prepared, the treated tooth is gently inserted in an axial direction using digital pressure. In case of resistance to the replanting procedure, some authors have suggested utilizing the pressure of the patient's bite to insert the original socket (30, 31). The splinting phase is controversial; in fact, several methods and different types are reported in the literature, including a splint with orthodontic wire, with composite resin or with sutures (27). The removal times vary accordingly; some cases may require removing the splint after seven-ten days, others after three-four weeks.

Figure 1
Keywords with the number of articles identified.

Keywords	n°
Intentional Replantation	**263**
Intentional Replantation Procedure	**179**
Intentional Replantation Techniques	**175**
Intentional Replantation Case-Report	**163**

The aim of this work was to analyze and discuss, through a review of the literature, the surgical procedures of intentional replacement described in the literature by different authors, to report the success rates of the technique and to describe what are the main causes of treatment and, in addition, provide an explanatory case report.

Review

A review of articles that have reported case reports dealt with the intentional re-implant technique was performed.

Eligibility criteria
Inclusion criteria
-Type of study: case report or case series published between 1996 and 2021 about Replantation Techniques, which explained the cause of treatment and outcome.
-Type of population: studies performed in human subjects using permanent teeth as a study unit.
-Type of intervention: studies using Replantation Techniques as a treatment modality.
Studies have been excluded when the cause of treatment and outcome was not specified.

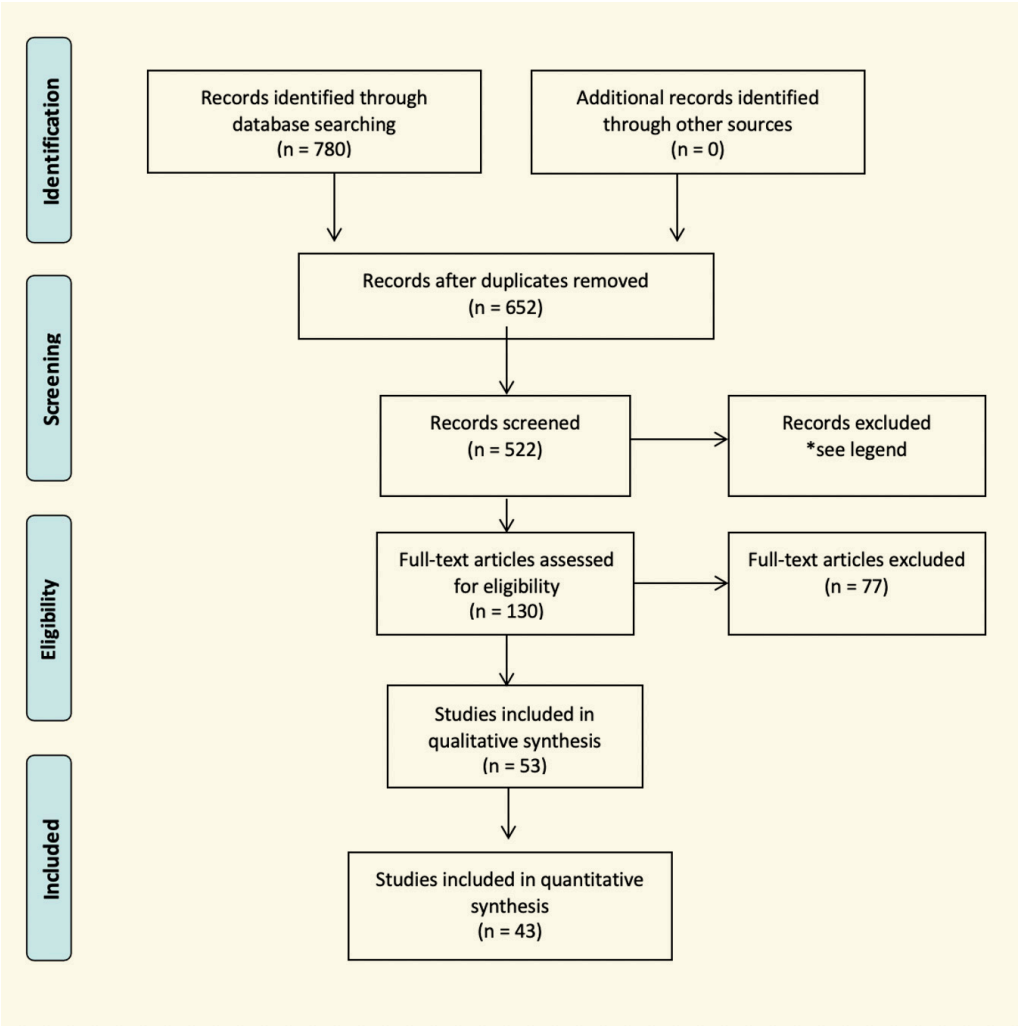
Search strategy
The research was conducted independently by three authors, G.S., A.I. and G.S. This bibliographical search has been carried out through four databases, PubMed, Scopus, EMBASE and Google Scholar for gray literature, using as "Intentional Replantation" keywords, "Intentional Replantation Techniques", "Intentional Replantation Case-Report", "Intentional Replantation Procedure" (Figure 1).
Articles updated from 1996 to December 1st 2021, were included. Each reviewed article was evaluated using a ten-question data extraction form to identify the type of study, the sex and age of the patients, the teeth treated, the extra-alveolar time of the elements, the techniques used and the time of follow up. In case of disagreement between the authors in evaluating the included studies, the majority's evaluation was considered (two authors out of three). The overlaps were removed using EndNote. The authors categorized all the cases according to age, patient sex, age, type of tooth re-implanted, cause of treatment, extra-alveolar tooth-time, outcome and healing time.

Statistical analysis
A descriptive analysis measured the relationship between studied factors, follow-up period, and outcomes of the procedure. The outcomes of the Replantation Technique '' successful '' or '' failure '' of each factor were recorded as dichotomous data. Were reported: the percentage of subjects divided by sex, the mean age of the population, the percentage of items treated and the causes of treatment, the success rate and the mean follow-up time

Results

Seven hundred eighty articles related to the keywords entered were selected from a first search. Of these, 128 were excluded as duplicates or full-text not available. Of the remaining 652 items, 130 were considered eligible, but 77 were excluded because the full-text analysis did not show clinical cases covered with the intentional re-implant technique. At the end of the screening, 43 articles were definitively included (Figure 2).
Forty-three articles were included as com-

Figure 2
Flow chart depicting the article selection process. *Exclusion criteria: studies have been excluded when the cause of treatment and outcome was not specified.



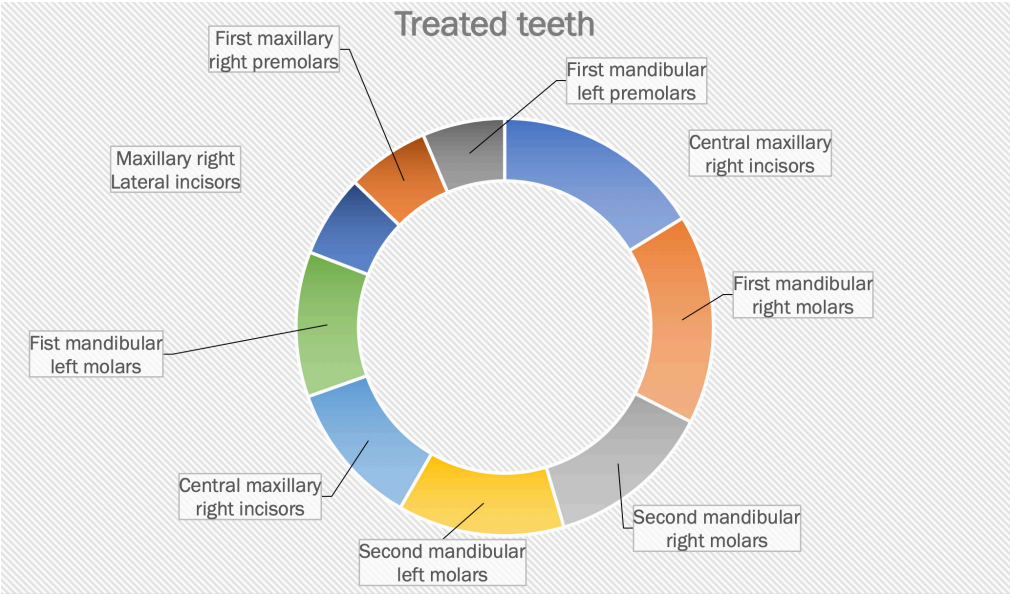
patible with relevant inclusion criteria, with a total of 82 clinical cases covered with the technique of intentional replantation. Successively, a statistical analysis of the results was carried out.

The sample consisted of 82 subjects, of which 35 males (42.7%) and 47 females (57.3%) (Table 1). The age varied from seven to 86 years, with an average age of 35.8 years.

The total number of teeth on which the technique of the re-implant intention was practised is 86. Most of the treated teeth were the upper right central incisors (11.7%) and the first mandibular right molars (11.7%). Following the second mandibular right molars (9.3%) and the second mandibular left molars (9.3%). Central maxillary left incisor (8.1%), first mandibular left molars (8.1%), lateral maxillary left incisors (4.6%), first maxillary right premolars (4.6%), and first mandibular left premolars (4.6%) were processed in these percentages (Figure 3).

The cause that led to the implementation, in 67 cases, is represented by the presence of periapical pathology (77.90%); 16 teeth have been re-implanted to treat crown-root/root fractures (18.6%); 18 due to an endodontic failure (20.93%) of which four presented a perforation (22.2%) and five with the presence of an intracanal fractured instrument (27.7%). Ten elements presented a condition of periodontitis (11.6%), five teeth showed resorption (5.81%). The intentional replantation technique also treated a case of parenthesis and a development anomaly with fused teeth.

Figure 3
Distribution of the treated dental elements.



In 55 articles, the extra-alveolar time of the treated teeth was reported, which is an average of 13.44 minutes.
The treatment success was reported in 75 replanted teeth, with a successful percentage of 87.2% with an average follow-up time of 26.8 months.

The following review was limited by the high number of articles in the literature that deal with reimplantation. Furthermore, another challenge was that the conservation method of the teeth was not considered in the data collection.

Table 1
Clinical case results included in the review

Authors	Gender	Age	Tooth	Cause	Extra-alveolar tooth-time	Outcome	Healing time
Tang 1996 (32)	Male	29 yr	3.6	Iatrogenic perforation of the furcation	-	success	17 months
Poi 1999 (33)	Male	30 yr	4.5	Instrument separation/root perforation	-	success	8 years
Aqrabawi 1999 (34) Case 1	Female	46 yr	3.7	Endodontic failure/periapical disease	15 min	success	5 years
Aqrabawi Case 2	Female	38 yr	3.7	Endodontic failure/periapical disease	20 min	success	5 years
Benenati 2003 (35)	Female	45 yr	4.7	Pain	-	success	16 years
Fariniuk 2003 (36)	Male	11 yr	1.1	Crown-root fracture	-	success	3 years
Ward 2004 (37)	Female	68 yr	3.4	Apical periodontitis	15 min	success	18 months
Shintani 2004 (38)	Male	7 yr	3.1	Periapical disease with coronal fracture	10 min	success	5 years
Peer 2004 Case 1 (5)	Male	47 yr	3.5	Periapical lesion	-	success	30 months
Peer 2004 Case 3	Male	70 yr	3.2	Periapical disease/sinus tract	-	success	4 years
Peer 2004 Case 4	Male	40 yr	3.7	Periapical disease/sinus tract	-	questionable	7 years
Cotter 2006 (39)	Female	47 yr	3.1	Periapical lesion	5 min	success	1 years
Herrera 2006 (40)	Female	56 yr	4.6	Periapical disease/endodontic failure	30 min	success	14 years

Table 1

Clinical case results included in the review

Authors	Gender	Age	Tooth	Cause	Extra-alveolar tooth-time	Outcome	Healing time
Penarrocha 2007 (41)	Female	20 yr	2.6	Odontogenic maxillary sinusitis	5 min	success	2 years
Sivolella 2008 (42)	Male	9 yr	1.2	Double tooth	20 min	success	6 years
Wang 2008 (43)	Female	8 yr	1.1	Complicated crown-root fracture	15 min	questionable	3 months
Al-Hezaimi 2009 (44)	Female	15 yr	1.2	Pulp necrosis with suppurative apical periodontitis	-	success	4 years
Ozer 2010 (45) Case 1	Male	36 yr	1.1 1.2	Vertical root fracture	(1.1) 12 min (1.2) 16 min	success	2 years
Ozer Case 2	Female	25 yr	2.2	Vertical root fracture	18 min	success	2 years
Ozer Case 3	Male	32 yr	1.3	Vertical root fracture	24 min	success	2 years
Hsiang Lu 2011 (46)	Male	50 yr	4.6	Periapical disease	13 min	success	3 months
Unver 2011 (47)	Female	41 yr	1.4	Vertical fracture	25 min	success	36 months
Kim 2011 (48) Case 1	Female	23 yr	1.1 2.1 2.2	Complicated crown-root fractures	-	failure success success	90 months
Kim 2011 Case 2	Female	27 yr	2.1	Complicated crown-root fracture	-	success	24 months
Moura 2012 (49)	Female	11 yr	1.1	Complicated crown-root fracture	-	failure	2 years
Dogan 2013 (50)	Female	9 yr	2.1	Complicated crown-root fracture	28 min	success	3 years
Shin 2013 (51)	Male	39 yr	4.6	Apical periodontitis	17 min	success	9 months
Yuan 2013 (52)	Female	11 yr	2.1	Complicated crown-root fracture	-	success	3.5 years+
Nagappa 2013 (53) Case 1	Female	18 yr	1.1	Severe periodontitis	-	questionable	3 months
Nagappa Case2	Male	24 yr	2.1	Severe periodontitis	-	success	14 months
Moradi Majd 2014 (54)	Female	44 yr	3.5	Periapical disease/necrotic	-	success	1 year
Subay 2014 (55)	Female	45 yr	4.3	Periapical disease/instrument separation	14 min	success	24 months
Asgary 2014 (56) Case 1	Male	25 yr	4.6	Periapical disease	14 min	success	23 months
Asgary Case 2	Male	45 yr	3.4	Periapical disease	10 min	success	30 months
Asgary Case 3	Male	41 yr	4.7	Periapical disease	8 min	success	24 months
Asgary Case 4	Male	23 yr	4.6	Periapical disease	12 min	success	15 months
Asgary Case 5	Female	46 yr	4.7	Periapical disease	8 min	success	27 months
Asgary Case 6	Female	31 yr	4.7	Periapical disease	9 min	success	12 months
Asgary Case 7	Female	30 yr	1.4	Periapical disease	10 min	failure	18 months
Asgary Case 8	Female	36 yr	3.6	Periapical disease	13 min	success	14 months

Table 1

Clinical case results included in the review

Authors	Gender	Age	Tooth	Cause	Extra-alveolar tooth-time	Outcome	Healing time
Asgary Case 9	Male	48 yr	4.7	Periapical disease	14 min	Success	16 months
Asgary Case 10	Female	24 yr	4.6	Periapical disease	14 min	Success	8 months
Asgary Case 11	Female	43 yr	2.6	Periapical disease	14 min	Success	17 months
Asgary Case 12	Male	34 yr	3.4	Periapical disease	12 min	Success	15 months
Asgary Case 13	Female	29 yr	3.6	Periapical disease	10 min	Success	11 months
Asgary Case 14	Male	63 yr	3.6	Periapical disease	14 min	Success	12 months
Asgary Case 15	Male	31 yr	1.7	Periapical disease	13 min	Success	10 months
Asgary Case 16	Female	46 yr	4.6	Periapical disease	14 min	Success	8 months
Asgary Case 17	Female	40 yr	4.6	Periapical disease	12 min	questionable	8 months
Asgary Case 18	Female	27 yr	4.7	Periapical disease	13 min	Success	20 months
Asgary Case 19	Female	41 yr	3.6	Periapical disease	10 min	Success	12 months
Asgary Case 20	Male	37 yr	4.7	Periapical disease	10 min	Success	9 months
Asgari 2014 (57)	Female	28 yr	1.4 1.5	Periapical disease	8 min	success	2 years
Penarrocha Diego 2014 (58)	Male	51 yr	1.7	Follicular cyst	30 min	success	12 months
Tsesis 2014 (59)	Female	20 yr	4.7	Paraesthesia	8 min	success	4 years
Keceli 2014 (60)	Female	20 yr	3.2	Severe periodontitis	6 min	success	15 months
Pruthi 2015 (61)	Male	28 yr	1.1	External root resorption	15 min	success	18 months
Forero-Lopez 2015 (62)	Male	25 yr	1.2	Apical periodontitis	8 min	success	3 months
Garrido 2016 (63)	Female	50 yr	1.1	Endo-parodontal disease	4 min	success	1 year
Oishi 2017 (64)	Male	7 yr	1.1	Trasverse root fracture/endo-perio disease	-	success	5 years
Grzanich 2017 (65) Case 1	Female	64 yr	3.1	Apical periodontitis/separated instrument	-	success	28 months
Grzanich Case 2	Male	35 yr	1.4	Periapical disease/endodontic failure	-	success	2 years
Grzanich Case 3	Female	86 yr	1.8	Apical periodontitis/vertical root fracture	-	success	2 years
Asgari 2018 (66)	Female	22 yr	4.6	Apical periodontitis	7 min	success	2 months
Krug 2019 (67)	Male	37 yr	1.1	External cervical resorption	12 min	success	2.5 years
Cunliffe 2020 (68) Case 1	Male	33 yr	4.1	Instrument separation/root perforation	15 min	success	6 months
Cunliffe Case 2	Female	45 yr	3.4	Periapical disease with missed anatomy	15 min	questionable	3 months

Table 1
Clinical case results included in the review

Authors	Gender	Age	Tooth	Cause	Extra-alveolar tooth-time	Outcome	Healing time
Cunliffe Case 3	Female	52 yr	4.6	Periapical disease with over-filled	15 min	failure	3 months
Cunliffe Case 4	Female	57 yr	4.4	Periapical disease/pain	4 min	success	1 year
Cunliffe Case 5	Female	42 yr	3.6	Periapical disease	-	success	3 months
Cunliffe Case 6	Male	64 yr	2.1	External root resorption	15 min	success	4 months
Cunliffe Case 7	Female	76 yr	3.7	Periapical disease with sclerosed canals	-	failure	1 year
Cunliffe Case 8	Male	53 yr	3.7	Pulpar floor perforation	-	success	3 months
Cunliffe Case 9	Male	50 yr	2.1	Internal root resorption	-	success	15 months
Cunliffe Case 10	Female	64 yr	3.7	Instrument separation	15 min	success	6 months
Cunliffe Case 11	Female	45 yr	3.7	Periapical disease with over-filled	-	success	28 months
Cunliffe Case 12	Male	45 yr	4.5	Periapical lesion	-	success	9 months
Cunliffe Case 13	Female	39 yr	3.6	Periapical lesion with procedural errors	-	failure	3 months
Asgary 2019 (69)	Female	28 yr	3.7	Periapical lesion/endodontic failure	10 min	success	1 year
Fujii 2020 (70)	Female	30 yr	1.6	Instrument separation	15 min	success	1 year
Ganapathy 2020 (71)	Male	10 yr	2.1	Complicated crown-root fracture	-	success	2 years
Yang 2021 (72)	Male	20 yr	1.5	Chronic apical abscess with internal root resorption and root fracture	15 min	success	2 years

Clinical case

A 52 years old male patient was presented to our clinic with pain associated with the anterior mandibular area. No abnormality was observed upon traditional radiographic examination (Figure 4). On the contrary, the lingual side of central incisors was associated with swelling at clinical examination. A 3D cone beam computed tomography (CBCT) radiographic examination was performed, and a root fracture in the apical third of tooth 3.1 was observed (Figure 5). Tooth 3.1 did not respond to the vitality test. The diagnosis of the tooth was necrosis caused by the apical fracture.

The treatment of choice was non-surgical root canal treatment performing mechanical shaping, 3D cleaning and 3D obturation (Figure 6). Nevertheless, the swelling was persistent one week after the treatment, so the new treatment plan was decided in the form of intentional replantation.

The IR was chosen as the substitute treatment plan because an endodontic surgery could not be done due to an unfavourable crown-root ratio.

After tooth extraction, the fractured root fragment was removed, and the retro preparation was completed without removing any other mm of the root. This phase was done rapidly with the aid of magnification, light, and an ultrasonic tip. After retro preparation, the retro cavity was cleaned with Ethylenediaminetetraacetic acid (EDTA) and Sodium hypochlorite

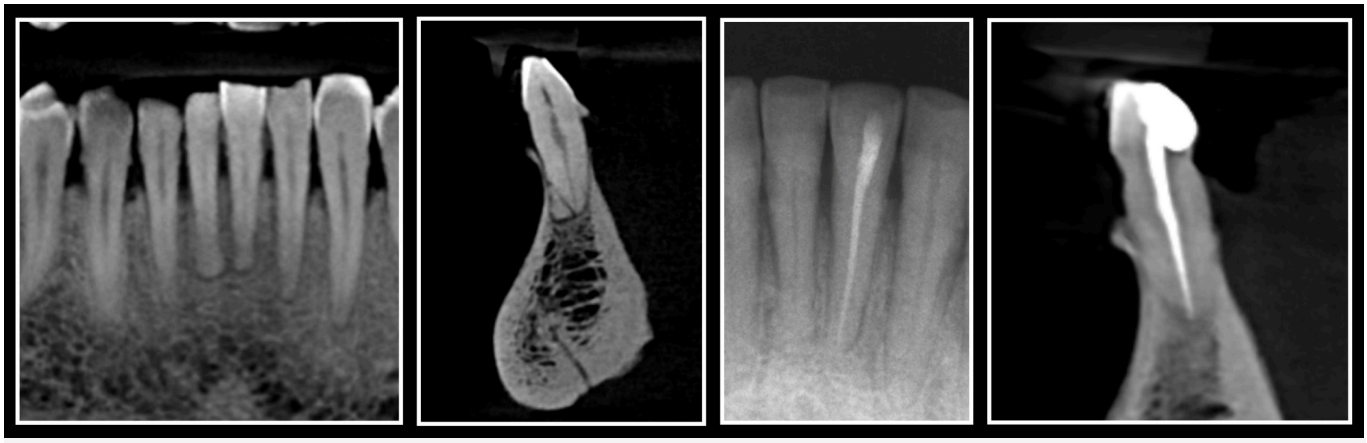


Figure 4 Figure 5 Figure 6 Figure 7

Figure 4, 5
Pre-operative CBCT radiographic evaluation.

Figure 6, 7
Post-operative CBCT radiographic evaluation.

(NaOCl). Afterwards, the retro cavity was dried and filled with white mineral trioxide aggregate (MTA), and the tooth was replanted and fixed to the other teeth with composite resin. After ten days, the composite was removed, and a one-year follow up showed the tooth was without swelling, pain or mobility (Figure 7).

Discussion

Despite the many indications reported in the literature, intentional replanting is considered a last resort to maintain natural teeth (1). The numerous operating steps provide various opportunities for mishaps, which therefore make this procedure highly dependent on the operator. These factors justify the diversity of success rates in the literature ranging from 80 to 100% (73). A recent systematic review of the literature found an 88% success rate for intentionally replanted teeth (74). The success rate concluded from our study is 87.2%. Therefore it is in accordance with that reported in the literature. This data is closely related to the extra-alveolar time of the re-implanted element, which has been seen to be a determining factor as it is directly involved in the conservation of PDL cells (22, 23). The extra alveolar time varies considerably in the different studies: from a maximum of 30 minutes (Penarrocha Diego et al., Herrera et al.) (40, 58) to a minimum of 4 minutes (Cunliffe et al., Garrido et al.) (63, 68). Jang et al. (75) reported higher success rates for those elements replanted with an extra-alveolar time of fewer than 15 minutes compared to those replanted with extra-alveolar time greater than 15 minutes. High success rates have also been reported in cases where the extra-alveolar time was greater than 15 minutes. This data should be associated with the approaches of extra-alveolar preservation of the teeth. As reported by a study by Andreasen in 1981, it is more promising in a humid environment (such as water, physiological solution, saliva) than in a humid environment (such as water, physiological solution a dry environment. (76) In all the reports we reviewed, which showed an extra-alveolar time greater than 15 minutes, the teeth were stored in a moist rather than dry environment to preserve the viability of the PDL cells.

Intentional re-implantation has a large number of clinical indications such as apical periodontitis, (2-4) in cases of improper endodontic therapy, (3) inaccessible external root resorption, (6) root perforations, (7) root/coronal-root fractures complex, (7-9) teeth with developmental anomalies such as fused teeth. (11) In the current review, a periapical lesion was associated with a fracture of the apical segment of the root that could not be treated with a surgical endodontic approach. The cone beam radiographic investigation played a fundamental role in the diagnosis as based on a conventional 2D examination, no fracture lines or discontinuities between the root tissues were observable.

CBCT has only recently been introduced to assist in surgical planning, and there are only case reports in the literature that report the implementation of the planning phase with the use of 3D reconstructions (77).
Modern technologies such as microscopy, ultrasound, CBCT (78) and the latest generation biomaterials (79-81) can improve treatment and minimize extra alveolar time. Therefore, encouraging results have been reported, and in particular, it has been highlighted that surgical re-implantation can be shorter and less invasive and with a lower percentage of failures (82).

Conclusions

The choice of the line of treatment to be adopted must be built on the basis of the characteristics of each clinical case. Based on this review, a success rate of 87.2% of teeth treated with the replantation technique was found, confirming the high reproducibility of the treatment. Furthermore, this success can be guaranteed by the reduced extra-alveolar storage time of the replanted tooth, which, in the prior revision, is on average 13.44 minutes.
In conclusion, if performed correctly, the replantation with standardized procedures that consider the basic biological principles represents a therapeutic choice with a high percentage of success and is highly predictable.

Clinical Relevance

Intentional re-implantation represents a valid therapeutic alternative in cases where definitive endodontic treatment is ineffective. With this review, we intend to analyze and evaluate the predictability of this method in the cases reported in the literature so as to provide the clinician with a complete view of the technique and the outcome associated with it.

Conflict of Interest

All authors declare no conflicts of interest. In addition, all authors have read and approved the manuscript as submitted, are qualified for authorship, believe the submission represents honest work and take full responsibility for the reported findings.

Acknowledgements

None.

References

1 *Grossman LI. Intentional replantation of teeth. J Am Dent Assoc 1966; 72:1111-8.*
2 *Messkoub M. Intentional replantation: a successful alternative for hopeless teeth. Oral Surgery, Oral Medicine, Oral Pathology 1991; 743-747.*
3 *Asgary S, Alim Marvasti L, Kolahdouzan A. Indications and case series of intentional replantation of teeth. Iran Endod J. 2014; 9:71-8.*
4 *Majd N M, Arvin A, Darvish A, Aflaki S, Homayouni H. Treatment of Necrotic Calcified Tooth Using Intentional Replantation Procedure. Case Reports in Dentistry 2014.*
5 *Amato, M., Pantaleo, G., Abdellatif, D., Blasi, A., Gagliani, M., Iandolo, A. An in vitro evaluation of the degree of pulp tissue dissolution through different root canal irrigation protocols. J Conserv Dent 2018, 21 , 175-9.*
6 *Pruthi P J, Dharmani U, Roongta R, Talwar S. Management of external perforating root resorption by intentional replantation followed by Biodentine restoration. Dent Res J (Isfahan) 2015; 12: 488-493.*
7 *Martina, Stefano et al. Modern rotary files in minimally invasive endodontics: a case report. Frontiers in bioscience (Elite edition) vol. 13,2 (2021): 299-304. doi:10.52586/E886.*
8 *Kim M, Lee S, Lee N. Intentional Replantation of a Root-Fractured Tooth with Pulp Canal Obliteration. J Korean Acad Paediatr Dent 2016; 200-206.*
9 *Zafar K, Badar S.B, Khan F R. Intentional Replantation in a Maxillary Molar with Undesirable Root Fracture: A Case Report. J Pakistan Dent Assoc 2018; 132-136.*
10 *Wang Z, Heffernan M, Vann WF Jr. Management of a complicated crown-root fracture in a young permanent incisor using intentional replantation. Dent Traumatol. 2008; 24:100-3.*
11 *Iandolo, A., Amato, M., Dagna, A., Poggio, G., Abdellatif, D., Franco, V et al. Intracanal heating of sodium hypochlorite: Scanning electron microscope evaluation of root canal walls. J Conserv Dent 2018, 21 , 569-73.*
12 *Iandolo A, Iandolo G, Malvano M, Pantaleo G, Simeone M. Modern technologies in Endodontics.G Ital Endod, 2016; 2-9.*
13 *Simon JH, Kimura JT. Maintenance of alveolar bone by the intentional replantation of roots. Oral Surg Oral Med Oral Pathol. 1974; 37:936-45.*
14 *Demiralp B, Nohutcu R M, Tepe D I, Eratalay K. Intentional replantation for periodontally involved hopeless teeth. Dental Traumatology 2003; 45-51.*
15 *Emmertsen E, Andreasen JO. Replantation of extracted molars a radiographic and histological study. Acta Odontol Scand 1966; 24:327-46*
16 *Kratchman S. Intentional replantation. Dent Clin North Am 1997; 41:603–17-*

17 Dumsha TC, Gutmann JL. Clinical guidelines for intentional replantation. Compend Contin Educ Dent 1985; 6:606-8.
18 Iandolo A, Ametrano G, Amato M, Rengo S, Simeone M. IG-File: a novel tool to improve root canal cleaning and measurement of the apical foramen. G Ital Endod 2011; 72–81.
19 Iandolo A, Simeone M, Riccitiello F. The preparation of coronal isthmus is a fundamental step for long term success. G Ital Endod 2012; 26:150-154.
20 Iandolo Alfredo et al. Dentinal tubule penetration and root canal cleanliness following ultrasonic activation of intracanal-heated sodium hypochlorite." Australian endodontic journal : the journal of the Australian Society of Endodontology Inc vol. 46,2 (2020): 204-209. doi:10.1111/aej.12393.
21 Iandolo A, Dagna A, Poggio C, Capar I, Amato A, Abdellatif D. Evaluation of the actual chlorine concentration and the required time for pulp dissolution using different sodium hypochlorite irrigating solutions. J Conserv Dent 2019; 22(2):108-113.
22 Raghoebar G M, Vissink A. Results of intentional replantation of molars. J Oral Maxillofac Surg 1999; 57: 240–244.
23 Ministero della Salute (Italian Ministry of Health) 2014. Raccomandazioni cliniche in odontostomatologia.
24 Kvint S, Lindsten R, Magnusson A, Nilsson P, Bjerklin K. Autotransplantation of teeth in 215 patients. A follow-up study. Angle Orthod 2010; 80: 446–451.
25 Andreasen JO. Relationship Between Cell Damange in the Periodontal Ligament After Replantation and Subsequent Development of Root Resorption. Acta 1981; 15-25.
26 Kingsbury Jr B C, Wiesenbaugh Jr J M. Intentional replantation of mandibular premolars and molars. J Am Dent Assoc 1971; 1053-1057.
27 Becker BD. Intentional Replantation Techniques: A Critical Review. Journal of Endodontics. 2018; 44, 14-21.
28 Kingsbury BC Jr, Wiesenbaugh JM Jr. Intentional replantation of mandibular premolars and molars. J Am Dent Assoc 1971; 83:1053-7.
29 Alfredo I et al. European Journal of Paediatric Dentistry, Dec. 2021, Riga-Fede disease: a Systematic Review and Report of Two Cases. Accessed Dec. 2021.
30 Tewari A, Chawla H. Intentional replantation of pulpal or periapically involved permanent posterior teeth. J Indian Dent Assoc 1974; 46:385–9.
31 Bender IB, Rossman LE. Intentional replantation of endodontically treated teeth. Oral Surg Oral Med Oral Pathol 1993; 76:623–30.
32 Tang PM, Chan CP, Huang SK, Huang CC. Intentional replantation for iatrogenic perforation of the furcation: a case report. Quintessence Int 1996; 27:691-6
33 Poi WR, Sonoda CK, Salineira SL, Martin SC Treatment of root perforation by intentional reimplantation: a case report. Dental Traumatology 1999; 15: 132-134.
34 Aqrabawi J. Five-year follow-up of successful intentional replantation. Dent Update 1999; 26:388-90.
35 Benenati FW. Intentional replantation of a mandibular second molar with long-term follow-up: report of a case. Dent Traumatol 2003; 19:233-6.
36 Fariniuk LF, Ferreira EL, Soresini GC, Cavali AE, Baratto Filho F. Intentional replantation with 180 degrees rotation of a crown-root fracture: a case report. Dent Traumatol 2003; 19:321-5.
37 Ward J. Intentional replantation of a lower premolar. Aust Endod J 2004; 30:99-102.
38 Shintani S, Tsuji M, Toyosawa S, Ooshima T. Intentional replantation of an immature permanent lower incisor because of a refractory peri-apical lesion: case report and 5-year follow-up. International Journal of Paediatric Dentistry 2004, 14: 218-222.
39 Cotter MR, Panzarino J. Intentional replantation: a case report. J Endod 2006; 32:579-82.
40 Herrera H, Leonardo MR, Herrera H, Miralda L, Bezerra da Silva RA. Intentional replantation of a mandibular molar: case report and 14-year follow-up. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;102(4):e85-7.
41 Peñarrocha M, García B, Martí E, Palop M, von Arx T. Intentional replantation for the management of maxillary sinusitis. Int Endod J 2007; 40:891-9.
42 Sivolell, S, Bressan E, Mirabal V, Stellini E, Berengo M. Extraoral endodontic treatment, odontotomy and intentional replantation of a double maxillary lateral permanent incisor: case report and 6-year follow-up. International Endodontic Journal 2008, 41: 538-546.
43 Wang Z, Heffernan M, Vann WF Jr. Management of a complicated crown-root fracture in a young permanent incisor using intentional replantation. Dent Traumatol. 2008; 24:100-3
44 Al-Hezaimi K, Naghshbandi J, Simon JH, Rotstein I. Successful treatment of a radicular groove by intentional replantation and Emdogain therapy: four years follow-up. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009; 107:82-5.
45 Özer SY, Ünlü G, Değer Y. Diagnosis and treatment of endodontically treated teeth with vertical root fracture: three case reports with two-year follow-up. J Endod. 2011; 37:97-102.
46 Lu CH, Lu HC, Ke JH, Lan WH. Laser assisted tooth replantation case report. Laser Ther 2011; 20:273-7.
47 Unver S, Onay EO, Ungor M. Intentional re-plantation of a vertically fractured tooth repaired with an adhesive resin. Int Endod J. 2011; 44:1069-78.
48 Kim DS, Shin DR, Choi GW, Park SH, Lee JW, Kim SY. Management of complicated crown-root fractures using intentional replantation: two case reports. Dent Traumatol. 2013; 29:334-7.
49 Moura LFAD, Lima MDM, Moura MS, Carvalho PV, Cravinhos JCP, Carvalho CMRS. Treatment of a crown-root fracture with intentional replantation – case report with 16-year followup. International Endodontic Journal 2012; 45, 955–960
50 Dogan MC, Akgun EO, Yoldas HO. Adhesive tooth fragment reattachment with intentional replantation: 36-month follow-up. Dent Traumatol. 2013; 29:238-42.
51 Shin Y, Kim Y, Roh BD. Maxillary first molar with an O-shaped root morphology: report of a case. Int J Oral Sci 2013; 5:242-4.
52 Yuan LT, Duan DM, Tan L, Wang XJ, Wu LA. Treatment for a complicated crown-root fracture with intentional replantation: a case report with a 3.5-year follow up. Dent Traumatol. 2013; 29:474-8.
53 Nagappa G, Aspalli S, Devanoorkar A, Shetty S, Parab P. Intentional replantation of periodontally

compromised hopeless tooth. J Indian Soc Periodontol. 2013; 17:665-9.
54 Moradi Majd N, Arvin A, Darvish A, Aflaki S, Homayouni H. Treatment of necrotic calcified tooth using intentional replantation procedure. Case Rep Dent. 2014; 2014:793892.
55 Sübay RK, Sübay MO, Balkaya CM. Intentional replantation of a mandibular canine with multiple iatrogenic endodontic complications. Oral Health Dent Manag. 2014; 13:811-4.
56 Asgary S, Alim Marvasti L, Kolahdouzan A. Indications and case series of intentional replantation of teeth. Iran Endod J 2014; 9:71-8.
57 Asgary S, Nosrat A. Concurrent intentional replantation of maxillary molars using a novel root-end filling. Gen Dent 2014; 62:30-3.
58 Peñarrocha-Diago MA, Aloy-Prósper A, Peñarrocha-Oltra D, Peñarrocha-Diago M. Replantation of a maxillary second molar after removal of a third molar with a dentigerous cyst: Case report and 12-month follow-up. J Clin Exp Dent. 2014; 6:185-8.
59 Tsesis I, Taschieri S, Rosen E, Corbella S, Fabbro M. Treatment of paraesthesia following root canal treatment by intentional tooth replantation: A review of the literature and a case report;Indian Journal of Dental Research 2014; 25:231-235.
60 Keceli HG, Hendek MK. Fifteen months follow-up of a hopeless tooth treated with two-step procedure involving intentional replantation and free gingival graft. Eur J Dent. 2014; 8:559-562.
61 Pruthi PJ, Dharmani U, Roongta R, Talwar S. Management of external perforating root resorption by intentional replantation followed by Biodentine restoration. Dent Res J (Isfahan). 2015; 12:488-493.
62 Forero-López J, Gamboa-Martínez L, Pico-Porras L, Niño-Barrera JL. Surgical management with intentional replantation on a tooth with palato-radicular groove. Restor Dent Endod. 2015; 40:166-71.
63 Garrido I, Abella F, Ordinola-Zapata R, Duran-Sindreu F, Roig M. Combined Endodontic Therapy and Intentional Replantation for the Treatment of Palatogingival Groove. J Endod. 2016; 42:324-8.
64 Oishi A. Intentional Replantation of an Immature Incisor with a Transverse Root Fracture and Endo-Perio Condition: 4 Year Follow-Up. J Clin Pediatr Dent 2017; 41:187-192.
65 Grzanich D, Rizzo G, Silva RM. Saving Natural Teeth: Intentional Replantation-Protocol and Case Series. J Endod 2017; 43:2119-2124.
66 Asgary S, Roghanizadeh L. Rapid Bone Healing after Intentional Replantation of a Molar with Apical Actinomycosis. Iran Endod J 2018; 13:135-138.
67 Krug R, Soliman S, Krastl G. Intentional Replantation with an Atraumatic Extraction System in Teeth with Extensive Cervical Resorption. J Endod 2019; 45:1390-1396.
68 Cunliffe J, Ayub K, Darcey J, Foster-Thomas E. Intentional replantation - a clinical review of cases undertaken at a major UK dental school. Br Dent J. 2020; 229:230-238.
69 Asgary S, Talebzadeh B. Intentional replantation of a molar with several endodontic complications. J Stomatol Oral Maxillofac Surg. 2019; 120:489-492.
70 Fujii R, Morinaga K, Asai T, Aida N, Yamada M, Sako R, Furusawa M. Intentional Replantation to Treat Apical Periodontitis of Maxillary First Molar with Foreign Body Located Outside Apical Foramen Using CBCT: A Case Report. Bull Tokyo Dent Coll 2020; 61:127-133.
71 Ganapathy S, Vedam V, Rajeev V, Nair SV. Intentional replantation with 180° rotation of a complicated crown-root fracture: A Case Report. Trauma Case Rep. 2020 11; 27:100306.
72 Yang Y, Zhang B, Huang C, Ye R. Intentional Replantation of a Second Premolar with Internal Resorption and Root Fracture: A Case Report. J Contemp Dent Pract. 2021; 22:562-567.
73 Plotino, G., Abella Sans, F., Duggal, M., Grande, N., Krastl, G., Nagendrababu, V., & Gambarini, G. Clinical procedures and outcome of surgical extrusion, intentional replantation and tooth autotransplantation – a narrative review. International Endodontic Journal 2020.
74 Torabinejad M, Dinsbach NA, Turman M, et al. Survival of intentionally replanted teeth and implant-supported single crowns: a systematic review. J Endod 2015; 41:992–8.
75 Jang Y, Lee S-J, Yoon T-C, et al. Survival rate of teeth with a c-shaped canal after intentional replantation: a study of 41 cases for up to 11 years. J Endod 2016; 42:1320–5.
76 Andreasen, J. O. (1981). Effect of extra-alveolar period and storage media upon periodontal and pulpal healing after replantation of mature permanent incisors in monkeys. International Journal of Oral Surgery, 10(1), 43–53.
77 Rohof ECM, Kerdijk W, Jansma J, Livas C, Ren Y. Autotransplantation of teeth with incomplete root formation: a systematic review and meta-analysis. Clin Oral Investig. 2018; 22:1613-1624.
78 Spagnuolo G, Ametrano G, D'Antò V, Formisano A, Simeone M, Riccitiello F, Amato M, Rengo S. Microcomputed tomography analysis of mesiobuccal orifices and major apical foramen in first maxillary molars. Open Dent J. 2012; 6: 118-25.
79 Tatullo M, Riccitiello F, Rengo S, Marrelli B, Valletta R, Spagnuolo G. Management of Endodontic and Periodontal Lesions: the Role of Regenerative Dentistry and Biomaterials. Dent J (Basel). 2020 Apr 3;8(2):32. doi: 10.3390/dj8020032. PMID: 32260114; PMCID: PMC7346003.
80 Muedra P, Forner L, Lozano A, Sanz JL, Rodríguez-Lozano FJ, Guerrero-Gironés J, Riccitiello F, Spagnuolo G, Llena C. Could the Calcium Silicate-Based Sealer Presentation Form Influence Dentinal Sealing? An In Vitro Confocal Laser Study on Tubular Penetration. Materials (Basel). 2021 Jan 31; 14 (3): 659.
81 Furtado Leite MC, Maniglia Ferreira C, de Almeida Gomes F, Geraldo Pappen F, Kerber German T, Bissoto Calvo AF, Pettorossi Learned JC. Regenerative endodontic treatment options for immature permanent teeth: a case report with 21-month follow-up. Italian Journal of Endodontics 2020; 34 (1): 35-40.
82 Shahbazian M, Jacobs R, Wyatt J, Denys D, Lambrichts I, Vinckier F, Willems G. Validation of the cone beam computed tomography-based stereolithographic surgical guide aiding autotransplantation of teeth: clinical case-control study. Oral Surg Oral Med Oral Pathol Oral Radiol. 2013; 115:667-675.