CLINICAL AND RADIOGRAPHIC EVALUATION OF INTENTIONAL REPLANTATION OF TEETH UTILIZING ATRAUMATIC EXTRACTION TECHNIQUE AND BIODENTIN AS ROOT END RESTORATIVE MATERIAL. AN IN VIVO STUDY

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Conflicts of Interest: Nil

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Abstract:

Aims: Aim is to evaluate the clinical and radiographic outcome of Intentional Replantation of teeth utilizing Atraumatic extraction technique and Biodentin as root end restorative material

Materials and Methods: Any patients irrespective of age & sex who reported to the Department of Conservative Dentistry & Endodontics, D. J. College of Dental Sciences & Research with the post endodontic treatment periapical pathology where orthograde retreatment and apical surgery was unfeasible or declined by patients and where extraction be the last resort was selected for the procedure. Informed consent was taken. Retention and healed status without complications (periapical radiolucency, external root resorption, ankylosis, signs/symptoms, probing <6 mm) was recorded and analyzed with Kaplan-Meier survival analysis and Cox proportional hazard regression model ($P < .05$). Bivariate associations of the investigated variables with the main complications (ankylosis, periapical radiolucency, external root resorption) evaluated.

Results: Cumulative healed rates from 60% at 6 months to 92% at 12 months seen. Complications leading to extraction observed in 1 of 15 attending teeth. The Kaplan-Meier survival function suggested an expected 1-year cumulative retention rate of 92%. Among the 15 teeth, 1 tooth with complication was due to persistent periapical radiolucency and mobility.

Null hypothesis was that IR is to preserve the natural dentition, there by upholding the main goal of Conservative treatment.

Conclusions: Within the limitations of this study, after analyzing the results and obtaining a complete follow up of 12 months radiographically and clinically, it can be concluded that Intentional replantation is an alternative treatment and should be included in the savior procedures as it has shown a success rate of 92%.

Keywords: endodontic complications, intentional replantation, physics forceps, Biodentin

Introduction:

The primary goal of endodontic treatment is to take care of the integrity of the natural dentition that is important for full perform and natural aesthetics. In spite the very fact that non-surgical endodontic procedures have a high success rate, failures do occur. Root canal re-treatment or surgical endodontic intervention often managed

these, however in some cases that re-treatment or apical surgery is not possible or impractical, intentional replantation is also thought about as an answer to preserve the tooth. We typically think intentional replantation procedure of as an ultimate resort however why not, if it's to preserve nature dentition.

Grossman has outlined intentional replantation, "as the purposeful removal of a tooth and its reinsertion into the socket almost immediately after the apical seal."¹

Intentional replantation isn't a completely unique procedure. it's reported as back as in eleventh century once Albulcasis, Associate nursing Arab physician explained replantation according to Weinberger.² the development of the technique in later years has included modification of methods of tooth extraction, root-end surgery and preparation, handling of the tooth during cautiously throughout surgical manipulation and materials used for root-end filling. There are some of prognostic factors for IR, for example, guaranteeing a sound periodontic ligament (PDL), preventing mechanical damage and microorganism contamination, short extra oral time and careful handling of the tooth.

Mostly clinical and radiographic assessments are used to investigate the rate of success of the procedure that primarily rely upon peri-radicular healing.^{3,4} With acceptable case selection and strict execution of treatment protocols, it very well is also viewed as an affordable treatment of choice with usually better prognosis. The principle advantage of intentional replantation procedure is that tooth surfaces, as well as inaccessible areas, are often visualized and instrumented whole while not harming contiguous periodontal tissues, adding to restoration of sound peri-radicular tissues^{4,5}

Multiple studies have shown that IR features a high survival rate. A meta-analysis revealed in 2015 that enclosed eight studies have shown a survival rate of 88% for IR teeth.²⁵ The evolution of the procedure in recent times has concerned modification of techniques for tooth extraction, root-end surgery and preparation, handling of the tooth throughout surgical manipulation, and materials used for root-end filling.^{20,23}

Periodontal ligament Preservation Factors:

Atraumatic extraction:

The Physics forceps were developed by Golden Dental Solutions, Michigan that relies on the

biomechanical principles of a first-class lever, creep and stress distribution without the compressing, grasping, twisting and pulling forces to perform atraumatic extraction.²⁴

Extra oral time:

Proposals for extraoral times have likewise differed. In 1966, Grossman elaborated the time out of the mouth to be "an issue of minutes," listening of expressly that the pdl explicitly saved alive for fifteen to twenty minutes. Kratchman suggested a most extreme extraoral time of 10 to 15 minutes.^{15,16,17}

The technique itself, however, is easy but should be performed meticulously in sterile conditions.

The juncture in any replantation following extraction or avulsion is that the maintenance and preservation of the cellular vitality of the periodontal Ligament that is very important for the regeneration of the pdl, therefore to the survival of the tooth. Hank's balanced salt solution is the best medium to keep the pdl safe.³⁴ The extracted tooth ought to be kept moist all the time throughout the extraoral manipulation.^{34,35,38}

Retrograde Restorations:

Retrograde filling materials like amalgam, gutta percha, zinc-oxide eugenol cements were ordinarily used retrograde filling material within the past. With development of your time numerous retrograde filling materials of endodontic surgery were introduced that have superior properties. Recent advancements in retrograde filling material are bioactive filling materials like Mineral trioxide aggregate (MTA), Mineral trioxide aggregate plus and Biodentin^{21,30}

Bio-dentine shows apatite formation when immersion in phosphate solution indicative of its bioactivity. because of its higher handling properties. The working time of Biodentin is up to 6 minutes with an initial setting period of 9–12 minutes and final setting time of 45 minutes.. a positive feature of Biodentin was that blood contamination had no impact on the push-out bond strength, irrespective of the duration of

setting time, that makes it a good alternative as retrograde restoration.

Aim:

Aim is to evaluate the clinical and radiographical healing outcome of Intentional Replantation of teeth utilizing Atraumatic extraction technique and Biodentin as root end restorative material.

Materials and Methods

Any patients no matter age & sex who reported to the Department of Conservative medicine & endodontics, D. J. college of Dental Sciences & research with the post endodontic treatment periapical pathology where orthograde retreatment and top surgery was infeasible or declined by patients and wherever extraction be the last resort was selected for the procedure. The ethical committee of the D.J college of Dental science and research approved the study.

Informed consent was taken.

A criterion was included in selection of patients-

Inclusion Criteria

- Teeth with separated instrument in canal on the far side peri apical region. where in the retreatment was unsuccessful.
- Teeth with recurrent endodontic failures, wherever apical surgery was difficult to perform.
- Large peri-apical lesions, but without periodontal pockets and /or mobility.
- Teeth having periodontal pockets >4mm, and therefore there was no communication with the pocket and the peri-radicular lesion.
- Teeth with calcified canals with persistent apical periodontal disease wherever in endodontic treatment was difficult.

Exclusion Criteria-

- Teeth with class 2 mobility or greater, was excluded from the study.
- Teeth with divergent roots or with weakened coronal tooth structure.
- Teeth with preoperative periodontal defects >6mm.

- Teeth with resorption were excluded.

Surgical Procedure

Before the surgical treatment of endodontic surgery, a preoperative RVG was taken to locate the separated instrument and to measure the lesion.

The following are the detailed Surgical Procedure Steps:

- Each patient was directed to rinse his or her mouth with 15 ml of chlorhexidine mouth wash 0.12% for 2 minutes to decrease the microorganism load throughout and after surgery.
- All teeth were extracted under local anesthesia using with 2% Lignocaine with 1:80,000 vasoconstrictor. (Lignox).
- The attached gingiva and adjacent interdental papillae were separated from the tooth with a periosteal elevator.
- Extraction was carefully done care using Physics forceps, the utilization of elevators was contraindicated to avoid the potential injury to the periodontal ligament. The physics forceps have 2 handles, one among that is connected to a bumper that functions as the fulcrum throughout extraction. it's applied to the buccolabial side, typically at the mucogingival junction. the opposite beak is applied to the palate/lingual side of the tooth into the gingival sulcus, at a lower level than the bumper. This "beak and bumper" style aids the extraction without the utilization of excessive force. Thus, the beaks of forceps are placed on the crown and weren't were not the Cemento-enamel junction to avoid violating the integrity of the periodontium.
- After extraction, touching the alveolar socket was avoided to keep up the integrity of the bony part of the periodontal ligament. only if necessary, the apical area of socket was to be curetted gently to get rid of any pathosis. This should solely take a couple of seconds.
- With the tooth held between the forefinger and thumb (from crown portion) of the non-operating hand and also the root portion kept continuously soaked with physiological normal saline 0.9% (NaCl--) by spouting from a 10ml disposable syringe, 2-3mm of the apex was

resected by a small tapered diamond bur mounted on a high-speed air rotor under copious distal water irrigation. The resected end of tooth is flattened and a small class I cavity of 2mm depth and encompassing the width of the canal was prepared with a small diamond pro-ultra-piezo tip.

- The apex was gently dried and Biodentin was mixed and prepared in a very little ball and compacted into the cavity with the condenser.
- Before the tooth was to get replaced within the socket, the walls of socket were gently flushed with normal saline to get rid of the blood clot. Additionally, the tooth was irrigated with saline to get rid of any residual cotton fibers and debris from root end filling material.
- The tooth was gently placed into its socket. Slight pressure was applied to the buccal and lingual cortical plates to make sure adaptation.
- The time was calculated from the start of extraction to complete insertion of the tooth in its socket ranged between (10-15) minutes.
- The patient was requested to carefully bite on his teeth and also the occlusion was checked. The tooth ought to be free from occlusion.
- Tooth stability was reinforced with composite splinting and splint was removed after three weeks.
- After the procedure patients were recalled in to assess the clinical and radiographic signs of healing. Follow up was regular for 12 months (2nd week, 1st month, 3rd month, 6th month and 12 months post operatively).

Healing Criterion:

Follow up criteria were based on clinical and radiographical observations at every visit and as follows:

Clinical Examination:

- Pain level evaluated by the visual analogue scale (VAS) as no pain, mild pain, moderate pain, severe pain.
- Presence or absence of sinus was ascertained in oral examination as present and absent.
- Mobility of replanted tooth this criterion, was recorded in line with the subsequent classification:

Grace & Smales mobility Index

- Grade 0: No apparent mobility
- Grade 1: Perceptible mobility <1mm in buccolingual direction
- Grade 2: >1mm but <2mm
- Grade 3: >2mm or repressibility within the socket

Radiographic Examination:

- Periapical radiolucency by scrutiny the pre and post RVG periapical radiolucency taking opinion of 2 specialists not concerned in procedure.
- Root resorption by comparing pre and post RVG
- Bone ankylosis by clinical percussion and RVG analysis.

Outcome Assessment:

Information of each patient were recorded in MS word 10. preoperative data associated with the (sex, age), and endodontic condition (periapical radiolucency, sinus tract, root filling adequacy). Patients were regular for post-treatment follow-up examinations at 1, 3, 6, and 12 months. Patients who failed to show at regular examinations were contacted by phone and rescheduled. Patients were educated regarding the findings at every follow-up session. Outcome in all retained teeth was assessed by combined clinical and radiographic criteria. Teeth were thought of healed, after they had no periapical radiolucency, no proof of external root resorption or ankylosis (indicated by percussion sound and blurring of the periodontal ligament area in periapical radiographs), no signs/symptoms, and probing depth <6 mm²⁴. Prevalence of any of the above was recorded as a complication. 2 examiners evaluated the radiographs independently by using standardized analysis criteria for periapical healing, ankyloses, and periodontal involvement. Inter-examiner reliableness was determined with Cohen kappa statistics in accordance with Landis and Koch⁴⁷

Statistical Analysis:

All subjects with 12 months of follow-up were included in the analysis. Kaplan-Meier survival curves were plotted to chart retained teeth during the duration of the follow-up period, as well as healed teeth free of complications (periapical radiolucency, external root resorption, ankylosis,

signs/symptoms, probing >6 mm). Bivariate associations between complications and clinical variables were explored with the log-rank test, followed by multivariate analysis with the Cox

proportional hazard model. All statistical analyses were performed with SPSS v21.0 software and interpreted at the 5% level.

Case 1:

Case 2:
Instrument separation in mesio-buccal canal beyond apex

Results

Table 1: Characteristics of the Study Sample of Treated by Intentional Replantation and Bivariate Associations between Investigated Variables and Occurrence of Main Complications* during the Follow-up Period

Pre- operative variable	Complications, n (%)				
	Pain	Mobility	Periapical radiolucency	Root resorption	Ankylosis
Female (05)	04 (80.0%)	04 (80.0%)	04 (80%)	00 (0%)	00 (0%)
Male (10)	09 (90%)	09 (90%)	07 (70%)	00 (00%)	00 (0%)
	P= 0.571	P= 0.571	P=0.593	P=1.000	P=1.000
Less than 40 years (09)	07 (77.8%)	07 (77.8%)	06 (66.7%)	00 (0%)	00(0%)
More than 40 years (06)	06 (100%)	06 (100%)	05 (83.3%)	00 (00%)	00(0%)
	P= 0.343	P= 0.343	P=0.462	P=1.000	P=1.000
PR Absent (03)	02 (66.7%)	02 (66.7%)	02 (66.7%)	00 (0%)	00 (0%)
PR Present (12)	11 (91.7%)	11 (91.7%)	09 (75.0%)	00 (00%)	00(0%)
	P=0.371	P=0.371	P=0.637	P=1.000	P=1.000
Mobility Absent (04)	04 (100%)	04 (100%)	00 (00%)	00 (0%)	00 (00%)
Mobility Present (11)	09 (81.8%)	09 (81.8%)	11 (100%)	00 (00%)	0(0%)
	P=0.524	P=0.524	P=0.001	P=1.000	P=1.00
Sinus Absent (15)	13 (88.7%)	13 (88.7%)	11 (73.3%)	0 (0%)	00 (0%)
Sinus Present (00)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Graph 1:

Graph 2: Kaplan Meier Curve

Table 2: Cumulative Healed Rate of Replanted Teeth at Scheduled Follow-up Intervals Observation

	Eligible	Lost to follow up	Examined	Complication	Healed
3 months	15	00	15	09	60%
6 months	15	01	14	00	100%
12 months	14	00	14	01	92.85%

Table 3: Kaplan-Meier survival function curve after intentional replantation of teeth with follow-up examinations

	Eligible	Extracted	Survival Rate
3 months	15	00	100%
6 months	15	00	100%
12 months	14	01	92.85%

Table 4: Complications recorded during follow-up period of teeth with follow-up examinations after intentional replantation.

	Pain Present	Swelling Present	Mobility Present	Sinus Present	Periodontal pocket Present
2 Weeks	13 86.7%	0 0.0%	11 73.3%	0 0.0%	4 20.0%
1 Month	00 0.0%	0 0.0%	2 13.3%	0 0.0%	0 0.0%
3 Month	00 0.0%	0 0.0%	1 6.7%	0 0.0%	0 0.0%
6 Month	00 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
12 Months	00 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
P value	0.001 (Sig)	1.000 (NS)	0.001 (Sig)	1.000 (NS)	0.099 (NS)

Table 4: Cox Proportional Hazard Model Identifying Predictors of Occurrence of Main Complications up to 12 Months after Intentional Replantation

	Regression coefficient (b)	Standard error (b)	P value	Hazard ratio
Gender	-0.576	0.421	0.548	0.612
Periapical Radiolucency	-0.168	0.475	0.627	0.823
Age	0.546	0.439	0.211	0.523
Mobility	2.321	0.412	0.031	2.123

Inter examiner agreement regarding preoperative periapical lesions, root-filling adequacy, postoperative periapical lesions, and external root resorption ranged from $k = 0.94$ to 0.97 , suggesting very good agreement⁴⁷.

Of 15 cases, 1 case was lost to follow-up within 6 months before the first juncture used for analysis. The attending sample of 14 out of 15 teeth and cases (92% recall) is characterized in regard to preoperative variables in Table 1. The majority of subjects were males and younger than 40 years of age. The teeth were molars with periapical radiolucency, adequate root filling, and without sinus tract. All the teeth were root-end filling used was Bio-dentine and replanted within 15 minutes. Follow-up periods ranged from 1 month, 3 months, 6 months and 12 months.

Cumulative healed rates observed from 60% at 6 months to 92% at 12 months (Table 2).

The Kaplan-Meier survival function (Table 1) suggested an expected 1-year cumulative retention rate of 92%.

The complications recorded during the follow-up period shown in Table 4. Among the 15 teeth, 1 tooth with complication, due to persistent periapical radiolucency and mobility was extracted

Bivariate associations of the investigated variables with the main complications (Pain, Mobility ankylosis, periapical radiolucency, external root resorption) presented in Table 1. Periapical radiolucency was significantly less ($P = .063$) in teeth with preoperative periapical radiolucency. Periapical radiolucency was significant in teeth present with preoperative mobility. The cox proportional Hazard ration of 2.12 was seen with the complication of mobility.

Discussion:

As Grossman stated, "Intentional replantation should no longer be considered a "last resort" treatment, prescribed to hopeless teeth.¹ It is certainly not as 'a procedure with the poorest prognosis' in view of Wein. Long-term results indicates that the success rates of IR and apical surgery are comparable, though recent studies

support apical surgery. IR is less invasive procedure compared to apical surgery.^{1,9}

Advantage of IR over apical surgery is that there is good access to the tip of root and root end preparation and restoration are done better extra orally. IR is relatively fast and simple procedure that gives the patient minimal postoperative discomfort and has less possible complications and less cost than periapical surgery and dental implant.

The duration and method of extraction, extra -oral time and preservation of cellular vitality of periodontal ligament are critical parameters. These parameters are controlled by performing whole procedure under aseptic conditions and extra oral time should be brief < 15 min.^{10,11} which has a good impact on the maintaining cell viability of PDL. In this study, the extra oral time was kept maintained at 10-15 mins. Extending the extra oral time above 15 mins increased risk of post treatment complications mainly ankylosis.

Oral hygiene plays an important role in success of the IR, thus use of 2% chlorohexidine mouth wash prior to surgery was done to reduce the bacterial load. Antibiotic therapy was also given 2 days prior to surgery and continued for further 3 days.^{20,23}

Splinting was done for the stabilizing the tooth and splint removed after 3 weeks. The use of a semi-rigid splint was preferred since it does not hamper physiologic mobility, further decreasing chances of ankylosis.¹⁴ In addition, fibre-reinforced splints offer the advantage of increased strength and fracture toughness which are particularly desirable properties in the mandibular molar region.^{24,26}

The recent modern technique for IR by using the latest technique and materials and instruments has been shown to have a very good success rate. The good prognosis also depends on atraumatic extraction means minimum damage to surrounding tissues and bone is very important. So, this study was done by using Physics Forceps for extraction. Which lead to the minimum damage to the PDL and the bone.

Torabinejad et al²⁸ did a systemic review and meta-analysis of articles from 1966-2014 and have reported a success rate for intentional

replantation of 88%. Root resorption was reported as an adverse outcome in all included studies, with an overall prevalence of 11%.¹⁷ Other studies have shown clinical success rate of intentional replantation cases after 1 year be 89% which decreased to 59% at 5 years. Jang et al.²⁶ found higher success rates for teeth in which the extraoral time was minimal, that is, 15 min or less compared with those which were kept out for >15 min. Similarly, Hammarström et al.⁴⁵ showed that intentionally replanted teeth with 1 h of extraoral time revealed extensive root resorption whereas the other teeth with 15 min of extraoral time showed better periodontal healing associated with reattachment of the periodontal membrane. We tried to avoid this aspect as extraoral wet time by keeping the tooth moist in saline for the minimum 15 minutes of extraoral time. We used the normal saline as a medium to prevent dehydration and damage to PDL cells which is essential in the peri- radicular healing. Using saline as a root hydration medium has been followed unanimously till recently by Choi et al, Asgary et al, Cho et al, and Jang et al.^{20,22,24}

In this study. the tooth was moist continuously. This helped in prevention of resorptive processes such as replacement resorption, ankylosis, internal and external root resorption.

Once the tooth extraction was completed, most operators, Kratchma³⁶ and Peer¹⁶ recommended holding the tooth by the crown with a saline-soaked gauze as a measure to provide continued hydration of the root surface and periodontal ligament cells. Nearly the same number recommended holding the tooth by the crown using the beaks of the forceps, limiting contact to enamel.^{17,18}

Studies by Guy and Goerig⁴³, Dumsha and Gutman⁴², a recommended root-end preparation on an “as-needed” basis. The root-end preparations come in various lengths and techniques. Some authors reported 2 to 3 mm, others 3 to 4 mm, and Deeb reported one-third the root length. Carbide bur is usually used to prepare the root end by most of the authors Cho et al²⁹ were the only authors that reported the use of ultrasonic instrumentation for root-end preparation, and especially in cases of thin roots.

Highly recommendations were optimum resection of 3 mm root, a 0o bevel angle, and a 3-mm root preparation depth. Which we followed in our cases.

In this study. Bio ceramic root end restoration, Bio-dentine was used for root end restorations. Bio-dentine shows apatite formation after immersion in phosphate solution indicative of its bioactivity. Because of its better handling properties.

In the current study, the extra-alveolar duration was less than 15 minutes. Semi ridged splinting was used to secure the stability of the replanted tooth because rigid splinting may harbour bacteria, delay healing and promote replacement resorption by not allowing physiological mobility. Patient hygiene plays a compulsory role in plaque control before and after surgery which successively has significant influences in success of the treatment.⁴⁴ in the current study, scaling and polishing and chlorhexidine mouth wash before and after surgery was administered.

Following intentional replantation, there was marginal bone loss but less risk of causing bone dehiscence and in fact no soft tissue injury or scars in comparison with surgery because the osteogenic capacity of periosteum was reduced.^{35,36} In most cases of peri radicular surgery, there's usually post-operative discomfort like pain and swelling while intentional replantation is typically uneventful. the lack of pain in this study is comparable to the literature. Most studies have reported minor complaint of pain or discomfort. Any pain and swelling are presumably associated with the extraction instead of the replantation portion of the procedure. Therefore, the initial pain and swelling should not be confused with rejection.⁴⁶

Replacement resorption and ankylosis are often used as synonyms. Ankylosis is a common finding following tooth replantation and the ankylosed teeth may remain for many years. Clinically, ankylosis is diagnosed by absent tooth mobility and by a percussion tone that is higher than in a normal tooth. In this study the Ankylosis was not reported in any case, it's because our extraoral time was maintained and kept under 20 min.

Several resources have reported the success rate of intentional replantation. The success rate of intentional replantation as stated by Kingsbury⁶ varies from 52% to 95%, inversely related to the observation period and criteria of success. In a study of 31 teeth followed for up to 22 years, Bender and Rossman found that 81 percent of them were successful and Weissenberg reported a success rate of 95% for 151 teeth followed for 3 years.¹²

The current study showed around 92% success rate over a 1 year follow up. Importantly, the rates of retention (>92%) and healing (72%–91%) reported herein and in other contemporary studies (18–22) were consistent with the rates of functional retention (90%–95%) and complete healing (74%–85%) reported for both nonsurgical endodontic treatment and apical surgery.^{28,29,33,39}

The comparable retention and healing prognosis supported the use of intentional replantation as an endodontic treatment modality.

Null hypothesis was that IR is to preserve the natural dentition, thereby upholding the primary goal of Conservative treatment.

Conclusion:

Within the limitations of this study, after analyzing the results and obtaining a complete follow up of 12 months radiographically and clinically, it can be concluded that Intentional replantation is a treatment of choice and should be included in the savior procedures as it has shown a success rate of 92% and with the innovation of the bioactive material like biodentin, the success rate high. IR will achieve a good success rate with bio-regenerative materials and be much less costly than most treatment options with proper case selection and proper training.

However, further clinical trials are needed to explore the long-term retention period of the Intentionally Replanted teeth.

References:

1. Grossman L. Endodontic practice. 11th ed. Philadelphia: Lea & Febiger, 1988:334-42
2. Weinberger B. Introduction to the History of Dentistry, vol. I. St Louis, MO: CV Mosby; 1948
3. Weine F. Endodontic therapy. 4th ed. St Louis: CV Mosby. 1989:210-3.
4. Ingle J. Endodontics. 3rd ed. Philadelphia: Lea & Febiger. 1985:664-6.
5. Cohen B, Burns RC. Pathways of the pulp. 4th ed. St Louis: CV Mosby, 1987:607
6. Kingsbury, B. C., & Wiesenbaugh, J. M. (1971). Intentional Replantation of Mandibular Premolars and Molars. The Journal of the American Dental Association, 83(5), 1053–1057.
7. Weine FS. The case against intentional replantation. J Am Dent Assoc 1980 100:664–668.
8. Charles S. Solomon, DDS, and Jacob Abelson, DDS Intentional replantation: report of case. Journal of endodontics 5 I vol 7, no 7, July 1981
9. Grossman LI. Intentional replantation of teeth: a clinical evaluation. J Am Dent Assoc 1982;104: 633–9
10. David M. Nosonowitz, DDS et al Intentional replantation to prevent predictable endodontic failures (ORAL SURG. 57:423-432, 1984.)
11. Mahnaz Messkoub, DDS, MScD,” Houston, Intentional replantation: A successful alternative for hopeless teeth. Oral surg oral med oral pathology 1991;71:743-7
12. Bender, DDS,” and Louis E. Rossman, DMD Intentional replantation of endodontically treated teeth (ORAL SURG ORAL MED ORAL PATHOL 1993;76:6%3-30)
13. Andreasen JO, Borum MK, Jacobsen HL, et al. Replantation of 400 avulsed permanent incisors: 4—factors related to periodontal ligament healing. Endod Dent Traumatol 1995;11: 76–89.
14. S P Niemczyk Re-inventing intentional replantation: a modification of the technique Pract Proced Aesthet Dent 2001 Aug;13(6):433-9
15. James Wolcott 1, Louis E Rossman Intentional replantation of endodontically

- treated teeth: an update *Compend Contin Educ Dent*. 2003 Jan;24(1):68-72, 74.
16. Peer M. Intentional replantation: a 'last resort' treatment or a conventional treatment procedure? nine case reports. *Dent Traumatol* 2004;20: 48–55B.
 17. Kim S, Kratchman S. Modern endodontic surgery concepts and practice: a review. *J Endod* 2006; 32:601–23
 18. Ingle J *Endodontics* 6th Edition Philadelphia 2007
 19. Choi YH, Bae JH, Kim YK (2010) Atraumatic safe extraction for intentional replantation. *The Journal of the Korean Dental Association* 48, 531–7.
 20. Choi YH, Bae JH (2011) Clinical evaluation of a new extraction method for intentional replantation. *Journal of Korean Academy Conservative Dentistry* 36,211–8.
 21. Priyanka SR, Veronica D. A Literature Review of Root-End Filling Materials. *Journal of Dental and Medical Sciences* 2013;9(4):20-25.
 22. Choi YH, Bae JH, Kim YK, Kim HY, Kim SK, Cho BH. (2014) Clinical outcome of intentional replantation with preoperative orthodontic extrusion: a retrospective study. *International Endodontic Journal*, 47, 1168–1176.
 23. Nima Moradi Majd, Armita Arvin, Alireza Darvish, Sareh Aflaki, Hamed Homayouni, "Treatment of Necrotic Calcified Tooth Using Intentional Replantation Procedure", *Case Reports Dentistry*, vol. 2014, ArticleID 793892, 5 pages, 2014.
 24. Saeed Asgary et al Indications and Case Series of Intentional Replantation of Teeth *IEJ Iranian Endodontic Journal* 2014;9(1):71-78
 25. 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
 26. Jang et al Survival Rate of Teeth with a C-shaped Canal after Intentional Replantation: A Study of 41 Cases for up to 11 Years *JOE* Vol.42, Issue 9, September 2016;:1320-1325
 27. Tomer Anil K, Malik Nidhi, Bhardwaj Gaurav, Muni Sagarika. Intentional Replantation: A Report of Two Cases. *IJSS Case Reports & Reviews*. 2016 Mar; 2(10): 24-27
 28. Mahmoud Torabinejad, DMD, MSD, PhD; Shane N. White, BDentSc, MS, MA, PhD Endodontic treatment options after unsuccessful initial root canal treatment Alternatives to single-tooth implants <http://dx.doi.org/10.1016/j.adaj.2015.11.017>
 29. Sin Yeon Cho et al Clinical Outcomes after Intentional Replantation of Periodontally Involved Teeth <http://dx.doi.org/10.1016/j.joen.2016.11.024>
 30. Huseyin Akcay1, Hakan Ar,et al. Evaluation of the bond strength of root-end placed mineral trioxide aggregate and Biodentine in the absence/presence of blood contamination
 31. Mandal S, Mandal SB, Kamal V, Kumar A, Gorka K, Kumar A. Physics Forceps: A New Sensation in Exodontia? *Int J Oral Care Res* 2016;4(1):45-47.
 32. Ove A Peters Enrique M Merino *Guide Book to Molar Endodontics* 2017 chapter 10 (287-93)
 33. Derek Grzanich, DDS, MsD, Gabriella Rizzo, DDS, and Renato Menezes Silva, DDS, MS, PhD Saving Natural Teeth: Intentional Replantation—Protocol and Case Series s. (*J Endod* 2017;:-1–6)
 34. Anshul Mainkar A Systematic Review of the Survival of Teeth Intentionally Replanted with a Modern Technique and Cost-effectiveness Compared with Single-tooth Implants (*J Endod* 2017;:-1–6)
 35. Bradley D. Becker et al Intentional Replantation Techniques: A Critical Review. (*J Endod* 2018; 44:14–21
 36. Samuel Kratchman *Beyond Endodontic Microsurgery 1: Intentional Replantation*. Springer Nature Switzerland AG 2019 [doi.org, /10.1007/s40496-019-00238-1](https://doi.org/10.1007/s40496-019-00238-1)
 37. Ralf Krug et al Intentional Replantation with an Atraumatic Extraction System in Teeth with Extensive Cervical Resorption *JOE* Volume 45, Number 11, November 2019

38. Deshpande NM, Shah D, Wadekar S. Maintenance of cell viability in extraoral conditions for a case of intentional replantation to retrieve a separated endodontic instrument. *J Conserv Dent* 2019; 22:207-12.
39. Lin Wang, Hua Jiang, Yang Bai, Qiang Luo, Hao Wu, and Hongchen Liu* Clinical outcomes after intentional replantation of permanent teeth: A systematic review *Bosn J Basic Med Sci.* 2020; 20(1): 13–20
40. Plotino G, Abella Sans F, Duggal MS, Grande NM, Krastl G, Nagendrababu V, Gambarini G. Clinical procedures and outcome of surgical extrusion, intentional replantation and tooth auto-transplantation – a narrative review. *International Endodontic Journal* doi:10.1111/iej.13396
41. Bing Han et al Is Intentional Replantation Appropriate for Treatment of Extensive Endodontic-periodontal Lesions Related to Palatogingival Groove? *Chin J Dent Res* 2020;23(3):205-214
42. Dumsha TC, Gutmann JL. Clinical guidelines for intentional replantation. *Compend Contin Educ Dent* 1985;6: 604. 606–8.
43. Guy SC, Goerlg AC: Intentional replantation: Technique and rationale. *Quintessence Int* 1984
44. Trope M, Friedman S. Periodontal healing of replanted dog teeth stored in Viaspan, milk and Hank's balanced salt solution. *Endod Dent Traumatol* 1992;8 :183–8.
45. Hammarstrom L, Pierce A, Blomlof L, et al. Tooth avulsion and replantation: a review. *Endod Dent Traumatol* 1986
46. Emmertsen E, Andreasen JO. Replantation of extracted molars: a radiographic and histological study. *Acta Odontol Scand* 1966; 24:327–46
47. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977; 33:159–74.