

Technical note

Tooth replantation: an update

Omar Marouane¹, Asma Turki², Lamia Oualha³, Nabih Douki⁴

¹ Postgraduate student; restorative dentistry and endodontics; dental surgery department University Hospital Sahloul Sousse, Tunisia

² Postgraduate student; oral medicine and oral surgery; dental surgery department University Hospital Sahloul, Tunisia

³ Professor; dental surgery department University Hospital Sahloul Sousse, Tunisia

⁴ Professor; restorative dentistry and endodontics; head of dental surgery department University Hospital Sahloul Sousse, Tunisia

(Received 4 December 2015, accepted 30 October 2016)

Key words:

Tooth Replantation /
periodontal ligament /
periodontal splints

Abstract – Introduction: Intentional replantation is a recognized endodontic procedure in cases in which root canal and surgical endodontic treatments are not recommended. Although not frequently used, intentional replantation is a treatment option that dentists should consider. Three keys point should be kept in mind to ensure the success of replantation procedure: to overcome any complications, the surgical procedure have to be rigorous, the extra-alveolar time properly managed, and the splint adapted. In the other hand, the knowing of the indications and the advantages is advocated for the success of this procedure. **Conclusion:** When standard protocols of intentional replantation are followed, clinical and radiological success is expected. From this point of view, intentional replantation should be considered as a viable therapeutic and not as a procedure of last resort

Introduction

Conventional root canal treatment is the therapeutic choice for managing pulpal and periapical inflammation or infection. However, even when non-surgical treatment has perfectly been performed, periapical lesion and related symptoms may persist [1].

Apical surgery is often the last resort to treat persistent periapical lesion in an endodontically treated or retreated tooth, allowing millions of people to preserve their natural teeth [2].

Despite providing high long-term survival and success rates, apical surgery may be difficult to perform due to anatomical obstacles such as the mental foramen or the mandibular canal, not to mention that it might be challenging in molars because of limitations in instrumental access, mainly on the lingual or palatal roots [3].

From this point of view, intentional replantation may be an alternative choice for some of these cases [4,5].

Intentional replantation is defined as the extraction of the tooth and its reinsertion into the socket after sealing the resected root end with a root-end filling material [6].

Replantation is not a new procedure. It has been performed for more than ten centuries. Abu Al-Qasim described the first replantation technique using ligatures to splint the replanted tooth [7].

Over the years, the procedures of the intentional replantation have been progressively modified and refined.

To date, our understanding of this technique, its outcome and its complications derive largely from the long-term studies of Andersen [8].

Due to the lack of long-term evidence, intentional replantation is often considered as a procedure of last resort. However, in an effort to retain the natural tooth, intentional replantation should be considered as a reliable and predictable procedure.

The aims of this review are to summarize the surgical knowledge of this procedure, discuss their advantages and disadvantages, reveal the clinical criteria for optimal case

* Correspondence: Marouane Omar, marouane.omar@yahoo.com

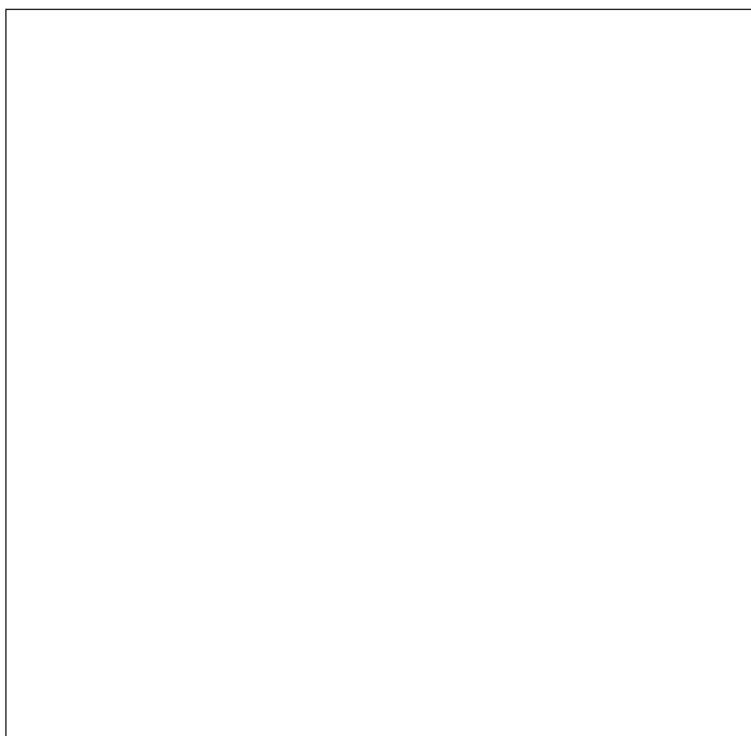


Fig. 1. During extraction, the vitality preservation of a sound periodontal ligament and the extracted root surface (a) and into the socket wall (b) is necessary to obtain retention and healing of intentionally replanted teeth.

selection and eventually proposed the critical factors that may influence the outcome of intentional replantation procedure.

Tooth replantation procedure

It's been well documented that the vitality preservation of a sound periodontal ligament around the extracted root surface is necessary to obtain a successful intentional replantation. From this point of view, the goal of the surgical procedure is to prevent mechanical and chemical damage, during extraction, extra-oral time and the replantation.

Atraumatic surgical technique

To prevent damage of the periodontal ligament, the use of an elevator during extraction time should be avoided. Moreover, the beak of the conventional forceps should be firmly placed on the crown above the cemento-enamel junction while exerting a slow luxation force [9,10] (Fig. 1).

Due to previous root canal treatment, extensive restoration and the presence of posts many teeth which are destined for intentional replantation are already weakened, which increases the possibility of tooth fracture [1].

Therefore, new methods and materials were suggested to assure a safe extraction for a successful intentional replantation without crown or root fracture.

The use of periotome, powered periotome or even piezosurgery may help in removing the tooth with little or no trauma to the root surface and periodontal ligament and decrease the incidence of a root fracture [2,13].

Lately, Choi et al suggested that using physics forceps could be considered as a reliable extraction instrument for a successful intentional replantation [4,15].

On the other hand, a new method of atraumatic and safe extraction using orthodontic extrusion was recommended for intentional replantation.

As a matter of fact, 2 to 3 weeks before extraction, orthodontic extrusion can increase both tooth mobility and periodontal ligament volume permitting an easier extraction without a risk of tooth fracture [5].

Extra-alveolar time

Once the tooth has been extracted, care should be taken to avoid any contact with the socket wall, and thus, prevent damage of the remaining periodontal ligament which is the key in promoting reattachment [9] (Fig. 1).

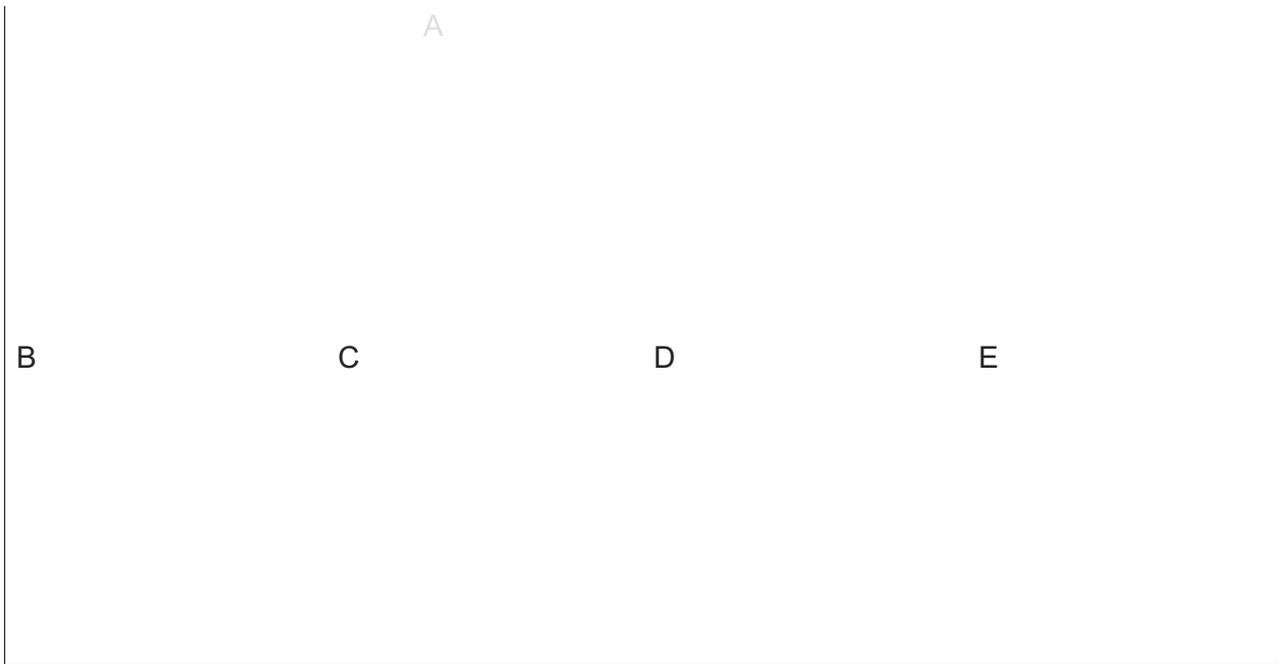


Fig. 2. Continuous immersion technique permit to place the tooth in humid environment (a,b) to more easily perform root-end resection (c), preparation (d), and placement of root-end fillings (e).

Subsequently, any existing granulation tissue should be removed using a small curette without involving any sharp curettage of the socket wall. Also, to avoid damage to the periodontal ligament, the extracted tooth should be always held gently with moist gauze whilst the root-end treatment is carried out extraorally [3].

It is generally accepted that 3 mm resection starting from the apical tip of the root with a high speed diamond bur will permit a thorough preparation of the cavity and the placement of a biomaterial as a retrograde seal.

It is important to keep the tooth in a humid environment, as in Viaspan solution, saline or Hank's buffered salt solution, to maintain it moist. This will actually maintain the periodontal ligament vital and therefore reduce complications after replantation procedures [9].

Recently, continuous immersion of the tooth in solution was described in order to perform easier root-end resections, preparation, and placement of root-end fillings (Fig. 2).

Moreover, numerous studies suggested treating root surface before replantation with solutions such as tetracycline, citric acid or EDTA in order to enhance reattachment of the periodontal ligament on the socket wall [6, 17].

Conditioning the root surface with culture media or with enamel matrix protein prior to replantations has been also described [8, 19].

However, although some of these different surface treatments do have certain experimental evidence, and are used today in clinical practice, there is no evidence to be recognized as recommendations for the time being and further investigations [20].

More important than the root conditioning, maintaining the vitality of the periodontal ligament during the extra-alveolar time is absolutely necessary to ensure the best possible outcome of the intentional replantation. It is well known that the remaining periodontal ligament may heal after replantation [21].

Because that the viability of periodontal ligament exposed to the extra-oral space decreases rapidly after 18 minutes, the extra-oral procedure time should be reduced as much as possible in order to obtain optimal healing [22, 23].

To date, there are no clinical guidelines specifically adapted for the intentional replantation. However, the outcomes

of splinting types and duration on periodontal healing have been widely studied on replanted teeth. A recent evidence based appraisal of the literature indicates that splint type and duration were not generally a significant variable in relation to healing outcomes [24].

Although, ankylosis and replacement resorption may be observed with a long-term splinting, significant improvements in outcomes with short-term splinting have not been shown [25, 27].

Now it is recommended that the tooth be splinted for up to two weeks contrary to six weeks as before [26].

Moreover, the prognosis of splinting types on replanted teeth outcome is not well assessed to date [28].

Despite the fact that the splint type should permit physiological movement during the fixation period, recent evidence based studies demonstrate that splint types do not affect the outcome of the periodontal healing process [24, 28].

Others studies show that suture splint appears to be more favorable than wire composite splint. Indeed, suture splinting provides physiological loading on the replanted teeth, which might facilitate periodontal healing [28, 29].

Unfortunately, there is still a lack of evidence concerning splinting duration and types and it is now recommended that the tooth should be splinted for up to two weeks with flexible types [24].

Antibiotics

With regard to the influence of systemic antibiotics, several studies suggest that their prescription may prevent complications to the replanted teeth [30, 31].

In 2009, a systematic review demonstrated that there are insufficient clinical benefits for administration of antibiotics in cases of dental replantation.

On the other hand, in agreement with recent meta-analysis, the Affssaps recommendations, state that prescribing antibiotics may prevent complications and increase the survival rate of replanted teeth, which is in agreement with recent meta-analysis [29, 32].

Healing and complications

As mentioned previously, vitality of periodontal ligament cell, affected by extraoral time and storage conditions, has greater effect on healing than splinting period or type [33].

When these factors are properly managed, favorable healing occurs and the complete regeneration of the periodontal ligament along the root surface takes about 7 to 10 days [34].

However, during replantation procedure surface root may get damaged. And so, depending on the degree of this damage, various complications can occur.

If there is only a small damaged area, cells which have the potential to form a new cementum and periodontal ligament are capable to cover the damaged root. This type of healing is termed surface resorption. Clinically, the tooth is asymptomatic and has a normal percussion tone [35].

As reported by Andreasen *et al.*, ankylosis comes about when more than 9 mm² of the surface root is damaged [36].

Ankylosis is defined by the fusion of the bone and the root surface; consequently, the tooth is not mobile and gives a high percussion tone. Over the time, physiologic bone turnover takes place and similarly to the adjacent bone, the root is resorbed and replaced with bone. This process is called replacement resorption.

If inflammatory stimulus persists, healing cannot occur and inflammatory resorption takes place. During this process, bone is resorbed until the tooth becomes mobile and extruded (Fig. 3).

Indications

Past negative opinions may limit the consideration of intentional replantation. In 1966, Grossman stated that intentional replantation should be a procedure of last resort. and proposed a wide range of indications for performing intentional replantation [6].

Over the time, these indications evolved and refined in order to be more suitable for this procedure.

The failure of an endodontic treatment or retreatment when periapical surgery is not feasible is one of the most common indication for tooth replantation. This situation may be associated with a wide range of others complications including iatrogenic or natural canal obstruction such as crowns, posts or fractured instruments [37].

Intentional replantation is also indicated for root perforation when it is too large to repair and when the perforation is surgically inaccessible without requiring excessive bone removal [38].

Intentional replantation has been also described for managing vertical root fracture after extra-oral bonding of the fractured fragment. Based on this procedure, several case reports and clinical studies showed promising results especially for single rooted teeth [39, 40, 41, 42].

Finally, although intentional replantation is not recommended for teeth with periodontal disease [9], recent studies showed good results in periodontally compromised teeth [43] (Fig. 4).

Survival rates

Until this day, there is a lack of consensus on the criteria describing a successful intentional replanted teeth or the amount of root resorption that constituted a failure. Success was variously and arbitrarily defined as the retention of the

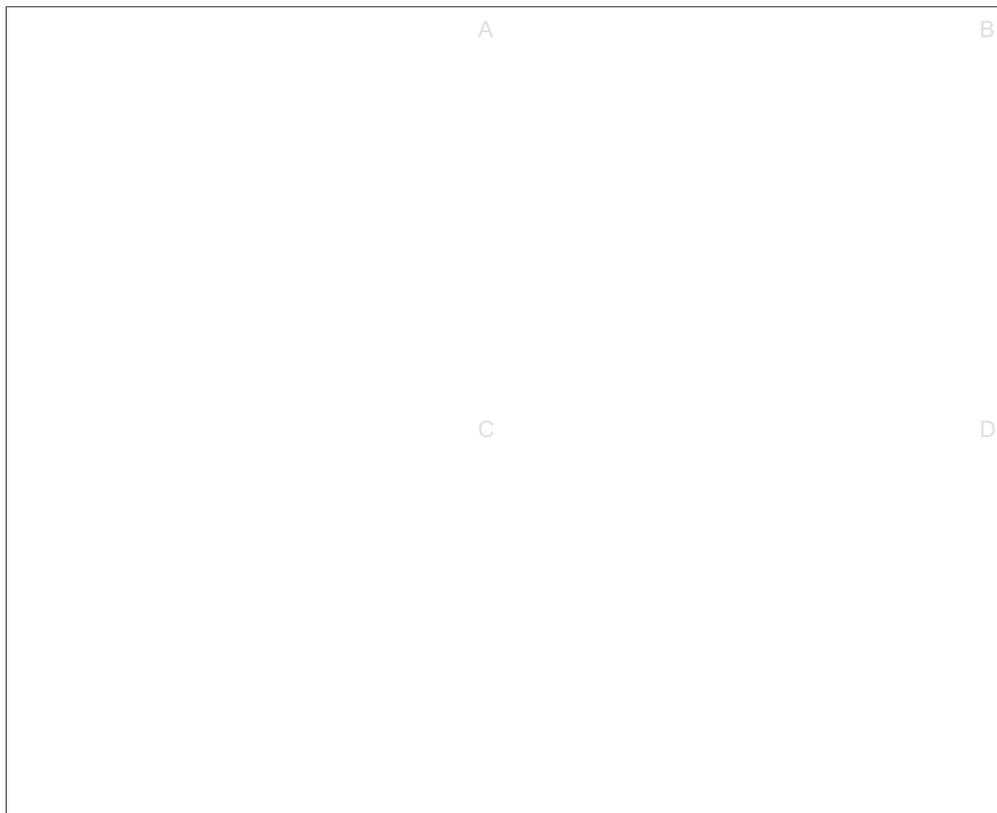


Fig. 3. Intentionally replanted mandibular second molar assessed as complication. (a) Radiographic image before treatment. The tooth was symptomatic. Orthograde retreatment was attempted, but canal could not be renegotiated. (b) Postoperative radiograph of the replanted molar after apical resection and root end filling. (c) Radiographic image after 1 month. Periapical radiolucency appeared increased, and the tooth was asymptomatic. (d) Radiographic image after 3 months. Periapical radiolucency expanded and the replanted tooth became mobile.

tooth, which may reach as long as 3, 5 or 10 years. [Comparison of dental implants and intentional replanted teeth

From this point of view, recent prospective study of intentional replantation suggested a cumulative 12-year retention rate of 93% [44].

Moreover, in others studies, radiographic evaluation of the periapical healing or in combination with functional success is assessed to describe the success of this procedure [40, 45].

According to these heal and fonctional criteria, Lee for the implant supported single crowns with a mean of 4 years of follow-up [5].

The extremely high survival rate for implant-supported single crowns identifies this procedure as the treatment of choice for replacing missing or hopeless teeth.

Furthermore, the outcomes of intentionally replanted teeth may be influenced by various factors including tooth morphology and location, patients' oral hygiene and age, or orthodontic extrusion before intentional replantation. However, before choosing the treatment option, it is necessary to know the advantages and the disadvantages for each procedure.

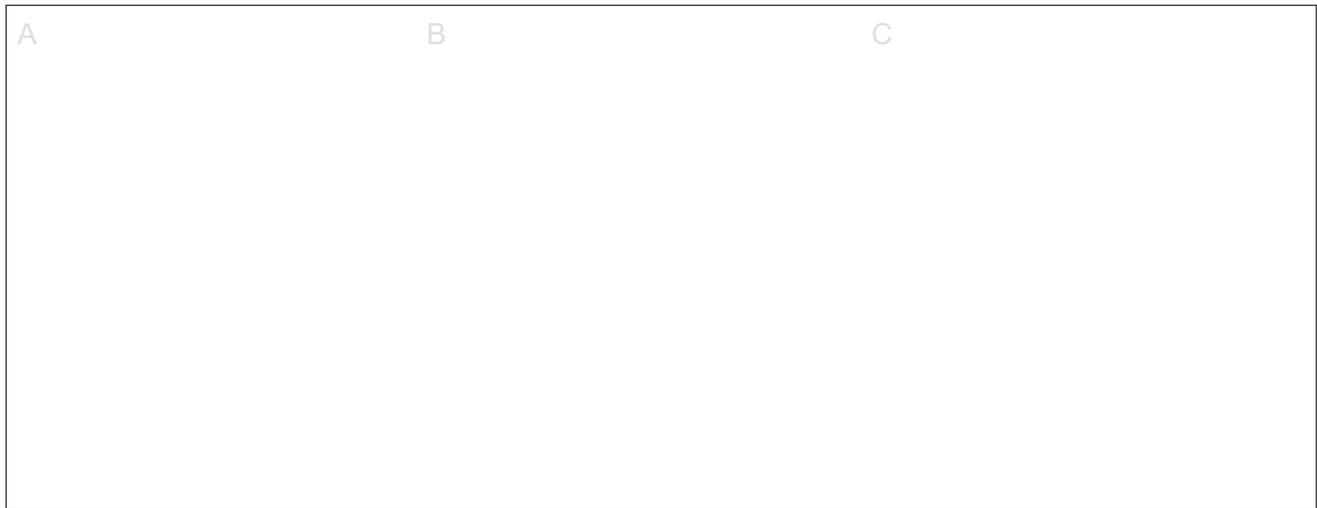


Fig. 4. Intentional replantation for periodontally involved hopeless teeth representing external resorption assessed as success. (a) Operative radiograph of the replanted central incisor after apical resection, root end filling and management of the external resorption using Biodentine. (b) Radiographic image after 3 months. Periapical radiolucency appeared decreased, and the tooth was asymptomatic. (c) Radiographic image after 5 months showing complete resolution of the periapical radiolucency and vertical bone gain.

Age of the patient

Contrary to tooth replantation, implants are contraindicated in growing children. Indeed, implants do not grow along with the developing dentition, which results in infraocclusion aside from esthetic and functional problems [35,46].

On the other hand, given that bone turnover follows a slower pace in adult patients, replanted teeth can remain normal in function and esthetics for many years even when the ankylosis or replacement resorption take place.

From this point of view, for growing patient, intentional transplantation, offers several advantages such as maintaining a viable periodontal ligament, offering the possibility of an orthodontic movement, continuous alveolar growth while preserving alveolar volume; in case of failure, the replanted tooth do not exclude the option of implant placement.

Function

After replantation, the healing occurs rapidly and the function is obtained almost immediately.

Replanted teeth also provide periodontal proprioception just like other natural teeth. Finally, osteoinducting properties that result in bone regeneration around the replanted teeth may also be considered as an advantage comparing to implant.

Time

Surgical and post-surgical operations are generally easier for replanted teeth than for implant-supported single crowns. Indeed, the position of replanted teeth is already established.

In contrast, implant therapy requires diagnostic wax up and several prosthetic steps to permit a correct placement [47].

Conclusion

Although until this day intentional replantation is considered « the procedure of the last resort », dentists may still be unfamiliar with this technique. However, when the procedure is carefully performed with proper case selection, success can be expected with an acceptable survival rate. Intentional replantation should be considered as an alternative treatment in the selected case and should be part of the therapeutic armamentarium

Knowledge of the prognosis, the surgical procedure, the risk and benefits may assist patients and dentists in effective decision-making.

Conflicts of interest: the authors declare that they have no conflicts of interest in relation to this article.

References

1. Lee W, Shon W-J, Baek SK, Kim K-Y, Kim H-C. Outcomes of intentionally replanted molars according to preoperative locations of periapical lesions and the teeth. *Journal of Dental Sciences* 2012;7:125-129.
2. von Arx T. Failed root canals: the case for apicoectomy (periradicular surgery). *Journal of Oral and Maxillofacial Surgery* 2005;63:832-837.
3. Wolcott J, Rossman LE. Intentional replantation of endodontically treated teeth: an update. *Compendium of continuing education in dentistry (Jamesburg, NJ: 1995)* 2003;24:68-72,74.
4. Song M, Chung W, Lee S-J, Kirtong. Long-term outcome of the cases classified as successes based on short-term follow-up in endodontic microsurgery. *Journal of endodontics* 2012;38:1192-1196.
5. Torabinejad M, Dinsbach NA, Turman M, Handysides R, Bahjri K, White SN. Survival of intentionally replanted teeth and implant-supported single crowns: a systematic review. *Journal of endodontics* 2015;41:992-998.
6. Grossman LI. Intentional replantation of teeth. *The Journal of the American Dental Association* 1966;72:1111-1118.
7. Weinberger BW. *An introduction to the history of dentistry*: Mosby.
8. Mendoza A, Solano Reina E, Iglesias Linares A, Garcia Godoy F, Abalos C. Retrospective long evaluation of autotransplantation of premolars to the central incisor region. *International endodontic journal* 2012;45:88-97.
9. Kratchman S. Intentional replantation. *Dental Clinics of North America* 1997;41:603-617.
10. Niemczyk S. Re-inventing intentional replantation: a modification of the technique. *Practical procedures & aesthetic dentistry: PPAD* 2001;13:433-439; quiz 440.
11. Kany FM. Single... Tooth Osteotomy for Intention Replantation. *Journal of endodontics* 2002;28:408-410.
12. Blus C, Szmukler-Moncler A. Traumatic tooth extraction and immediate implant placement with Piezosurgery: evaluation of 40 sites after at least 1 year of loading. *The International journal of periodontics & restorative dentistry* 2010;30:355.
13. Weiss A, Stern A, Dym H. Technological advances in extraction techniques and outpatient oral surgery. *Dental Clinics of North America* 2011;55:501-513.
14. Choi Y, Bae J, Kim Y. Atraumatic extraction for intentional replantation. *J Korean Dent Assoc* 2010;48:531-537.
15. Choi Y, Bae J, Kim Y, Kim S, Cho B. Clinical outcome of intentional replantation with preoperative orthodontic extrusion: a retrospective study. *International endodontic journal* 2014;47:1168-1176.
16. Terranova VP, Franzetti LC, Hidiario RM, Lyall RM, Wikesjö UM, et al. A biochemical approach to periodontal regeneration: tetracycline treatment of dentin promotes fibroblast adhesion and growth. *Journal of periodontal research* 1986;21:330-337.
17. Moradi Majd N, Arvin A, Darvish A, Aflaki S, Homayouni H. Treatment of necrotic calcified tooth using intentional replantation procedure. *Case reports in dentistry* 2014;2014.
18. Saito A, Saito E. The Effect of EMD Application for Intentional Replantation of Periodontally Involved Teeth in Dogs. *J Interdiscipl Med Dent Sci* 2014;2:2.
19. Saito A, Saito E. Healing Following Implantation of Root with Remaining Periodontal Ligament Cultured In vitro. *Dentistry* 2014;4:1.
20. Diangelis A, Andreasen J, Ebeleseder K, Kenny D, Trope M, Sigurdsson A, et al. [International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. Refu'at ha-peh veha-shinayim (1993) 2014;31:57-68,90.
21. Andreasen J. Periodontal healing after replantation and autotransplantation of incisors in monkeys. *International Journal of Oral Surgery* 1981;10:54-61.
22. Andreasen J. Effect of extraveolar period and storage media upon periodontal and pulpal healing after replantation of mature permanent incisors in monkey. *International Journal of Oral Surgery* 1981;10:43-53.
23. Tsukiboshi M. Autotransplantation of teeth: requirements for predictable success. *Dental Traumatology* 2002;18:157-180.
24. Hinckfuss SE, Messer LB. Splinting duration and periodontal outcomes for replanted avulsed teeth: a systematic review. *Dental Traumatology* 2009;25:150-157.
25. Andreasen J. The effect of splinting upon periodontal healing after replantation of permanent incisors in monkeys. *Acta Odontologica Scandinavica* 1975;33:313-323.
26. Andreasen J, Borum M, Jacobsen H, Andreasen F. Replantation of 400 avulsed permanent incisors. 4. Factors related to periodontal ligament healing. *Dental Traumatology* 1995;11:76-89.
27. Bauss O, Schwestka-Polly R, Behr R, Kiliaridis S. Effect of different splinting methods and fixation periods on root development of autotransplanted immature third molars. *Journal of oral and maxillofacial surgery* 2005;63:304-310.
28. Almpanti K, Papageorgiou SN, Papadopoulos MA. Autotransplantation of teeth in humans: a systematic review and meta-analysis. *Clinical oral investigations* 2015;19:1157-1179.
29. Chung WC, Tu YK, Lin YH, Hsu H. Outcomes of autotransplanted teeth with complete root formation: a systematic review and meta-analysis. *Journal of clinical periodontology* 2014;41:412-423.
30. Andreasen JO, Hansson L. *Atlas of replantation and transplantation of teeth*: WB Saunders Company.
31. Tsukiboshi M, Andreasen JO. *Autotransplantation of teeth*: Quintessence Pub Co.
32. Lesclous P. *Prescription des antibiotiques en pratique bucco-dentaire-Recommandations Afssaps 2011*. Médecine Buccale Chirurgie Buccale 2011;17:334-346.
33. Lekic P, Kenny D, Barrett T. The influence of storage conditions on the clonogenic capacity of periodontal ligament cells: implications for tooth replantation. *International endodontic journal* 1998;31:137-140.
34. Flores MT, Andersson L, Andreasen JO, Bakland LK, Malmgren B, Barnett F, et al. Guidelines for the management of traumatic

- dental injuries. II. Avulsion of permanent teeth. *Dental Traumatology* 2007;23:130-136.
35. Unni K, Singh V. Autotransplantation of teeth...An overview. *Amrita Journal of Medicine* 2012;8:1-44.
 36. Andreasen JO, Kristerson L. The effect of limited drying or removal of the periodontal ligament: periodontal healing after replantation of mature permanent incisors in monkeys. *Acta Odontologica Scandinavica* 1981;39:1-13.
 37. Asgary S, Marvasti LA, Kolahzadeh A. Indications and case series of intentional replantation of teeth. *Iranian endodontic journal* 2013;9:71-78.
 38. TSESIS I, FUSS Z. Diagnosis and treatment of accidental root perforations. *Endodontic Topics* 2006;13:95-107.
 39. Hayashi M, Kinomoto Y, Takeshige F, Ebisu S. Prognosis of intentional replantation of vertically fractured roots reconstructed with dentin-bonded resin. *Journal of endodontics* 2004;30:145-148.
 40. Hayashi M, Kinomoto Y, Miura S, Sato I, Takeshige F, Ebisu S. Short-term evaluation of intentional replantation of vertically fractured roots reconstructed with dentin-bonded resin. *Journal of endodontics* 2002;28:120-124.
 41. Özer SY, Ünlü G, Deveci Y. Diagnosis and treatment of endodontically treated teeth with vertical root fracture: three case reports with two-year follow-up. *Journal of endodontics* 2011;37:97-102.
 42. Nizam N, Kaval M, Gürlek Ö, Atila A, Şahin M. Intentional replantation of adhesively attached vertically fractured maxillary single-rooted teeth. *International endodontic journal* 2015.
 43. Demiralp B, Nohutcu RM, Tepeli D, Eratalay K. Intentional replantation for periodontally involved hopeless teeth. *Dental Traumatology* 2003;19:45-51.
 44. Cho S-Y, Lee Y, Shin S-J, Kim Jung I-Y, Friedman S, et al. Retention and Healing Outcomes after Intentional Replantation. *Journal of endodontics* 2016;42:909-915.
 45. Koenig K, Nguyen N, Barkhorst P. Intentional replantation: a report of 192 cases. *General dentistry* 1987;36:327-331.
 46. Cross D, El-Angbawi A, McLain PL, Keightley A, Brocklebank L, Whitters J, et al. Developments in autotransplantation of teeth. *The Surgeon* 2013;11:49-55.
 47. White SN, Mikus VG, Potter KS, Cho J, Ngan AY. Endodontics and implants, a catalog of therapeutic contrasts. *Journal of Evidence Based Dental Practice* 2006;6:101-109.