

A 14 year old boy with reimplantation of avulsed maxillary central incisors

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Presentation of Case

Md. Abdul Hannan Sheikh: A 14 year old boy, came to the Department with the complaint of accidental missing of upper two central incisor teeth (Figure 1A, B). The teeth were brought by the patient those were healthy and intact. His medical history was non-contributory and he was tetanus immunized. He came 2 hours after the accident with the missing teeth immersed into 0.9% sodium chloride solution. On clinical examination, there were missing of both central incisors. Sockets were full of blood. On palpation, no other tooth was tender.

Dr. Mozammal Hossain: On radiological examination, there was no bony damage found. The teeth sockets were found intact. There was no alveolar bone fracture and no fracture part of tooth or foreign body was found. No fracture line or root fracture was detected in the adjacent teeth.

Clinical Procedure for Reimplantation

Dr. Sheikh: It was decided to reimplant the maxillary central incisors after appropriate endodontic preparation with the consent of the patient's guardian. The teeth were placed into sodium hypochlorite for 30 min to remove the necrotic periodontal fiber. Then placed into citric acid for 3 min, washed with saline and finally left 5 min in a solution of 1 mg/20 mL minocycline. Endodontic preparation of the teeth was completed using standardized technique by careful holding the teeth crowns with gauge. The canals were obturated and retrograde filling was done by mineral trioxide aggregate (Figure 1). The traumatized sockets were inspected for any bone or tooth fragments. Prior to reimplantation under local anesthesia, the sockets were cleaned and irrigated with 0.9% sodium chloride solution. The root filled teeth were reimplanted carefully into the alveolar sockets by holding it's crown with the fingers and any contact with the roots were

avoided to contamination. The successful reimplantation was assessed by comparing the level of incisal edge of the reimplanted incisors with the adjacent lateral incisors and the position was verified by the guardian, and then the patient was asked to bite gently to verify normal occlusion. The immobilization was done by functional splint (Figure 1D).

Radiograph was taken to confirm the repositioning of the teeth (Figure 1E).

Cefradine (500 mg) was advised for 1 week and ibuprofen (400 mg) was advised if pain occurred.

The patient was instructed to take soft diet, not to bite with the splinted tooth and to maintain proper oral hygiene for 3 weeks, to brush with soft toothbrush after every meal and to use chlorhexidine mouthwash twice a day, until splint was removed.

The patient was advised to visit after 1 week, 2 weeks, 3 months, 6 months and once in a year for the next 5 years to evaluate the healing of the reimplanted tooth and the pulp status of the adjacent teeth. The teeth were assessed clinically and radiographically followed by removal of splinting at 2 weeks. At 3 and 6 months, radiographical evaluation revealed no root resorption, intact periodontal ligament without any periapical pathology (Figure 1). Clinical observation showed that both treated and adjacent teeth were healthy.

Differential Diagnosis

Differential diagnosis may be chronic periodontitis, root resorption, and tooth mobility. All these are excluded by clinical and radiological examinations.

Chronic periodontitis

Dr. Md. Joynal Abdin: Functional difficulties plays an important role during the treatment of anterior teeth with excessive periodontal destruction.¹ In most of the cases, extraction is the only treatment of choice for teeth with



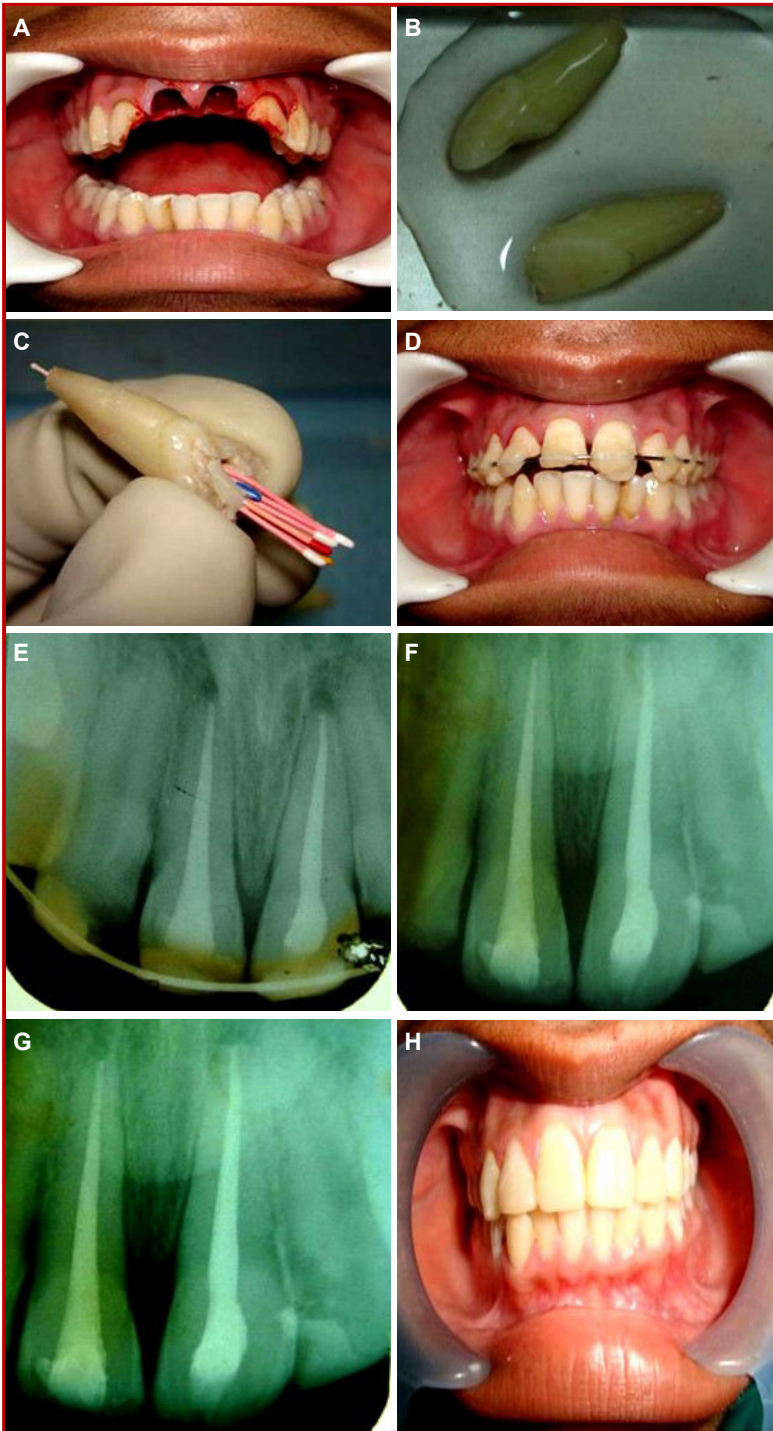


Figure 1: Absence of two central incisor teeth following accident (A), The avulsed teeth (B), Root canal filling (C), Functional splinting (D), Periapical image after replantation of teeth (E), Periapical image after 3 months (F), Periapical image after 6 months (G) and Photograph after 6 months (H)

severe periodontitis. Although replantation is contraindicated in teeth having moderate-to-severe periodontal involvement, several studies have indicated that successful results could be achieved with periodontally involved teeth.^{2,5} In the reim-

plantation of tooth, avulsed tooth is reinserted into the socket as soon as endodontic management was completed.⁶⁻⁸ Furthermore, this treatment option is considered as one of the feasible mode of treatment, where more conventional forms of treatment are failed or impossible to preserve the natural dentition.⁹⁻¹¹ However, it is contraindicated in the presence of severe periodontal complications such as fracture of tooth and gross bony damage into the socket, and gingival inflammation.^{4,12} Furthermore, a lower success rate has been reported in periodontally compromised tooth where interseptal bone was lost.¹³ Based on the previous studies, it can be assumed that treatment of replantation with periodontally involved teeth is still controversial as many investigators revealed periodontal involvement as a contraindication for replantation but others indicated that successful results could be achieved with periodontally involved teeth.

Tooth mobility

Dr. Abdin: Tooth mobility is an important feature of periodontal disease which results in early loss of dentition. Assessment of tooth mobility is an indirect method for evaluating the functional condition of the periodontium as well as possible aggravating co-factor for periodontal disease.¹⁴

Root resorption

Dr. Abdin: Dental trauma often leads to tooth resorption followed by early loss of tooth.¹⁵⁻¹⁶ However, diagnosis of types of tooth resorption is still controversial. In the inflammatory root resorption, trauma due to orthodontic movement, periapical periodontitis may cause inflammation of periodontal space and ligament as well as resorption of mineralized root tissue.¹⁷⁻¹⁸ On the other hand, replacement resorption usually occurs as a result of alveolodental ankylosis and it may occur as a consequence of trauma to the erupted teeth or severe atrophy of the periodontal ligament or both.¹⁹⁻²⁰ Therefore, alveolodental ankylosis of a tooth is called as bone structure due to its constant renewal processes, remodeling, and is replaced by bone.²¹

Clinical Diagnosis

Avulsion of teeth

Dr. Hannan's Diagnosis

Avulsion of teeth

Discussion

Dr. Sheikh: The treatment of avulsed teeth has changed rapidly in the last several years. The previously

reported poor success rates of reimplanted avulsed teeth (4 to 50%) can be improved to over 90% with a modified approach to treatment.²² The prognosis of an avulsed tooth depends on its extraoral time because it is directly correlated with the periodontal ligament cells.²³ One study indicated that replanted teeth may be functioning for five years but tooth can be lost either due to progressive root resorption or ankylosis.²³

Pathophysiology of avulsion

Dr. Sultana Parveen: When extrusive forces applied on the teeth, it can cause displacement of tooth out of its socket. As the periodontal ligament is ruptured due to trauma, some parts of the periodontal ligament still remains attached with the cementum of the root and the destruction of inner walls of the alveolar socket may happen.²⁴ At the same time, the blood vessels may be severely damaged or cessation of blood supply to the pulp may occur.²⁵⁻²⁶ When the extent of injury continued, it may also damage the periodontal ligament and the pulp.²⁵⁻²⁶ Furthermore, the healing of these tissues depend on the extra-alveolar storage period.²⁷

Discussion on treatment procedure

Dr. Sheikh: Re-implantation of a tooth may be performed with or without local anesthesia. In many cases, local anesthesia is desirable to facilitate adequate socket preparation and re-positioning of the tooth.²⁸ In the present case, local anesthesia was used and root canal treatment was performed prior to re-implantation.^{28,29} Previous studies have indicated that re-implantation technique have poor prognosis due to excessive damage to the periodontal ligament cells, especially when drying and handling technique is prolonged.^{3,30} It is, therefore, important to keep a patent root canal which acts as a medium for application of medicaments into the root canal to reduce infection and internal absorption.

However, it is necessary to complete the endodontic treatment before implantation of the tooth into the socket. In the present case, root canal treatment was performed in the second visit and teeth were kept in splinting for 14 days. Previous studies have recommended fixation of reimplanted tooth for 7-10 days or it can be extended up to eight weeks if there is a fracture of alveolar process.³¹⁻³² Therefore, it can be considered that the required time of splinting can be extended until the tooth is stable into the socket. In this case, systemic antibiotics were used as prophylactic measures against bacteria.³³ Other antibiotics such as tetracycline, doxycycline and penicillin V are also beneficial to decrease root resorption.³³ The need for analgesics depends on the individual case basis. Mild analgesics or a non-steroidal anti-inflammatory drug can be prescribed. Furthermore, to prevent environmental contamination, a tetanus booster may be required. Early removal of the pulp is also recommended because it

will resist the development of inflammatory resorption, especially in young patients who have more patent dentine tubules than the advance age.³⁴

Discussion on storage and length of time since avulsion

Dr. Hossain: Successful treatment of avulsed teeth depends on the status of the periodontal ligament, the stage of root development, and the length of time since avulsion (extraoral time).³⁵ The success depends on the availability of tooth, storage in favorable preservation medium, use of topical antibiotics, and enamel matrix protein promoters can increase the reimplantation success.²² It is reported the ideal extraoral time is ranged from 20 min to 48 hours.³⁶ Preferable storage media for an avulsed tooth are milk, saliva and saline.³⁷⁻³⁹ However, another commercially available, antibiotic-free, protective medium the EMT Tooth Saver, Viaspan and Hank's Balance Salt Solution (HBSS) have exceptional ability to keep cells alive for long period of 24-96 hours.⁴⁰ However, storage in normal saline for 2 hours is enough for the successful treatment as reported by a previous study.⁴¹ The present study also supported the storage medium and its duration.

On the other hand, in dry environment, death of 50% periodontal ligament cells occurs within 30 min, after 1 hour no viable cementum remains, and after 2 hours necrosis of periodontal ligament occurs.⁴² As an alternate approach for teeth that have been outside the mouth for more than 1 hour in a non-physiologic medium, a regenerative therapy can be used.⁴² Since the periodontal ligament cells will be necrotic, they are scraped from the root surface and the tooth placed in a sodium hypochlorite solution to remove cellular debris.⁴³ In this case report, periodontal ligament was gently scrapped by soaking the tooth in sodium hypochlorite for 30 min followed by citric acid saturated solution for 3 min to generate roughness of cementum for new periodontal ligament insertion. They were then washed with saline and left in a solution of 1 mg/20 mL minocycline for 5 min. Furthermore, root canal therapy was completed extraorally before the placement of the teeth into the socket.

Discussion on immobilization

Dr. Sheikh: Immobilization prevents vertical displacement of tooth, but it allows tiny horizontal movement that contributes to periodontal ligament repair. After reimplantation, tooth should be splinted with flexible splint and should be removed within 1-2 weeks. However, there is exception for recommended period of splinting 4-8 weeks when there is associated alveolar fracture.⁴⁴ Recently available stabilizing aids are: Orthodontic-wire splints, wire composite splints, resin splints, porcelain veneers, miniplate or acrylic splints, currently non-rigid splinting TTS (titanium trauma splint). In this

case presentation, 0.3 mm orthodontic wire was used to make functional splint which was splinted for 2 weeks using composite resin. A previous study reported that TTS offers improved comfort and handling to the patient and dentist as well as short time immobilization (10 days).⁴¹ Another study performed splinting by orthodontic band and wire, removed after 6 weeks.⁴⁵

Discussion of healing process

Dr. Kamrun Nahar Shanta: Immediately after re-implantation, the inflammatory process in periodontal tissues induced healing process. Healing process may occur in the periodontal ligament either by healing with normal periodontal ligament, healing with the surface resorption, healing with replacement resorption or healing with inflammatory resorption.⁴⁶ However, favorable healing process of the avulsed tooth can be expected if replantation is performed immediately (within 5 min) after trauma, because avulsion usually damage the gingiva, periodontal ligament and pulp tissues.⁴⁷ In this case, the replanted tooth was stable and neither clinical ankylosis nor any replacement resorption was found during the 6 months follow-up period. Although several complications such as root resorption and ankylosis may occur within the first year after replantation. A previous study indicated that it can also be seen in the later periods.⁴ Therefore, long-term follow-up is needed.

Follow-up

Dr. Sheikh: Six months clinical and radiographical evaluation revealed no root resorption and periodontal ligament was intact without any periapical pathology. The adjacent teeth were also found healthy by pulp vitality test.

Dr. Md. Asaduzaman: What is the effect of avulsion on the surrounding tissues?

Dr. Sheikh: The avulsion is the most serious periodontal ligament injury. The tooth is completely displaced out of the socket, causing the immediate break from all of the periodontal ligament fibers, blood and lymph vessels and neurovascular bundle. They cause damage to the root cement and alveolar bone due to the detachment of periodontal fibers as well as traumatic injuries in the permanent anterior dentition results in tooth avulsion.⁴⁸⁻⁵⁰

Dr. Rubaiya Hakim: What is the complication of the treatment of avulsed tooth?

Dr. Sheikh: There are several possible effects on the root surface and attachment apparatus of an avulsed tooth. These include normal periodontal ligament healing, surface resorption, ankylosis and replacement resorption, external inflammatory root

resorption.⁴⁸⁻⁵⁰

Dr. Tanima Nusrat Jabeen: How could an avulsed tooth reattached with the alveolar bone?

Dr. Abdin: Yes, it is the important and significant part of this treatment protocol. Actually, a tooth floats over the surrounding periodontium in a socket. Whenever it is avulsed, the periodontium is torn off and remains partly in root and partly in alveolar bone. Those periodontal ligament cells should be kept vital. That's why, immediately after avulsion, the tooth needs to be kept in an environment of original socket. Also, the avulsed tooth is needed to be immediately reimplanted. Whenever, maintaining the proper environment, within one hour it is reimplanted with root canal treatment and fixation, the periodontium gradually regenerate and repair.⁵¹ Whenever, the previously torn off periodontium gets its favorable environment, the treatment gets success but if gets foreign environment, there is periapical abscess and treatment failure. Here, the avulsed tooth was kept immediately in 0.9% sodium chloride solution and also reimplanted within one hour. So, the favorable environment was maintained and there was successful gradual reattachment with the previous socket.

Dr. Shegufta Tabassum: Should we consider a reimplanted tooth as a foreign body?

Dr. Sheikh: : No, since the tooth is supplied by blood vessels present in periodontal ligament, it continues to receive the nutrition and remain healthy. The abrupt, complete interruption and the neurovascular blocking might causes complete degeneration of the entire cell population. On dental pulp cell, death is inevitable. In case of incompletely developed apices, revascularization can be expected. On the other hand, if the apex of the tooth is closed and the extra oral period is longer, endodontic treatment should be initiated. However, this procedure is beneficial to retain alveolar bone as well as tooth to tooth relationship that will allow abutments to permit fixed prosthesis if required.

Dr. Hossain: The long-term prognosis of reimplanted tooth was thought poor, but this case found significant success. Although extraoral dry time and media of transportation is a matter of concern in respect of reimplantation, a properly reimplanted tooth with standard protocol may show long-term success. So, people should aware that it is necessary to bring the avulsed tooth at the dental office as early as possible.

Final Diagnosis

Avulsion of teeth

References

1. Yi SW, Carlsson GE, Ericsson I, Wennstöm JL. Long-term follow-up of cross-arch fixed partial dentures in patients with advanced periodontal destruction: Evaluation of occlusion and subjective function. *J Oral Rehabil.* 1996; 23: 186-96.
2. Lin YT, Huang YL, Chang SH, Hong HH. Sequelae of iatrogenic periodontal destruction associated with elastics and permanent incisors: Literature review and report of 3 cases. *Pediatr Dent.* 2011; 33: 516-21.
3. Lee EU, Lim HC, Lee JS, Jung UW, Kim US, Lee SJ, Choi SH. Delayed intentional replantation of periodontally hopeless teeth: A retrospective study. *J Periodontal Implant Sci.* 2014; 44: 13-19.
4. Cho SY, Lee SJ, Kim E. Clinical outcomes after Intentional replantation of periodontally involved teeth. *J Endod.* 2017; 43: 550-55.
5. Baltacoiglu E, Tasdemir T, Yuva P, Celik D, Suku-roglu E. Intentional replantation of periodontally hopeless teeth using a combination of enamel matrix derivative and demineralized freeze-dried bone allograft. *Int J Periodontics Restorative Dent.* 2011; 31: 75-81.
6. Brandini DA, Amarla MF, Debortoli CVL, Panzarini SR. Immediate tooth replantation: Root canal filling for delayed initiation of endodontic treatment. *Braz Oral Res.* 2018; 32: 7.
7. Ferrazzano GF, Orlando S, Ingenito A, Tia M, Sammartino G. Tooth replantation as an alternative to dental implantology in adolescent patients. *Eur J Paediatr Dent.* 2010; 11: 216-18.
8. Maniglia-Ferreira C, de Almeida Gomes F, Vitoriano MH. Intentional replantation of an avulsed immature permanent incisor: A Case Report. *J Endod.* 2017; 43: 1383-86.
9. Asgary S, Alim Marvasti L, Kolehdozan A. Indications and case series of intentional replantation of teeth. *Iran Endod J.* 2014; 9: 71-78.
10. Greiner JH, Hawkins RD. Intentional replantation. *Endod Rep.* 1991; 6: 11-13.
11. Rouhani A, Javidi B, Habibi M, Jafarzadeh H. Intentional replantation: A procedure as a last resort. *J Contemp Dent Prac.* 2011; 12: 486-92.
12. Drain DE, Petrone JA. Intentional replantation: A case report and review of the literature. *J N J Dent Assoc.* 1995; 66: 63-65.
13. Weine FS. The case against intentional replantation. *J Am Dent Assoc.* 1980; 100: 664-68.
14. Wucher T, Dippenaar AM, Wucher M. *In-vivo* determination of critical force levels using an intraoral electromechanical device to measure non-pathologic tooth mobility. *Am J Orthod Dentofacial Orthop.* 2017; 152: 592-600.
15. Yamashita FC, Previdelli TS, Pavan NNO, Endo MS. Retrospective study on sequelae in traumatized permanent teeth. *Eur J Dent.* 2017; 11: 275-80.
16. Cho WC, Nam OH, Kim MS, Lee HS, Choi SC. A retrospective study of traumatic dental injuries in primary dentition: Treatment outcomes of splinting. *Acta Odontol Scand.* 2017; 11: 1-4.
17. Abbott PV. Prevention and management of external inflammatory resorption following trauma to teeth. *Aust Dent J.* 2016; 61: 82-94.
18. Patel S, Ricucci D, Durak C, Tay F. Internal root resorption: A review. *J Endod.* 2010; 36: 1107-21.
19. Maslamani M, Joseph B, Gabato S, Andersson L. Effect of periodontal ligament removal with gauze prior to delayed replantation in rabbit incisors on rate of replacement resorption. *Dent Traumatol.* 2018 (in press).
20. Maslamani M, Almusawi A, Joseph B, Gabato S, Andersson L. Experimental model for studies on delayed tooth replantation and ankylosis in rabbits. *Dent Traumatol.* 2016; 32: 443-49.
21. Erausquin J, Devoto FC. Alveolodental ankylosis induced by root canal treatment in rat molars. *Oral Surg Oral Med Oral Pathol.* 1970; 30: 105-16.
22. Krasner P, Rankow HJ. New philosophy for the treatment of avulsed teeth. *Oral Surg Oral Med Oral Pathol.* 1995; 79: 616-23.
23. Donaldson M, Kinisons MJ. Factors affecting the time of onset of resorption in avulsed and replanted incisor teeth in children. *Dent Traumatol* 2001; 17: 205-09.
24. Steiner DR. Avulsed maxillary central incisors: The case for replantation. *Am J Orthod Dentofacial Orthop.* 2012; 142: 8-16.
25. Sabuncuoglu FA, Ersahan S. Changes in human pulp blood flow during canine retraction. *Acta Odontol Scand.* 2016; 74: 436-42.
26. Mourad MS, Spleith CH, Alkilzy M. Obliteration after recurrent dental trauma in a 7-year-old patient: 4-year follow-up. *Quintessence Int.* 2018; 49: 287-91.
27. Abd-Elmeguid A, El Salhy M, Yu DC. Pulp canal obliteration after replantation of avulsed immature teeth: A systematic review. *Dent Traumatol.* 2015; 31: 437-41.
28. Casas MJ. Immediate replantation of an avulsed permanent incisor. *J Can Dent Assoc.* 2014; 80: 56.
29. Krasner PR. Avulsed teeth: Management during anesthesia induction, surgery. *AORN J.* 1991; 53: 998-1004.
30. Coulter JM, Wilson OL, Marks MK. Management of traumatic tooth injuries in the dental office. *J Tenn Dent Assoc.* 2014; 94: 31-37.
31. 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.
32. Sela G, Aizenbud D, Lin S. Fixation of injured tooth. *Refuat Hapeh Vehashshinayim.* 1993; 24: 45-50.
 33. Melo ME, Silva CA, de Souza Gomes WD, da Silva VF, Brandini DA, Poi WR, Castilho LR, Sonoda CK. Immediate tooth replantation in rats: Effect of systemic antibiotic therapy with amoxicillin and tetracycline. *Clin Oral Investig.* 2016; 20: 523-32.
 34. Lin LM, Shimizu E, Gibbs JL, Loghin S, Ricucci D. Histologic and histobacteriologic observations of failed revascularization/revitalization therapy: A case report. *J Endod.* 2014; 40: 291-95.
 35. O'Hehir TE. Research on periodontal ligament healing boosts success rate of tooth transplants. *RHD.* 1995; 15: 14.
 36. Tsukubushi M. Autotransplantation of teeth: Requirements for predictable success. *Dent Traumatol.* 2002; 18: 157-80.
 37. Hiltz H, Trope M. Vitality of human lip fibroblasts in milk, Hank's balanced salt solution and Viaspan storage media. *Endod Dent Traumatol.* 1991; 7: 69-72.
 38. 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: 183-88.
 39. Blomlof L. Milk and saliva as possible storage media for traumatically exarticulated teeth prior to replantation. *Swed Dent J.* 1981; 8: 1-26.
 40. Ebenezar AV, Priya J. Addition of L-dopa to HBSS in enhancing the maintenance of cell viability of periodontal ligament (PDL) cells: An *in vitro* study. *J Clin Diagn Res.* 2014; 8: 79-80.
 41. Von Arx T, Filippi A, Buser D. Splinting of traumatized teeth with a new device: TTS (titanium trauma splint). *Dent Traumatol.* 2001; 17: 180-84.
 42. Poubel DLN, Almeida JCF, Dias Ribeiro AP, Maia GB, Martinez JMG, Garcia FCP. Effect of dehydration and rehydration intervals on fracture resistance of reattached tooth fragments using a multi-mode adhesive. *Dent Traumatol.* 2017; 33: 451-57.
 43. Bai J, Qin M, Zhao YM, Huang MW, Ji AP. Chemical removal of necrotic periodontal ligament on delayed replanted teeth by sodium hypochlorite: Morphological analysis and microhardness indentation test of cementum. *Int Endod J.* 2016; 49: 393-401.
 44. Filippi A, Pohl Y, von Arx T. Treatment of replacement resorption with emdogain: Preliminary results after 10 months. *Dent Traumatol.* 2001; 17: 134-38.
 45. Adil NF, Ahmed SS, Jindal MK, Arshad SH. Delayed replantation of avulsed teeth. *J Indian Soc Pedod Prev Dent.* 2007; 25: 17-19.
 46. Flores MT, Andreasen JO, Bakland Ik. Guidelines for avulsion and management of traumatic dental injuries. *Dent Traumatol.* 2001; 17: 193-98.
 47. Hermann NV, Lauridsen SS, Ahrenburg SS, Gerds TA, Andreasen JO. Periodontal healing complications following concussion and subluxation injuries in the permanent dentition: A longitudinal cohort study. *Dent Traumatol.* 2012; 28: 386-93.
 48. Andreasen JO. Etiology and pathogenesis of traumatic dental injuries: A clinical study of 298 cases. *Scand J Dent Res.* 1970; 78: 329.
 49. Hedegård B, Stålhane I. A study of traumatized permanent teeth in children aged 7-15 years. Part I. *Swed Dent J.* 1973; 66: 431.
 50. Cvek M, Granath LE, Hollender L. Treatment of non-vital permanent incisors with calcium hydroxide. III. Variation of occurrence of ankylosis of reimplanted teeth with duration of extra-alveolar period and storage environment. *Odontol Revy.* 1974; 25: 43-56.
 51. Goswami M, Chaitra T, Chaudhary S, Manuja N, Sinha A. Strategies for periodontal ligament cell viability: An overview. *J Conserv Dent.* 2011; 14: 215-20.
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