

Naturally Available Transport Medium For Avulsed Teeth- A Review

Ramya Chellammal¹, Jeevarathan J², Ponnudurai Arangannal³, Vijayakumar M⁴, Amudha S⁵, Aarthi J⁶

¹Post Graduate Student, Department of Pedodontics, ²Professor, ³Professor and Head of The Department, ⁴Senior Lecturer, ⁵Reader, ⁶Reader, SreeBalaji Dental College, BIHER, Pallikarani, Chennai

Abstract

Tooth avulsion or exarticulation is a traumatic injury of dental tissue characterised by complete displacement of the tooth out of its socket. Successful treatment outcome is dependent on the survival of the viable periodontal ligament cells attached to the tooth root surface. This review discusses various storage/ transport media for avulsed tooth obtained from natural sources. The knowledge of availability and accessibility of such natural storage media would increase the awareness among the healthcare providers and would therefore improve the prognosis of the treatment protocol by reducing extra-oral dry time of the avulsed tooth.

Keywords: Avulsion, Periodontal Ligament, Trauma

Introduction

Tooth avulsion or exarticulation is a traumatic injury of dental tissue characterised by complete displacement of the tooth out of its socket.^[1] Children of age group of 7 to 9 years are more likely to suffer these injuries particularly involving avulsion. Ideal management of tooth avulsion is prompt treatment of socket and tooth, with reinsertion of the tooth into its socket. Reinsertion of tooth back within 5 minutes has the best outcome in which there is least loss of viability of periodontal ligament cells and hence reestablishment of periodontal fibres occurs, regaining the functionality of tooth.^[2,3,4]

The ideal requirements for a storage medium are^[5,6]

- It should have antimicrobial characteristics
- It should maintain the viability of periodontal fibres for an acceptable period of time

- It should not produce any antigen-antibody reactions
- It should reduce the risk of post-replantation root resorption or ankylosis
- It should have a good shelf life
- It should be effective in different climates and under different conditions
- It should wash off extraneous materials and toxic waste products
- It should aid in reconstitution of depleted cellular metabolites.

The various naturally available transport medium discussed in this article are milk, saliva, green tea, egg white, coconut water, green tea, aloe vera, soy milk, rice water, honey and tap water.

MILK

Milk has a unique combination of nutrients, capable of maintaining the PDL cell viability, and with physiological pH range of 6.5-7.2.^[6] Milk is a compatible short-term storage medium for teeth if they were placed in it within 15 to 20 min of being avulsed^[7,8,9]

Corresponding author:

Jeevarathan MDS

Professor Department of Pedodontics & Preventive Dentistry, SreeBalaji Dental College & Hospital, Narayanapuram, Pallikarani, Chennai 600100

In spite of offering no conditions for the restoration of cell morphology nor cell differentiation or mitosis, milk prevents cell death^[6-11] Several authors that evaluated the viability of PDL cells in contact with milk have reported 70 to 90% survival rates and low frequency of root resorptions after periods up to 72 h.^[5-9] Regarding the different milk presentations reported there was no significant difference between regular pasteurized milk and long shelf-life ultra high temperature [UTH] pasteurized whole milk at any time period.^[10] Low fat content milk and chilled milk has shown better results in maintaining the viability of PDL and for a longer time period.^[5,7,9,10,11]

The pasteurization of milk is responsible for diminishing the number of bacteria and bacteriostatic substances also for the inactive presence of enzymes, which could be potentially harmful to the fibroblasts of the periodontal ligament.^[12,13,14,15]

SALIVA

Though readily and most easily available, saliva is not considered as an effective interim transport medium.^[15] Recent literature indicates that saliva may not be a suitable transport medium for avulsed teeth due to its non-physiologic osmolarity and the presence of microorganisms.^[16] Saliva may be used as an immediate interim storage medium. Saliva contains potentially harmful substances, such as enzymes, bacteria and their by-products^[17]. A clonogenic capacity of 1.5% is obtained when PDL cells are stored in saliva for more than 30 min. In an animal study it was proven that saline and saliva were suitable storage medium for protection against root resorption for short extra-alveolar periods.^[18]

GREEN TEA

Epigallocatechin-3-gallate [EGCG], an important polyphenol of green tea, is known to have various biological effects such as antioxidative, anticarcinogenic, antimutagenic, anti-inflammatory, antimicrobial and antiviral activities^[19]. Additionally, Hwang et al.^[20] and Jung et al.^[21] in the search for a medium capable of minimizing the infections after tooth replantation, maintaining PDL cell viability and reducing root resorption and ankylosis, reported enthusiastic results with green tea, with the maintenance of 90% of cell

viability for up to 24 h, similar to the HBSS control. Jung et al.^[21,22,23,24]

EGG WHITE

Egg white and ovalbumin, the major protein in egg white, are considered a good choice as a storage media for teeth undergoing delayed replantation due to its high content of proteins, vitamins and water, absence of microbial contamination and easy access^[25,26,27,28]. Sousa et al.^[29] evaluating human PDL adhered to extracted tooth roots and maintained in this storage medium observed that the egg white provided cell viability and histological characteristics similar to those of milk. Khademi et al.^[30,31] Khademi et al have compared milk and egg white as solutions for storing avulsed teeth, and the results have shown that teeth stored in egg white for 6 to 10 hours had a better incidence of repair than those stored in milk for the same amount of time [$p < 0,05$].^[32]

COCUNUT WATER

Coconut water is a natural, biologically pure, sterile product rich in amino acids, proteins, vitamins and minerals. Several studies have been performed to use this substance as a storage medium for avulsed teeth, but the results are contradictory. Gopikrishna et al.^[33] and Gopikrishna et al.^[34] found greater efficacy of coconut water over HBSS and milk for the viability of PDL. Thomas et al.^[35] found that 15 to 120 min storage in coconut water is as efficient as storage in HBSS. On the other hand, Pearson et al.^[36,37,38,39]

SOYMILK

Soy milk; the extract of the soybean, is rich in protein, aminoacids, vitamins and essential minerals. It contains very low amounts of saturated fat acids and have a physiological pH^[40]. Due to its positive effects on cell growth and its biochemical activities, the use of soy milk as a storage medium for the avulsed teeth has been deemed appropriate^[41,42]. In studies, it has been reported that the durability of the periodontal cell viability is maintained over 90% in the avulsed teeth kept in soy milk for 24 hours and it is emphasized that soy milk is a very effective storage medium^[43,44]. The authors have reported the excellent potential of soymilk as a storage medium and for proliferation of several cell types^[45,46,47,48].

RICE WATER

Rice is believed to play an important role in acute inflammation due to low sodium, high potassium, niacin and thiamin contents in its structure, and in collagen synthesis due to the presence of iron and zinc. Due to its nutritional value, especially in countries with intense rice consumption, rice water is newly studied as a storage medium for avulsed teeth [49,50,51].

ALOE VERA

Aloe vera is a plant that featured in the medical field due to its antidiabetic and anticarcinogenic properties. It is also used in dentistry due to its anti-inflammatory and analgesic properties. The antioxidant property of aloe vera, which plays an important role in the viability of the cells, has attracted the interest of researchers in terms of storage of avulsed teeth [42,43].

HONEY

A large volume of literature reporting its effectiveness indicates that honey has potential for the treatment of periodontal disease, mouth ulcers, and other problems of oral health [49].

Maintenance of viability of PDL cells in the long shelf-life honey milk may be due to the nutrients that are present such as proteins, essential amino acids, vitamins and minerals which help in nourishing the cells and maintaining their viability.[48] Due to its ease of storage and long shelf life, it can be available in schools, gyms, and outdoor athletic fields, where tooth avulsions are most likely to occur.[52]

TAP WATER

Tap water has inadequate characteristics to be used as a storage medium for avulsed teeth because it has bacterial contamination, hypo-tonicity, and non-physiological pH and osmolality, which favours the PDL cells lysis[50-52]. Several studies have shown that cells stored in water did not maintain their morphology, with visible destruction and rapid cell death.[51] Tap water should be used only to avoid the tooth from dehydration. [52] it should be remembered that it is the least desirable storage medium available and its use will lead to ankylosis and replacement resorption. [52]

Discussion

As of now, there is not a single product or solution that possesses all the characteristics required to be indicated as the ideal storage medium for avulsed teeth, that is, be capable of preserving the vitality of the PDL and pulp cells, while presenting compatible physiological pH and osmolality, clonogenic capacity, antioxidant property, no or minimal microbial contamination, high availability, ready accessibility at accident sites, homes, schools, hospitals and dental offices, and low cost.[43,31] Studies on duration of extra-alveolar period and successful replantation of avulsed teeth have sharpened the issue of dry period. The dry period should be as less as possible and it would be better if immediate replantation can be achieved.[36]

Conclusion

Currently there is no national data on incidence of avulsion injuries in the Indian population. Therefore the demand to know about the storage medium was not at high interest, the best storage media would be natural products with easy accessibility to general public and dentists as well. Chilled low fat/skimmed milk is the best available storage medium followed by honey and child's own saliva. Tap water was proven to be the least advisable storage medium. Newer research is still required to find that easily available, cheap and low maintenance storage medium which can maintain the viability of PDL cell and regenerate them as well.

Ethical Clearance – Not required since it is a review article

Source of Funding – Nil

Conflict of Interest – Nil

References

1. McDonald RE, Avery DR, Dean JA, Jones JE. Management of Trauma to the teeth and supporting tissues. In Dentistry for the child and adolescent. McDonald RE, Avery DR, Dean JA [Ed]; 9th Ed: Mobsy Elsevier 2011, New Delhi: pp 403-44.
2. Flores MT, Andreasen JO, Bakland LK et al. Guidelines for the evaluation and management of traumatic dental injuries. Dent Traumatol 2001; 17: 193-8.
3. Hamilton FA, Hill FJ, Mackie IC. Investigation

- of lay knowledge of management of avulsed permanent incisors. *Endod Dent Traumatol* 1997; 13:19-23.
4. Andreasen JO, Borum MK, Jacobsen HL, Andreasen FM. Replantation of 400 avulsed permanent incisors. 4. Factors related to periodontal ligament healing. *Endod Dent Traumatol* 1995; 11:76-89.
 5. McCulloch CA, Bordin S. Role of fibroblast subpopulations in periodontal physiology and pathology. *J Periodontal Res* 1991; 26: 144-54.
 6. Lekic P, Kenny D, Moe HK, Barretti E, McCulloch CA. Relationship of clonogenic capacity to plating efficiency and vital dye staining of human periodontal ligament cells: implications for tooth replantation. *J Periodontal Res* 1996; 31: 294-300.
 7. Ingle JI, Bakland LK, Baumgartner JC. *Ingle's endodontics*. 6th ed. Hamilton, ON: B.C. Decker Inc; 2008.
 8. Neeraj Malhotra, Rajesh Cyriac, Shashirashmi Acharya. Clinical implications of storage media in dentistry: a review. *ENDO [LondEngl]* 2010; 4[3]:179-188.
 9. Siddiqui et al., *Br J Med Health Res*. 2014; 1[3] ISSN: 2394-2967 9. Mackie IC, Worthington HV. An investigation of replantation of traumatically avulsed permanent incisor teeth. *Br Dent J* 1992; 172: 17-20.
 10. Hank JH. Hanks 'balanced salt solution and pH control. *Tissue culture association* 1975; 1[1]:3-4.
 11. Blomlof L, Otteskog P, Hammraström L. Effect of storage in media with different ion strengths and osmolality's on human periodontal cells. *Scan J Dent Res* 1981; 89: 180- 187.
 12. Khademi AA, Saei S, Mohajeri MR et al. A new storage medium for an avulsed tooth. *J Contemp Dent Pract* 2008; 9: 25-32.
 13. Krasner PR. Avulsed teeth: improving the diagnosis. *Dent Prod Rep* 2007; 2: 52-64.
 14. Matsson L, Andreasen JO, Cvek M, Granath LE. Ankylosis of experimentally reimplanted teeth related to extra-alveolar period and storage environment. *Pediatr Dent* 1982; 4: 327-30.
 15. Krasner P, Rancho HJ. New philosophy for the treatment of avulsed teeth. *Oral Surg Oral Med Oral Pathol Oral RadiolEndod* 1995; 79: 616-23.
 16. Krasner P, Person P. Preserving avulsed teeth for replantation. *J Am Dent Assoc* 1992; 123:80-88.
 17. Facade OO. Extra-alveolar storage media for tooth auto transplants and replants. *Internet J Dent Sic* 2005; 2: 1-10.
 18. Blomlof L. Storage of human periodontal ligament cells in a combination of different media. *J Dent Res* 1981; 60: 1904-6.
 19. Lekic PC, Kenny DJ, Barrett EJ. The influence of storage condition on clonogenic capacity of periodontal ligament cells: implication for tooth replantation. *IntEndod J* 1998;31:137-140.
 20. Layup ML, Barrett EJ, Kenny DJ. Interim storage of avulsed permanent teeth. *J Can Dent Assoc* 1998; 64: 357-63. 365-9.
 21. dos Santos C L, Sonora C K, Poi W R, Panzarini S R, Sundefeld M L, Negri M R. Delayed replantation of rat teeth after use of reconstituted powdered milk as a storage medium. *Dent Traumatol* 2009; 25: 51-57.
 22. Pearson R M, Liewehr F R, West L A, Patton W R, McPherson J C 3rd, Runner R R 2
 3. Human periodontal ligament cell viability in milk and milk substitutes. *J Endod* 2003; 29: 184-186.]
 24. Weine FS. *Endodontic emergency treatment. Endodontic therapy*, 6th ed. Mosby, 1996:74-103.
 25. Effect of extra-alveolar period and storage media upon periodontal and pulpal healing after replantation of mature incisors in monkeys. *Int J Oral Surg* 1981; 10: 43-53.
 26. Pileggi R, Antony K, Johnson K, Zuo J, Shannon Holliday L. Propolis inhibits osteoclast maturation. *Dent Traumatol* 2009; 25: 584-8.
 27. Mori GG, Nunes DC, Castilho LR, de Moraes IG, Poi WR. Propolis as storage media for avulsed teeth: microscopic and morphometric analysis in rats. *Dent Traumatol* 2010; 26: 80-5.
 28. Gopikrishna V, Thomas T, Kandaswamy D. A quantitative analysis of coconut water: a new storage media for avulsed teeth. *Oral Surg Oral Med Oral Pathol Oral RadiolEndod* 2008;105:61-65.
 29. Gopikrishna V, Baweja PS, Venkateshbabu N, Thomas T, Kandaswamy D. Comparison of coconut water, Propolis, HBSS, and milk on PDL cell survival. *J Endod* 2008; 34:587- 589.
 30. Moreira-Neto JJ, Gondim JO, Raddi MS, Pansani CA. Viability of human fibroblasts in coconut water as a storage medium. *IntEndod J* 2009; 42:

- 827–30.]
31. Khademi A A, Atbaee A, Razavi S M, Shabani M. Periodontal healing of replanted dog teeth stored in milk and egg albumen. *Dent Traumatol* 2008;24: 510–51452
 32. Malhotra N. Current developments in interim transport [storage] media in dentistry: an update. *BDJ* 2011; 211[1]:29-33.
 33. Sculean A, Schwarz F, Becker J, Brex M. The application of an enamel matrix derivative [Emdogain] in regenerative periodontal therapy: a review. *Med Princ Pract* 2007; 16: 167–180.
 34. Schjott M, Andreasen J O. Emdogain does not prevent progressive root resorption after replantation of avulsed teeth: a clinical study. *Dent Traumatol* 2005; 21: 46–50.]
 35. Wiegand A, Attin T. Efficacy of enamel matrix [Emdogain] in treatment of replanted teeth - a systematic review based on animal studies. *Dent Traumatol* 2008; 24: 498–502.
 36. Wang J, Wu F A, Zhao H, Liu L, Wu Q S. Isolation of flavonoids from mulberry [*Morus alba* L.] leaves with macroporous resins. *African J Biotech* 2008; 7: 2147–2155.
 37. Ozan F, Tepe B, Polat Z A, Er K. Evaluation of in vitro effect of *Morus rubra* [red mulberry] on survival of periodontal ligament cells. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008; 105: e66–69.
 38. Fellah S, Diouf P N, Petrisans M et al. Supercritical CO₂, hydro distillation extractions of *Salvia officinalis* L. Influence of extraction process on antioxidant properties. Presented at the 10th European Meeting on Supercritical Fluids, Strasbourg/Colmar, France, 12-14 December 2005.
 39. Ozan F, Polat Z A, Tepe B, Er K. Influence of storage media containing *Salvia officinalis* on survival of periodontal ligament cells. *J Contemp Dent Pract* 2008; 9: 17–24.
 40. Nozari A, Esmaeilpour T, Fijan S, Salmannejad M. Evaluation of the long-shelf life honey milk as a storage media for preservation of avulsed teeth. *Caspian J Dent Res* 2013;2[1]:42-47
 41. Shaher AA, Wallace J, Agarwal S, Bretz W, Baugh D. Effect of Propolis on human fibroblasts from the pulp and periodontal
 45. Andreasen JO, Reinholdt J, Dybdahl R, Soder PO, Otteskog P. Periodontal and pulpal healing of monkey incisors preserved in tissue culture before replantation. *Int J Oral Surg* 1978;7:104-112. ligament. *J Endod* 2004;30:359-361.
 46. Lynch SE, de Castilla GR, Williams RC, Kiristy CP, Howell TH, Reddy MS. The effect of short term application of a combination of platelet-derived and insulin-like growth factors on periodontal wound healing. *J Periodontol* 1991;62:458-467.
 47. Matsuda N, Lin WL, Kumar NM, Cho MI, Genco RJ. Mitogenic, chemotactic and synthetic responses of rat periodontal ligament fibroblastic cells to polypeptide growth factors in vitro. *J Periodontol* 1992;63:515-525.
 48. Ashkenazi M, Marouni M, Sarnat H. In vitro viability, mitogenic and clonogenic capacities of periodontal ligament cells after storage in six different media. *Endod Dent Traumatol* 1999;15:149-156.
 49. Ashkenazi M, Marouni M, Sarnat H. In vitro viability, mitogenic and clonogenic capacities of periodontal ligament cells after storage in four media at room temperature. *Endod Dent Traumatol* 2000;16:63-70 30.
 50. Hiltz J, Trope M. Vitality of human lip fibroblast in milk, Hank's balanced Salt Solution and ViaSpan storage media. *Endod Dent Traumatol* 1991;7:69-72.
 51. Margaret PM, Pileggi R. A quantitative analysis of Propolis: a promising new storage media following avulsion. *Dent Traumatol* 2004;20:85-89.
 52. Ozan F, Polat ZA, Er K, Ozan U & Deger O. 2007. Effect of propolis on survival of periodontal ligament cells: new storage media for avulsed teeth. *J Endod*, 33: 570–3.