

Naturally Available Transport Medium For Avulsed Teeth- A Review

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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. The viability of the periodontal ligament cells is best preserved either when the tooth is immediately replanted into its socket or if it is stored in an appropriate storage /transport medium till a time, the tooth can be replanted into its socket. A number of storage /transport medium are available both of natural origin and laboratory prepared solutions. 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.

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] However, this is may not always be possible owing to the various associated factors such as the person's conscious state, lack of first aid knowledge, informed consent issues and lack of confidence in strangers gathered at the scene of accident. Clinically a variety of factors such as age of the individual, width and length of the root canal, stage of root development, mechanical damage during trauma and replantation, type of splinting, mastication, treatment of the socket, endodontic treatment, antibiotics, time of replantation, macroscopic contamination, storage media and storage period are important and can influence the clinical success of replantation.[3] A storage medium may be defined as a physiological solution that closely replicates the oral environment to help preserve the viability of PDL cells following avulsion.[4]

The ideal requirements for a storage medium are[5]

- It should have antimicrobial characteristics
- It should maintain the viability of periodontal fibres for an acceptable period of time
- It should favour proliferative capacity of the cells [clonogenic and mitogenic capacity]
- It should have the same osmolarity as that of body fluids [290-300 mosmol/ kg] and pH balanced [7.2 – 7.4]
- It should be unreactive with body fluids
- 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]

The low cost, presence of nutrients and easy availability make milk a more practical choice than any other medium. [8]Being a gland secretion, milk contains epithelial growth factor [EGF], which stimulates the proliferation and regeneration of epithelial cell rests of Malassez and activates the alveolar bone resorption. This will ultimately contribute to isolate the bone tissue from the tooth and decrease the likelihood of ankylosis.[9] 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 main drawback is the presence of antigens that may interfere with the reattachment process.[12]Its clinical efficacy is considered equivalent to HBSS for

maintaining the vitality of the PDL cells of an avulsed tooth for an extended period of time [up to six hours].[7-9]Milk is superior to saliva with regard to the number of viable cells and the ability of the cells to recover and heal wounds. [3]

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]Also, not all types of milk are equally effective as storage media. Avulsed teeth stored in chilled milk for up to 1 h can maintain sufficient numbers of viable pdl cells and also showed that milk with lower fat content may be more appropriate at maintaining cell viability than milk with higher fat content.[11]

Powdered milk is one of the presentation forms of bovine milk and is considered as a feasible medium in cases of delayed tooth replantation. [13] It has shown similar results to long shelf-life whole milk in relation to the healing process after delayed replantation of avulsed teeth.[13,14] However, the powdered form is more effective than pasteurised milk as a medium only up to four hours, following which these substitutes perform worse than whole milk. [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. Though very readily available, avulsed teeth should not be stored for longer than 30 min in saliva. 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] also observed that the higher the extract concentration the more efficient the medium. In view of this, the use of green tea extract and its compounds may be an alternative for the conservation of avulsed teeth and its beneficial effect is enhanced by higher extract concentrations.[22]The antibacterial and antiinflammatory actions of green tea and propolis demonstrate their capacity to inhibit prostaglandin synthesis, aiding the immune system in the phagocytic activity and promoting healing effects in the epithelial tissue [19-24]. Additionally, one or more antioxidant composites in these substances may increase the success rate of tooth replantation because Propolis also contains iron and zinc, important for collagen synthesis, and bioflavonoids that help in the contention of hemorrhages of the PDL tissue and stimulate the stimulate enzymes that fortify the walls of the blood vessels in the periodontium [25].However, commercially produced green tea has been reported to cause necrosis of cells due to its low osmolarity and that it can be regarded as a sufficient storage medium for up to 1 hour [26]

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 [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] compared milk and egg white as solutions for storing avulsed teeth, and found that teeth stored in egg white for 6 to 10 h had a better incidence of repair and lower surface resorption than those stored in milk for the same amount of time and index than the controls. Some experiments indicate that this is a very good medium to maintain cell viability, but others show a small loss of efficacy overtime, possibly due to egg's high pH and also because the PDL cells could target the several egg proteins as strange bodies. Further studies are required to confirm these adverse effects, as there are wide variations in egg composition and quality.[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] and Thomas et al. [35] observed that inflammatory resorption was more frequent when the tooth was maintained in coconut water compared with milk. It is therefore difficult to consider coconut water as an adequate storage medium for avulsed teeth. [37]Standardized studies with similar methods are required to avoid diverging results and eliminate doubts over its use, as this is a medium with easy access and good biological characteristics that Storage media for avulsed teeth could be promising for its indication.[38]Sodium bicarbonate or mineral water was added to neutralize the coconut water because it was thought that the acidic pH, which is harmful for the cell metabolism, was likely to play a role in this end, but it still did not catch the expected success [39].

Soy milk

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]. Both physio- logical osmolality and pH are important factors in preserving the viability of PDL cells. It has been reported that the growth of cells happen mainly at an osmolality of 230–400 mOsmol/kg and a pH of 6.6–7.8 and that soy milk will satisfy both these conditions.[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]. In in vitro study comparing the different storage media for avulsed teeth, it has been reported that high amounts of live periodontal ligament cells are seen in rice water after 30 minutes and that the nutritive contents of the rice water have positive effects on the viability of the cells [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]. In study evaluating different concentrations of aloe vera, it has been reported that concentrations of 10%, 30% and 50% are favorable in maintaining viability of periodontal ligament cells and can be used for up to 9 hours, however the efficacy decreases over time by the 100% concentration, according to the fact that it has an acidic pH [42]. By avulsed teeth kept in aloe vera, it was reported that 45% of the periodontal ligament cells survived after 2 hours. The researchers attributed this result to the high proliferation activity of the glycoprotein in the aloe vera structure, and explained that allantoin in it stimulates fibroblast activity and collagen proliferation [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].

Various studies showed that long-shelf life honey milk showed better results in comparison to fresh milk. 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]

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.

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