

STORAGE MEDIA USED FOR AVULSED TEETH – THE FIRST AID.

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Article Received on 16/12/2016

Article Revised on 05/01/2017

Article Accepted on 26/01/2017

ABSTRACT

Avulsion of tooth (dental avulsion) is a type of trauma, which results in the complete displacement of the tooth from the alveolar (bone) socket. The ideal treatment for teeth with such a trauma and displacement would be immediate re-implantation. However, in some cases it might be difficult if not impossible to re-implant immediately, and the avulsed tooth may have to be transported for the treatment, while maintaining the vitality, clonogenic and mitogenic properties of periodontal ligament (PDL) cells attached to the root. Therefore, transporting medium in such cases plays an important role while storing avulsed tooth and maintaining the vitality of the PDL cells. The current paper aims at providing an overview of storage media reported in literature addressing their suitability as storage or transport medium.

KEYWORDS: Avulsion, re-implantation, transport media, trauma.

INTRODUCTION

An injury leading to complete displacement of the tooth from its socket, damaging the periodontal ligament, cementum, alveolar bone, gingival and pulp tissues is termed as Dental Avulsion (DA). The most indicated procedure for this kind of dental trauma is re-implantation.^[1] The prognosis of the tooth to be re-implanted is governed by; the existence of feasible cells in the periodontal ligament and also those, which need to be able to proliferate on the damaged site on the root.

The vitality of the periodontal ligament on this surface increases the probability of reinsertion of alveolar dental fibers, when re-implanted immediately. Besides the immediate re-implantation, the storing medium used for the tooth is also a determining factor for extending the life of the tooth. These solutions are used when immediate re-implantation is not possible.^[2] The ideal properties of the transport media are presented in Table 1.

Table 1: Ideal properties of transport media for avulsed teeth.

1.	It should be capable of preserving the feasibility of the cellular PDL.
2.	It should preserve the majority of the functional capacities of the cells of PDL.
3.	It should maintain the vitality of the remaining PDL.
4.	It should have physiologic pH. (7.2 – 7.4)
5.	It should have physiologic Osmolality. (290- 330 mOsm/kg.)
6.	It should have Antimicrobial characteristics.
7.	It should favor proliferative capacity of cell. (Clonogenic & Mitogenic capacity)
8.	It should be unreactive with body fluids.
9.	It should not produce any antigen –antibody reaction.
10.	It should reduce the risk of post-reimplantation root resorption or ankylosis.
11.	It should have good shelf life.
12.	It should be effective in different climates and different conditions.
13.	It should wash off extraneous materials and toxic waste products.
14.	It should aid in reconstitution of depleted cellular metabolites.

Predominately, in the philosophy of research of Andresen and Hjorting-Hansen pertaining to treatment of avulsed tooth it is rightly stated that "Replant the tooth immediately or as quickly as possible after traumatic avulsion."^[3,4] But in more severe injuries needing immediate medical attention or non-availability of a dental clinic, the teeth should be stored in a medium that helps in avoiding the violation of the periodontal ligament cell vitality, until definite dental treatment can be gained. Some experimental studies have also indicated that a storage medium is more critical prognostic factor than the extra alveolar time. Physiologic storage media such as milk, saline, saliva, HBBS, Visapan have been used for preserving the viability of the periodontal ligament cells.^[5,6] Some of the commonly used transport media for avulsed teeth are listed and discussed below.

Tap water

When used as a storage medium, was considered to be unsuitable for the PDL cells, due to its hypotonicity osmolality leading to rapid cell lysis.^[7] It is also pointed out that the teeth transported in this medium after avulsion were associated with replacement resorption resulting from decrease in periodontal ligament cell viability.^[8,9]

Saliva

Saliva was considered to be more effective than tap water, but it also has a potential for bacterial contamination. The osmolality of saliva (60-80Osm/l) was deemed much lower than the normal range (230-400 mOsm/l) required for cell growth. Further, saliva is a hypotonic solution, causing periodontal ligament cells to swell and burst. This medium can be employed as an interim storage medium but no more than 30 minutes. If stored for more than 60 minutes, a significant decrease in functional capacity of PDL cells is seen. Blomlof et al concluded that storage of avulsed teeth in tap water and saliva to be damaging to periodontal ligament cells, which lead to root resorption.^[8,10]

Saline

It has been deemed as a short-term storage medium because of its physiologic osmolality. It has comparable osmolality to the PDL cells, but lacks nutrients. Cvek et al., reported, avulsed teeth soaked in an isotonic saline solution for 30 minutes before replantation were associated with less resorption compared to those stored dry for 15-40 minutes.^[11] However, in another study there was no significant difference in the development of ankylosis between teeth kept dry or placed in normal saline.^[12]

Milk and Variants

The use of milk as storage media is popular being easily available; cost effective, and physiologic osmolality. Various forms of milk like; whole, skimmed, low fat, baby formula and long shelf life have been investigated as transport media for avulsed teeth. Milk is considered

as a suitable storage medium because of its favorable pH (6.5-7.2), and the presence of nutrients responsible for maintaining the viability of the PDL cells, thus increasing their life.^[13,14] The reported literature suggests that milk helps in maintaining the viability of the PDL cells from 2 hours to 6 hours.^[8-10,15,16] Refrigerated milk or low fat milk is reported to exhibit better results.^[10,15-17] The cologenic and mitogenic property towards PDL cells is comparable to that of the Hank's Balanced Salt Solution (HBSS).^[18] However, the presence of antigens within the milk proves to be a drawback as they can interfere with the PDL cells reattachment during re-implantation.^[19] Also, it has no proven role in assisting cell mitosis in PDL cells.^[8,12]

Soy Milk

It is the water extract of soybean that contains no cholesterol or lactose with small amounts of saturated fatty acid. It is an excellent culture medium for cell growth. In recent studies reported in literature soy milk promotes cell viability, and is comparable to HBSS and milk.^[20, 21]

Hank's Balanced Salt Solution (HBSS)

It is a solution, which is pH balanced and contains essential metabolites, which is advantageous for the viability of PDL cells. It is reported to help maintain the vitality, clonogenic and mitogenic capacity of the PDL for up to 48 hours.^[7,8] It also has an added advantage to replenish metabolites those diminished from the PDL cells.^[22] Hence, it is recommended to store the avulsed tooth in this solution for 30mins, so as to replenish the PDL cells, before re-implantation. Practically speaking, HBSS is not commonly available to a majority of the people at the time of an accident. Recent studies have evaluated the use of 0.9% isotonic saline, milk, HBBS and viaspan as storage media for the preservation of cell viability.^[5,6,13]

ViaSpan

It is a cold transplant organ storage system. It shows excellent cellular growth. It's pH is 7.4, and the osmolality is 320 mOsm/kg. The disadvantages are its high cost.^[14] It has brief vitality expiration date causing difficulty in availability. It is small functional capacity of fibroblast of PDL; it is an effective hydrogen ion buffer (disodium hydrogen phosphate), which might be important in maintaining the pH. It also contains adenosine, which plays an important role in cell division. Both HBBS and ViaSpan proved to be superior to milk, with ViaSpan clearly indicating the most effective medium with 37.6% of vital fibroblasts after 168 hours of storage, thus showing a potential value as a superior long-term storage medium.^[15,16,23-25]

Eagle's Medium / Cell Cultural Medium

According to Ashkenazi et al,^[23] Hiltz J & Troupe M,^[13] Eagle's medium can preserve PDL fibroblasts for an extended period of time. According to Askenazi et al it has lower functional capacity of this medium on PDL

fibroblast, observed when compare to HBSS, ViaSpan; also addition of growth factor can show better viability, mitogenicity & clonogenic capacity of PDL after 24 hours.^[16] According to Andreasen et al.,^[4] it reduces the level of inflammatory resorption causes proliferation of PDL at the root surface, covering denuded / damaged part of root & pulp survival.

Growth Factors

According to Matsuda et al., Fibroblast growth factor maintains the elongated shape causing a high degree of cellular polarisation. Further they also help to increase in mitogenic capacity.^[24]

Gatorade

It is oral rehydration fluid. It is a non-carbonated sport drink consumed by non-athletes. pH is 3. Osmolality=280–360 mOsmo / Kg. It is hypertonic cellulose water. Gatorade causes damage to cellular membrane further leading to hamper the cell growth; because of high pH.^[29]

Propolis

It is a sticky resin that seeps from the buds or bark of trees chiefly Conifer. It has an antibacterial, anti-inflammatory and anti-oxidant, anti-fungal, antiviral, antithrombotic, immunomodulatory properties. Studies have been carried out using propolis and have shown that 10% propolis is effective as storage media compared to milk, HBSS, tap water and DMEM.^[30] According to Krell,^[31] viability of PDL fibroblast is maintained as long as 20 hours.

EMDOGAIN

It is enamel matrix protein, derived in 1996. It delays, but not stop the development of replacement resorption. It is used in prolonged extra-oral time (dry), diminishes the fibroblast of PDL to repopulate on root surface. Therefore, lack of adherent surface increase with the difference if fibroblast is seen. According to Kenny et al, Emdogain has been shown to significantly improve PL regeneration after periodontal surgery in adults; it also increases bone height and clinical attachment as seen in a case report and in an animal trial that used monkeys.^[32]

Egg White

This medium is significantly different from HBSS in studies concerning towards cell viability and is associated with better healing of the PDL when compared to milk.^[33] Egg white is the perfect storage medium in comparison of milk and artificial saliva. Osmolality is 251 to 298 mOsmo /Kg18. An avulsed tooth can be stored in this medium for 10 hours.^[34] Although readily available, it is impractical to use. Only one study reported no difference between milk, egg white and artificial saliva.^[35]

Green Tea Extract (GTE)

It has been reported to have a remarkable anti-inflammatory, antioxidant, and anticarcinogenic effects

and to prolong allograft survivals. A study was carried out to investigate in vitro efficacy of GTE as a storage medium for avulsed teeth in which they estimated the possibility for storage medium by maintaining the viability of human periodontal ligament (PDL) cells; which concluded; no difference in cell viability between GTE and HBSS media, whereas GTE showed higher cell viability than other media ($P < .05$). So it was stated that GTE could be a suitable, alternative storage medium for avulsed teeth.^[36]

Morus rubra

Morus rubra [red mulberry] belongs to the Moraceae family and active components include flavonoids, alkaloids and polysaccharides. In a study, Morusrubra juice at 4% concentration was found to advantageous over HBSS for maintaining PDL cell viability for upto 12 hours.^[37]

Coconut Water

It is a biological liquid, which is sterile and rich in nutrients. It includes amino acids, proteins, vitamins and minerals. It is an isotonic solution that can be obtained fresh directly from coconuts or commercially in packages and bottles. When compared with HBSS, propolis and milk, coconut water most effectively maintained viability of PDL cells.^[38] Also, a combination of coconut water with sodium bicarbonate to be more effective but some studies have contradicting results.^[39] Since the pH of coconut water is 4.1, it has an effect on cell metabolism until sufficiently neutralized.^[39] Further research is required before coconut water can be used effectively as a storage medium.

Oral Rehydration Solutions

Ricetral is a readily available oral rehydration formulation, consisting of essential nutrients like glucose and vital salts that help in maintaining cell metabolism. They are provided in sealed sterile pouches, and are economical too. It exhibits an ability to maintain PDL cell viability comparable or equal to HBSS, and also both retained PDL vitality better than milk.^[40]

Contact lens solutions

Contact lens solutions are fundamentally saline solutions; and their potential use as storage media for avulsed tooth has been reported in a few studies.^[17,41] However when compared with other media, they were deemed to be harmful by damaging the PDL cells and hence, are not recommended for storage and transportation of avulsed teeth.^[15]

Custodial

A registered trademark of Dr. Franz, this medium contains a histidine-tryptophan ketoglutarate solution with higher flow properties and low potassium content.^[42] It's primary use is to transport medium for an organ, and for perfusion and flushing donor organs prior removal. It exhibits an osmolality of 310 mosmol L-1.^[43] Alaçam et al., reported that custodial was analogous to

HBSS in maintaining cell preservation.^[44] Similar to other organ storage medium, it is not available to public which limits its practicality as a storage medium for avulsed teeth.

Dentosafe

It is also known as the tooth rescue box (Miradent, Germany), and contains Special Cell Culture Medium (SCCM); a combination of amino acids, vitamins and glucose.^[42] It has been made available in all schools of Austria, and some in Germany and Switzerland. It has highlighted in vitro, to maintain the vitality of PDL cells for 48 hours at room temperature.^[26] This medium exhibits a shelf life of 3 years if remained unopened and maintained at room temperature. Avulsed teeth placed in Dentosafe solution showed functional healing in a study and also stated that it should be included in all first aid kits. Although very effective, this medium is not yet readily available in most of the countries.

ACKNOWLEDGMENT: "The authors deny any conflict of interest."

CONCLUSION

In spite of the fact that research has been attempted on a wide variety of materials to be utilized as storage media for the transport of avulsed teeth, absence of availability and high cost restrains the use of most of these media. Therefore, as a result its acceptable performance, ease of availability and at lesser cost, milk remains the storage medium of choice in cases where avulsed teeth cannot be immediately re-implanted. This information ought to be made part of a public awareness program, so as to legitimately handle and save a large number of avulsed teeth, the prognosis of which can enormously enhance if placed in an appropriate storage medium.

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