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Dr. Mohsin Khan
Senior Lecturer,
Department of Public Health
Dentistry, Vyas Dental College
and Hospital, Rajasthan, India

Dr. Mridul Sharma
B.D.S, Visiting consultant at
City Dental, Jodhpur,
Rajasthan, India

Corresponding Author:
Dr. Mohsin Khan
Senior Lecturer,
Department of Public Health
Dentistry, Vyas Dental College
and Hospital, Rajasthan, India

Comparison of efficacy of different storage media for an avulsed tooth

Dr. Mohsin Khan and Dr. Mridul Sharma

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Abstract

Exarticulation or dental avulsion is considered as the most serious type of traumatic tooth injuries. The most common management of avulsion is reimplantation which is widely accepted as an effective treatment, but it depends on various factors such as extra alveolar storage period, vitality status of pulp and periodontal tissue. The important clinical factor for better prognosis is the appropriate use of wet storage media. The present review discusses the wide array of different types of wet storage media and the comparison of their clinical factors such as osmolarity, pH, storage time on their efficacy.

Keywords: storage medium, osmolarity, efficacy, ph, periodontal ligament cells

Introduction

Dental Avulsion is a complete displacement of the tooth from its alveolus. It is also called exarticulation and mostly involves maxillary teeth. It is the most severe type of traumatic tooth injury because it causes damage to several structures. Ideally, the ex articulated tooth should be reimplanted immediately after the trauma. Reimplantation success rates depend on various factors that may contribute to accelerate or minimize the occurrence of root resorption among which is the type and characteristics of the medium used for temporary storage during the time elapsed between avulsion and reimplantation. Teeth are usually subjected to a period of desiccation between their avulsion and reimplantation. Therefore it is desirable to reimplant the avulsed tooth as quickly as possible to ensure the viability of PDL cells attached to the root surface. The avulsed tooth must be prevented from drying by the use of storage media of correct osmolarity and pH. In the case where immediate reimplantation is not possible, the use of a storage medium helps to enhance and preserve the vitality of PDL fibroblast of an avulsed tooth. Tooth structure should be preserved in adequate wet medium as long as possible, the vitality of periodontal ligament cells that remain on the root surface is key to the success of reimplantation. The ideal storage medium should be capable of preserving the feasibility of cellular periodontal ligament so that the cell could go through mitosis and form clones of damaged fibroblast of the periodontal ligament and its generating cells. Immediate tooth reimplantation leads to better PDL repair and reduces the root resorption. Shortening of possible time elapsed between trauma and tooth reimplantation and maintaining the avulsed tooth in suitable transport medium attenuate the deleterious effects and increase the prognosis considerably. There are different storage media that are available but their efficacy varies. An ideal storage media must be capable of maintaining PDL and pulp cell viability should have the clonogenic capacity and antioxidant property, no or less microbial contamination, compatible physiologic pH and osmolarity, high availability and low cost.

Ideal requirements of a storage media

- Should have antimicrobial characteristics.
- Should be able to maintain the viability of periodontal fibres for an acceptable period of time.
- It should have the same osmolarity as that of body fluids.
- It should not produce any antigen-antibody reaction.

- It should have a good shelf life
- It should wash off extraneous materials and toxic waste products.
- It should aid in the reconstitution of depleted cellular metabolites.

Various types of storage/ transport media

There are different types of wet storage media for avulsed teeth, which may vary from the cell and tissue culture solution

like Hank balanced salt solution (HBSS); Medical product developed specifically for organ storage purpose such as viaspan; Saline; Natural products like water, saliva, milk, propolis, egg white, coconut water; Rehydrating solutions like Gatorade and ricetral; and even contact lens solution.

The osmolarity, pH, efficacy, and accessibility for different wet storage media for an avulsed tooth is described and summarized in this review.

Table 1: Categorization of storage media according to their osmolarity

S. No	Storage medium	Osmolarity
1.	Saline	280mOsm/kg
2.	Tap water	290mosm/kg
3.	Saliva	60mosm/kg
4.	Milk	300osm/kg
5.	HBSS	320mosm/kg
6.	Viaspan	320osm/kg
7.	Gatorade	280-360osm/l
8.	Propolis	350osm/l
9.	Emdogain	407mosm/kg
10.	Egg white	300mosm/kg
11.	Eagles Medium	310-360mosm/kg
12.	L-DOPA	238mosm/kg
13.	Cocunut water	288mosm/l
14.	Contact lens solution	310mosm/kg

Table 2: Categorization of storage media according to their pH

S. No	Storage Media	pH
1.	Saline	5.5
2.	Tap water	7
3.	Saliva	7.3
4.	Milk	6.7-6.9
5.	HBSS	7.2-7.4
6.	Viaspan	7.4
7.	Gatorade	3
8.	Propolis	5.1
9.	Emdogain	4.5
10.	Egg white	9.2
11.	Eagles Medium	6.8-7.2
12.	L-DOPA	2.3-8.11
13.	Cocunut water	5-5.4
14.	Contact lens solution	7.8

Table 3: Categorization of storage media according to their Storage time (shelf life)

S. No	Storage Media	Storage Time
1.	Saline	>2 hr
2.	Tap water	>1 hr
3.	Saliva	>1h r
4.	Milk	6 hrs
5.	HBSS	2 years
6.	Viaspan	144 hrs
7.	Gatorade	>1 hr
8.	Propolis	20 hrs
9.	Emdogain	>1 hr
10.	Egg white	6-10 hrs
11.	Eagles Medium	8 hr-24 hr
12.	L-DOPA	> 1 hr
13.	Cocunut water	>1 hr
14.	Contact lens solution	>1 hr

▪ Saline

The saline solution provides an osmolarity of 280 mosm/kg and a pH of 5.5. It can be easily available but it lacks essential nutrients like ions and glucose which are fundamentals for the

cells. It has a storage time of up to 2 hrs and if it is used for a longer duration it starts deteriorating PDL cells.

Saline is not an adequate medium but because of its easy accessibility, it can be used for a short period of time.

▪ Tap water

Tap water is an unacceptable storage media for avulsed tooth because of its bacterial contamination, hypotonicity, and non-physiologic pH and osmolarity. It causes PDL cell lysis and rapid cell death.

Thus water is not a suitable interim storage medium for retaining the viability of PDL cells.

▪ Saliva

Saliva can be used as storage media for a short period of time (>1hr). Its only advantage is easy accessibility. But it has unfavourable characteristics like high microbial contamination, non-physiologic pH and osmolarity and hypotonicity.

The osmolarity is much lower than physiologic saline, thus it boosts the harming effects of bacterial contamination.

▪ Milk

Milk is significantly better than other wet storage media because of its physiological properties, including pH and osmolarity compatible with those of cells from periodontal ligament. It is important that it is used in the first 20 min after avulsion. Milk contains essential epithelial growth factors which mainly stimulate the proliferation and regeneration of epithelial cell rest of malassez and activates the alveolar bone resorption. The pasteurization of milk is responsible for diminishing the various bacteria and bacteriostatic substances which could be harmful to the fibroblasts of the periodontal ligament. Blomlof (1983) and Trope and Freidman(1992) recommended milk as an excellent storing solution for 6 hrs, however, milk cannot revive the degenerated cells.

At the cellular level, milk is considered equal to hank balanced salt solution as a wet storage media but loses its effectiveness after 2 hrs. Thus milk is considered an adequate

medium due to its beneficial effects, and characteristics, and ease of access at the moment of trauma.

▪ **Hank's balanced salt solution**

It is a standard saline solution that is non-toxic, biocompatible with periodontal ligament cells, pH balanced at 7.2 and has an osmolarity of 320mosm/kg. It mainly composed of 8g/L sodium chloride; 0.09g/L sodium phosphate; 0.14g/L potassium phosphate; 0.4g/L D- glucose; 0.4g/L potassium chloride; 0.35g/L sodium bicarbonate; 0.14g/L calcium chloride; 0.1g/L magnesium chloride; 0.1g/L magnesium sulphate; and also contains essential ingredients such as glucose, calcium and magnesium ions which can sustain and reconstitute depleted cellular components of periodontal ligaments cells. Ashkenazi *et al.* showed that HBSS was the most effective medium for preserving viability, mitogenicity, and clonogenic capacities of PDL cells for up to 24 hours at 4 °C. It is commercially available as a SAVE-A-TOOTH which contains a soft membrane to minimize the cell trauma during transport.

▪ **ViaSpan**

ViaSpan is a medium used for the transportation of organs which are going to be transplanted and it has been an effective wet storage media for avulsed teeth. Its osmolarity is 320mosm/kg and pH of 7.4 which is ideal for cell growth. It is developed to receive organs to be transplanted, have peculiar characteristics that allow maintaining cell viability, minimize damages to PDL cells and provide conditions for cell proliferation, therefore can be indicated for use as storage media for avulsed teeth. Though the solution is efficient but due to lack of availability and high cost the practical usage of viaspan must be considered judiciously.

▪ **Gatorade**

It is a non-carbonated sports drink that mainly consists of water, sucrose, and glucose, fructose syrups, citric acid, sodium chloride, sodium citrate, monopotassium phosphate, flavouring and colouring agent. It has a pH of 3 and an osmolarity of 280-360mosm/kg. Gatorade preserves more viable cells than tap water. It only serves as a storage medium if other media are not available.

▪ **Propolis**

It is a sticky resin that sweeps from the buds of trees and mainly consists of resin, waxes fatty acids, essential oils, pollen proteins and other organic compounds and minerals. Due to its antiseptic, antibiotic, antifungal, antiviral, antioxidant, anticarcinogenic, antithrombotic and immunomodulatory properties considered as a promising medium for the maintenance of avulsed teeth. Propolis can act as a good alternative natural storage medium for an avulsed tooth.

▪ **Contact lens solution**

It is considered as the most convenient preservation medium for teeth after avulsion injuries as these solutions available everywhere. It mainly contains a buffered isotonic saline solution with the addition of preservatives that may preserve the viability of PDL cells. But some subsequent studies show that the preservatives in contact lens solution are worse and lead to PDL cell necrosis, therefore they are not recommended.

▪ **Egg white**

The osmolarity of egg white is 300mosm/kg. It has shown

better cell viability and significantly higher incidence of PDL healing as compared to milk for the same amount of time. It is considered as a good choice because of its high protein content, water, vitamins, lack of microbial contamination, and easy accessibility.

Egg white has been observed as an excellent medium for up to 10 hrs with the principle advantage being its availability.

▪ **Eagle's Medium**

Eagle's medium consists of 4 ml of L-Glutamine; 105 IU/L of Penicillin; 100µg/ mL of Streptomycin, 10µg/mL of Nystatin and calf serum (10% v/v). It has high viability, mitogenic and clonogenic capacity up to 8 hrs of storage at 4 c. The eagles medium at 37 °C (Biological Industries) is a recommended storage medium as it can preserve the PDL for extended periods before reimplantation.

▪ **L-DOPA**

Drug with possible mitogenic effects and promoter of healing. It stimulates dopaminergic systems in the anterior portion of the pituitary gland to secrete growth hormone, which is considered as a promoter of the healing process.

It can be used as a preserving medium for avulsed teeth.

▪ **Coconut water**

Coconut water is rich in amino acid, proteins vitamins and minerals. It has high osmolarity and can be used as potential interim storage for an avulsed tooth. Though coconut water has a pH of 4.1 which is deleterious to cell metabolism. However, the use of coconut water is not feasible under clinical conditions.

Table 4: Categorization of storage media according to their efficacy

S. No	Storage Media	Efficacy
1.	Saline	Inefficient
2.	Tap water	Inefficient
3.	Saliva	Inefficient
4.	Milk	Highly efficient
5.	HBSS	Highly efficient
6.	Viaspan	Highly efficient
7.	Gatorade	Less efficient
8.	Propolis	Highly efficient
9.	Emdogain	Less efficient
10.	Egg white	Moderately efficient
11.	Eagles Medium	Less efficient
12.	L-DOPA	Less efficient
13.	Cocunut water	Moderately efficient
14.	Contact lens solution	Inefficient

Conclusion

It is to be concluded that there are no single wet storage media posses all the required characteristics for an ideal storage medium i.e capable of preserving the vitality of PDL cells, compatible physiologic pH and osmolarity, minimal microbial contamination, and high availability. Based on literature saline, tap water, saliva, Gatorade, contact lens solution are inefficient and have been considered non-physiological and are not recommended due to factors such as pH and osmolarity Eagles medium and L- dopa are less effective and not feasible due to factors like lack of availability and cost. HBSS and milk are highly efficient due to its favourable factors like highly physiologically compatible pH and osmolarity, low or no bacterial content. To sum up after taking all factors into account, milk is the most appropriate wet storage media for an avulsed tooth.

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