

## Avulsed Tooth - A Storage Medium Dilemma an Update

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### Abstract

Dental traumatic injuries are the most uninvited emergencies causing panic, emotional, aesthetic, functional and psychological disturbances. Avulsion being the most common injury, it deals with exarticulation or total luxation of the tooth out of its socket as a result of sports injuries or fights. While *in-vitro* studies have shown that teeth can be kept in conditioned media for up to 96 hours and still present optimal healing, clinically emphasis on the extra-oral time and viability of the PDL cells decide the prognosis for the avulsed tooth. Transport or storage media for the tooth is of critical importance for survival of these PDL cells for successful replantation. This article highlights the different storage media available for an avulsed tooth and the most suitable ones to be used depending on their ease of availability for the general population.

**Keywords:** Traumatic injury; Avulsed tooth; Storage medium

### Introduction

Avulsion injuries deal with exarticulation or total luxation of the tooth out of its socket as a result of a blunt impact on the tooth due to contact sports, road accidents or fights which leads to severance of the neurovascular pulpal supply, separation of the PDL and exposure of the root surface (oral/extra-oral environment contaminated with microorganisms) [1,2]. The success of a replanted tooth depends upon the extra oral time of tooth out of its socket and its replacement in the socket, the viability of the periodontal ligament (PDL) cells, condition of the tooth and cementum and amount of bacterial load leading to complications like surface resorption, inflammatory resorption and replacement resorption/ankylosis [3].

The first line of treatment for an avulsed tooth is immediate replantation, however, most of the times it is not possible because of more complicated injuries to be taken care of and lack of awareness and confidence not just within the general population but amongst the professionals too [4,5]. When immediate replantation is not possible, the tooth should be stored in an appropriate transport media to maintain viability. Storage can be of three types, namely dry, wet or a combination of both, each having variable effects on the pulp and periodontal ligament. It was found that dry storage and a combination of dry and wet storage rendered poor healing as compared to wet storage, however, the unphysiologic media showed unsatisfying results [6,7]. Wet media is further divided into physiologic and unphysiologic media. If the tooth has been stored in an unphysiologic media such as tap water, chlorhexidine, chloramine, alcohol or other sterilizing solutions no prognosis calculation is possible. Physiologic media include saliva, saline, milk and culture media [8,9].

Various wet storage media have been tested time and again each having its own advantages over the other. This paper reviews the literature on different wet storage media, concluding the best one to use on the basis of its accessibility and efficacy for tooth survival.

An ideal storage medium should be capable of maintaining PDL and pulpal cells and tissue viability, physiological pH and osmolality similar to the surrounding tissues, sterile with excellent antioxidant properties, readily accessible and having a low cost [10-12].

Considering the unphysiologic media, tap water although is the most convenient medium, it causes rapid cell lysis similar to dry storage due to its hypotonicity, unphysiological pH and osmolality and microbial

contamination [8,13,14] and therefore Ozan et al. [15] in their study concluded that water was worse in comparison to saline [15]. Likewise saliva emphasizes similar properties as water and therefore inefficient to maintain the cellular integrity [16-19]. Even though saline solution has a physiological pH and osmolality, it does not contain the essential ions and cell nutrients for cell survival [13].

Tap water, saliva, and saline provide minimal efficacy but they can be considered as better options or interim-storage media in comparison to dry storage to the tooth.

A tooth preserving system, called as "SAVE A TOOTH" is commercially available [18]. It contains the Hank's Balanced Salt Solution (HBSS) with a pH of 7.2 and osmolality of 270-290 osmo/kg which inherently has active ingredients like 8 g/L sodium chloride, 0.4 g/L D-glucose, 0.4 g/L potassium chloride, 0.14 g/L calcium chloride, 0.35 g/L sodium bicarbonate, 0.09 g/L monobasic sodium phosphate, 0.1 g/L anhydrous magnesium sulphate and the vehicle as water. The presence of magnesium, glucose and calcium reconstitutes and sustains the PDL cell layers. It has a long shelf life of 2 years and does not require refrigeration. Souza et al. [18], Pillegi et al. [16] and Hwang et al. [20], in their respective studies concluded that HBSS is an ideal storage medium but because of its poor availability is minimally used.

Viaspan, commonly known as an organ transplant storage media has shown reduced incidence of root resorption after replantation and is debated as a better storage media than HBSS and milk [21]. Viaspan has an osmolality of 320 mosm/kg and pH of 7.4 which is ideal for cell growth and function [21]. Another organ transplant storage medium Euro-Collins is a hypothermal solution with pH similar to Viaspan and a slightly higher osmolality of 420 mosm/kg to avoid cellular edema [10,11,15].

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**Received** November 21, 2014; **Accepted** April 15, 2015; **Published** April 17, 2015

**Citation:** Abdul M, Date R, Yussuf C, Khandwawala N, Hegde V (2015) Avulsed Tooth - A Storage Medium Dilemma an Update. J Trauma Treat 4: 245. doi:10.4172/2167-1222.1000245

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Minimum Essential Medium (MEM) which was developed Harry Eagle is the most widely used synthetic cell culture medium [15]. Various formulations are available but the key ingredients include L-glutamin, streptomycin, penicillin, bovine serum, Nistatin and nutrients for cell growth and proliferation therefore indicated as a transport media with an added advantage of having bacteriostatic, bactericidal properties and growth factors [17,18,21].

The major disadvantages Viaspan, Euro-Collins and MEM carry are their cost and availability at the site of accident [1] (Table 1).

Milk is an excellent medium for storage [22-25] owing to its properties of a physiological neutral pH, isotonicity, minimal bacterial content due to pasteurization, presences of protective enzymes and epithelial growth factors which stimulate regeneration and proliferation with high availability. Courts et al. concluded that milk is a significantly a better preservative of PDL fibroblast viability than saliva, water, or air-drying, but not as good as HBSS [22]. Whereas, some authors reported milk as superior media as against coconut water, green tea, propolis, Euro-collins egg and Ricetral media [1,22-25]. Considering its properties and availability milk is a recommended storage medium by the International Association of Dental Traumatology [24] and the American Academy of Pediatric Dentistry [25].

Propolis produced by honeybees and green tea are both naturally occurring substances used as storage media and have strong antioxidant, anti-inflammatory and antibacterial properties which aid in inhibiting prostaglandin synthesis and triggering phagocytosis to promote healing. The antioxidant property helps in eliminating the free radicals signaling the osteoblastic and osteoclastic activity [26]. Propolis extends its usage not only in caries prevention but also for intracanal medicament. Various authors have proposed various efficacies of propolis based on its complex chemical nature [10,16,27]. But studies have shown that even though ethanol used for propolis dilution can cause variable results, propolis itself has the property to neutralize the toxicity of ethanol to some extent. It also promotes collagen synthesis and triggers signaling molecules to control hemorrhage [28].

Coconut water is a naturally occurring, sterile electrolyte, rich in proteins, vitamins and minerals. Also coconut water composition is similar to that of the intracellular fluid. Therefore, studies by Gopikrishna et al. [10] and Gopikrishna et al. [11] confirmed greater efficacy of coconut water over milk and HBSS for the viability of PDL but Thomas et al were of the opinion that more inflammatory resorption was seen with tooth stored in coconut water [29] (Table 2).

Another good choice of storage media for teeth undergoing delayed replantation is egg white due to its enormous contents of protein, vitamins and water as well as absence of microbial contamination and easy access. Suosa et al. [17] observed that viability and histological characteristics provided by egg white were similar to those of milk. A study by Khademi et al. [30] concluded that teeth stored in egg white for 6h to 8h had a better incidence of repair and lower surface resorption in dogs however experiments show a loss of efficacy over time possibly due to high pH of egg and also because the PDL cells could target the several egg proteins as foreign bodies [30].

Although these natural products sound promising, their availability render a set back to their usage. Elaborate studies are required for these media. Studies quoted Gatorade (commercially available sports drink) and contact lens solution used as a storage medium were not able to maintain the viability of PDL cells whereas Ricetral showed results similar to HBSS and superior to milk [31,32].

Commercially available storage media	Characteristics of the storage media	Availability at the accident site and Efficacy
Hank's Balanced Salt Solution (HBSS)	Physiological pH, osmolality and nutrients	--/Excellent
Euro-Collins	Physiological pH and hypothermal capacity	--/Excellent
Viaspan	Physiological pH, osmolality and favorable to cell growth	--/Excellent
Minimum Essential Medium (MEM) Or Eagles Medium	Nutrients, antimicrobial property and growth factors	--/Excellent
Saline	Physiological pH and osmolality	+ /Poor
Contact lens solution	Antimicrobial properties and preservatives	+ /Poor
Gatorade	Low pH and hypertonic	--/Poor
Ricetral	Essential cells and nutrients	--/Good
Ascorbic Acid	Alkaline and stimulates collagen	--/Good
Growth factors	Potent biological mediators and regulates wound healing(2h-8h)	--/Excellent
Emdogain	Antimicrobial ,osteoinductive and osteopromotive properties	--/Good
L-Dopa	Mitogenic Effects and promotes healing	--/Good
Cryoprotective agents	Preserves tissue and promotes Healing	--/Good
Catalase Supplementation	Antioxidant and favorable to cell growth	--/Good

Table 1: Commercially available transport media.

Naturally available storage media	Characteristics of the storage media	Availability at the accident site and Efficacy
Tap water	Microbial contamination, hypotonic, non-physiological pH and osmolality	++/Very Poor
Saliva	Microbial contamination, hypotonic, physiological pH and osmolality	++/Very Poor
Milk	Small bacterial contents, isotonic, physiological pH, osmolality, growth factors and nutrients	++/Excellent
Propolis	Anti-inflammatory, antibacterial and antioxidant properties	--/Excellent
Coconut water	Sterile, natural product and contains nutrients	--/Excellent
Egg white	Low microbial contamination, contains nutrients and water	--/Good
Green tea	Anti-inflammatory, antibacterial and antioxidant properties	--/Excellent

Table 2: Naturally available transport media.

## Conclusions

The instant availability of storage medium can provide immediate protection of viable periodontal cells and fibers following trauma. Various new storage medias have shown promising results *In-vitro*, but their clinical effectiveness has yet to be determined hence further *In-vivo* research would be required. Hence the Gold Standard in storage media's based on its clinical outcome in preserving viable cells and giving favorable prognosis are – HBSS and Chilled Milk (Authors assessment).

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