

PRESERVING AVULSED TEETH FOR REPLANTATION

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The condition of avulsed teeth before replantation—their handling and exposure to media—affects periodontal healing.¹⁻⁴ Despite the fact that 100 percent success of replanted teeth is possible, actual clinical experience with replantation is poor.^{9,10} The frequency of progressive root resorption on replanted teeth in a clinical setting ranges from 80 percent to 96 percent.^{2,11}

No single factor in the chain of events from the avulsion accident to the final obturation of the root canal space can be ignored to achieve long-term retention.^{1,7,8,12-15} The critical links in this chain are:

- Storage of the avulsed tooth in a physiological medium until replantation;
- Replenishment of the depleted cellular nutrients of the periodontal ligament cells;
- Protection of root PDL cell from trauma, especially crushing;
- Elimination of infection from the root canal system, root surface and socket;
- Physiological splinting of the avulsed tooth and its timely removal;
- Timely pulpal extirpation;
- Placement of calcium hydroxide as a medicament.

Failures of replanted avulsed teeth result from lack of imple-

ABSTRACT

This study describes the use of a tooth-preserving system containing Hank's Balanced Salt Solution and a cushioning apparatus for the storage and transport of avulsed teeth before replantation.

mentation of the first three factors, which are usually beyond the health care professional's control.^{1-5,10,16} Anyone at an accident can unknowingly cause irreversible damage to the avulsed teeth through the use of inappropriate handling, storage and transportation methods.

Immediate replantation is usually the best treatment for the avulsed tooth, but it isn't always accomplished for a variety of reasons: lay individuals may be afraid to replant a tooth or may fear contracting an infection. If multiple teeth are avulsed, lay persons may not know in which socket to place the teeth. An accident victim may be hysterical, uncooperative or unconscious, thus contraindicating immediate replantation because of possible aspiration of the avulsed tooth. Also, there may be more serious injuries that would require

immediate attention.

Because most avulsed teeth are not replanted immediately, they are usually stored in "on-the-spot" storage and transportation media, such as water, paper tissues or ice, which appeal to the common sense but are damaging to the PDL cells and lead to eventual root resorption.^{1,7,8,16}

The successful replantation of avulsed teeth can be increased by storing and handling them in optimum preservation media such as Hank's Balanced Salt Solution (HBSS).^{1,6,17-22} This medium has been used extensively for years to support and maintain a variety of mammalian tissues in tissue culture. It has also been shown to successfully preserve and reconstitute the PDL cells of avulsed teeth for at least 24 hours.^{17,23}

In this study, we found that the avulsed tooth storage system (Emergency Tooth Preserving System, a trademark of Biological Rescue Products) provides both an optimum storage and transport medium and a PDL cell trauma reduction apparatus that can be available at the scene of an accident or later.

This study determines if the success of replanted avulsed teeth are influenced by their

storage in a biological environment provided by ETPS before implantation.

METHODS AND MATERIALS

The solution, Hank's Balanced Salt Solution, is a standard cell culture medium used in biomedical research depending on the tissues involved and supports many cell types.^{16-21,24,25} Many variations are available. HBSS is non-toxic, pH balanced at 7.2 and has an osmolality of 320 milliosmol/kilogram. It is composed of 8 grams/liter of sodium chloride, 0.4 g/L of D-glucose, 0.4 g/L of potassium chloride, 0.35 g/L of sodium bicarbonate, 0.09 g/L of sodium phosphate, 0.14 g/L of potassium phosphate, 0.14 g/L of calcium chloride, 0.1 g/L of magnesium chloride and 0.1 g/L of magnesium sulfate.

After an avulsed tooth is picked up by the crown, the top of the ETPS container (which is lined with a plastic sponge) is unscrewed. A tamper-proof aluminum foil seal is removed from the container and the tooth is dropped into the Hank's

solution. The tooth falls gently into the net, which is placed into an open slat basket within the container, and both the container and the patient are brought to a dentist. The tooth remains suspended in the solution and simultaneously is held securely and washed of debris by the Hank's medium. Because the net is tapered, the tooth will not move excessively during transportation.

When the patient arrives at the dentist's office with the container and the tooth, the dentist unscrews the lid and removes the basket and net within it from the container. The lid is then placed on the top of the basket. The top and basket, held firmly together, are inverted. The basket is removed and the tooth is left on the sponge, allowing the dentist to replant the tooth.

With user mail return cards, we contacted the 34 patients who experienced traumatic tooth avulsion and were treated with ETPS. The patients provided the names of their treating dentists. We mailed their dentists a questionnaire,

which asked for the patient's name, age, gender, date of avulsion, tooth or teeth avulsed, dates of follow-up examinations and findings, and copies of pre- and post-treatment radiographs. We also obtained from the treating dentist the storage time before placement in ETPS and total extraoral time.

All teeth were replaced in their sockets digitally or with forceps, functionally splinted. They were treated endodontically within a week of replantation, and received a temporary restoration. We excluded teeth that had endodontic therapy or an apicoectomy performed extraorally or were splinted in a nonfunctional manner.

The teeth were evaluated clinically by the treating dentist at varying time intervals for the appearance of root resorption on radiographs, for mobility and for clinical function. Based on this, the replantations were rated as very successful, moderately successful or unsuccessful. A rating of very successful was given if there were no signs of resorption on the radiographs, no abnormal mobility, and the tooth was asymptomatic. A rating of moderately successful was given if there was some radiographic resorption, no abnormal mobility and no other adverse symptoms. A rating of unsuccessful was given if there was ongoing severe resorption or abnormal mobility. The ETPS was also evaluated for causing any adverse side effects and for its usefulness in the replantation procedure, as judged by the treating dentist.

RESULTS

Follow-up times varied from three to 30 months (Table 1). The data show that of the 34

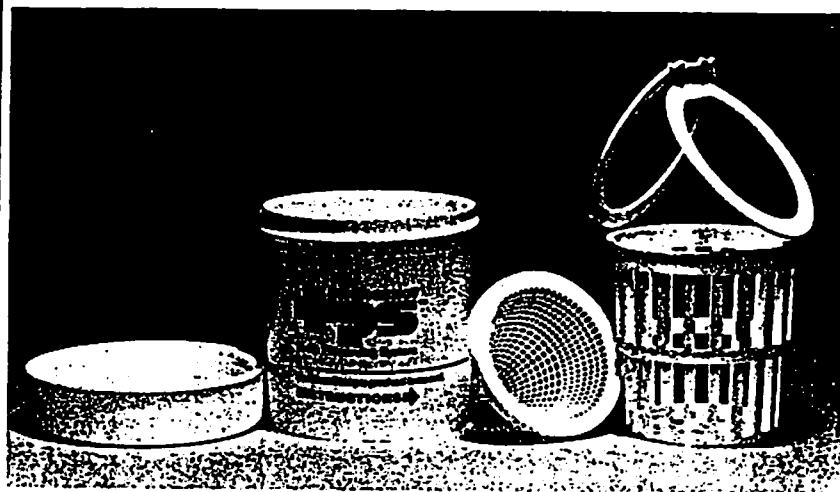


Figure 1. The Emergency Tooth Preserving System (ETPS) from left to right, screw cap with inside plastic sponge liner, outer container, plastic tooth supporting net and carrying basket for net.

TABLE 1

Months	Very successful	Moderately successful	Unsuccessful
3	2	0	1
6	9	0	1
9	1	0	0
12	8	1	0
18	1	1	0
24-30	5	0	1
Total	29 (85.3%)	2 (5.9%)	3 (8.8%)

teeth studied, replantations were very successful in 29 (85.3 percent) instances, moderately successful in two (5.9 percent) instances and unsuccessful in three (8.8 percent) instances. Twenty-eight (82.4 percent) of the avulsed teeth were maxillary, and six (17.6 percent) were mandibular. Fourteen teeth were monitored for less than 12 months, 12 (85.7 percent) were rated very successful, and two teeth (14.3 percent) were unsuccessful.

Fourteen teeth were monitored for 12 to 23 months of which 12 (85.7 percent) were rated very successful, and two (14.3 percent) teeth showed moderate success. Six teeth were followed for 24 to 30 months: five (83.3 percent), very successful; and one (16.6 percent), unsuccessful.

The time between avulsion and placing the tooth in the ETPS varied from 15 to 120 minutes. The total extraoral time (15 to 120 minutes plus the time in the ETPS before replantation) ranged between 45 to 360 minutes (Table 3).

There were no reported adverse reactions following use of the ETPS: no unusual swellings, infections or delays in healing. All of the dentists

reported that ETPS was an effective adjunct for the replantation procedure.

DISCUSSION

Although a prospective double-blind human study is always desirable, in the case of an avulsed tooth this is not feasible. We can never predict where or when an accident will occur, and placing an ETPS at every site where the avulsion may occur is not possible. Therefore, we performed a retrospective study on cases that used ETPS and were able to acquire follow-up data for three to 30 months after replantation.

In this investigation, the control was literature about the

success of replanted avulsed teeth, bearing in mind that no other clinical study used an ETPS, Hank's solution or any protective container system.

The manner in which avulsed teeth are handled and stored until replantation affects the success of the replanted tooth.^{1,2,6,10,12,26-28} Immediate replantation in the initial 15 extraoral minutes is preferred.²⁹

Some workers have suggested that when teeth are extraoral for 15 to 60 minutes, they should be soaked in a pH balanced solution for 30 minutes before replantation to reconstitute depleted cellular metabolites and wash extraneous materials and toxic breakdown products from the root surface.⁶ Blomlof reported that water and saliva can be very destructive to PDL cells and should be avoided as storage media if possible,^{1,16} although he found milk to be superior to water and saliva as a storage medium.^{1,16} Milk, however, has not been shown to have the capacity to reconstitute lost cellular metabolites. It also doesn't have the ability to maintain morphological integrity of the PDL cells, and it has been shown that PDL cell

TABLE 2

Minutes	Very successful	Moderately successful	Unsuccessful
15	4	0	0
30	6	1	1
45	6	1	1
60	13	0	1
120	1	0	0
Total	29 (85.3%)	2 (5.9%)	3 (8.8%)

TABLE 3

FATE OF TOOTH REPLANTS RELATED TO TOTAL LENGTH OF EXTRAORAL TIME.

Minutes	Very successful	Moderately successful	Unsuccessful	Total
0-15	0	0	0	0
16-30	0	0	0	0
31-60	9(90%)	0	1(10%)	10(29.4%)
61-120	16(89.9%)	0	2(11.1%)	18(52.8%)
121-240	2(66.6%)	1(33.4%)	0	3(8.8%)
241-360	2(66.6%)	1(33.4%)	0	3(8.8%)

mitotic ability diminishes dramatically after storage (in milk) for more than an hour.^{1,17,21}

The best storage media for avulsed teeth are pH balanced cell-supporting fluids such as Hank's solution and Eagle's medium.^{1,17,21,20,22} These fluids can preserve and reconstitute PDL cells of avulsed teeth for many hours, if not days. Hank's solution can preserve PDL cells in vitro for up to 120 hours.¹⁷ In vivo studies on dogs show that replanted teeth stored in Hank's solution for as long as 96 hours can have significant success and little resorption.²³

The efficacy of a Hank's solution in preserving avulsed teeth is shown in many clinical and laboratory studies.^{6,16-20,22} Other studies show that for long storage periods (six hours or more), Hank's solution was superior to milk for PDL cell maintenance.^{17,23}

Our clinical results of 34 avulsed teeth stored in ETPS are considered to be excellent. Of the teeth evaluated, 85.5 percent were very successful, 5.9 percent were moderately successful and 8.8 percent were unsuccessful.

This high success rate is considered to result from using the optimal preservation fluid, minimizing root PDL cell damage in transport and during

dental manipulation, and the timely availability of the ETPS for minimizing PDL trauma.

According to Andreasen and Andreasen, the success of replanted teeth placed in an unsuitable storage environment for 45 minutes or more was less than 20 percent.⁸ In our study, 64.7 percent were extraoral for more than 45 minutes, and of these, 90.9 percent were either very or moderately successful.

We even found that teeth dry-stored for 60 minutes or more before placement into the ETPS benefited from soaking in Hank's solution. Only one (6.7 percent) of these teeth was unsuccessful after 24 months of follow-up.

These results coincide with the finding of Matsson who shows a decrease in ankylosis when avulsed teeth were soaked in a Hank's solution for 30 minutes after dry avulsed tooth storage.⁶ Matsson, however, didn't find significant reduction in ankylosis after 60 minutes of dry storage followed by 30 minutes of soaking in Hank's solution.⁶ It's possible that these results differ because Matsson performed histological sections on replanted avulsed teeth, whereas the results of this study were clinical.

According to Andreasen and others, teeth that have been

dry-stored and extraoral 60 minutes or more have less than a 10 percent chance of success.⁸ Our study shows that ETPS produces significant success within the time frame of this study (six months for teeth that have been extraoral for up to 120 minutes).



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The high success in this study are due to both the reconstitutive and protective nature of the ETPS. This latter factor probably plays a greater role in the failure of replanted avulsed teeth than previously suspected. The

special basket and net in the ETPS reduces crushing damage of the PDL during transport to the dentist or when the dentist attempts to remove the teeth from the container.^{20,21}

Research shows that crushing the PDL can lead to increased ankylosis.²⁶⁻²⁸ When a dentist attempts to remove an avulsed tooth from its container, he can damage the root

PDL cells with his fingers, with forceps or even with gauze.

If it should be the case that the tooth doesn't fit back into the socket easily during replantation, it is put back into a physiological storage medium while the socket is recleaned or modified to accept the replant.

We attribute the successful replantations to the availability of an optimum chemical and protective mechanical environment for avulsed teeth. Preservation fluids and protection devices are rarely available at the time of the accident. We also advocate the use of the ETPS for elective replant or transplant procedures performed in the dental office.

SUMMARY

We performed a retrospective study of 34 replanted avulsed teeth placed in an EPTS before replantation. Even when extraoral time was 120 minutes or more, 91 percent of the teeth showed excellent or moderate success for follow-up periods ranging from three to 30 months. We think that the success of a replanted avulsed tooth is increased by use of a prefabricated tooth preserving and protecting system as described. ■

Publication of names of products does not imply endorsement by the American Dental Association.

Editor's note: The product named in this



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article was invented by the first author, Dr. Paul Krasner. Its mention should not be construed as an endorsement by The Journal of the American Dental Association or the ADA. Please direct any questions to Dr. Krasner.

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