The Effect of Sodium Chloride Rinsing on Socket Depth Reduction

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Abstract

Sodium chloride solution (NaCl) is regarded as the most suitable and recommended medical irrigation, because of the nontoxic and isotonic properties. The previous in vitro study showed that NaCl solution induced migration and extracellular matrix excretion from human gingival fibroblast. However, there is no report concerning the effect of rinsing extraction wound with NaCl solution in clinical trial study. This research study is split mouth single-blind randomized controlled clinical trial to investigate if rinsing with 0.9% and 1.8% NaCl solution on extraction wound can promote soft tissue healing. The operation was performed in 57 socket sites. The patients, who had been planned for bilateral premolar extraction, were randomly divided into 3 groups with different solutions used including sterile water solution (control), 0.9% NaCl solution, and 1.8% NaCl solution, respectively. The depth of sockets was evaluated to determine the socket wound healing property on day 0 (immediate post-operation), 7 and 21, respectively. The results showed that the percentage reduction of the depth of socket in the 0.9% NaCl group and 1.8% group was shallower compared to the sterile water group clinically in third week period, although the result was not statistically significant. The result of this study may be helpful in term of the acceleration of the healing period in the complicated case or in immunocompromised patients.

Keywords**:** *Extraction Wound, 0.9% Sodium Chloride Solution, 1.8% Sodium Chloride Solution*

1. Introduction

The healing of an extraction socket depends on the individual and circumstances including age, location of the extraction, the pathology of the teeth, physical health, the difficulty of the extraction (Adeyemo et al., 2006; Khosla & Gough, 1971), and the current medication (Gosain & DiPietro, 2004). The major problem of delayed wound healing is the increasing of risk of infection.

There are five stages of healing process that occur in the extraction socket. After tooth extraction treatment, the coagulation from red blood cells occurs. White blood cells and the coagulating factors create blood clot in the socket, which leads to the eventual closure of the extraction wound. The second stage is the transformation from blood clot into granulation tissue over a 4 to 5 days period. Then the connective tissues, which compose of spindle shaped fibroblasts, collagen, and the ground substance come to replace the granulation tissue in the third stage. The process occurs over a 14 to 16 days period. For the large wound heals by secondary intention, the extracellular matrix production, degradation, and remodeling continue slowly. Reaching the final remodel of the wound may take about 3 weeks to 1 month or longer, depending on the size of the defect (Häkkinen et al., 2011). In the fourth stage, noncalcified osteoid appears at the base of the socket after 7 to 10 days, the event occurs in parallel with the loss of periodontal ligament and bundle bone, and trabecular bone fills the socket completely after 6 weeks. In the fifth stage, epithelial closure will be completed in 24 to 35 days. The socket bone formation occurs in the healing phase after 5 to 10 weeks of recovery. At week 16-24, bone development will be completed. The dimension of the extraction socket alters in first 6 months and continues remodeling over time, up to at least 12 months (Cohen & Mast, 1990; Farina & Trombelli, 2011; S. Guo & L. A. Dipietro, 2010; Khosla & Gough, 1971).

Fibroblasts play a significant part in the healing process. They provide framework for tissues and organs. Fibroblasts' primary duty is to maintain the integrity of the tissues by creating collagen fibers, extracellular matrix components, and ground substances. They are crucial in the immune response to tissue

damage, as well as in initiating and promoting inflammation in response to the invasion of microorganisms through the generation of cytokines, which in turn stimulates a series of events to eliminate the pathogen and create tissue healing (James et al., 1998). The goal of wound irrigation is to remove foreign objects, exudate, and debris to lower the risk of contamination and bacterial infection. The ideal environment for healing could be created by thorough wound cleaning. Many different cleaning agents have been introduced to the medical field and will be used based on their suitability, as long as they are cytotoxicity free. While many cleaning agents have produced outcomes that are both safe and effective, other risks damaging or even destroying cells that are vital to the healing process (Fernandez & Griffiths, 2012; S. a. Guo & L. A. DiPietro, 2010; Kim et al., 2015; Mathieu et al., 2006; Weiss et al., 2013)

Isotonic sodium chloride is 154 mEq of sodium ions and 154 mEq of chloride ions in every 100 mL of 0.9 percent sodium chloride solution. The pH ranges from 4.5 to 7, and the osmolarity is 308 mOsmol/liter. The predominant ion in saline solution is sodium. They are the primary electrolytes in extracellular fluid and control a wide range of body functions (Chang et al., 2016; Epstein & Waseem, 2022; Takagi et al., 2000; Van Donkelaar et al., 2018). The chloride ions serve as buffering agents, make it easier for carbon dioxide and oxygen to bind to hemoglobin, among many other functions. Without altering ion concentration or creating significant fluid movements between intracellular, intravascular, and interstitial areas, normal saline expands intravascular volume without disturbing ion concentration (Barr, 1995; Beam, 2006; Fernandez & Griffiths, 2012; Huynh et al., 2016; Lewis & Pay, 2022).

Yu and Qi(2016) evaluated wound irrigation between normal saline and the antiseptic solution (0.1% polyhexanide + 0.1% betaine) for negative pressure wound therapy with instillation. It was found that using normal saline produced a successful wound closure rate of 98%. The result showed that both antiseptic and normal saline solution had a comparable effect for wound irrigation drainage and facilitated angiogenesis, allowed systemic antibiotic to establish maximum capacity. The study was concluded that normal saline may be as effective as antiseptics for the negative-pressure wound therapy with instillation for adjunctive management of infected wound (Yu & Qi, 2016).

The study of Huynh et al. (2016) found that human gingival fibroblasts are regulated by being rinsed with 0.9% to 1.8% NaCl for 2 minutes, three times a day. NaCl in the proper concentrations (0.9% to 1.8%) stimulates human gingival fibroblast cell migration and the synthesis of extracellular matrix. On the other hand, using NaCl at a concentration of 7.2% can have negative effects (Huynh et al., 2016). An excessive amount of NaCl, especially over an extended period of time, can damage DNA and render it incapable of repair. Additionally, there is little evidence to support the effect of NaCl on human gingival fibroblasts (Koo & Li, 2016).

The healing index of the extraction socket can be measured in both soft tissue and hard tissue aspects. There are a lot of equipment and accessories for soft tissue healing measurement such as Michigan probe, the acrylic stent with 4 notches as a marker, which was made before the extraction(Yerke et al., 2017), the Landry wound healing index, which evaluates the tissue color, bleeding, presence of the granulation tissue, suppuration and the characteristic of the incision margin (Landry, 1985). In the aspect of hard tissue healing, the X-ray periapical radiograph or CBCT are used to evaluate the bone healing (Srinivas et al., 2018; Yingcharoenthana et al., 2021).

2. Objectives

To investigate the efficacy of 0.9% and 1.8% NaCl solution on extraction wound healing in the aspect of socket depth reduction.

3. Materials and Methods

This research study was a split mouth double-blind randomized controlled clinical trial. The study was approved by ethical committee of the faculty of dentistry Chulalongkorn University (REC-DCU 2022-027). Patients who underwent tooth extraction at the Faculty of Dentistry, Chulalongkorn University were enrolled to the study according to the criteria as following.

Inclusion criteria

1) Patients who had bilaterally non-infected premolars needed for extraction such as extraction for orthodontic treatment

2) Age between 15 to 35 years old

3) Patients who had American Society of Anesthesiologist (ASA) class I or II

4) No antibiotic usage

5) Simple/atraumatic extraction

Exclusion criteria

1) Infection is found at the site of extraction

2) Smokers or alcoholics

3) On drug therapy which may affect wound healing such as glucocorticoid steroids and non-steroidal anti-inflammatory drugs and oral contraceptive

4) Pregnant woman, lactating woman and patients who take estrogen-containing contraceptive drugs

5) Patients who have blood disorders like thalassemia, G6PD deficiency, sickle cell disease and hemochromatosis

6) Psychiatric patients

7) Patients who cannot participate with the study and post-operative follow-up

All patients were requested for the consent prior to enrollment. The demographic data included their age, gender, and information about their health, medications, and allergies were documented. Panoramic radiographs were performed to confirm the bilateral premolar teeth. One operator performed tooth extraction. The patient's vital signs were taken before the extraction. The procedure for extracting teeth was standardized. Under local anesthetic with 2% mepivacaine and 1:100,000 epinephrine. Using an elevator and specially designed forceps, the tooth was extracted. A gauze was applied to the extraction site for one hour. The identical post-operative instructions and medication, 500 mg Paracetamol tablet, was provided to every patient.

The intervention of this study was a rinsing mouth with sterile water, 0.9% and 1.8% NaCl solution. The solution was prepared by researcher for the accuracy of the outcomes of the study and the patients were instructed to keep the solution in the mouth for 2 minutes and split out for 2 times a day.

Each side of extraction site was chosen randomly on the initial visit to determine which tooth was pulled and under which intervention, in order to produce accurate and impartial findings. Only one surgeon was the operator, and then the treatment for each group was recommended for 14 days, the 7 more days were for wash out period. The intervention was started 24 hours after the tooth was extracted for the blood clot preservation. One blinded examiner completed the post-operative evaluations, which was measuring the depth of the sockets.

The depth of the socket was measured by the periodontal probe using the mid-buccal of the gingival margin of the adjacent teeth as a reference point and measured at mid-buccal of the socket margin as a repeatable measuring reference point. The sockets were examined and measured immediately as a baseline and measured again at day 7 and day 21 after operation date (Pisalsitsakul et al., 2022; Yingcharoenthana et al., 2021). Then, the study was continued on the other side. The tooth on the other side was extracted on Day 21, after the records of the previous extraction socket had been completed, by the same method, and was measured by the same procedures. Based on the study of Häkkinen et al. (2011), the remodeling of the connective tissue by secreting of extracellular matrix from fibroblasts in secondary wound intention as in extraction wound starts around day 7-14 and the strength of the wound maybe about 20%, the final strength occurs after day 21, the remodeling continues slowly and can last for month (Häkkinen et al., 2011). There was a 7-day wash out period before starting the extraction on the other side to remove all the effects of previous intervention and make the results more precise.

The statistical analyses were performed by using SPSS version 22.0 (SPSS Inc., Chicago, IL). All *p*-values less than 0.05 would be considered significant. The reliability of intra-interclass correlation coefficient was performed prior to start measuring the results of the study. And the measurements from one blinded examiner must be accurate. The distribution test was analyzed by Kolmogorov-Smirnov test and the data was analyzed by Kruskal-wallis test.

4. Results and Discussions

4.1 Results

30 patients (57 extraction sites) were included in this pilot study. There were 19 extraction sites for sterile water, 18 extraction sites for 0.9% NaCl solution and 20 for 1.8% NaCl solution. Because of the difference in the number of teeth, which were planned for extraction in each patient, the extraction sites of each group were different. Nevertheless, there was no statistically significant difference for the distribution of the data. The age, gender and location of the teeth could be seen in Table 1. The distribution of the demographic data in table 1 was in normal distribution with no statistically significant difference in the age, gender and the locations of extraction presented. No complication was found during the healing period.
Comparing the percentage reduction in the depth of socket between the extraction sites, the sterile water group demonstrated more reduction in the socket depth compared to 0.9% and 1.8% NaCl group on day 7, however on day 21, 0.9% and 1.8% NaCl group demonstrated more reduction in socket depth compared to sterile water group without statistically significance in both first and third week period as seen in Figure 1 and Figure 2

Table 1 Demographic data

Group	Gender	Age	Location
Sterile water	Male 57.14%	22.63±3.79	Maxillary 66.67%
	Female 42.86%		Mandible 33.33%
0.9% NaCl	Male 63.16%	19.11±4.16	Maxillary 63.16%
	Female 36.84%		Mandible 36.84%
1.8% NaCl	Male 35%	20.15±4.74	Maxillary 30%
	Female 65%		Mandible 70%
P-value	0.311	0.879	0.828

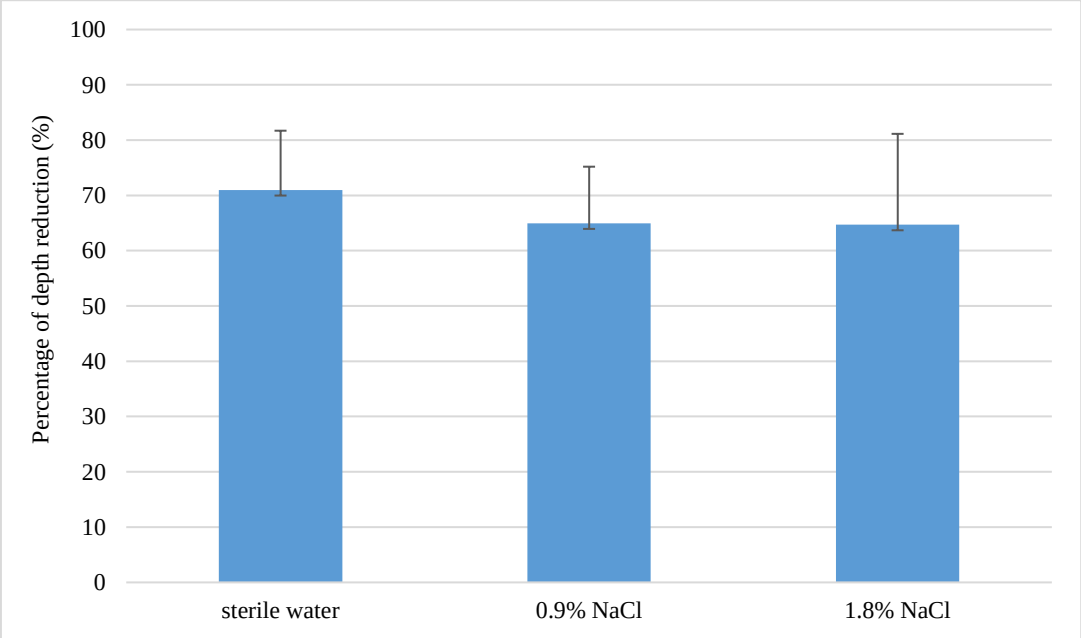

Figure 1 Percentage of the depth reduction at 1st week

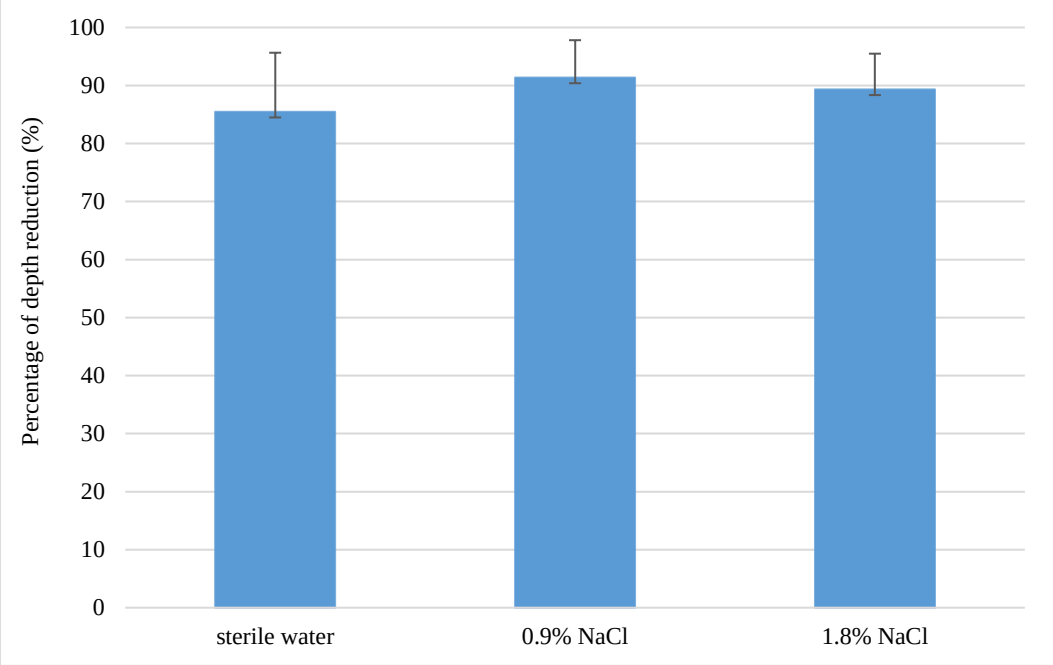

Figure 2 Percentage of the depth reduction at 3rd week
P-value from Kruskal-wallis test of percent of depth reduction in first and third week are 0.345 and 0.200 respectively

4.2 Discussions

Extraction socket healing depends on multifactorial factors. Therefore, we designed a double-blind, randomized, controlled clinical trial with a split-mouth to eliminate errors and bias. Saline is used extensively in medical and dentistry fields. It is applied to treat dehydration, injected into the venous system, wound irrigation or administered topically. According to the in vitro study of Huynh et al. (2016), human gingival fibroblast cells can be induced to migrate by being rinsed with 0.9% to 1.8% NaCl solution for 2 minutes, three times a day. The right amounts of NaCl solution (0.9% to 1.8%) promote the migration of human gingival fibroblasts and the production of extracellular matrix. In addition, using NaCl solution at a concentration of 7.2% NaCl can be harmful and make the cells dead when used in excessive amount, especially over a long period of time. NaCl can harm DNA and make it unable to repair. The interesting of the results of Huynh et al. (2016) leading to this clinical trial.

From the clinical study of Osundae (2014), rinsing mouth with warm saline 2 times and 6 times daily after 24 hours of extraction for 2 days has statistically significant less post-op alveolar osteitis than non-rinsing group ($P<0.001$) (Osunde et al., 2014). This confirms the benefit of using sodium chloride solution on extraction wound. Moreover, the study of Collins (2021) also shows the interesting result of rinsing the periodontal surgery wound with sodium chloride and 0.12% chlorhexidine mouth rinse. The results show the anti-inflammatory effectiveness, which are the statistically significant difference in the reduction of the gingival index at 1 week and 3 months after surgery. The result has no significant difference when compared with 0.12% chlorhexidine group. In their pilot study, sodium chloride was more effective in the aspect of plaque regrowth (Collins et al., 2021). Consequently, sodium chloride solution reduced the risk of alveolar osteitis and its anti-inflammation effect is comparable to chlorhexidine.

The blood clot in an extraction wound is replaced by granulation tissue in 1 week. Granulation tissue formation and collagen deposition occur from day 4–14 after the injury. The extraction socket decrease in depth begins after the granulation tissue is well-established, which takes about 3 weeks to month long or more in large defect (Häkkinen et al., 2011). In case where normal wound healing is hard to occur or in the case that need soft tissue to heal faster, the short period of bone exposure is highly required to reduce the risk of

osteonecrosis of jaw bone. In immunocompromised patients who have higher rate of infection, the delayed healing may cause more complications than healthy patients (S. a. Guo & L. A. DiPietro, 2010). The spread of infection in immunocompromised patients is harder to manipulate, accelerating wound to heal faster is the only thing that can prevent the complications.

Concerning the socket depth in the 0.9%, 1.8% NaCl group, the data demonstrated more reduction in socket depth compared to the sterile water group, although there was no significant difference. The result might be because of the small sample size and patients who might be healthy, which can make the results indistinctly different than in immunocompromised patients, especially in patients who have tendency of healing impairment. Therefore, more data collection may need to be done in the future.

5. Conclusion

In conclusion, this study demonstrated that rinsing mouth with 0.9% and 1.8% NaCl solution has tendency to reduce the depth of extraction socket clinically although the data did not show a statistically significance but clinically improved in the third week period. Nevertheless, there is no complications from rinsing the wound with 0.9% and 1.8% NaCl solution. The result of the study may help reducing the healing time and preventing post-op complication from delayed wound healing in the complicated case or in immunocompromised patients.

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