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Comparison of three cooling methods for burn patients: A randomized clinical trial

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ABSTRACT

Tap water may not be readily available in numerous places as a first aid for burns and, therefore, tea tree oil products are recommended alternatives. Our aim in this study was to compare the cooling effects of three burn-cooling methodologies, running tap water, Burnshield®, and Burn Cool Spray®, and suggest indications for each cooling method.

This randomized, controlled, study enrolled patients with burns who used the emergency service of Seoul Bestian Hospital from June 2015 to October 2015. The allocation of the cooling methods was randomly generated using a computer. We cooled the burn wounds by applying one of the three methods and measured the skin surface temperature and pain level using a visual analog scale (VAS) scoring.

Ninety-six patients were enrolled in this study. The variability in the median(IQR) skin temperatures of the three groups was from 33.5 °C (31.5–35.0) to 28.7 °C (25.9–30.9), 33.8 °C (32.0–35.4) to 33.2 °C (30.5–35.0), and 34.0 °C (32.0–35.1) to 34.4 °C (32.7–35.6) for the tap water, Burn Cool Spray®, and Burnshield®, respectively. The variability of the mean VAS pain scores was 6.9 to 4.8 (tap water), 5.6 to 4.5 (Burn Cool Spray®), and 5.5 to 3.3 (Burnshield®). The reduction of skin surface temperature by tap water was significantly greater than that by the other two methods. All three methods reduced the VAS pain score after 20 min of treatment ($p < 0.001$). The tap water had a similar effect to that of the Burn Cool Spray® but significantly better than that of Burnshield®. There was a significant difference in the skin surface temperature and VAS pain score reduction ($p = 0.014$ and $p = 0.007$, respectively) between the groups cooled by tap water below and above 24 °C. The patients who visited the center within 30 min showed a significantly higher skin temperature than those who came after 30 min did ($p = 0.033$).

Tap water and Burn Cool Spray® reduced the skin surface temperature, but the Burnshield® slightly increased it. All three cooling methods were effective in relieving pain. The temperature of the tap water used was related to the reduction in skin surface temperature and VAS pain score. The patients who visited the hospital within 30 min of their burn accident needed a longer cooling time to attain a comparable skin surface temperature to those who visited after 30 min.

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1. Introduction

Cooling is a well-known initial treatment to relieve pain and minimize ongoing tissue damage in patients with burns [1–4]. The British Burn Association recommends the use of ordinary tap water as the treatment of choice for the first aid management of burns. The Australian and New Zealand Burn Association recommends the removal of all clothing from the burn area and application of cool running tap water for 20 min [5]. However, there are numerous locations where tap water may not be readily available such as cars, airplanes, and fields. Furthermore, numerous burn patients arrive at the hospital without having cooled their wounds even when tap water is available. According to our data, approximately 10% of patients with burns that visited Seoul Bestian Hospital in 2013 had not performed any first aid measures after being injured. Furthermore, the use of tap water in an ambulance is not advised because the ambulance floor could become slippery, creating further safety hazards, particularly if the use of electrical equipment such as a defibrillator is necessary.

Tea tree (*Melaleuca alternifolia*) oil products are recommended as alternative first aid treatments for burns. The Australian ambulance and paramedic services have adopted them, and they are widely used in Korean medical emergency services [6,7]. Burnaid®, Burnshield®, Burnfree®, and Water-jel® are some commercialized products containing tea tree oil, and in Korea, they are currently mostly used in the form of sterile gel soaked dressings. Burnshield is a thin layer of foam impregnated with 96% water, tea tree oil, and emulsifiers at a pH of 5.5–7. Burnshield® comes in the form of sterile sheets sealed in aluminum packets, which are available in several sizes. However, the dressing form has limitations, including for the treatment of multiple wounds or wounds on irregular or hair-covered surfaces such as the fingers or scalp. The spray formulations such as Burn Cool Spray® have an advantage over the dressing form because they can be applied to a wider variety of surfaces and they allow multiple applications.

Our aim in this study was to compare the cooling effects of three burn-cooling methodologies, running tap water, Burnshield® (dressings), and Burn Cool Spray® (spray), and suggest the indications for each cooling method.

2. Materials and methods

2.1. Patients

We carried out a randomized, controlled study, which enrolled patients with burns who attended the emergency service of Seoul Bestian Hospital from June 2015 to October 2015. The inclusion criteria were 1) $\geq$ 16 years, 2) visited the hospital visit within 3 h of burn accident (some authors have suggested that cooling may be effective up until 3 h after the accident [8]), and 3) burn area covered less than 5% of the total body surface area (TBSA). We excluded patients with the following characteristics: (1) chemical burn, (2) hypothermia, (3) received analgesics prior to the cooling treatment, and (4) patients who were uncooperative or with neurologic or psychiatric disorders or both. Patients who fulfilled the inclusion criteria and agreed to participate in the study signed an informed consent form prior to enrolment.

2.2. Wound treatment and measurement of skin surface temperature and pain score

We cooled the burn wounds by applying one of three methods, running tap water, Burn Cool Spray® (T&L Co. Ltd., Korea), and Burnshield® (Levtrade International, South Africa). We did not use any analgesics during the cooling treatment. The allocation of the cooling method was randomly generated using a computer. The research coordinator applied the respective cooling procedure for 20 min and measured the skin surface temperature every 5 min (five times in total from 0 to 20 min) using an infrared camera (FLIR T420, FLIR Systems Inc., Danderyd, Sweden). During the temperature measurements, we used a 50-cm long plastic ruler to keep a constant distance (approximately 50 cm) between the wound and the infrared camera. The pain score was assessed using a 10-cm visual analog scale (VAS) where 10 cm reflects worst pain [9]. The VAS was a straight horizontal line of 10 cm. We measured the initial VAS scores prior to every application. The specific cooling procedures are described below.

Cooling with tap water was carried out for 20 min in the shower mode. We used the tap water after setting the temperature to the coolest point. The temperature of the tap water ranged from 23.9 °C to 27.3 °C. The Burn Cool Spray® was sprayed on the burn wound covering the whole surface every 5 min, just after measuring the surface temperature. The Burnshield® was applied to the burn wound, and the surface temperature was measured after partially removing the Burnshield® dressing, which was replaced once the measurement was performed. All the skin surface temperatures were measured leaving a 50-cm distance between the infrared camera and the burn wound. FLIR Tools (version 4.1) was used to analyze the images. The wound temperature was defined as the hottest point of the wound (Fig. 1).

Because of the nature of this study, the patients and research coordinator who applied the cooling procedure and measured the surface temperature or recorded the pain scores but not the treating physician were allowed to know the cooling methods used.

2.3. Statistical analysis

All the analyses were performed using the statistical package for the social sciences (SPSS) software program for Windows (version 14.0, SPSS Inc., Chicago, IL, USA). Nominal variables are presented as frequencies and percentages. We used the Shapiro–Wilk test to assess the normality of the continuous variables, which are presented as the means $\pm$ standard deviations (SD) for normally distributed data, and medians and interquartile ranges for non-normally distributed variables. Analysis of variance (ANOVA) tests were used to assess differences between the three independently sampled groups. The Kruskal-Wallis test was used to assess the differences between the three independently sampled groups of non-normally distributed continuous variables. For the nominal variables, the Chi-squared (X^2) test was used to identify differences between the groups. When the expected

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