Comparing the Antiswelling and Analgesic Effects of Three Different Ice Pack Therapy Durations: A Randomized Controlled Trial on Cases With Soft Tissue Injuries

Chia-Chi Kuo1 • Chiu-Chu Lin2* • Wei-Jing Lee3 • Wei-Ta Huang3

1MSN, RN, Advanced Practice Nurse, Emergency Department, Chi-Mei Medical Center; Doctoral Student, School of Nursing, Kaohsiung Medical University; and Adjunct Instructor, Department of Nursing, Chang Jung Christian University • 2PhD, RN, Associate Professor, College of Nursing, Kaohsiung Medical University • 3MD, Visiting Staff, Emergency Department, Chi-Mei Medical Center.

ABSTRACT

Background: Ice pack therapy has been widely used in treatment for soft tissue injuries. However, no studies have yet explored the most appropriate and effective duration for ice therapy with ice packs.

Purpose: This study explored the antiswelling and analgesic effects of different ice pack therapy durations on soft tissue injuries as well as patient discomfort.

Methods: An experimental design including pretest and three posttests with three groups was used in this study. Using convenience sampling and randomized block assignment, 99 participants with soft tissue injuries from the emergency department of a medical center in southern Taiwan were included in this study. With 33 participants in each group, three groups with ice pack therapy for 10, 20, and 30 minutes were indicated to compare skin temperature, swelling, and pain differences in ice-treated areas as well as participant discomfort.

Results: This study found no significant differences in the effect of different ice pack therapy durations among the three groups. However, this study identified significant differences between pretest and each posttest in terms of changes in skin temperature, pain, and numbness and rash-related discomfort in each group.

Conclusion/Implications for Practice: Research results found that the three different ice pack therapy durations could lower skin temperature and reduce partial pain. The different ice pack therapy durations would cause similar discomfort incidence rates in the three groups. Ice pack therapy for 10 minutes could reduce partial swelling and pain effectively. Accordingly, we suggest that 10 minutes is the optimal ice pack therapy duration for persons with soft tissue injuries. However, the ice pack therapy duration should be adjusted according to individual needs and situation.

Key Words
soft tissue injuries, ice pack therapy, antiswelling, analgesic, randomized controlled trial.

Introduction

Cryotherapy is the most commonly used method in clinical practice for managing regional strain, sprain, contusion, and hematoma caused by sports injuries or accidents. There are different types of cryotherapy, the simplest, most convenient, and most economic of which is ice pack therapy (Chen, 2000; Fang, Hung, Wu, Fang, & Stocker, 2012). Ice pack therapy is applied to reduce regional skin temperature and cause blood vessel contraction to provide antiswelling and analgesic effects in the acute stages of injuries (Nadler, Weingand, & Kruse, 2004). Studies have shown a significant reduction in skin temperature at initiation 8–10 minutes after ice pack therapy (Chen & Huang, 2000; Enwemeka et al., 2002; Palmer & Knight, 1996); yet, case studies showed that excessive ice pack therapy duration can induce frostbite or cold injuries such as regional redness, tingling, and swelling, with significant risk of vesicular and ice burns in severe cases (Keskin, Tosun, Duymaz, & Savaci, 2005; Kujawska, Kwaselow, & Pansare, 2009; O’Toole & Rayatt, 1999; Palmer & Knight, 1996). Accordingly, ice pack therapy duration correlates positively with regional skin and nerve damage risk (Nadler et al., 2004). Sustained ice pack therapy durations in experimental studies have varied greatly from 10 to 40 minutes, and most participants have been healthy adults (Bleakley, McDonough, & MacAuley, 2006; Chen & Huang, 2000; Enwemeka et al., 2002; Herrera, Sandoval, Camargo, & Salvini, 2010; Palmer & Knight, 1996; Palmieri et al., 2006). Also, few experimental studies have examined the discomfort induced by ice pack therapy. Therefore, this study attempted to explore the antiswelling, analgesic, and discomfort effects...
of different ice pack therapy durations of 10, 20, and 30 minutes on participants with soft tissue injuries using a randomized controlled trial. Study findings can be used to propose an optimal ice pack therapy duration in clinical practice.

Methods

Design and Data Collection
This study used an experimental design with three groups. Data collection included one pretest and three posttest readings. A convenience sampling was used to recruit participants with soft tissue injuries from the emergency department of a medical center in southern Taiwan. Randomized block assignment was used to assign each participant to the 10-minute group \( n = 33 \), 20-minute group \( n = 33 \), or 30-minute group \( n = 33 \) for ice pack therapy. Ninety-nine participants were included in this study, which ran from May to November 2011. There were no dropouts or withdrawals.

A randomized block procedure (Kang, Ragan, & Park, 2008) was performed as follows: (a) a block size of 3 was chosen; (b) balanced combinations with 10-minute (A), 20-minute (B), and 30-minute (C) packing, subjects were calculated as six conditions (ABC, ACB, BAC, BCA, CAB, and CBA); and (c) blocks were randomly chosen to determine the assignment of all 99 participants, with an allocation ratio of 1:1.

Participants who met the inclusion criteria were introduced to the study purpose and procedures, asked to sign an informed consent form if they agreed to participate, and then assisted by research nurses to fill out the demographic scale and receive pretests. Ice pack therapy was applied as specified based on group assignment using the randomized block assignment sequence. Posttests were administered immediately, and results were recorded in the scale after three sessions of ice pack therapy. Completed scale data were encoded, keyed using the Microsoft Excel software, and saved by the researcher.

Study Participants and Sampling
Study inclusion criteria included (a) being diagnosed with regional strain, sprain, contusion, or hematoma on limbs and prescribed to receive ice pack therapy; (b) \( \geq 20 \) years old, without visual, hearing, or psychiatric disorder; (c) conscious and able to communicate in Mandarin or Taiwanese; and (d) literate with at least an elementary education.

Exclusion criteria included those who met the above inclusion criteria but had regional soft tissue injuries accompanying bone fractures or laceration and those who had peripheral neurovascular dysfunction, Raynaud’s disease, or a history of cold allergy.

Sample size was determined based on the study results of Bleakley et al. (2006) on participants with ankle sprain, with an effect size of .16, an \( \alpha \) of .05, and a power of .8. A sample size of 90 was determined using the G*power 3.1 software. Assuming an attrition rate of 10% and estimating that 33 are needed for each group, a total sample size of 99 was required.

Intervention Program
The ice packs used in this study were prepared according to the “cold and hot therapy” standard established by the nursing department of the study hospital. According to the applicable area and lesion size, we filled one half to two thirds of a clinical-use plastic bag (approximately 20 \( \times \) 25 cm) with ice cubes and adequate water, wrapped the ice pack in a single layer of pillowcase, and gently placed it on the affected area. To ensure the participant received a complete intervention (i.e., ice pack bags completely cover lesions and also achieve the required packing time), research nurses monitored the treatment process throughout the participant ice pack therapy session. We established the three ice pack therapy durations (10, 20, and 30 minutes) in accordance with evidence-based data. After continuous ice pack therapy had been applied for the specified durations in the three groups, ice packs were removed for 30 minutes and then reapplied for the specified duration. Ice pack therapy sessions were repeated for a total of three times for all three groups to assess the change effects on skin temperature, swelling, pain, and discomfort in the ice-treated areas at the following time points: before ice therapy (baseline), immediately after the first ice therapy session, immediately after the second ice therapy session, and immediately after the third ice therapy session.

Instruments
Before the study, the researcher provided training and showed study instrument operation and data interpretation to the three research nurses. The researcher also randomly inspected research nurses’ recruitment, research implementation, and data collection procedures to ensure internurse consistency and execution accuracy.

Skin temperature
A TES-1306 thermometer was used to measure skin temperature, and measurements were recorded on the scale by research nurses. The TES-1306 thermometer has a measurement range between \(-20^\circ C\) and \(760^\circ C\). To ensure accurate measurements, the researcher trained the research nurses on TES-1306 operation before participant recruitment. To ensure measurement consistency, researchers calibrated the thermometer before each measurement. To avoid the influence of environmental temperature on skin temperature, the recruitment environment was controlled at a room temperature of \(21^\circ C\)–\(23^\circ C\) using a central air-conditioning system.

Swelling degree (circumference of affected area)
Research nurses used same-model measuring tapes to measure the affected side circumferences. Circumference periphery was marked with a ballpoint pen during the pretest to ensure the
consistency and accuracy of the following three measurements. To ensure interrater consistency and accuracy in swelling degree, the primary researcher showed the procedure to measure the circumference (cm) of affected limbs before data collection.

**Pain score**

Pain in the affected area was assessed on a 10-cm visual analogue scale ranging from 0 (no pain at all) to 10 (the worst pain). Scores reflected participants’ subjective feelings at that time of scoring. Research nurses recorded the results on the scale.

**Ice pack therapy discomfort index**

The four discomfort indices including feelings of numbness, itching, cold, and observation of ice pack therapy-induced rash were measured according to a 10-cm visual analogue scale from 0 (no numbness, no rash, no itching, no cold at all) to 10 (the worst numbness, rash, itching, and cold). Research nurses recorded all the results. This index was developed based on the related literature (Keskin et al., 2005; Kujawskas et al., 2009; O’Toole & Rayatt, 1999; Palmer & Knight, 1996) and our clinical experience. Furthermore, the index was evaluated and confirmed by the research team including an advanced practice nurse, a nursing faculty, and two emergency department physicians. To ensure interrater rash-level measurement consistency, the research team designed a rash-level assessment tool that optimized objective data collection.

**Ethical Considerations**

This study was approved by the institutional review board (IRB099911–009) of the medical center in southern Taiwan. At the beginning of this study, the research nurses explained the study purpose, methods, and procedures to all participants and then started conducting the data collection and intervention program after having obtained written informed consent. During the study period, all participants were free to withdraw from this study. To protect participant privacy, all data were encoded and used only for research purposes. For the sake of fairness, this study adopted a randomized block assignment to evenly assign participants who met the inclusion criteria to the three ice pack therapy groups.

**Data Analysis**

Data were analyzed using SPSS for Windows 17.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to determine frequency distributions, percentages, means, and standard deviations. The chi-square test or Fisher’s exact test was used to examine the homogeneity of demographic characteristics and test the incidence rates of discomfort induced by ice pack therapy among the three groups. Analysis of variance (ANOVA) compared between-group differences before pretest and each posttest in terms of changes in skin temperature, swelling, pain, and discomfort. Analysis of covariance compared only the changing effects on pain scores between pretest and each posttest among the three groups after adjusting for analgesic use. Repeated measures ANOVAs compared the overall changing effects between pretest and posttests in each group.

**Results**

**Participant Characteristics Distribution and Pretest Results**

Table 1 summarizes the distribution of demographic characteristics. The main cause of injury was a traffic accident (n = 85, 85.86%), contusion or hematoma (n = 94, 94.95%) were the main nature of injury, and most reported no analgesic use during ice pack therapy (n = 68, 68.69%). The chi-square test showed no significant difference in demographic characteristics among the three groups (p > .05), meaning that the three groups were similar.

The comparison of pretest baseline among the three groups showed that mean skin temperature before ice pack therapy was 31.45°C ± 2.45°C; mean swelling degree (circumference) was 27.32 ± 9.04 cm; mean pain score was 3.03 ± 2.33; mean rash discomfort index was 0.74 ± 0.98; and mean numbness, itching, and cold discomfort index was 0 ± 0. No statistically significant difference was found (p > .05), suggesting the homogeneity and comparability of pretests among the three groups.

**Changes in Skin Temperature, Swelling, Pain, and Discomfort**

ANOVA was used to test the range of changes in skin temperature, swelling, pain, and discomfort among the three groups. Repeated measures ANOVAs were used to compare the overall changing effects of time in each group (Table 2).

With regard to skin temperature effect, the mean range of changes at posttest 1 (posttest 1–pretest) was −9.22°C ± 4.38°C in the 10-minute group, −9.77°C ± 4.73°C in the 20-minute group, and −10.39°C ± 5.07°C in the 30-minute group. ANOVA revealed no statistically significant difference between pretest and posttests in ranges of change among the three groups (F = 0.5 and p = .6055, F = 0.95 and p = .3896, and F = 1.86 and p = .1614, respectively). Furthermore, based on the repeated measures ANOVAs on skin temperature, results showed a significant difference across time in each group (F = 108.80 and p < .0001, F = 126.53 and p < .0001, and F = 104.91 and p < .0001, respectively). Post hoc analysis showed the pretest of skin temperature as significantly higher than posttest 1, posttest 2, and posttest 3 in each group. Results showed that all three groups achieved significantly reduced skin temperatures after the first ice pack therapy, with the three groups having the same temperature reduction effect.

With regard to anti-swelling (changes in circumference) effect, ANOVA showed a downward trend in swelling (circumference) at posttest 1, posttest 2, and posttest 3 when
compared with the pretest but no statistically significant difference in ranges of change among the three groups ($F = 0.27$ and $p = .7646$, $F = 0.8$ and $p = .4529$, and $F = 1.36$ and $p = .2611$, respectively). Repeated measures ANOVAs showed a significant difference across time in circumference in the 10-minute group ($F = 3.83$, $p = .0323$) but no significant difference across time in the 20-minute and 30-minute groups. Post hoc analysis showed no significant difference between pretest and posttest in each group. Results showed that ice pack therapy did not produce a significant swelling reduction effect.

With regard to the analgesic effect, ANOVA showed a downward trend in pain at posttest 1, posttest 2, and posttest 3 when compared with pretest, but there was no statistically significant difference in ranges of change among the three groups ($F = 1.09$ and $p = .3411$, $F = 1.41$ and $p = .2481$, and $F = 0.95$ and $p = .3897$, respectively). After adjusting for analgesic use, changes in pain scores at posttest 1–pretest, posttest 2–pretest, and posttest 3–pretest among the three groups still revealed no significant difference ($F = 1.11$ and $p = .3340$, $F = 1.41$ and $p = .2500$, and $F = 0.96$ and $p = .3870$, respectively). Repeated measures ANOVAs showed a significant difference in analgesic effect across time in each group. Post hoc analysis showed the pretest of pain scores to be significantly higher than posttest 1, posttest 2, and posttest 3 in each group. Results showed significantly reduced pain scores after the first ice pack therapy for all three groups and the same.

### TABLE 1.
Comparisons of Demographic Characteristics and Pretest Results Among the Three Groups ($N = 99$)

<table>
<thead>
<tr>
<th>Item</th>
<th>Total ($N = 99$)</th>
<th>10-Minute Group ($n = 33$)</th>
<th>20-Minute Group ($n = 33$)</th>
<th>30-Minute Group ($n = 33$)</th>
<th>$\chi^2/F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>52 (52.53)</td>
<td>15 (45.45)</td>
<td>21 (63.64)</td>
<td>16 (48.48)</td>
<td>2.51</td>
<td>.2849</td>
</tr>
<tr>
<td>Female</td>
<td>47 (47.47)</td>
<td>18 (54.55)</td>
<td>12 (36.36)</td>
<td>17 (51.52)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td>38.64 (15.62)</td>
<td>38.30 (14.76)</td>
<td>40.45 (17.07)</td>
<td>37.15 (15.24)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤Junior high school</td>
<td>24 (24.24)</td>
<td>10 (30.30)</td>
<td>6 (18.18)</td>
<td>8 (24.24)</td>
<td>2.70</td>
<td>.6090</td>
</tr>
<tr>
<td>General or vocational high school</td>
<td>33 (33.33)</td>
<td>8 (24.24)</td>
<td>12 (36.36)</td>
<td>13 (39.39)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above college</td>
<td>42 (42.42)</td>
<td>15 (45.45)</td>
<td>15 (45.45)</td>
<td>12 (36.36)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>History of chronic disease</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.33</td>
<td>.8479</td>
</tr>
<tr>
<td>Yes</td>
<td>24 (24.24)</td>
<td>9 (27.27)</td>
<td>8 (24.24)</td>
<td>7 (21.21)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>75 (75.76)</td>
<td>24 (72.73)</td>
<td>25 (75.76)</td>
<td>26 (78.79)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cause of injury</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.1589b</td>
<td></td>
</tr>
<tr>
<td>Traffic accident</td>
<td>85 (85.86)</td>
<td>30 (90.91)</td>
<td>25 (75.76)</td>
<td>30 (90.91)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupational or activity injury</td>
<td>14 (14.14)</td>
<td>3 (9.09)</td>
<td>8 (24.24)</td>
<td>3 (9.09)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Nature of injury</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.1232b</td>
<td></td>
</tr>
<tr>
<td>Sprain or strain</td>
<td>5 (5.05)</td>
<td>1 (3.03)</td>
<td>4 (12.12)</td>
<td>0 (0.00)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contusion or hematoma</td>
<td>94 (94.95)</td>
<td>32 (96.97)</td>
<td>29 (87.88)</td>
<td>33 (100)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ice pack therapy experience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.57</td>
<td>.7510</td>
</tr>
<tr>
<td>Yes</td>
<td>44 (44.44)</td>
<td>16 (48.48)</td>
<td>15 (45.45)</td>
<td>13 (39.39)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>55 (55.56)</td>
<td>17 (51.52)</td>
<td>18 (54.55)</td>
<td>20 (60.61)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Analgesic use</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.66</td>
<td>.7198</td>
</tr>
<tr>
<td>Yes</td>
<td>31 (31.31)</td>
<td>9 (27.27)</td>
<td>12 (36.36)</td>
<td>10 (30.30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>68 (68.69)</td>
<td>24 (72.73)</td>
<td>21 (63.64)</td>
<td>23 (69.70)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Time of injury (hours)</strong></td>
<td>4.29 (4.77)</td>
<td>4.34 (4.47)</td>
<td>3.97 (4.63)</td>
<td>4.57 (5.31)</td>
<td>0.13</td>
<td>.8787</td>
</tr>
<tr>
<td><strong>Skin temperature (°C)</strong></td>
<td>31.45 (2.45)</td>
<td>30.76 (2.63)</td>
<td>31.90 (2.22)</td>
<td>31.67 (2.39)</td>
<td>2.03</td>
<td>.1373</td>
</tr>
<tr>
<td><strong>Swelling (circumference, cm)</strong></td>
<td>27.32 (9.04)</td>
<td>27.52 (8.59)</td>
<td>27.32 (9.05)</td>
<td>27.11 (9.69)</td>
<td>0.02</td>
<td>.9833</td>
</tr>
<tr>
<td><strong>Pain score (VAS score)</strong></td>
<td>3.03 (2.35)</td>
<td>2.67 (2.13)</td>
<td>2.94 (2.50)</td>
<td>2.40 (3.48)</td>
<td>1.04</td>
<td>.3579</td>
</tr>
<tr>
<td><strong>Numbness index (VAS score)</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rash index (VAS score)</strong></td>
<td>0.74 (0.98)</td>
<td>0.55 (0.71)</td>
<td>1.02 (0.88)</td>
<td>1.14 (0.79)</td>
<td>1.03</td>
<td>.3605</td>
</tr>
<tr>
<td><strong>Itching index (VAS score)</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cold index (VAS score)</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Unless otherwise indicated, data are presented as mean and SD. VAS = visual analog scale.

*Data are number and percentage. $^b$p of Fisher’s exact test.
analgesic effect between the three groups after adjusting for the covariate of analgesic use.

With regard to ice pack therapy-related numbness and rash, ANOVA showed an upward trend in numbness and rash at posttest 1, posttest 2, and posttest 3 when compared with pretest. However, there was no statistically significant difference in ranges of change among the three groups. Repeated measures ANOVA results showed a significant difference across time in each group on numbness and rash. Post hoc analysis showed the pretest of numbness as significantly lower than posttest 1 and posttest 2 in the 10-minute group and significantly lower than posttest 2 and posttest 3 in the 30-minute group. Results showed that all three groups had significantly increased incidence of numbness and rash after the first ice pack therapy, with the same discomfort level for numbness and rash between groups. However, a potential upward trend in numbness and rash discomfort was observed when therapy duration gradually increased to 30 minutes.

With regard to itching and cold caused by the ice pack therapy, ANOVA showed no significant difference in ranges of change among the three groups. Repeated measures ANOVA results also showed no significant difference across time in each group in terms of itching and cold. This means that the three groups did not experience significant discomfort related to itching or cold.

Incidence Rates of Ice Pack Therapy-Induced Discomfort

The above results indicate no significant difference in the degree of discomfort induced by ice pack therapy in terms of numbness, rash, itching, and cold among the three groups. However, a potential upward trend in numbness and rash discomfort was observed when therapy duration gradually increased to 30 minutes.
In addition, researchers compared the incidence of discomfort in terms of numbness, rash, itching, and cold by the number of occurrences, with results summarized in Table 3. The chi-square test showed no significant difference in the incidence rates of numbness ($p = .4557$), rash ($p = .8533$), itching ($p = 1.0000$), and cold ($p = .9460$) during the ice pack therapy among the three groups. One third of the participants (32.32%, $n = 32$) experienced numbness, 80.81% ($n = 80$) experienced rashes, 5.05% ($n = 5$) experienced itching, and 18.18% ($n = 18$) experienced cold.

**Discussion**

A systematic review of the study by Bleakley, McDonough, and MacAuley (2004) on cryotherapy in the management of soft tissue injuries found that only five studies used subjects with acute ligament sprains. These five studies did not explore the effects of different ice pack therapy durations. Accordingly, our research team further conducted a comprehensive literature review from which only one experimental study (Bleakley et al., 2006) evaluated the effect of different ice pack therapy durations on acute soft tissue injuries; however, this experimental study did not explore the side effect of ice pack therapy. Therefore, this present study only compared the temperature reduction, antiswelling, and analgesic effects of different ice pack therapy durations with the results of similar studies on the applications of ice pack therapy on healthy adults or participants with soft tissue injuries.

**Temperature Reduction Effect of Ice Pack Therapy**

Our study results indicate that all the three groups of ice pack therapy could significantly reduce skin temperature in ice-treated areas, with a mean reduction of $9^\circ C$–$10^\circ C$. Our finding is in line with the crossover study of Chen and Huang (2000), who showed that a significant within-group difference in skin temperature before and after ice therapy among all the three ice pack therapy durations of 10, 20, and 30 minutes ($p < .005$) occurred in 12 healthy adults. Our study found no significant between-group difference among the three groups. This is consistent with a study by Palmer and Knight (1996) who designed a crossover study including 12 healthy adult athletes assigned to 20-minute, 30-minute, and 40-minute groups. Their results showed no significant between-group differences in skin temperature ($p = .07$). They also found a significant $8^\circ C$–$10^\circ C$ reduction in skin temperature during the initial 10 minutes, which is similar to our study of a mean of $9.22^\circ C$ reduction in the 10-minute group.

The above results indicate that ice pack therapy for 10, 20, and 30 minutes all significantly reduce skin temperature. The mean time taken to reduce skin temperature by $10^\circ C$ was 10 minutes of ice pack therapy at $0^\circ C$, with the reduced skin temperature effect lasting for up to 60 minutes (Yanagisawa, Homma, Okuwaki, Shimao, & Takahashi, 2007). Thus, it may take 60 minutes to recover skin temperature to normal after the removal of ice packs. Palmer and Knight (1996) found two cases that still had the discomfort effects of tingling even when the skin was touched gently 1 week after the ice pack therapy. In view of this, healthcare professionals should cautiously evaluate the discomfort effects induced by ice pack therapy during the process and minimize the duration for ice pack therapy to reduce side-effect risks.

**Antiswelling Effect of Ice Pack Therapy**

The antiswelling effect with different ice pack therapy durations achieved a significant circumference reduction in the
10-minute group. This finding is similar to the study of Bleakley et al. (2006) that significantly reduced ankle pain swelling of patients using 10-minute ice pack therapy \((p < .05)\). However, there was no significant circumference reduction effect in the 20-minute and 30-minute groups in our study. Average circumference reduction ranged from 27.52 ± 8.59 cm at pretest to 26.92 ± 8.7 cm at posttest in the 10-minute group. However, the clinical significance of this circumference reduction range should be considered with regard to clinical application.

**Analgesic Effect of Ice Pack Therapy**

The analgesic effect of the three groups with different ice pack therapy durations showed significant pain score reduction but no difference in the range of pain score reduction among the three groups. This finding is also consistent with Bleakley et al. (2006), who found that both groups could significantly reduce the pain score of patients with ankle sprain \((p < .05)\). Our finding is also similar to Fang et al. (2012), who applied ice pack therapy on postoperative pain following arthroscopy. The study compared changes in pain at pretest and posttests between an experimental group (ice pack therapy for 10 minutes, removing for 50 minutes for three times consecutively) and control group. Their results showed a significant difference between the two groups \((p < .05)\), suggesting that 10 minutes of ice pack therapy could significantly reduce patient pain scores.

In addition, Herrera et al. (2010) conducted a randomized controlled study with 36 healthy subjects to compare the effects of ice massage, ice pack, and cold water immersion on sensory nerve conduction velocity. The randomized controlled study results showed that, after 15 minutes, ice massage, ice pack, and cold water immersion reduced the sensory nerve conduction velocity by 20.4, 16.7, and 22.6 m/s, respectively \((p < .05)\). This finding indirectly proves that ice pack therapy can lower the pain conduction velocity to achieve analgesic effect.

In summary, empirical evidence from this study is consistent with the findings of previous studies concerning ice pack therapy. Ice therapy for 10 minutes can effectively reduce skin temperature and achieve regional antiswelling and analgesic effects. There was no significant difference between groups in ice pack therapy effects, which indicates that ice pack therapy effects will not vary with ice pack therapy duration.

**Conclusions, Study Limitations, and Suggestions**

Ice pack therapy is a common, simple, convenient, and economic method for the urgent treatment of soft tissue injuries. Results from this evidence-based study suggest that the application of ice pack to the affected areas related to soft tissue injuries for 10 minutes can significantly reduce regional skin temperature and alleviate regional swelling and pain among participants. On the other hand, our results indicated that temperature reduction, antiswelling effects, and analgesic effects did not increase with prolonged ice pack therapy duration. Furthermore, the degree and incidence rates of discomfort induced by ice pack therapy also did not increase with prolonged ice pack therapy duration. Even so, there is a potential upward trend in the discomfort of numbness and rash when ice therapy time increased up to 30 minutes.

Because of the time limitation, this study only conducted three follow-up posttests of ice pack therapy. Thus, it is difficult to presume the longer-term effects of applying ice pack therapy after the initial 2–3 days of soft tissue injury. Therefore, we suggest that future studies follow changes in pain, swelling, and discomfort 2–3 days after ice pack therapy use to reflect subsequent effects of different ice pack therapy durations. Moreover, this study compared neither the skin temperature recovery effect nor the time of pain recurrence after the removal of ice packs. Therefore, we are unable to infer optimal ice pack therapy duration interval. Future studies should monitor changes in temperature recovery and pain recurrence after the removal of ice packs to obtain an optimal duration interval recommendation.

On the basis of our evidence-based results, we suggest that, when ice pack therapy is applied to soft tissue injuries in clinical practice, healthcare professionals should provide health education to patients on adjusting ice pack duration according to individual effects and perceptions. In other words, an individual’s self-adjustment of ice pack duration should reflect both discomfort caused by numbness, rash, itching, and cold and regional changes in pain and swelling. Moreover, the potential upward trend in the discomfort of numbness and rash when ice pack therapy duration reached 30 minutes has clinical implications. In view of this, the authors suggest an optimal ice pack therapy duration of 10 minutes to achieve the maximum effects with minimum harm. In addition, healthcare professionals should not only recognize the contraindications of ice therapy including peripheral neurovascular dysfunction, Raynaud’s disease, rheumatoid arthritis, and history of cold allergy but also cautiously evaluate the effects of ice pack therapy and changes in regional blood circulation, feelings, and motion functions. Accordingly, a person with soft tissue injuries may benefit from cryotherapy.

**Acknowledgments**

We would like to express our appreciation to the Taiwan Nurses Association for funding this study (TWNA-0092029). Special thanks to Chia-Ying Chen, Chia-Chen Wu, and Ya-Wen Chen, doctoral students at the College of Nursing at Kaohsiung Medical University, for their contribution in the evidence-based literature appraisal. Our sincerest gratitude also goes to Ju-Chun Wei, Ya-Chan Yang, and Chen-Yun Wu, who are registered nurses at the Department of Emergency Medicine of the Chi Mei Medical Center, for their assistance in data collection.
References


不同冰敷時間對軟組織傷害個案之制腫與止痛效果：
隨機控制試驗

郭嘉琦1 林秋菊2* 李維鈞3 黃威達3

1奇美醫院急診室高階護理師，長榮大學護理系兼任講師暨高雄醫學大學護理學研究所
博士生 2高雄醫學大學護理學院副教授 3奇美醫院急診室主治醫師

背景 冰敷已被普遍運用於局部軟組織傷害的治療，但卻缺乏一致性冰敷時間與效應探討。

目的 本研究旨在探討，不同冰敷時間對軟組織傷害病人的局部制腫、止痛效果與冰敷不適
感的影響。

方法 研究採前測及三次後測之三組實驗設計：方便取樣南部某醫學中心急診之軟組織傷害
個案，以隨機區集(randomized block)方式分配至冰敷10分鐘組、20分鐘組、30分鐘組
各33人，比較各組受試者冰敷部位的體表溫度、腫脹、疼痛、不適感指數的前後測差
異。

結果 研究結果發現，不同冰敷時間，對局部組織的體表溫度、腫脹、疼痛、不適感指數的
前後測變化，三組之間未達顯著差異，但三組各自組內前後測的比較，在體表溫度、
疼痛、麻與紅之不適感均達顯著差異。

結論／研究結果顯示，三種冰敷時間均可達到降低體表溫度、減少局部疼痛之效果；三種冰
敷時間均有相近的麻與紅之不適感發生率；每次冰敷10分鐘便可達到有效的局部制腫
與止痛效果。據此實證結果，吾人建議對局部軟組織傷害最佳的冰敷時間為10分鐘，
但可依個案之需求及舒適情況作調整。

關鍵詞：軟組織傷害、冰敷、制腫、止痛、隨機控制試驗。