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Original Research

# The Effect of Cold Therapy Applied to the Incision Area After Abdominal Surgery on Postoperative Pain and Analgesic Use

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ABSTRACT

*Background:* Cold therapy is one of the most common nonpharmacologic pain treatments. Despite the existence of many studies about cold therapy, few have examined the effects of cold therapy after abdominal surgery.
*Aims:* The purpose of the study was to investigate the effect of cold therapy applied to the incision area after abdominal surgery on postoperative pain and analgesic use.
*Design:* This study was a randomized controlled trial
*Methods:* The sample included 60 patients (30 control, 30 experimental) undergoing abdominal surgery. Researchers recorded information from a patient information form, a visual analogue scale (VAS), a pain evaluation form, and the vital signs recording form.
*Results:* There was no statistically significant difference in pain level between the experimental and control groups as measured by VAS at postoperative hour 1 ($p > .05$). Furthermore, no statistically significant difference in VAS pain levels between groups was observed at postoperative hours 1, 2, and 8 prior to application of cold therapy ($p > .05$). Then, when cold therapy was applied at hours 1, 2 and 8, the pain level decreased significantly in the experimental group ($p = .001$). Pain also decreased in the control group between hours 1 and 8, but this decrease was not as great as that in the experimental group ($p = .024$).
*Conclusions:* Both groups had decreased pain levels, and the decrease in the experimental group was greater than in the control group but cold therapy had no statistically significant effect on analgesics use.


Pain is an expected result of a surgical intervention that can affect patient recovery (Buyukyilmaz & Asti, 2009; Topcu & Findik, 2012). Thus, the aim of postoperative pain management is to provide patient comfort, as well as to prevent any negative systemic effects (Arslan & Celebioglu, 2004; Kilic & Oztunc, 2012). Uncontrolled postoperative pain can also affect recovery times, leading to prolonged stays in the intensive care unit or hospital and increasing the cost of care. Furthermore, postoperative pain can lead to decreased patient satisfaction and quality of life, and to the development of chronic pain (Tur, 2007; Nett, 2010; Srivastava et al., 2012).

The management of postoperative pain may include pharmacologic and non-pharmacologic methods. Non-pharmacologic methods are increasingly applied in many specialties, supported by numerous studies. One non-pharmacologic method to relieve postoperative pain is cold therapy (Kuzu, 1999; Koc et al., 2006; Shin et al., 2009; Saeliw et al., 2010; Kilic & Oztunc, 2012; Mahshidfar et al., 2016; Paiva et al., 2016).

Cold therapy is a simple and inexpensive treatment that may employ a variety of delivery methods. Ice bags, cold/ice packs, ice massage (friction), ice-water immersion, cold sprays, or cold compresses can all be used as cold therapy. Applying ice/cold reduces the skin temperature and slows activity in nerve fibers and receptors, thereby changing pain perception. Cold therapy also causes venous constriction, relieving pain by reducing bleeding, swelling, and edema (Yagiz On, 2006; Srivastava et al., 2012).

The effect of cold therapy on human skin occurs in four stages. During minutes 1-3, the patient feels cold. This changes to burning and pain sensations during minutes 2-7. In the third stage, at 5-12 minutes, the patient feels less numbness or pain, neural transmission decreases, and painful spasms stop. During minutes 12-15, the metabolic rate increases, and deep tissue reflex

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vasodilation occurs, allowing proper tissue perfusion. Paler and colder skin is expected during cold therapy (Karagozoglu, 2001; Demir, 2012), as cold gel/ice packs decrease the skin temperature by 10-–15°C within 15 minutes. Nerve conduction slows when the skin temperature decreases to 27°C, and analgesic effects are noted at 13.6°C (Sunitha, 2010; Erek Kazan, 2011).

Studies have shown that cold therapy is effective in reducing pain after orthopedic, gynecologic, and cardiac surgery (Demir & Khorshid, 2010; Dambros et al., 2012; Zencir & Eser, 2016; Francisco et al., 2018), but limited studies have examined its effect on pain after abdominal surgery (Koc et al. 2006; Watkins et al. 2014). Koc et al. (2006) concluded that a 20-minute application of an ice bag on the incision after inguinal hernia surgery was an effective and safe method for pain control when used on the first postoperative day. Watkins et al. (2014) reported that 27 patients who received cold therapy during the first 1-3 postoperative days after midline incisions had lower pain scores and opioid use than patients in the control group.

The present study investigated the effects of cold therapy applied to the incision area after abdominal surgery on postoperative pain and analgesic use.

The results of the study are expected to confirm that there is not a delay in healing and that there is an increase in quality of life and patient satisfaction while providing the patient comfort after surgery. The study is also expected to contribute to the current research regarding the benefits of cold therapy which is simple, inexpensive, and reliable method for preventing adverse systemic effects from pain or opioids.

## Methods

### *Patient Population and Randomization*

This prospective, randomized, and controlled trial was approved by the Institutional Review Board of Istanbul Medeniyet University Goztepe Research and Training Hospital (IRB no: 2014/0145), and was conducted in accordance with the Declaration of Helsinki. Participants were informed about the study; oral and written consent was obtained.

Power analysis was used to calculate the sample size. In the calculation, it was decided that 17 patients should be included in each group by predicting 0.80 difficulty value, 0.05 error level, 0.25 effect level, and 2.0-point difference. However, to apply parametric and nonparametric tests in the minimum number of patients recommended for experimental studies and analysis of the data, it was considered appropriate to include at least 30 patients in both groups.

After providing written informed consent, the study enrolled 60 patients (according to the result of power analysis) who had undergone abdominal surgery at the General Surgery, Emergency Surgery, and Urology clinics of a university-affiliated education and research hospital between September 2015 and January 2016.

Patients aged ≥18 years who underwent any abdominal surgery and provided consent were included in the study. Patients were excluded if they had minimally-invasive surgery, had a second surgery during hospitalization, needed intensive care after surgery, had a change in state of consciousness or acute confusion after surgery, had any additional diseases that reduced skin sensitivity (circulatory disorder, congestive heart failure, diabetes mellitus), had hypersensitivity or intolerance to cold, had optional patient-controlled analgesia or an epidural catheter, or had local anesthesia at the incision site.

According to a computer-generated randomization table, patients who met the sampling criteria and gave consent to participate in the study were assigned to groups according to the order of surgery and recorded by researcher. The experimental group included patients who received cold therapy at the incision site (30 patients), and the control group consisted of patients who did not receive cold therapy (30 patients) (Fig. 1).

### *Surgical Procedure and Intervention*

#### *Preoperative and intraoperative care*

Data were collected during the preoperative period using a patient information form specifically prepared for this study. This form had five sections. The first three sections addressed the patient's descriptive characteristics, surgical intervention, and treatment. The fourth and fifth sections included questions and comments about experience with pain and treatment of pain.

This part of the form included questions and comments about the factors that increase pain (such as movement, oral intake and emotional state), whether there are symptoms accompanying the pain, activities adversely affected by pain (such as sleep, appetite, physical activity, concentration, social relations), worst pain experience ever (such as previous operation / disease, current surgery, head, waist and neck pain and the others), and patients' pain reduction methods (pharmacologic methods, cognitive behavioral techniques, and peripheral/physical techniques such as TENS, massage).

These last two sections were collected at postoperative hour 8 to provide an opportunity for patients to express their views more easily on the current pain experience and cold therapy application. The most recent surgical intervention was considered when questioning patients about their pain. Information about the patient was obtained from the patient's own responses and medical records. A visual analogue scale (VAS) was used to measure the level of pain before and after cold therapy application, and data were recorded using the pain assessment form and the vital signs recording form.

#### *Anesthetic process*

All the surgeries were performed under general anesthesia. The protocol of pain medication was the same for both groups. The patients were premedicated with midazolam (1 miligram per kilogram), and fentanyl (100 microgram). The anesthesia protocol for the surgery was: propofol (2 miligram per kilogram), rocuronium bromide (0.5 miligram per kilogram), sevoflurane %1, and remifentanil (0.05 miligram per kilogram). At the end of surgery before the patient tranferred to the post-anesthesia care unit, tramadol 100mg and paracetamol 1000mg combined in an intravenous infusion were administered for pain.

The clinical protocol for postoperative pain medication for frequency of administration of analgesic drugs was two times a day. Every patient was treated with standard analgesics. Tramadol 100-mg vial as an opioid and paracetamol 1000-mg vial as a nonopioid, combined in an intravenous infusion were given just once at the end of the surgery. After the patient transferred to the clinic, postoperative first day, tenoxicam 20 mg intravenous pulse /diclofenac sodium 75 mg intramuscularly as NSAID was used for were administered two times a day. On postoperative second and third day diclofenac sodium 75mg was used as an analgesic if needed twice per day.

#### *Cold therapy protocol*

Cold therapy application protocol was started in the operating room, immediately after the operation and wound dressing was complete. The cold therapy included cold gel packs (13 × 25 cm)

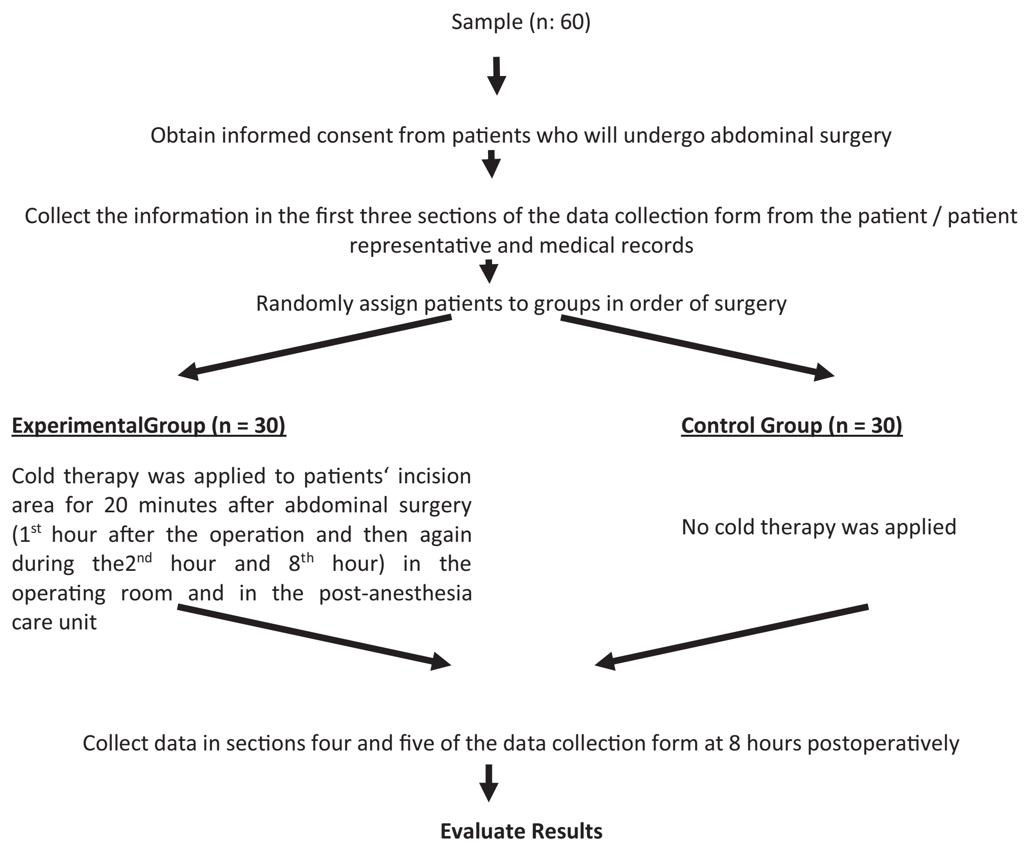


**Figure 1.** Research design.

to cover all incisions, including additional incisions and drain locations. If necessary, two or three gel packs were applied. These cold gel packs were kept in the freezer section of refrigerators in the operating room. Cold therapy was applied for 20 minutes, as longer application with the thin dressing material would increase the risk of complications (Ibrahim et al., 2005; Greenstein, 2007; Algafly & George, 2007; Janwantanakul, 2009; Dambros et al. 2012; Lui, 2012; Breslin et al., 2015). Cold therapy was applied at the first, second, and eighth hours postoperatively. The first application (as it was applied within the first hour after the completion of surgery, it was called the first-hour application) was applied in the operating room and post-anesthesia care unit, whereas the second and eighth hour applications occurred in the surgical clinic. Before and after cold therapy, vital signs were measured, and the VAS was used to quantify pain levels.

The same methods, materials, and devices (cold gel packs, sphygomanometer, stethoscope, and thermometer) were used by the researcher to evaluate pain and vital signs in patients in the experimental and control groups. All wounds were dressed with standard two-layer gauze and tape.

*Postoperative assessment*

After the first postoperative day, cold therapy application occurred at the patient's request. Patients were asked to repeat the application as soon as they felt that they were in pain, and to inform the researcher of the timing and intervals of the cold therapy.

The cold therapy application protocol included cold therapy for the first 3 days after surgery. Patients who were discharged within this period were asked to contact the researcher with details of their post-discharge use of cold therapy.

No intervention was performed in the control group.

### *Statistical Analysis*

SPSS for Windows 17.0 was used for statistical analysis, and descriptive statistical methods in order to determine mean, number, and percentage. To examine differences between the groups in parametric data, independent-sample *t* tests and ANOVA were used; for non-parametric data, the Mann–Whitney U-test and Kruskal–Wallis test were used. Relationships between variables were assessed using the Pearson correlation test (for parametric data) and the Spearman correlation test (for non-parametric data). In addition, the Wilcoxon and Friedman Tests were used to evaluate VAS scores. Results were considered significant within a 95% confidence interval (CI) ($p < .05$).

## Results

### *Demographic Profiles and Surgical Outcomes of Patients*

There was no statistically significant differences between descriptive characteristics and surgical and treatment-related characteristics in the experimental (n = 30) and control (n = 30) groups ($p > .05$) (Table 1).

This study showed a correlation of pain with age, as the pain scores increased with age in the control group (r = 0.521, $p = .003$), but no differences between the groups. Although there were no gender differences in VAS score between the experimental and control groups, the mean VAS for women (5.06 ± 1.25) was higher than that for men (4.00 ± 1.09) ($p < .05$) in the experimental group, whereas there was no significant difference between women's and men's VAS scores ($p > .05$) in the control group. In the experimental group, the mean VAS (5.40 ± 1.18) of

**Table 1**
Comparison of VAS Means by Descriptive Characteristics.

| | Experimental Group (n = 30) | | | | Control Group (n = 30) | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean VAS | SD | r[a], K-W[b], Z[c] | *p* | Mean VAS | SD | r[a], K-W[b], Z[c] | *p* |
| **Age (Mean ± Sd)** | | | 0.205[a] | .278 | | | 0.521[a] | **.003** [d] |
| **Sex** | | | −2.216[c] | **.027**[d] | | | −0.754[c] | .451 |
| Female | 5.06 | 1.25 | | | 5.07 | 1.82 | | |
| Male | 4.00 | 1.09 | | | 4.43 | 0.80 | | |
| **Marital status** | | | −1.160[c] | .246 | | | −0.797[c] | .425 |
| Married | 4.26 | 1.21 | | | 4.60 | 1.23 | | |
| Single | 4.95 | 1.34 | | | 5.00 | 0.94 | | |
| **Education** | | | 2.736[b] | .603 | | | 2.285[b] | .515 |
| None | 5.06 | 1.16 | | | 5.67 | | | |
| Primary school | 4.33 | 1.72 | | | 4.90 | 1.15 | | |
| Middle school | 3.67 | 1.41 | | | 4.25 | 0.50 | | |
| High school | 4.21 | 0.83 | | | 4.50 | 1.50 | | |
| University | 4.50 | 0.64 | | | 3.56 | 1.35 | | |
| **BMI** | | | 0.460[b] | .794 | | | 0.689[b] | .709 |
| Normal | 4.59 | 1.36 | | | 4.52 | 1.14 | | |
| Overweight | 4.24 | 1.26 | | | 4.82 | 1.13 | | |
| Obese | 4.56 | 1.02 | | | 4.17 | 1.77 | | |
| **Job** | | | 3.476[b] | .482 | | | 6.041[b] | .196 |
| Paid employee | 3.79 | 1.05 | | | 5.00 | 0.98 | | |
| Officer | 4.00 | 0.00 | | | 4.33 | 0.00 | | |
| Retired | 4.80 | 1.22 | | | 3.88 | 0.85 | | |
| Homemaker | 4.69 | 1.27 | | | 5.46 | 1.50 | | |
| Self-employed | 4.67 | 2.08 | | | 4.33 | 0.47 | | |
| **Chronic disease** | | | −2.878[c] | **.004** [d] | | | -1.542[c] | .123 |
| Yes | 5.40 | 1.18 | | | 4.21 | 1.16 | | |
| No | 3.93 | 0.99 | | | 4.94 | 1.17 | | |
| **Continuous medication** | | | −2.534[c] | **.011** [d] | | | -1.967[c] | **.049** [d] |
| Yes | 5.24 | 1.24 | | | 5.07 | 1.18 | | |
| No | 3.95 | 1.01 | | | 4.18 | 1.08 | | |
| **Alcohol intake** | | | −0.139[c] | .889 | | | [e] | [e] |
| Yes | 4.44 | 0.84 | | | 3.00 | - | | |
| No | 4.42 | 1.30 | | | 4.68 | 1.18 | | |
| **Smoking** | | | −1.025[c] | .305 | | | 0.000[c] | 1.000 |
| Yes | 4.19 | 1.45 | | | 4.40 | 0.95 | | |
| No | 4.52 | 1.18 | | | 4.67 | 1.26 | | |
| **Previous experience of pain** | | | −0.023[c] | .982 | | | −1.385[c] | .166 |
| Yes | 4.46 | 1.38 | | | 4.51 | 1.27 | | |
| No | 4.33 | 0.97 | | | 5.00 | 0.94 | | |

BMI = body mass index; SD = standard deciation; VAS = visual analogue scale.
[a] Spearman Correlation.
[b] Z = Mann–Whitney U-test.
[c] Kruskal–Wallis test.
[d] $p < .05$
[e] Analysis could not be performed due to insufficient data.

patients with a chronic disease was higher than that (3.93 ± 0.99) of patients without a chronic disease ($p < .05$). Patients with long term use of medication due to chronic disease had a higher mean VAS in both the experimental group (z = -2.534, $p = 0.011$) and the control group (z = -1.967, $p = 0.049$) ($p < 0.05$).

Differing incision types (K–W = 11.806; $p = .038$) and incision lengths (K–W = 8.789; $p = .012$) were associated with statistically significant differences in mean VAS scores among patients in the experimental group but no differences between the groups. In relation to the incision type, the longer the incision was, the higher was the reported pain. The lowest pain level was in patients with inguinal incisions and an incision of 5-13 cm; the highest pain level was in patients with subcostal incisions and an incision of 23 cm or longer. Table 2 also shows that the mean VAS score (4.86 ± 1.32) of patients with an additional incision was significantly higher than that (3.67 ± 0.67) of patients without. VAS scores were also positively correlated with the time of mobilization and time of first oral food intake (mobilization time = 0.436, $p = 0.016$; oral food starting time: r = 0.524, $p = 0.003$) (Table 2).

At hour 1, the control group's mean VAS was 5.03 ± 1.99. At hour 1 and before cold therapy, the experimental group's VAS mean score was 5.57 ± 1.72; the value then decreased to 5.10 ± 1.58 after cold was applied. There was no difference in the mean VAS scores between the experimental and control groups at hour 1 prior to cold therapy ($p > .05$) (Table 3) (Figure 2).

Measurements at hour 2 showed that the mean VAS before cold application in the experimental group was 5.97 ± 1.94; this value decreased to 4.67 ± 1.75 after the cold therapy intervention. At hour 2, the mean VAS in the control group showed a slight decrease (4.73 ± 1.34) relative to hour 1 (Table 3) (Fig. 2).

At hour 8, the mean VAS score for the experimental group decreased from 5.03 ± 2.04 before cold therapy to 3.50 ± 1.76 after. The control group also showed a decrease at hour 8, with a mean VAS of 4.10 ± 1.06. In the experimental group, the mean decreases in VAS with the application of cold therapy were significant for hour 2 and hour 8 ($p < 0.001$) (Table 3) (Fig. 2). There was no statistically significant difference between the VAS scores according to the analgesic usage ($p > 0.05$). There was no significant harm or adverse effect in each group.

## Discussion

Cold therapy is one of the most common non-pharmacologic pain treatments. Despite the existence of many studies about

**Table 2**
Comparison of VAS Means According to Surgical Intervention and Treatment Characteristics.

| | Experimental group (n = 30) | | | | Control group (n = 30) | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean VAS | SD | r[a], K-W[b], Z[c] | *p* | Mean VAS | SD | r[a], K-W[b], Z[c] | *p* |
| **Diagnosis type** | | | 4.572[b] | .206 | | | 2.586[b] | .460 |
| Inguinal hernia | 3.79 | 1.21 | | | 4.58 | 0.85 | | |
| Incisional hernia | 4.47 | 1.46 | | | 4.08 | 1.93 | | |
| Tumor(colon, prostate,stomach) | 5.04 | 1.26 | | | 4.00 | 0.72 | | |
| Acute appendicitis | 3.75 | 0.74 | | | 4.83 | 0.71 | | |
| Other | 4.92 | 1.00 | | | 5.60 | 1.66 | | |
| **Type of surgery** | | | −0.130[c] | .896 | | | −0.893[c] | .372 |
| Elective surgery procedures | 4.43 | 1.30 | | | 4.55 | 1.21 | | |
| Emergency surgery | 4.39 | 1.16 | | | 5.08 | 1.20 | | |
| **Incision type** | | | 11.806[b] | **.038**[d] | | | 5.235[b] | .388 |
| MUB | 3.58 | 0.79 | | | 4.83 | 1.82 | | |
| MAB | 4.92 | 1.26 | | | 3.92 | 0.17 | | |
| MUB + MAB | 5.17 | 1.10 | | | 4.11 | 2.36 | | |
| Subcostal | 5.42 | 1.45 | | | 5.67 | 1.45 | | |
| İnguinal | 3.44 | 0.75 | | | 4.62 | 0.87 | | |
| McBurney | 3.75 | 0.74 | | | 4.83 | 0.71 | | |
| **Incision length (cm)** | | | 8.789[b] | **.012**[d] | | | 3.724[b] | .155 |
| 5-13 | 3.79 | 1.05 | | | 4.45 | 1.13 | | |
| 14-22 | 4.96 | 0.86 | | | 4.67 | 1.22 | | |
| ≥23 | 5.39 | 1.37 | | | 6.50 | 0.24 | | |
| **Additional incision (drain/colostomy)** | | | −2.426[c] | **.015**[d] | | | −0.986[c] | .324 |
| Yes | 4.86 | 1.32 | | | 4.83 | 1.51 | | |
| No | 3.67 | 0.67 | | | 4.44 | 0.86 | | |
| **Mobilization time (hours)** | | | 0.436[a] | **.016**[d] | | | 0.153[a] | .42 |
| **Oral feeding time (hours)** | | | 0.524[a] | **.003**[d] | | | 0.267[a] | .153 |

SD = standard deciation; MUB = median under the belly; MAB = median above the belly; VAS = visual analogue scale.
[a] Spearman correlation.
[b] Z = Mann–Whitney U-test.
[c] Kruskal–Wallis test.
[d] $p < .05$.

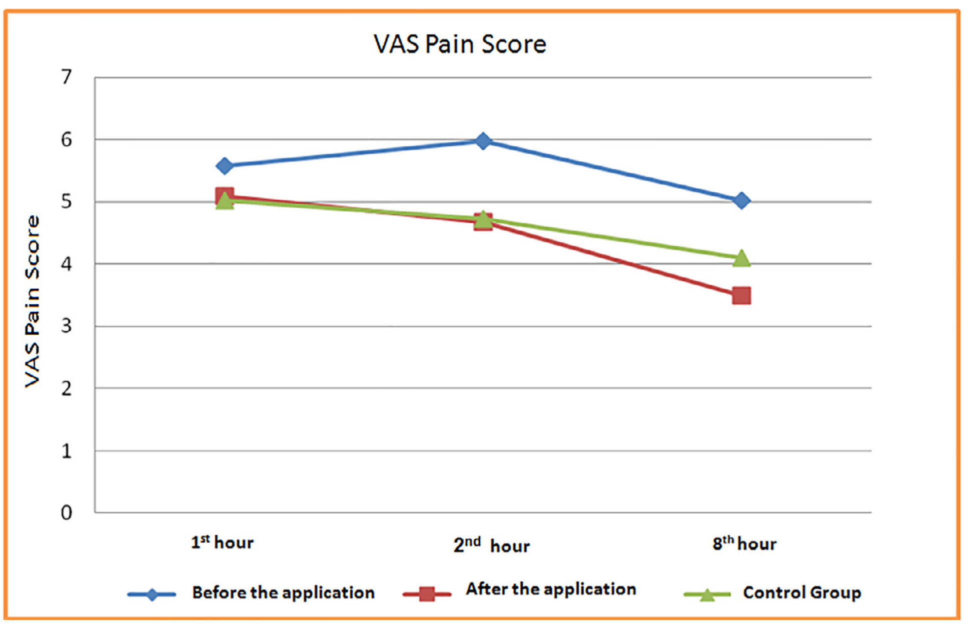


**Figure 2.** Visual analogue scale pain scores.

cold therapy (Kuzu, 1999; Koc et al. 2006; Shin et al., 2009; Saeliw et al., 2010; Ertug & Ulker 2012; Watkins et al. 2014; Paiva et al. 2016; Mahshidfar et al. 2016), few have examined the effects of cold therapy after abdominal surgery.

Pain is a universal experience in all age groups, although the risk may increase with age. Age may affect individuals' pain perception and reporting (Edwards & Fillingim, 2001; Yezierski, 2012; Riley et al. 2014), but there is not enough evidence that nociception changes with age (Cavdar & Akyuz, 2017). This study showed a correlation of pain with age, as the pain scores increased with age in the control group. In addition, although the experimental and control groups were similar in terms of descriptive properties, cold therapy was effective in the experimental group, reducing the age-related increase in pain relative to that in the control group.

Gender-related effects on pain and analgesia have been the subject of many studies, especially in the last 10-15 years, with

**Table 3**
VAS Pain Measurements.

| Experimental group (n = 30) | First hour Mean ± SD | Second hour Mean ± SD | Eight hour Mean ± SD | *p* |
|---|---|---|---|---|
| *Before cold application*[1] | 5.57 ± 1.72 | 5.97 ± 1.94 | 5.03 ± 2.04 | .052 |
| *After cold application*[2] | 5.10 ± 1.58 | 4.67 ± 1.75 | 3.50 ± 1.76 | **.001**[c] |
| Control group[3] (n = 30) | 5.03 ± 1.99 | 4.73 ± 1.34 | 4.10 ± 1.06 | **.024**[c] |
| Significance (*p* value) | [1] vs. [2] = .091 | [1] vs. [2] **< .001**[a] | [1] vs. [2] **< .001**[a] | |
| | [1] vs. [3] = .230 | [1] vs. [3] = **.013**[b] | [1] vs. [3] = .072 | |
| | [2] vs. [3] = .810 | [2] vs. [3] = .833 | [2] vs. [3] = .106 | |

SD = standard deviation; VAS = visual analogue scale.
[1] Before cold application [a] Wilcoxon test.
[2] After cold application [b] Mann–Whitney U-test.
[3] Control group [c] Friedman test.

some studies concluding that women are at greater risk of, and have higher sensitivity to, pain (Fillingim et al., 2009; Bartley & Fillingim, 2013). However, other studies have reported that gender does not affect pain reporting (Cavdar & Akyuz, 2017). Although there were no gender differences in VAS score between the experimental and control groups, in the present study women in the experimental group reported greater pain than did men ($z = -2.216$; $p = .027$). Clearly, more comprehensive research is needed to define the role of gender-specific characteristics (hormones, psychosocial factors, response to analgesics) and the underlying mechanisms in gender differences in pain (Schiltenwolf & Pogatzki-Zahn, 2015; Pieretti et al., 2016).

Some previous studies have also reported a relationship between patients' past pain experiences and surgical pain (Bastami et al., 2015; Ayhan & Kursun 2017), whereas others have found no such correlation (Acar et al., 2016). The current study showed that patients' experiences of pain in the current setting were not affected by previous pain experiences.

Chronic diseases may cause pain to persist for longer periods, possibly due to complications after surgery and delayed healing, as well as recurrence of chronic pain (Topcu & Findik, 2012). Moreover, the need to use medications chronically to control disease may cause anxiety. Chronic disease can be long lasting with complex medical and psychosocial dimensions (Altuntas et al., 2015). Chronic diseases and pain might pose an important, potentially-modifiable risk for recurrence of depressive and anxiety disorders for various reasons (Gerrits et al., 2014). Supporting the psychosocial adaptation of individuals can support patients with chronic disease and promote pain acceptance and adaptation skills (Altuntas et al., 2015). In the present study, the pain levels of patients with chronic diseases in the experimental group and the patients who used long-term medication due to chronic disease in both the experimental and control groups were higher than those of patients who did not ($p < .05$).

When Proske et al. (2005) compared transverse and midline incisions in terms of lung function, incisional pain, and wound characteristics, they found that incisional pain was significantly lower and postoperative pulmonary function significantly better in patients who underwent a transverse rather than a midline incision. Burger et al. (2002) also reported that the amount of pain and analgesic use in transverse and oblique incisions was less than with midline incisions, and concluded that these incisions should be used for smaller unilateral operations. Santoro et al. (2014) argued that transverse incisions were preferable, but suggested that both midline and transverse incisions have advantages. According to Brown and Tiernan (2005), even though transverse incisions seem to be advantageous, the complication rate is similar to that with midline incisions. Therefore, the type of incision that provides the best visibility in abdominal surgical procedures remains the surgeon's choice. In this study, the lowest pain level was observed in patients who underwent inguinal incision (oblique incision).

It is known that age, female sex, surgical type, incision length, blood pressure, heart rate, presence and severity of preoperative pain, and health-related quality of life affect the perception of postoperative pain (Kalkman et al., 2003). In the present study, the pain level increased as the incision length increased in the experimental group, although interestingly, there was no relationship between the incision length and pain in the control group. In the experimental group, patients with additional incisions had higher pain levels than those without additional incisions. In this study, incisions (5-10 cm), drains (0.5-2 cm), and ostomy openings (5-10 cm) were evaluated as additional incisions. Furthermore, pain is expected to increase as the incision size increases.

The most common problems in the early period after abdominal surgery are nausea and vomiting, difficulty in swallowing, and abdominal distension (Vermisli & Cam, 2015; Erden & Celik, 2013; Yolcu et al., 2016). This study revealed positive associations in the experimental group of VAS scores with the time of mobilization and the time of first oral food intake (mobilization time = 0.436, $p = .016$; oral food start time: $r = 524$, $p = .003$). It is possible that food intolerance may present as pain, and the start of oral feeding may be delayed due to these symptoms. Similarly, as pain increases, the mobilization time may be delayed, as physical activity affects pain tolerance.

Although cold therapy is accepted as a simple, inexpensive, and effective non-drug treatment for pain, some researchers have urged that more comprehensive studies are needed before this method is adopted for routine use. Adie, Naylor, and Harris (2010) found that cold therapy had no benefit in post-traumatic pain, swelling, analgesia, and length of hospital stay, and it had little benefit with respect to blood loss and range of motion. They concluded that the available evidence was not sufficient to support the routine use of this practice. In a similar literature review, Collins (2008) found insufficient evidence that cold therapy improved clinical outcomes in soft tissue injuries. Zandi et al. (2016) and Van der Westhuijzen et al. (2005) studied the effects of cold therapy on pain, trismus, and swelling but found no differences between the experimental and control groups. However, Shin et al. (2009) and Mahshidfar et al. (2016) concluded that cold therapy was cost-effective and an effective technique. Saeliw et al. (2010), Koc et al. (2006), Kuzu (1999), and Paiva et al. (2016) also found a decrease in pain intensity after cold therapy. The present study found no difference in pain level between the experimental and control groups at hour 1; however, in the experimental group, pain levels decreased after cold therapy application. The control group also showed a reduction in pain over time, but this decrease was not as great as that in the experimental group (Table 3).

Pharmacologic methods are widely used to control pain after surgery. Due to their rapid effect and ease of delivery, analgesics remain the preferred mode of treatment (Ozveren, 2011; Ayhan & Kursun, 2017). Quinlan et al. (2017) found that the morphine equivalent use by patients receiving cold therapy was reduced compared with the control group. Similarly, Finan et al. (1993) and Kol et al. (2013) found that analgesic consumption was lower in their experimental (cold therapy) group compared with the control group. However, Daniel, Stone, and Arendt (1994) found that although cold therapy lowered skin temperature, there was no difference between the experimental and control groups in terms of analgesic use, hospital stay duration, pain, or knee joint range of motion. In the present study, both groups received analgesics, and cold therapy did not affect analgesic use in either the experimental or the control group.

### *Limitations of the Study*

A limitation of the study was the assessment of pain, which is subjective data based on verbal expressions of patients.

## Conclusions

In conclusion, in this study, although there was no significant difference between the two groups indicating that cold therapy reduced pain, there was a significant decrease in VAS score from before to after the application in the experimental group. It was observed that both the experimental group and the control group had decreased pain levels, and the decrease in the experimental group was higher than in the control group. Cold therapy applied to the incision area after abdominal surgery decreased pain severity in the first 8 hours postoperatively in the experimental group but had no statistically significant effect on the amount of analgesic use. Therefore, more extensive researchs is needed to determine the effects of cold therapy.

### *Implications for Nursing*

Nurses often evaluate the patient pain and apply non-pharmacologic therapies. Cold therapy application, a practical nursing intervention, can contribute to the healing process by reducing pain. The results of this study, are expected to contribute to the literature regarding the common use of cold therapy which is a simple, inexpensive, and reliable method for preventing adverse systemic effects of the pain and opioids.

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