

The Effectiveness of Ice Therapy in the Treatment of Acute Pain in the Early Postoperative Period in Sports-Related Knee Injuries

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ABSTRACT

Objectives: To examine the effectiveness of ice therapy in reducing acute pain in the early postoperative period in patients with sports-related knee injuries at the Pediatric Orthopedics Department of the Children's Hospital Zagreb.

Study Design: Cross-sectional study.

Participants and Methods

The research included a total of 84 examinees who underwent knee surgery. For the purposes of this research, data was collected from the Hospital Information System on examinees who underwent surgery after a knee sports-related injury between April 2022 and April 2023 at the Pediatric Orthopedics Department of the Children's Hospital Zagreb, with regard to gender, age, diagnosis, type of surgery, the use of pain medication therapy, the use and duration of physical therapy with cold compresses, the length of postoperative treatment in the hospital, during which data on self-assessment of pain based on the visual-analogue scale (VAS) were collected every day.

Results

The most common cause of knee injuries was football (31%), with the most common diagnosis being patellar injury (24%). The most frequently performed surgical procedure was arthroscopy with reconstruction (64.3%). Out of all examinees who received ice therapy, 88.1% had a positive reaction, while 7.1% had a negative reaction. All of the examinees received therapy with cold compresses several times a day, and 33.3% of them received painkillers along with cold compresses. The most frequently used therapy was paracetamol (25%), followed by ketoprofen (19%) and ibuprofen (4.76%).

Conclusion

This study showed that painkillers are more effective in reducing the level of pain than the application of cold compresses. However, ice therapy significantly reduced postoperative pain both in girls and boys. Ice therapy and painkillers are most effective on the second postoperative day of treatment.

Keywords: Children, Ice, Ice-Therapy, Pain, Sports-Related Knee Injuries

Introduction

Cryotherapy is the application of cold, in any form, to treat physical injuries, and is defined as the reduction of tissue

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temperature by drawing heat from deeper structures to the surface [1]. Ice, a simple and readily available element, is among the first medicines used by man as a method of treating various diseases. In the Edwin Smith Papyrus, the oldest Egyptian medical text dating back to approximately 3500 BC, ice is mentioned several times as a method of treatment [2]. Hippocrates, in his work “On Airs, Waters and Places”, stated that “water can cure all things” and mentioned that treatment with ice and snow showed great results in reducing soft tissue edema [1]. A physician in Napoleon’s army, Baron Larrey, described the use of ice and snow in performing painless amputations and other surgical procedures on the battlefield. Ice therapy only began to be recommended as a treatment method in the 1960s, primarily for musculoskeletal injuries [1-3].

Effects of Ice Therapy

Ice therapy is a popular treatment method used in sports medicine for treating injuries or for recovering from exercise [1-4]. By exposing the skin and local tissue to a cold medium, the blood flow is affected as well as muscle elasticity and nerve conduction [4-7]. Cooling the tissue causes vasoconstriction, which reduces edema and bleeding [7]. Research shows that cooling the knee with an ice pack for 20 minutes reduces blood flow through soft tissue by 26% and blood flow to bone by 19% [6]. Metabolic processes in the cooled tissue change, leading to hypometabolism, which reduces the inflammatory response. Cooling reduces elasticity and flexibility, and increases muscle endurance [5-7]. Muscle spasms, which are the most common cause of discomfort, are alleviated. Cold affects the speed of nerve impulse conduction through nerve endings in the skin and superficial nerves [5-7]. All these mechanisms are responsible for the analgesic effect of ice therapy [7].

Ice Therapy Indications

Cryotherapy can be used in various pathological processes that occur after soft tissue injuries. These processes can be divided into three phases:

1. **acute inflammatory phase** – up to 48 (72) hours after trauma;
2. **recovery phase**– between 48 (72) hours and 6 weeks after the trauma;
3. **remodeling stage**– between 6 weeks and 12 months after trauma [4].

Cold therapy is best applied as soon as possible, along with the other components of the RICE (Rest, Ice, Compression, Elevation) protocol [8]. Rest is necessary in the first few days after the acute injury, and includes the use of immobilization devices [9]. Compression is usually used together with cooling and often refers to the use of elastic or compression bandages [8, 9]. Elevation of the injured part of the body (above the level of the heart) is necessary to achieve the effect of venous or lymphatic drainage, as well as the prevention/treatment of edema and hematoma. Support is important in both the early and late stages of treatment and rehabilitation of sports injuries, and includes the wearing of various orthopedic devices (splints, orthoses, corsets, bandages) [9].

Complications

Complications with cold therapy are rare (frostbite and nerve paralysis) and can be avoided by following the proper treatment

protocol [5-10]. Frostbite is the reaction of the skin as a result of direct contact between the skin and ice, which can be avoided by placing ice over a protective layer of clothing, bedding or by shortening the skin’s exposure to cold for a maximum of 30-45 minutes. Nerve paralysis occurs by applying ice to areas where large nerves are located directly under the skin. Most often n. peroneus and n. ulnaris [10]. The first sign of nerve paralysis is loss of motor function distal to the area exposed to cold, then ice therapy should be stopped immediately. Optimal use of cold is about 20 minutes [10-11].

Contraindications

Ice therapy should not be used before intense exercise, as it increases the stiffness of collagen fibers, leading to muscle stiffness and increasing the risk of injury [4]. Cold therapy is not recommended for patients who are sensitive to cold due to possible complications. Absolute contraindications to ice therapy include cold allergy, Raynaud’s disease, and cryoglobulinemia, while relative contraindications to ice therapy include arthritis, polyneuropathies, and cardiovascular diseases [4].

Cold Therapy Application Techniques

There are many techniques for applying ice therapy. In healthcare settings, ice is most commonly applied in the form of cold packs made of water or gel (usually menthol-based). Ice therapy can be applied in the form of cold baths, cold sprays, or compression devices [5-15]. A compression device uses a so-called compression sleeve through which cold fluid circulates while providing compression. The disadvantages of this technique are its dependence on technology and its limited application to specific anatomical locations (e.g., distal limbs) [15].

Sports Knee Injuries

The term sports injuries includes injuries that occur during any type of sports activity (training, competitions, physical education class, recreation, professional sports) [9]. In sports traumatology, it is important to distinguish between the terms injury and damage. An injury occurs as a result of an acute force acting on a specific part of the locomotor (or other) system, while damage is the result of microtrauma, or long-term, chronic action [9-18]. One of the most common sports injuries of the knee is the meniscus tear, which often requires surgical treatment due to pain and knee dysfunction [18]. The anterior cruciate ligament is the most commonly injured ligament in children and young athletes (football, basketball, skiing) [19]. After the injury, patients complain of a “pop” sound in the knee and pain, reduced range of motion, and difficulty moving, and they can be treated conservatively or surgically.

Pediatric Pain Management

Postoperative pain relief is one of the basic treatment principles in pediatric surgery/orthopedics [20]. The main problem in treating pain in children is the difficulty in assessing it [21]. Knee pain is the most common reason why children with sports-related knee injuries present to an orthopedist [20]. According to the guidelines of the International Association for the Study of Pain, pain must be treated comprehensively and interdisciplinary, including pharmacological, behavioral, cognitive, psychological, and physical approaches [21]. Available research shows the harmful psychological effects of untreated pain in childhood [20, 21]. Pain assessment scales and self-report scales are used

to assess pain, depending on the child's age [21]. The following scales are most commonly mentioned in the literature: CHEOPS, FLAAC, and CHIPPS [21]. The most commonly used pain scales in toddlers and preschoolers are: Wong-Baker, Objective Pain Score (OPS), Modified Objective Pain Score (MOPS), Pieces of Hurt, Oucher Facial Scale, and Faces Pain Scale-Revised (FPS-R) [21]. School-aged children are successful in verbalizing pain, which is why the Visual Analogue Scale (VAS) and Numeric Rating Scale (NRS), which are the gold standard for pain assessment, are used to assess their pain [21].

Non-opioid analgesics, such as non-steroidal anti-inflammatory drugs (NSAIDs) and paracetamol, are the most commonly used pain medications in children. They are administered orally, intravenously, or rectally, according to the 2018 guidelines for the management of pain in children published by the European Society for Paediatric Anaesthesiology (ESPA) [21]. Orthopedic procedures are among the most painful surgical procedures [20]. Unrecognized, untreated, and poorly treated pain is a source of grief, discomfort, suffering, and dissatisfaction for patients, prolongs hospitalization, makes recovery more difficult and prolonged, promotes complications, and increases the risk of rehospitalization [20, 21]. A multimodal approach is used in pain management, which involves "the use of multiple drugs with different mechanisms of action that act at different sites along the nociceptive pathway" [20-22]. The goal of this approach to pain management is to control pain as effectively as possible with the lowest possible doses of analgesics and with minimal risk of adverse side effects [20]. This approach places great emphasis on the use of nonpharmacological pain management methods, such as hypnosis, acupuncture, and ice therapy [23].

Aim

The aim of the study was to examine the effectiveness of ice therapy in reducing acute pain in the early postoperative period in patients with sports-related knee injuries at the Department of Pediatric Orthopedics, Children's Hospital Zagreb.

Examinees and Methods

Study Structure

The research was conducted as a cross-sectional study [24].

Examinees

This research was approved by the Ethics Committee of the Children's Hospital Zagreb (no. 02-23/13-1-22) and was conducted in accordance with the guidelines of the Declaration of Helsinki. The study included data from patients who were hospitalized at the Department of Pediatric Orthopedics of the Children's Hospital Zagreb from April 2022 to April 2023 and who had surgery for sports-related knee injuries. Data for the study were collected from the Hospital Information System (HIS).

The Inclusion Criteria

- sports-related knee injuries,
- examinees for whom there is data on estimated pain before and after the use of pain medication therapy;
- examinees for whom there is data on estimated pain before and after application of cold pack therapy.

The exclusion criteria, of examinees, from the study were lack of pain assessment data and diagnostic discrepancies.

Methods

Data was collected from the HIS on patients who underwent surgery after a sports-related knee injury between April 2022 and April 2023 at the Department of Pediatric Orthopedics. The collected information included gender, age, diagnosis, type of surgery, use of pain medication, use and duration of physical therapy with cold compresses, length of postoperative treatment in the hospital, during which data on pain assessment based on the Visual Analogue Scale (VAS) were collected every day. Pain assessment in patients began on the day of admission. Pain was assessed using the Visual Analogue Scale. The range of numbers on the scale is from 0 to 10 (0 - no pain, 10 - the worst possible pain). Depending on the severity of preoperative pain, physical methods of applying cold compresses were used to treat the children, which allowed them to get used to this method of pain management.

The surgeries were performed under general anesthesia, and after awakening from anesthesia, the children received early postoperative analgesia, which, depending on the type and duration of the surgery, was mainly based on the use of NSAIDs and the performance of peripheral nerve blocks (n. saphenus, n. femoralis), using a single local anesthetic infiltration under the skin. The goal of such early postoperative analgesia was to relieve pain for the first 12 hours postoperatively. Pain management in the ward depended on the child's verbalization of pain. If the VAS pain score was 1-4, the pain was treated with physical methods. A compress was placed over a crepe, elastic bandage, and then a cold compress was placed over it. Pain was assessed before and 15 minutes after the application of the cold compress. If the VAS pain score was 5-10, it was treated with pain medication (NSAIDs and/or paracetamol) in addition to physical methods with cold compresses. In this case, pain was assessed before, 15 minutes after the application of the cold compress, and one hour after the application of the pain medication, and the assessed pain values were recorded in the HIS.

Statistical Methods

Data are presented as arithmetic mean and standard deviation (SD) and as absolute and relative frequencies. The difference in pain reduction after the use of painkillers and cold compress therapy was tested by paired t-test. Differences between genders were analyzed by Mann-Whitney U test, while differences between different types of surgery and days of discharge after surgery were tested by Kruskal-Wallis test. SPSS statistical program (26.0, SPSS Inc., Chicago, IL, USA) was used for statistical data processing, and statistical significance (P) less than 0.05 was considered significant. GraphPad Prism program (5.03, San Diego, CA, USA) was used for graphical presentation of results.

Results

The study included a total of 84 children who underwent surgery at the Department of Pediatric Orthopedics of the Children's Hospital Zagreb over a period of one year (Table 1). The age of the examinees ranged from 7 to 18 years, the length of postoperative hospitalization was from one to eleven days, and the majority of

patients (35.71%) were discharged from the hospital on the second postoperative day. The most common cause of knee injuries was football (31%) with the most common diagnosis being patellar injury (24%). The most common surgical procedure performed was arthroscopy with reconstruction (64.3%). On the day of surgery 7.1% examinees received only pain medication, 41.7% of the examinees received pain medication and ice therapy, and 51.2% of them received no therapy at all. Of all the examinees

who received ice therapy, 88.1% had a positive reaction, while 7.1% had a negative reaction. All of the examinees received cold compression therapy several times a day, and 33.3% received pain medication in addition to the cold compression therapy. In patients who received pain medication alone, the estimated pain level before therapy was 3.29 ± 3.53 , while the estimated pain level after therapy was 0.36 ± 0.94 (Table 1).

Table 1: Assessed pain before and after administration of pain medication therapy (N = 84)

	Pain before medicine	Pain after medicine	T statistics	P*
Day of surgery (N = 84)	$3,29 \pm 3,53$	$0,36 \pm 0,94$	8,53	< 0,001
First postoperative day (N = 60)	$3,86 \pm 1,17$	$0,68 \pm 1,52$	26,61	< 0,001
Second postoperative day (N = 27)	$6,07 \pm 1,17$	$0,52 \pm 1,05$	25,00	< 0,001
Third postoperative day (N = 9)	$6,11 \pm 1,05$	$0,22 \pm 0,67$	22,59	< 0,001

The results are presented as arithmetic mean and standard deviation. *paired t-test

Examinees that received physical therapy with cold packs in addition to pain medication, the estimated pain before the application of cold packs was 4.08 ± 1.46 , while after the application of cold packs for 15 minutes, the pain was estimated at 1.96 ± 1.74 (Table 2).

Table 2: Assessed pain before and after application of physical therapy with cold compresses (N = 84)

	Pain before cold compresses	Pain after cold compresses	T statistics	P*
Day of surgery (N = 80)	$4,08 \pm 1,46$	$1,96 \pm 1,74$	15,73	< 0,001
First postoperative day (N = 81)	$3,86 \pm 1,17$	$1,79 \pm 1,64$	20,94	< 0,001
Second postoperative day (N = 56)	$3,36 \pm 0,98$	$1,32 \pm 1,39$	14,59	< 0,001
Third postoperative day (N = 27)	$3,04 \pm 1,02$	$1,04 \pm 0,94$	18,74	< 0,001

The results are presented as arithmetic mean and standard deviation. *paired t-test

The results obtained indicate that painkillers are much more effective than the application of cold compresses (Table 3). The day after surgery, 33.33% of children received painkillers in addition to cold compresses. During the first postoperative day, this percentage increased to 61.9%, while on the second postoperative day, only 9.52% of children required analgesics in addition to cold compresses. During the third postoperative day, the number of children who received analgesics in addition to cold compress therapy decreased further, to only 3.57%.

Table 3: Difference in assessed pain after pain medication therapy and physical therapy with cold compresses (N = 84)

	Pain after medicine	Pain after cold compresses	T statistics	P*
Day of surgery (N = 80)	$0,34 \pm 0,91$	$1,96 \pm 1,74$	-9,45	< 0,001
First postoperative day (N = 60)	$0,68 \pm 1,52$	$2,27 \pm 1,69$	-6,05	< 0,001
Second postoperative day (N = 27)	$0,52 \pm 1,05$	$2,11 \pm 1,52$	-4,82	< 0,001
Third postoperative day (N = 9)	$0,22 \pm 0,67$	$1,67 \pm 1,12$	-3,04	0,02

The results are presented as arithmetic mean and standard deviation. * paired t-test

The differences in pain reduction with the use of painkillers and ice therapy were not significant compared to pain reduction with the use of analgesics alone (Table 4).

Table 4: Difference in assessed pain according to type of therapy (N = 84)

	Medication	Medication and compress	Z statistics	P*
Day of surgery	$0,67 \pm 1,21$	$0,74 \pm 1,27$	-1,658	0,09
First postoperative day	$1,33 \pm 0,58$	$1,03 \pm 1,99$	-1,036	0,30
Second postoperative day	$2,00 \pm 0,98$	$3,29 \pm 0,75$	-1,058	0,29
Third postoperative day	$2,04 \pm 1,02$	$2,70 \pm 0,94$	-1,361	0,17

The results are presented as arithmetic mean and standard deviation. *Mann-Whitney U test

Discussion

For the past fifteen years, there has been intense debate among experts about the best approach to treating soft tissue injuries. Some advocate, while others oppose, cold therapy [1]. This study showed that cold therapy is effective in reducing acute pain in the early postoperative period in sports-related knee injuries. However, painkillers are still more effective. Therefore, this study is important because of the lack of research that has been conducted to examine the effectiveness of cold therapy for soft tissue injuries in people, especially children. Most of these studies have been conducted in animals, mainly rodents [1].

Although this study did not show that ice physical therapy is more effective than analgesics in reducing acute pain in the postoperative period, the results show that cold packs significantly contribute to pain reduction and their use in daily practice can reduce the use of analgesics. This is crucial because frequent use of analgesics leads to addiction, which makes it difficult to employ stronger analgesics for other therapies. In the treatment of pain in the early postoperative period, the emphasis is on a multimodal approach [25]. Avoiding opioid analgesics, which carry a high risk of adverse side effects and slow functional recovery, leaves room for the use of non-opioid analgesics combined with non-pharmacological methods. In orthopedics, these non-pharmacological methods are summarized in the RICE protocol: rest, cold, compression, elevation [8]. NSAIDs are still the gold standard when it comes to pharmacological pain management, although studies have mentioned their potentially negative effect on wound healing and bone tissue recovery [25].

Review of the literature showed that 44% of studies reported a significant reduction in pain with the use of cold compresses compared to not using them. Additionally, almost half of the studies (48%) reported a reduction in pain medication use in the group of examinees that received cold compress therapy [26]. Studies have shown that the use of cold compresses reduces pain and that analgesic consumption was reduced in almost half of the studies that used cold compresses during postoperative recovery, which is confirmed by the results of this study, in which cold compresses significantly contributed to pain reduction [16]. Other reviewed studies showed that there was no significant difference in the assessed pain between the group of examinees who received cold compress therapy after knee surgery and those who did not. However, the group that received cold compresses had significantly greater range of motion and less joint swelling than the group that did not use cold compresses [27]. This shows that cryotherapy can help improve range of motion after knee surgery.

A serious shortcoming is the lack of large-scale randomized clinical trials supporting the use of cryotherapy, making it difficult to draw relevant conclusions. Therefore, further multicenter randomized controlled trials with a representative sample are needed [28]. The limitations of this study are the relatively small number of examinees included in the study. As the study was conducted based on data from the hospital system, there was no control group with which to compare the results of the study [29-31]. Ideally, the study would have included three groups of subjects – one group receiving analgesic therapy only, another receiving cold compress therapy only, and a third receiving both therapies [32-34].

Conclusion

Based on the conducted study, the following conclusions can be drawn:

1. Ice therapy is effective in reducing pain in the early postoperative period following surgery for sports-related knee injuries.
2. Pain medication therapy is more effective at reducing pain levels than cold compress therapy

Differences in the reduction of pain in the case of the use of painkillers and ice therapy were not significant compared to the reduction of pain with the use of analgesics alone

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