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Reprint | Cold therapy

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SPECIAL FOOTBALLMEDICINE: MUSCLE & REGENERATION

Cold therapy

The use for musculoskeletal disorders and acute pain management

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In the literature, it has been shown that cold therapy (ice application) will be an effective treatment for soft tissue injuries. It reduces the swelling, and it will improve the range of motion. However, there are still some doubts if it is actually effective for pain relief. So the application of ice may be useful for a variety of musculoskeletal disorders and painful conditions.

Never use heat during this phase because heat increases the blood flow into the injured area and increases the amount of swelling. The inflammatory phase has a duration of 2 days.

- 2) During the second phase, the proliferation phase, new tissue and scar tissue are formed. Heat can now be applied to the injured area to facilitate the healing process.
- 3) The third and final phase, the remodeling phase, is the process of returning to health: the restoration of structure and function of injured or diseased tissues. The healing process includes blood clotting, tissue mending, scarring and bone healing. Heat therapy can also be used during this phase.

There are beliefs that topical cold modalities are useful only for immediate care of acute injuries and are safe with only short duration of treatment. However, the clinical evidence supports the use of topical cold in a variety of situations. Depending upon the method of application, cold modalities may have different physiologic effects. Ice massage cools the muscle faster than an ice pack. In one clinical trial, both ice pack and cold whirlpool treatment for 20 minutes decreased calf muscle temperatures at the same rate. After 20 minutes, muscle tissue temperatures continued to decline for the whirlpool-treated group, but progressively increased in subjects treated with an ice pack. These results suggest that cold whirlpool cold therapy is most appropriate when long-term tissue cooling is needed. Cold-water immersion may reduce muscle stiffness and the amount of post-exercise damage after strenuous eccentric activity. There appears to be no effect on the perception of tenderness and strength loss, which is characteristic after this form of activity. The results of various studies are consistent on that the effects are mediated through neuromuscular and pain processes. One study showed that after four days' treatment, the intermittent

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The pathophysiologic effects of cold therapy are summarized in Table 1. Cold therapy decreases tissue blood flow by causing vasoconstriction, and reduces tissue metabolism, oxygen utilization, inflammation, and muscle spasm. Cold therapy also induces effects both locally (at the site of application) and at the level of the spinal cord via neurological and vascular mechanisms. Topical cold treatment decreases the temperature of the skin and underlying tissues to a depth of 2 to 5 cm, decreasing the activation threshold of tissue nociceptors and the conduction velocity of pain nerve signals. This will conduct to a local anesthetic effect called cold-induced neuropraxia.

For acute tissue injury there will be three phases of the healing process: 1) the inflammatory phase, 2) the proliferation phase and 3) the remodeling phase.

- 1) The first phase, known as the inflammatory phase, protects the injured area from further injury while the body contains the damaged tissue. During this phase, cold therapy can help to reduce swelling.

Table. 1
Pathophysiologic effects
of topical modalities

	Cold	Heat
Pain	↓	↓
Spasm	↓	↓
Metabolism	↓	↑
Blood Flow	↓	↑
Inflammation	↓	↑
Edema	↓	↑
Extensibility	↓	↑



compression and continuous ice water treatments were essentially equivalent with an approximately 70 % reduction in swelling, compared with a 45 % reduction with intermittent ice pack therapy. These trials showed that cold therapy will be used during the recovery after trauma as one therapy tool.

Adverse effects of Cold therapy

In general the cold therapy is well tolerated. Some cautions have to be realized. One caution will be the vicinity of superficial nerves, especially, if cold is combined with compression. Peroneal neuropathy as well as ulnar, axillary, and lateral femoral cutaneous nerve injury after cold therapy has been documented in the literature. Other reported side effects of cold therapy include cardiovascular effects (bradycardia), Raynaud's phenomenon, cold urticaria, frostbite, and slowed wound healing secondary to decreased metabolic activity. Patients with cold allodynia will the cold therapy be contra indicated. All these adverse events will be inhibited by careful evaluation before treatment and patient education.

Ankle sprains – one most common sports injury

Acute ankle injury, – a common musculoskeletal injury – may lead to ankle sprains. Some evidence suggests that previous injuries or limited joint flexibility may contribute to ankle sprains. The initial assessment of an acute ankle injury should include questions about the timing and mechanism of the injury. The clinical practice guidelines will conduct for excluding a fracture in adults and children and determining if radiography is indicated at the time of injury. Re-examination three to five days after injury, when pain and swelling have improved, may help with the diagnosis. Therapy for ankle sprains focuses on controlling pain and swelling. PRICE (Protection, Rest, Ice, Compression, and Elevation) is a well-established

protocol for the treatment of ankle injury. There is some evidence that applying ice and using nonsteroidal anti-inflammatory drugs improves healing and speeds recovery. Functional rehabilitation (e.g., motion restoration and strengthening exercises) is preferred over immobilization. (Douglas Ivins 2006)

In the acute inflammatory phase after soft tissue injury, cold therapy is thought to decrease oedema formation via induced vasoconstriction, and reduce secondary hypoxic damage by lowering the metabolic demand of injured tissues. Cooling skin surface temperature to approximately 5 °C is also thought to exert a localized analgesic effect by inhibiting nerve conduction velocity. Short periods of ice application have been used during the later, sub-acute phase of inflammation to produce a similar analgesic effect, thus facilitating earlier and more aggressive therapeutic exercise after muscle injury. The clinical evidence has suggested that the addition of exercise to ice application is more effective than ice application alone after acute ankle sprain. However, by reducing the conduction velocity of other, non-nociceptive fibres, cold application may also have a number of deleterious effects, including reduced muscle torque. This means that it will be relevant to be apply ice in combination with therapeutic exercise in the early stages after an acute soft tissue injury.

Ice application does not affect negatively on the myotatic reflex activity, joint position sense, plantar flexion torque or more functional measures of agility. Intermittent cold therapy applications of 10 minutes are most effective at reducing tissue temperature in human tissues. Such ice applications have been shown to reduce skin temperature to 5 °C immediately after treatment. It has also found that intermittent ice applications are more effective than continuous ice at reducing pain on activity after ankle sprain. Hubbard concluded that cold therapy positively affected return to work and sports. Intermittent applications might enhance the analgesic effect of ice after acute ankle injury. Ice application seems relatively safe and seems to influence ankle function. Cold application can be used before therapeutic exercise programs without interfering with normal sensory per-

Table 2. The indications for cold therapy

Acute injury or inflammation in soft tissue injuries
Pain (osteoarthritis, back and neck pain) acute and chronic
Muscle spasm, acute or chronic
Restoration of ROM
Small, superficial, 1 st degree burns
Post-surgical pain & edema
Neuralgia
Post-exercise (aching / sore muscles?)

ception and can be used before strenuous exercise without altering agility. There has been also reported that a 20-minute cold therapy applied to the ankle did not alter core temperature. The evidence from RCTs and reviews showed that the use of cold therapy for the treatment of acute ankle sprains will be beneficial.

Whole Body Cryotherapy

Whole-body cryotherapy (WBC) has become a popular mode of cold therapy. This involves exposure to extremely cold dry air (usually between -100°C and -140°C) in an environmentally controlled room for short periods of time (typically between 2 and 5 minutes). During these exposures, individuals wear minimal clothing, gloves, a woolen headband covering the ears, a nose and mouth mask, and dry shoes and socks to reduce the risk of cold-related injury. Originally WBC has developed to improve chronic medical inflammatory conditions, such as multiple sclerosis and rheumatoid arthritis. Recently WBC is being increasingly employed by athletes. Its expected effects include decreased tissue temperature, reduction in inflammation, analgesia, and enhanced recovery following exercise. WBC is typically initiated within the early stages (within 0–24 hours) after exercise and may be repeated several times in the same day or multiple times over a number of weeks.

Ice gel and other menthol gels and creams

The cellular and molecular mechanisms that enable to sense cold will be better understood after the recognizing the receptor level functions. Menthol elicit a cooling sensation. In 2002 have been characterized and cloned a menthol receptor that is also activated by thermal stimuli in the cool to cold range. This cold- and menthol-sensitive receptor, CMR1, is a member of the TRP family of excitatory ion channels, and it has been proposed that it functioned as a transducer of cold stimuli in the somatosensory system. This finding will demonstrate that menthol has an important role as a cold mediating factor. In this active

study gel the menthol and ethanol were taught to be the active and effective factor. In conclusion of prospective randomized controlled trial has shown that cold gel (Ice Power including ethanol and menthol) caused significantly faster pain relief and significantly faster rehabilitation results after minor soft tissue injuries. (Airaksinen et al 2004)

Menthol creams and gels are often used for treatment of various pain conditions, especially with superficial pain. They may be referred as 'cold gels' because menthol induces cooling sensation through TRPM8 channels. Furthermore, menthol has a pain relieving effect and it has been shown to enhance rehabilitation after minor soft tissue injuries. It is known that menthol reduces vascular conductance, but there are no studies on how the menthol concentration in topical cold gels affect skin temperature. Topical menthol gels typically consist of menthol, ethanol and adjuvants. The menthol percentage varies between manufacturers, but in many of the menthol-related studies, 3.5 % menthol gel is used as one alternative compound. In one study were investigated the effects of 3.5 % menthol gel and 10.0 % menthol wipe to popliteal arteria blood flow and found that both menthol treatments had a reducing effect on blood flow. They observed differences in the blood flow reduction between the used compounds. On the other hand, it has been reported that menthol increases skin blood flow. In these studies, ultrasound was used to measure menthol's effect to blood flow. Modern infrared thermal (IRT) imaging, providing good image and thermal resolution, is a potential method for detecting changes in skin temperature, e.g. due to variation in blood flow. It is known that different exposure times and menthol concentrations can lead to very different cooling sensations. Low concentrations cause rather mild cooling sensation, which is why is it used in topical gels and in candies.

In our study skin cooling was recorded with quantitative IRT imaging and cooling sensation was evaluated by means of VAS-rating. We observed that all menthol gels decreased skin temperature over five Celsius degrees and the cooling effect lasted at least for 40 min. However, despite there were major differences in



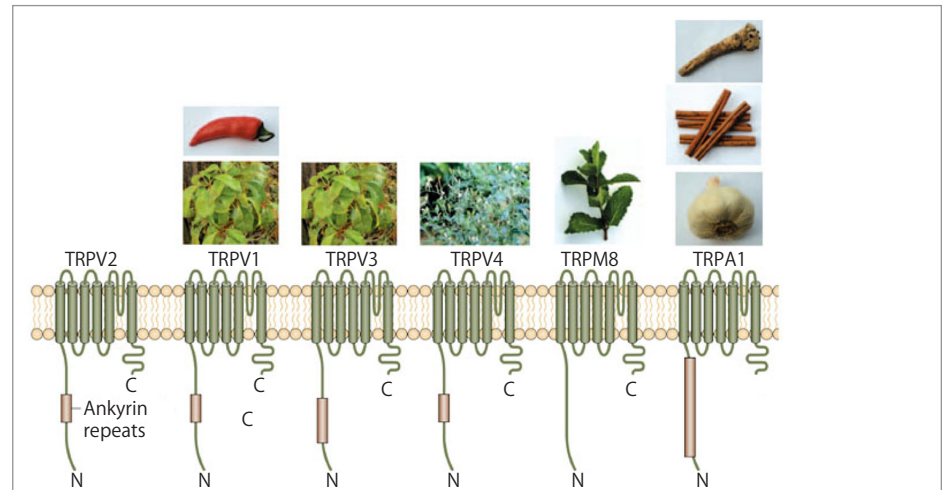
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the menthol concentrations, no significant differences were observed between the gels in skin cooling. However high concentration of menthol gel caused stronger cooling sensation than the other gels. The reason for this is unclear as it is known that higher concentrations (e.g. 40%) cause stronger cooling sensation and even pain. Skin permeability may partially explain the results. High concentrations may not absorb as efficiently as the lower ones. However, the menthol concentration and exposure time thresholds for cooling sensations are uncertain and may explain the present findings. Previous studies have reported that topical menthol ointments reduce arterial blood flow, which would implicate that menthol would affect the blood flow and temperature also at the surrounding skin areas – via receptor influence?

Conclusion

Our knowledge to understand the mechanisms of cold therapy has enhanced during last decade. The explanations of the effects on receptor level has been documented. The founding of thermoregulation channels of TRPV and TRPM8 for clarifying the action of men-



thol as cold mediator has also helped to understand the effects and influences of cold gels and creams. Also the clinical trials will supported that cold therapy will be beneficial not only the acute phase of injuries, but also on the whole therapy chain together with the medical rehabilitation. So we may conclude that cold therapy will be one of the basic tools for rehabilitation of musculoskeletal disorders and painful conditions – even it may have a role also for some areas after surgery and vascular diseases.

References by info@thesportgroup.de

Receptors of Heat (TRPV) and Cold (TRPM8, Menthol). Under the effect of Ca²⁺-ion penetration through receptors.

Case Report

26 years lady was practicing for Triathlon competition. Six week before the main competition she injured her right ankle – inversion injury – during her typical jogging exercise. The main symptoms after the injury was hard pain, swollen ankle and she was not able to walk with it. At the clinical examination the ankle was sore, swollen and painful. The most painful areas were the insertions of fibulotalar ligament (FTA) area but also the fibulocalcaneal ligament area was painful at palpation of ankle. The drawing sign was talked as negative – but the clinical evaluation was quite difficult due the serious pain and swelling. For that reason also the Magnetic Resonance Imaging was taken for being sure of the treatment protocol and also

to able to give exact prognosis for recovery for the Main Competition. The finding from MRI was grade 1 ligament rupture of FTA and FC – the ligament structure was good – only couple of them ruptured and partial bleeding.

The rehabilitation program were included first 4 days walking by sticks – no weight bearing – after that partial weight bearing and sticks away after one week. The patient used Ice Power gel about 5 grams four times a day for pain relieve and also to minimize the swelling. The patient distribute the gel over the injured area and smoothly massage about ten minutes to help the absorption of the gel in to the skin and injured area. The Ice Power treatment was continued together four weeks. In the beginning of treatment in first five

days she also took for pain relieve Etoricoxib 90mg once daily. The NSAIDS should use only at the beginning – no more than five to ten days. In that time window they do not disturb the normal regeneration process of collagen.

After three weeks the lady was able to start careful jogging exercise – before that after one and half week she was able to start swimming exercises. Ankle rehabilitation program was started after she was able to move the injured ankle and when the MRI images was evaluated with her. First mobilization exercises without resistance – after that exercises with resistant resistance bands. At finally she took part for the Main Triathlon competition and survived the whole competition without any problems with the ankle.

