National Council for NCOR Osteopathic Research

The Use of Ice in Patient Management – a snapshot summary report (Nov 2012)

- **Key messages**
- **Suggested physiological processes include:**
- *Vasoconstriction leading to reduced oedema and haemorrhage.*
- *Reduced hypoxic tissue damage.*
- *Reduced muscles spasm and interruption of pain-spasm cycle.*
- *Reduced pain due to cold induced neuropraxia and cold overriding pain impulses to the spinal cord.*
- It is difficult to ascertain whether or not ice combined with compression has a significant effect due to the varied methods used in studies. One study has shown it to accelerate cooling time.
- Frozen peas appear to be more effective than gel packs and ice massage appears to be better further still. Wetted ice appears to be more effective than crushed or cubed ice.
- Ice should be applied 24-72 hours post injury.
- A damp cloth has been shown to be the best cold-conducting barrier.
- Increased adipose tissue reduces the temperature decrease effect.
- **Contraindications include:**
- *Reduced skin sensitivity.*
- *Circulatory disorders.*
- *Sensitivity to cold.*
- *Sever cardiovascular disease of hypertension.*
- *Joint symptoms aggravated by cold.*
- Adverse events include frostbite and cold induced neuropathy.

Context

The use of cold, or cryotherapy, for medicinal purposes in the form of ice and snow has been used since the time of Hippocrates[1]. And this treatment strategy is still often used in osteopathic practice, as well as many other healthcare disciplines. The application of ice in osteopathic treatment is most commonly recommended for patients presenting with musculoskeletal injury[2,3]: ice is, however, frequently used post-operatively[4], in rheumatic disease[5] and occasionally for haemophilia[6] patients.

Proposed physiological processes

The rationale for using ice is to achieve a number of outcomes; these commonly centre around the processes that occur during an acute inflammatory process:

- *Reduction of oedema to reduce compartmental pressure.* Theoretically, the application of cold should cause vasoconstriction in superficial blood vessels, contributing to the reduction in oedema[7,8]. This point of view has, however, been challenged by Curl *et al*[9] who suggested an alternative mechanism must be operating. Cold is also believed to have a secondary nociceptive effect by limiting oedema formation and thereby limiting painful tissue distension.
- *Reduction of haemorrhage and haematoma formation.* Ho[10] and colleagues identified that applying ice for 20 minutes significantly decreased arterial and soft tissue blood flow around the knee joint; bone blood flow and metabolism were also significantly reduced. Paradoxically, periods of vasoconstriction are found to be followed by vasodilation and then vasoconstriction again. Grana *et al*[11] suggest that vasoconstriction would occur until subcutaneous temperatures fall below 15 degrees Celsius; this would then be followed by vasodilation, caused either by paralysis of the contractile mechanism or blockage of the constrictor signals. This dilation process is thought to account for the reddening that occurs when cold is applied to the skin surface.
- *Hypoxic tissue damage is reduced as the temperature reduction slows the metabolic rate of the injured tissue and reduces the rate of oxygen use*[12].
- *Muscle spasm is reduced due to the cold exerting an inhibitory effect on the muscle spindles.*
- *Pain is diminished due to a combination of three different processes:*
  - Cold-induced neuropraxia, where sensory nerve impulses are completely blocked or slowed down.
  - The cycle of pain and muscle spasm is interrupted as the reduction of muscle spasm diminishes levels of pain.

- Loeser[13] suggested that the application of cold causes signals to be transmitted to the spinal cord, which override pain impulses as they enter the spinal cord.

Reviewing the evidence

Chronic pain is less commonly associated with the use of cold packs; however, the pain-reducing effect of cold application can be helpful in some chronic pain conditions[14]. Healthcare practitioners frequently advocate the use of ice in acute symptom management post-surgery and particularly so in the care of sports injuries. One study comparing the use of ice with no ice in patients recovering from arthroscopic knee surgery found that patients using ice had significantly lower pain scores, when measured using the McGill Pain Questionnaire, and used significantly less prescription and non-prescription analgesia[15].

Reviews have been carried out to investigate whether cold therapy does hasten a return to sporting activity. However, the reviewers were concerned at the quality of the studies addressing this therapeutic area; they concluded that cryotherapy may have a positive effect on return to sport participation, but suggested that considerably more work was required to raise the quality of future studies and a greater need was identified for the use of return-to-participation outcome measures[16]. Various studies have looked at specific injuries associated with sportsmen and women and the use of ice in their management is a common thread[17].

The Cochrane Collaboration[18] recently published a review of the use of cryotherapy following total knee replacement. Most of the studies identified in their search were of low or very low quality. It was therefore difficult to draw solid conclusions regarding its use in this setting. They found a very small beneficial effect of cryotherapy on blood loss but stated that it may be too small to justify its use. They also found some evidence that cryotherapy reduces pain and improves knee range of motion in the short-term.

Compression

There is little evidence to suggest that the combination of ice and compression has any significant effect. Studies are predominantly limited to the treatment of hospital inpatients and very few studies have assessed the management of closed soft-tissue injuries. The studies involving ice and compression fail to use the same modes of compression, duration of ice and mode of ice application. It is therefore impossible to draw any objective information from the studies that add value to clinical practice[19]. Janwantanakul[20] conducted a study to investigate the effects of compression combined with ice and found that moderate compression accelerated cooling time. The following levels of compression were used in the study: 14± 2 mmHg, 24± 2 mmHg, 34± 2 mmHg, and 44± 2 mmHg as well as a no compression control. Compression didn't have an effect on the overall level of cooling but the greater the compression, the faster the cooling period. Janwantanakul[20] does highlight that the results from the study are limited in their generalisability to a clinical population.

Type of ice pack

Ice packs have become increasingly sophisticated; some patients still prefer to use good old-fashioned frozen peas, while others find that flexible gel packs are more convenient, especially when travelling while experiencing pain. Chesterton *et al*[21] compared the localised skin-cooling effects of an ice pack made from frozen peas with a flexible frozen gel pack. They found that the latter failed to cool the skin as well as the frozen peas and did not produce an effect that induced localised skin analgesia, reduced nerve conduction velocity and reduced metabolic enzyme levels to clinically relevant levels.

Zemke *et al*[22] compared the effect of ice pack application with ice massage. Ice massage involved an ice cup being massaged over the gastrocnemius muscle using overlapping horizontal strokes for 15 minutes. Ice massage reached a lower temperature of 17.9ºC in 2.4 minutes and the ice pack achieved a temperature of 28.2ºC in 12.5 minutes.

Kennet *et al*[23] compared the cooling efficiency of crushed ice (CI), gel pack (GP), frozen peas (FP) and ice-water immersion (WI) after a 20 minute application. They used a thermal imaging camera to record the skin surface temperature of the right ankle every minute for a 30 minute re-warming period. The authors found CI and WI to be the most effective. WI was superior but clinically potentially less practical so CI may be the more beneficial of the four in that respect.

Dykstra *et al*[24], on the other hand, found crushed ice (CI) to be the least effective overall in their study. They compared CI, cubed ice and wetted ice (WI) (a premade icepack that had started to melt). They found WI to be the most effective in lowering cutaneous and intramuscular temperatures. Although CI was more effective than cubed ice in lowering surface temperature during treatment, it was less effective in maintaining the lower temperature during the recovery period.

Janwantanakul[25] investigated the effect of quantity of ice and contact area in a study of 20 people. The results showed that the amount of ice influenced the degree of cooling but not the rate. The results showed that 0.6kg and 0.8kg of ice reduced skin temperature more than 0.3kg. Pack size was also compared and a larger pack size did not appear to add any further benefit.

When to apply ice

In the 1940's[26] the recommendation was to apply ice within the first 30-60 minutes after injury. By the 1950's this advice had changed to within the first 24-72 hours after injury[27].

Duration of application

Stitik and Nadler[28] recommend application of ice for 20-30 minutes every two hours, combined with rest and compression; they recommend this treatment to be continued until the swelling has gone down or after 48 hours has passed. They propose that the "20 minutes on, 20 minutes off" regime potentially increases the risk of thermal injury.

Hochberg[4] compared the effect of continuous ice application with that of intermittent application for patients following carpal tunnel surgery. Ice was applied continually for 20-minute periods during the first three post-operative days. Hochberg[4] found that patients using ice continually had a significantly greater decrease in pain. Unfortunately, the mode of ice application was not the same between the two groups, undermining the conclusions that can be drawn from the study. Bleakley *et al*[29] compared two different regimes of ice treatment management in an attempt to assess the most effective. The use of standard ice application and the intermittent application of ice were employed amongst two different groups of patients presenting with acute ankle sprain. Their findings suggested that intermittent applications of ice after acute soft tissue injury enhanced the effects of ice in relation to pain relief on activity in the early stages (first week) of the injury, but made no significant difference in terms of function, swelling, or pain at rest. Their intermittent treatment regime involved 10 minutes of ice, 10 minutes off and 10 minutes of ice, repeated every two hours for the first 72 hours after injury, as recommended by MacAuley[30].

Coté *et al*[31] investigated the use of ice, heat or a contrast bathing approach in first- and second-degree ankle sprains during the first three days after injury and before the onset of a rehabilitative exercise programme. This study concluded that the application of all three treatment modalities produced an increase in oedema in the post-acute phase in the sprained ankle; heat and contrast bathing produced identical increases in oedema; and ice therapy produced the least amount of oedema. The authors concluded that ice was the most appropriate treatment to use to minimise the development of oedema after injury.

The effects of barriers

The use of a barrier between the ice pack and skin is commonly recommended to protect the skin. Lavelle and Snyder[32] examined the effect of cooling when a barrier is present; they measured skin temperature after 30 minutes of ice application:

Type of barrier	**Mean skin temperature**
Padded bandage	30.5ºC
Unpadded bandage	20.5ºC
Dry washcloth	17.8ºC
No barrier	10.8ºC
Damp washcloth	9.9ºC

The effect of subcutaneous fat acting as insulation has been examined by Hocutt *et al*[33] and Myrer[34]. Hocutt *et al*[33] suggested that significant cooling occurred with ice application of 10 minutes to a depth of 2 centimetres (cm) in individuals with less than 1cm of fat. They suggested that in athletes with 2cm of fat, cooling was required for 20-30 minutes. Myrer[34] and colleagues also showed that the depth of adipose tissue was a significant factor in the first 15 minutes of ice therapy, showing an inverse relationship between adipose tissue and temperature decrease.

Ice and exercise

Bleakley *et al*[29] in their systematic review concluded that there was marginal evidence for the combined use of ice and exercise.

Contraindications and adverse effects

Therapeutic cold treatment should be avoided on areas of reduced sensitivity in order to avoid the potential risk of frostbite. This can include, for example, patients with locally anesthetised areas from nerve root compression syndromes, diabetic patients, patients with circulatory disorders, open wounds or skin conditions, patients with iron deficiency anaemia, and poor kidney function. Patients with sensitivity to cold, such as those with Raynaud's syndrome and thyroid conditions, should also avoid cold treatment. Similarly, patients with severe cardiovascular disease, severe hypertension and those whose joint symptoms are aggravated by use of cold should all avoid cold application[35].

Frostbite is one of the most common, yet rare, adverse effects of cold application[14,36]. Careless application of coolant sprays, particularly those containing ethyl chloride, are capable of causing localised frostbite[37,38].

Areas where nerves become more superficial should also be treated with extreme care and local cold application avoided; these include, for example, the ulnar nerve at the elbow and the peroneal nerve at the head of the fibular. Other cases in the literature have included cold-induced neuropathy in the axillary nerve and lateral femoral cutaneous neuropathy[39].

In common with so many other areas of healthcare, the evidence can be contradictory at times. The most recent work by Bleakley *et al*[29] appears to show the most extensive consideration of the literature and, most helpfully, compares the various components of management for acute injuries.

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