Column

Ice Freezes Pain? A Review of the Clinical Effectiveness of Analgesic Cold Therapy

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Abstract

Among the physical treatments to reduce pain, ice has had its place for many years. Experience tells us that ice has a strong short-term analgesic effect in many painful conditions, particularly those related to the musculoskeletal system. Serial applications may also be helpful. The scientific evidence from clinical trials is, however, fragmentary. This applies both for acute and serial cold-induced analgesia. The mechanisms by which cryotherapy might elevate pain threshold include an antinociceptive effect on the gate control system, a decrease in nerve conduction, reduction in muscle spasms, and prevention of edema after injury. It is concluded that ice may be useful for a variety of musculoskeletal pains, yet the evidence for its efficacy should be established more convincingly. J Pain Symptom Manage *1994;9:56–59.*

Key Words

Physical medicine, ice, pain, analgesia, cryotherapy, complementary therapy

Introduction

Physical medicine offers a variety of therapeutic principles that are effective in controlling pain.[1] These may have obvious advantages over drug treatments; for instance they could be associated with fewer or no systemic side effects and involve lower costs. Ice is one physical modality that, at first glance, seems to be associated with these benefits. It has long been used to relieve both chronic and acute (mostly musculoskeletal) pain.[2–5] As with other physical medicine approaches, however, the scientific basis is less well established than analgesic drugs.[6] This review summarizes the evidence for the clinical effectiveness of ice and tries to offer some explanations as to the mechanisms involved.

Methods of Cooling

The body or its parts can be refrigerated easily by applying ice to its surface. Depending on the clinical situation, cold water, cold gel packs, and ethylchloride or other sprays can be used. Whole-body cold therapy can also be employed. Application of cold leads to a lowering of the temperature of the skin, subcutaneous tissues, and, to a lesser degree, deeper tissues like muscle, bone, and joints.

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The kinetics of this temperature shift depends, among other factors, on the absolute temperature of the cooling agent, its length of application, the vascularity of the tissue, and local blood flow.[7] Usually the refrigerating effect is of short duration once the cooling agent has been removed, but deeper tissues may take some time before rewarming to baseline levels.

Acute Effects

Experiments by Parsons and Goetzl on the variability of the pain threshold gave the first scientific evidence that localized cooling might reduce pain.[8] These authors sprayed ethylchloride for 20 min onto the skin over the tibia and observed an increase in the pain threshold identified by tooth-pulp stimulation. Later, Halliday and coworkers published an uncontrolled study of 10 patients with rheumatoid arthritis,[9] who were treated for 5–10 min with ice packs applied over the painful joints and noted an immediate reduction of pain. The effect was substantial in 62% of the painful joints and persisted for up to 4 hr. Regrettably, this study was flawed by the lack of a control group and a somewhat dubious quantification of pain.

Benson and Copp determined the local pain threshold when ice was applied for 15 min on the shoulder of volunteers.[10] Immediately after cooling, the threshold was significantly increased. It was still elevated 15 min later, but after 30 min had returned to baseline. In a similar experiment, Bugaj showed that pain caused by a pin prick was abolished when the skin temperature was reduced to 13.6°C with the help of an ice massage.[11] After removal of the ice, pain was again felt when the temperature reached 15.6°C. Massage without ice was ineffective in altering the pain threshold. Interestingly, two-point discrimination is almost unaffected at temperatures above 8°C and is impaired only when the skin temperature falls to 4°C or less.[12]

Melzack and colleagues applied ice massages to the lower spinal region of patients suffering from low-back pain.[13] This produced immediate pain relief, which was felt 11–12 hr after the treatment had stopped. Unfortunately, this study lacked an untreated control group. Furthermore, it seems difficult to decide whether the massage or the ice affected the pain.

Recently, Samborski and colleagues[14] treated patients with fibromyalgia by whole body cryotherapy (–150°C). There was a significant reduction in pain immediately and 2 hr after treatment. The reduction was more pronounced than that in patients treated with a hot pack. Earlier, Travell and Renzler successfully alleviated myofascial pain with ice applied to trigger points.[15] Ice massages also have been used to reduce pain in myositis patients.[16] These studies lack an appropriate (untreated) control group. Based on the above results, one can but speculate that cold therapy is effective in reducing acute muscular pain.

These accumulated data on the short-term analgesic effect of ice give some indications as to the effectiveness of this form of treatment. Yet there are surprisingly few "hard data." Invariably the studies lack a rigorous design and are thus not fully convincing. Therefore, one has to conclude that the method is not scientifically proven at present. Nevertheless, clinical experience implies that ice can help acutely in controlling certain types of pain, particularly pains originating from the musculoskeletal system. Further controlled trials are needed to establish the short-term effectiveness of ice-induced analgesia.

Serial Applications

In the above-mentioned studies, analgesic effects are measured after one single application of the refrigerating agent. As cold therapy is usually prescribed as a series of treatments, it may be more relevant, from a clinical point of view, to look at the effects of repeated applications.

Kirk and Kersley treated 14 patients with painful knees due to rheumatoid arthritis. Ice plus exercise was compared with heat plus exercise, following a randomized crossover study design.[17] After a series of treatments, there was a significant reduction of pain in both groups. The authors state, however, that cold treatment was preferred over heat due to its acute analgesic effect after each single therapy.

Hammer and Kirk randomized 31 patients suffering from "frozen shoulder" to receive either ice plus exercise or ultrasound plus exercise.[18] Treatment was continued until pain had subsided. On average, this occurred after 12 sessions with ice and after 15 with ultrasound. Thus, both groups improved symptomatically; ice was marginally more effective than ultrasound, but the difference was not statistically significant.

The study by Melzack and colleagues mentioned above[13] also determined the outcome after serial treatments. There was no significant difference when ice was tested against transcutaneous electrical nerve stimulation (TENS) as a symptomatic therapy for low-back pain.

Hocut used ice to treat 21 patients with ankle sprains.[19] Therapy was started immediately after injury and continued intermittently for 36 hr. This resulted in faster recovery than either late treatment (started 36 hr after injury) or immediate heat applications. This study was not randomized and did not have an appropriate control group (placebo or no treatment), a drawback regretfully shared by earlier, similar research into ice-induced analgesia after trauma.[20]

Finally Williams and coworkers randomly assigned 18 patients with shoulder pain due to rheumatoid arthritis to receive either ice plus exercise therapy or heat plus exercise.[21] After a series of treatments, both groups demonstrated symptomatic improvement, but there were no significant intergroup differences.

These trials are burdened with crucial methodologic flaws and are, therefore, difficult to interpret. In particular, no study includes an appropriate control group. In the absence of a "gold standard" for any of the painful syndromes in question, one cannot conclude from the published evidence that any version of cold treatment investigated is superior to placebo. Future trials must include design features that would allow firm conclusions: an untreated control group, blinded evaluation of the outcome, and random allocation to treatment groups.[22] None of the above studies incorporates all of these conditions. Therefore, the existence of analgesic effects from serial cold therapy has not been established as yet. At the present, there are but suggestions that cryotherapy may relieve pain of the musculoskeletal system. Future studies should address the problem with more scientific scrutiny.

Possible Mode of Action

If, despite these critical drawbacks, one would accept the hypothesis that ice reduces pain, the question arises as to how cooling the body surface might bring about analgesia. One of the most obvious consequences of ice applied to the body surface is vasoconstriction of the skin blood vessels. This reflex is aimed at minimizing heat loss of the body and is mediated via both the autonomic nervous system and local hormonal control.[23] Vasoconstriction is followed by vasodilatation, usually lasting about 15 min, and further vasoconstriction.[24] This sequence of events may also be demonstrated on the untreated contralateral side of the body.[25]

If the temperature of a peripheral nerve is reduced, its conduction is slowed.[14] Unmyelinated fibers are less prone to this change than myelinated fibers, and in one set of animal experiments, the A delta fibers were affected most.[26] Several cases of reversible total palsy after local cryotherapy have been described in the world literature.[27] The phenomenon is explicable by the fact that nerve conduction is continually slowed down when temperatures fall, until finally nerve fibers cease conducting completely.[28] Warming to a point just above the core temperature has the opposite effect.[29] Although this reduction of nerve conduction could be involved, it is unlikely to play a major role: pain transmitted by C fibers would be little affected by moderate cooling, but it is C-fiber-mediated pain that usually requires treatment.

Of course, the application of a cooling agent to the skin also stimulates the sensation of cold. This sensation is triggered by thermal receptors in the skin. In the older literature, it was speculated that a "counterirritant" effect was produced by this mechanism, which somehow "overshadowed" the pain felt at the same or at a distant location.[30]

It is not clear which of these immediate sequelae of skin cooling might contribute to the analgesic effect (if any) of cryotherapy. Other mechanisms are also possible. For example, vasoconstriction could lead to minimization of edema production after trauma[31] and may also decrease the release of pain-producing substances locally. It is also tempting to speculate that the thermal receptors of the skin interfere with the gate control mechanism.[32] They might provide a strong sensory input to partly "close the gate," which consequently reduces the transmission of painful stimuli. By the same mechanism, cold might also release endorphins[33] and thereby influence opioid receptors in the central nervous system.[34]

Conclusion

Cooling (usually of small areas) of the body surface seems an attractive approach to treating musculoskeletal pain and it is used often for this purpose. Unfortunately, there is little scientific evidence to show that it is effective. All clinical studies that have evaluated this modality are severely flawed. Thus, further trials should be initiated to provide the scientific proof of its effectiveness and to test which type of pain responds best.

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