Fire and Ice: The Great Debate on the Relative Value of Heat and Ice in Musculoskeletal Therapy – A Narrative Review

John L McDonald* MAc
Australian College of Natural Medicine, Southport and Brisbane, Queensland, Australia

ABSTRACT

In contemporary musculoskeletal therapy it is common to apply topical cooling agents such as ice, particularly in the context of the RICE (Rest, Ice, Compression and Elevation) protocol. Traditional Chinese medicine (TCM) practice, however, has tended, for two millennia, to use heat rather than cold to treat musculoskeletal injuries, due to the traditional belief that enhancing circulation is likely to be beneficial, while impeding circulation is likely to be deleterious. This narrative review examines the evidence to support the use of ice alone (not as part of the RICE protocol) and the use of heat in the treatment of acute soft tissue injuries, rheumatoid arthritis, osteoarthritis and low back pain. Conclusions: Ice, applied to muscles, appears to have a local anaesthetic rather than an analgesic action. Evidence on the efficacy of ice in reducing oedema is contradictory. Insufficient evidence was found to support the assertion that ice can reduce muscle spasm, however there is evidence that heat can. In rheumatoid arthritis neither heat nor cold showed evidence of benefit. Knee oedema associated with osteoarthritis showed no significant improvement from ice massage, whereas knee oedema following arthroplasty improved with ice packs but not with hot towels. For low back pain there is moderate evidence of significant short-term benefit from heat wraps but insufficient evidence to draw conclusions on the use of cold. Low back pain studies comparing heat and cold yielded conflicting evidence.

KEYWORDS ice, heat, cryotherapy, thermotherapy, musculoskeletal, moxibustion.

Introduction

Current practice in physiotherapy and sports medicine makes extensive use of ice and other forms of cryotherapy (cooling), not only to treat soft tissue injuries, but also as a pre-exercise and post-exercise therapy to improve performance. Traditional Chinese medicine (TCM), in stark contrast, does not recommend the use of local ice application, and there appear to be no historical references to the use of ice for treating musculoskeletal disorders throughout the 2000-year-long literary tradition. This contradiction in approaches can often leave patients baffled when they visit a physiotherapist, doctor or chiropractor who recommends that they use ice to treat their muscular injury, and then consult an acupuncturist who advises them to use heat and not ice. This debate, which is not short of heated (and icy) opinions, could benefit from examination of the evidence for the effectiveness of heating and

* E-mail: twindragon@bigpond.com

Aust J Acupunct Chin Med 2007;2(2):3–8.

cooling therapies for musculoskeletal disorders. This review of the research literature will examine such questions as the following:

- What sorts of musculoskeletal disorders benefit from ice or heat (such as soft tissue injury, osteoarthritis, rheumatoid arthritis)?
- When should ice or heat be used (e.g. in the acute inflammatory stage of injury, in sub-acute or chronic cases)?
- On what parts of the body are ice or heat most effective (e.g. ankles, knees, neck, low back)?

The databases searched included ScienceDirect, PubMed, CINAHL Plus with Fulltext, PEDro, Sports Discus, The Cochrane Library and Ovid Full Text. Journals hand-searched in hard copy included *The Journal of Traditional Chinese Medicine* and *The World Journal of Acupuncture–Moxibustion*. The search terms used included: ice, cold, cryotherapy, thermotherapy, heat, musc*, sports injuries, moxa, moxibustion. An initial search found 695 articles, however only 69 of these articles were directly relevant to the treatment of musculoskeletal injury with either cold or heat.

Fire and Ice: The Philosophical Debate

Given that one of the earliest definitions of health recorded in the *Su wen* was unimpeded circulation of Qi and Blood in the channels and collaterals, it was a natural extension of this concept that therapy should be directed towards enhancing circulation of Qi and Blood. The corollary of this was that Cold was an external pathogen which caused disease by causing contraction, and hence impairment, of the circulation of Qi and Blood. The application of local heat as a therapy with heated stones (*bian* stones), burning twigs and other heat sources appears in the historical medical records before acupuncture and probably predates acupuncture. The *Mawangdui* silk scrolls, for example, buried in a tomb in 168 BC (and presumably old when buried) make reference to moxibustion but not to acupuncture.[1]

One of the earliest concepts of how moxibustion should be used was that heat should be applied to treat disorders caused by cold. In *Su wen*, chapter 12, moxibustion is said to originate from the north of China, where the people of the high plateau consumed a lot of dairy foods (from yak's milk), which were said to produce '*zang* Cold causing fullness'.[2] The author of the *Shang han lun* (*Treatise on cold injury*), Zhang Zhongjing, emphasised that moxibustion was suitable for treating Yin syndromes (Cold), while acupuncture should be used for Yang syndromes (Heat).[3] In this world view, cold was a pathogen while heat was a therapy. Of course, Heat and Fire were also seen as pathogens within TCM theory; however, the therapy was called 'clearing Heat or Fire' and the therapeutic application of local cold does not appear in the historical literature.

With regard to musculoskeletal therapy, Cold was said to make muscles contract while Heat was said to make muscles flaccid (*Ling shu*, chapter 13).[2] Also, the contracting action of Cold was blamed for producing the most painful musculoskeletal disorders such as White Tiger Wind, an extremely painful shoulder disorder where the patient 'wishes to break the arm off and throw it away' (the White Tiger symbolises Cold). Painful Bi syndrome (*tong bi*) is also caused by Cold, and for treating Cold/Painful Bi, moxibustion is strongly recommended (*Su wen*, chapter 43).[2] In TCM, relieving muscle spasm and enhancing local circulation is best achieved by the use of heat, such as moxibustion, and since painful muscle spasm is seen as being caused by cold, the application of ice would be seen as strictly contraindicated.

If TCM theory has been right about the dangers of using local ice application for musculoskeletal disorders, then the predicted long-term outcome of this practice would be an exponential rise in the rates of Cold Bi syndrome as the current generation of sports enthusiasts gets older. Such an epidemiological study in a few decades time may well provide a definitive answer to this ice question – when it is too late. An epidemiological study of ice-cream factory workers suggests that Cold Bi may perhaps be a real hazard. Italian researchers found 'an extremely high frequency of carpal tunnel syndrome (7.1%), epicondylitis (5.2%), and scapulo-humeral periarthritis (3.5%) in the over-35-years age group, with respect to a control population not exposed to the risk.'[4] (Scapulo-humeral periarthritis is also known as White Tiger Wind, a very painful form of Cold Bi syndrome.)

The worldview of the proponents of ice could not be more different. The use of ice to treat musculoskeletal disorders is currently strongly advocated by many sports medicine practitioners and physiotherapists. For example, the clinical practice guidelines of the Association of Chartered Physiotherapists in Sports Medicine (UK) advocate that in the inflammatory stage of an acute sports injury (which the authors nominate as the first 72 hours after acute injury) management should follow the PRICE format – Protection, Rest, Ice, Compression and Elevation.[5] The acute inflammatory phase in characterised by *rubor* (redness), *calor* (heat), *dolor* (pain) and *tumor* (swelling). In modern TCM practice the presence of local redness and palpable heat would constitute a contraindication for moxibustion, but would not necessarily make a case for using ice. The most commonly used 'Heat Clearing' technique used by acupuncturists for acute musculoskeletal injury with redness and heat would probably be non-retaining reducing (*xie*) technique. Other 'Heat Clearing' techniques in acupuncture

include microbleeding techniques, the use of the Ying-Spring points and the Ming Dynasty needle technique, *Tou tian liang* (Spreading Heavenly Coolness). So there is some agreement in treating the inflammatory stage of an acute injury – there is consensus that heat should not be used at this time.

The aims of using ice for the acute inflammatory stage include: to lower the temperature in the tissue, to produce vasoconstriction, to limit bleeding (and hence reduce bruising), to reduce oedema and to stop pain.[6,7]

Fire and Ice: The Evidence

ACUTE SOFT TISSUE INJURY

In the area of acute soft tissue injury management, it is common for reviews and clinical practice guidelines to recommend the use of the RICE (Rest, Ice, Compression, Elevation) protocol (or one of its derivatives), especially within the first 72 hours after injury.[5,6,8-11] What is less common, however, is to find research which examines the use of ice alone, rather than in the context of the RICE protocol, for acute soft tissue injuries.

OEDEMA

The evidence for the influence of ice on oedema is conflicting, with some studies actually showing an increase in swelling after the use of ice.[5] In their clinical practice guidelines, Kerr et al. conclude that 'empirical and biological evidence from animal and human studies seems to refute the notion that cold application reduces oedema. The same evidence is not widely apparent from clinical studies, but this may be because cold application is usually combined with compression and elevation.'[5] The appropriate and timely use of continuous compression has demonstrated unequivocal reduction in oedema due to acute soft tissue injury, and since compression is generally used with ice in the context of the RICE protocol, it is possible that it is compression which is responsible for reducing oedema, not ice.[5,12] In a systematic review of the evidence for the use of cryotherapy alone for acute soft tissue injury, Hubbard and Denegar found that there was little difference between the effectiveness of ice and compression used together and that of compression used alone.[13] Another systematic review by Bleakley, McDonough and MacAuley also found little evidence that adding ice to compression produced any additional benefits.[14] Not all researchers agree on this point. One study on rats has concluded that following contusion of striated muscle, ice can significantly reduce microvascular permeability and the researchers go on to hypothesise that this may in turn reduce leukocyte-endothelial interactions, thus decreasing oedema.[15] Another study, which compared cold, heat and alternating cold and heat to treat oedema on the third, fourth and fifth day after grade 1 and grade 2 ankle sprains, found that only ice therapy significantly reduced oedema.[9]

PAIN

Researchers have also found varying results for pain, including an initial increase in pain when ice is applied, followed by gradual numbness and then cyclical pain and numbness.[5] Ernst and Fialka, in a review on the use of cryotherapy for musculoskeletal pain relief, concluded not only that there is little evidence for the effectiveness of such therapy, but also that all of the clinical studies reviewed were severely flawed.[16] There appears to be a very close association between local numbness and pain relief, suggesting that perhaps this is not a truly analgesic effect as much as a local anaesthetic effect.[7] Other researchers accept that ice is effective in relieving pain.[5-10] However, some studies have also found that 'ice and compression seemed to be significantly more effective than ice alone in terms of decreasing pain.'[13]

MUSCLE SPASM

There are some claims that ice can reduce muscle spasm, but no evidence for this claim was found in the literature searched. It has been suggested that cryotherapy may relieve muscle spasm by interrupting the pain–spasm–pain cycle via local stimulation of both nociceptors and proprioceptors; however, no confirmatory clinical evidence has been cited by the authors.[7] There is, nevertheless, good evidence that heat reduces muscle spasm.[6,17,18] The idea that heat relieves muscle spasm is found in the *Ling shu* (as already mentioned), and in the same chapter, cold is said to cause muscles to contract, not relax (*Ling shu*, chapter 13).[2] A surprising historical curiosity is a letter to the editor of *The Lancet* dated 3 January 1828, in which Dr Patrick McIntyre records a case history of successful treatment of muscular contractions of the hand 'cured by moxa'.[19]

RHEUMATOID ARTHRITIS

Robinson et al. undertook a Cochrane systematic review of thermotherapy for treatment of rheumatoid arthritis.[20] A range of objective measures, including joint swelling, pain, medication use, range of motion, grip strength and hand function, showed no significant change in response to hot packs and ice packs, cryotherapy and wax baths.[20] The affected joints in the seven studies reviewed included hands, knees and shoulders.

In a recent study on rheumatoid arthritis in Hubei, 30 patients were given oral Methotrexate and non-steroidal anti-inflammatory drugs (NSAIDs), while another 30 patients received the same medication plus moxa cones on a slice of aconite (*fuzi*) on ST36 *Zusanli* and CV4 *Guanyuan*.[21] The medication plus moxa group showed a significantly greater reduction in NSAIDs dosage and greater symptomatic improvement than the medication only group.[21] While this study is probably the first of its kind and has a relatively small sample size, it does suggest that this style of moxibustion produces systemic improvement. However, what local

effect moxibustion may have remains an open question. An earlier animal study by Wang and Xie also showed an anti-inflammatory effect of moxibustion in experimentally induced adjuvant arthritis in rats.[22]

OSTEOARTHRITIS

Brosseau et al. conducted a Cochrane systematic review of three studies, of which two involved osteoarthritis of the knee, while the third related to post-surgical rehabilitation after total knee arthroplasty.[23] No significant difference was found between ice packs and control (untuned short wave) in relieving pain.[23] Knee oedema associated with osteoarthritis showed no significant improvement from ice massage; however, post-surgical knee oedema did improve significantly from ten sessions of ice packs.[23] The application of hot towels did not reduce post-surgical knee oedema significantly.[24] Curiously, the reviewers made no comment on whether or not heat was effective in relieving pain or improving range of movement.

LOW BACK PAIN

A Cochrane systematic review by French et al. compared superficial heat and superficial cold for low back pain, including both acute and sub-acute low back pain.[25] Of nine included studies, only three related to cold treatment, and these were judged to be of such poor quality that no conclusions could be drawn.[25] The reviewers concluded that there is moderate evidence for the effectiveness of heat wraps and heated blankets in reducing pain and disability in the short term.[25] One trial also suggested that adding exercise to heat wraps gave even better pain relief for acute and sub-acute low back pain.[25] Studies making comparisons between cold and heat for low back pain yielded conflicting evidence.[25]

MOXIBUSTION RESEARCH

Whilst moxibustion is a form of heating therapy, it is not necessarily the case that all forms of heating therapy can achieve the same results as moxibustion. Some specific therapeutic claims have been made for moxibustion which have not been made for any other form of heating therapy. Shen et al. cite research which shows moxibustion to be capable of enhancing 'physiological and immune functions'.[26] Toguchi cites the findings of various Japanese researchers on moxibustion and lists the following therapeutic actions of moxibustion:[27]

- produces histotoxin ('beneficial for neuralgia and rheumatism'),
- regulates intestinal peristalsis,
- promotes local vasodilation and enhances local microcirculation,
- promotes recovery from muscular fatigue,
- increases leucocyte count as well as leucocyte wandering speed and phagocytotic action,
- increases production of erythrocytes and haemoglobin.

Other moxibustion studies (a mixture of animal and human, in vivo and in vitro studies) have also suggested that moxibustion has the following effects:

- anti-inflammatory,[21,22,28,29]
- anti-oxidative,[29-31]
- anti-allergic,[28]
- immune-enhancing.[26-30]

The application of moxibustion in all the above studies was on a selected acupuncture point or points, not locally on the site of a musculoskeletal injury or disorder. So, although some early evidence outlined above does suggest that moxibustion may have an anti-inflammatory action when used systemically, this does not tell us whether local moxibustion is capable of a similar action. Unless further research suggests otherwise, at present it would seem prudent to follow the traditional rule of not using moxa on any local area which is red and hot.

Summary of research

'More large, well-constructed studies needed' is almost a cliché today in reviews of acupuncture and moxibustion research. However, it appears from the research reviewed above that the same can probably be said of many forms of cryotherapy which are currently in widespread use, and which are recommended in many clinical practice guidelines. While it appears there is good evidence that ice can cause vasoconstriction and reduced temperature in local tissue, the evidence for oedema reduction is contradictory. Ice does produce local numbness but this is not the same as analgesia – it is local anaesthesia.[7] No evidence was found to support the assertion that ice can relieve muscle spasm.

It is noteworthy that the studies which showed the best clinical results for ice tended to be for acute soft tissue injury, especially of the ankles and knees. The quality of studies of ice treatment on the low back was so poor that reviewers were unable to draw any conclusions, and no studies were found involving the use of ice on the neck. This may be because muscular problems of the neck are more often seen in chronic states and most of the clinical practice guidelines for the use of ice restrict its use to the acute inflammatory stage of a soft-tissue injury (nominated by some as the first 72 hours). For acute and sub-acute low back pain, heat wraps and hot blankets were found to be effective in short-term pain relief and reduction of disability. No research was found which evaluates the use of moxibustion alone for low back pain, but this is hardly surprising as moxibustion is usually used in conjunction with acupuncture in the treatment of low back pain.

For rheumatoid arthritis, reviewers found no good evidence of benefit from either heat or cold; however, some moxibustion

studies showed clinical improvements and suggest an anti-inflammatory action for moxibustion (when used on appropriate acupuncture points, not when applied locally). Osteoarthritis of the knee showed no oedema reduction from the use of ice, though post-surgical knee oedema (following total knee arthroplasty) did reduce with ice packs. Osteoarthritis studies involving moxibustion only were not found as this does not reflect current acupuncture practice. Studies of osteoarthritis treated with acupuncture only or acupuncture and moxibustion tell us little about the value of heat therapy alone for this condition.

Conclusions

Moxibustion is widely used by acupuncturists in conjunction with acupuncture in the treatment of chronic and acute musculoskeletal disorders, except when local redness and heat are present. Ice is widely used (usually in the context of the RICE protocol or one of its variants) by physiotherapists and other sports medicine practitioners for acute soft tissue injury in the acute inflammatory phase. Some also recommend ice to treat chronic musculoskeletal conditions.[6,7]

In sharp contrast, the use of ice has not been included in the historical repertoire of TCM musculoskeletal treatment. Indeed the TCM theory suggests that the use of ice, particularly if prolonged or used in a chronic condition, may even contribute to long-term problems, such as Cold Bi Syndrome, due to impairment of the circulation. At this time there is insufficient evidence to support this prediction.

Time will judge the value of the 'Ice Age' in the history of musculoskeletal medicine.

References

1. Unschuld PU. Medicine in China: a history of ideas. Berkeley: University of California Press; 1985.
2. Lu H. A complete translation of the Yellow Emperor's Classic of Internal Medicine and the Difficult Classic. Vancouver, BC: Academy of Oriental Heritage; 1978.
3. Wei J, editor. Ge jia zhen jiu shuo [Theories of the various schools of thought in acupuncture and moxibustion]. Shanghai: Shanghai Science and Technology Press; 1986.
4. Sannino G, Taviani A, Tartaglia R, Valiani M, Ianniello G. Repetitive movements of the upper limbs: results of exposure evaluation and clinical investigation in the production and packaging of ice cream [in Italian]. Med Lav 1996;87(6):598–602.
5. Kerr K, Daley L, Booth L, Stark J. Guidelines for the management of soft tissue (musculoskeletal) injury with protection, rest, ice, compression and elevation (PRICE) during the first 72 hours [Online]. Association of Chartered Physiotherapists in Sports Medicine; 1998 [cited 2 Apr 2006]. Available from: http://admin.csp.org.uk/admin2/uploads/-38c9a362-ed71ce5fa5--7ff7/ACPSMgl.pdf.
6. Geffen SJ. Rehabilitation principles for treating chronic musculoskeletal injuries. Med J Aust 2003;178(5):238–42.
7. Nadler SF, Weingand K, Kruse RJ. The physiologic basis and clinical applications of cryotherapy and thermotherapy for the pain practitioner. Pain Physician 2004;7(3):395–9.
8. Wolfe M, Uhl TL, Mattacola CG, McCluskey L. Management of ankle sprains. Am Fam Physician 2001;63(1):93–104.
9. Thompson C, Kelsberg G, St Anna L, Poddar S. Heat or ice for acute ankle sprain? J Fam Pract 2003;52(8):642–3.
10. Smith M. A review of the initial management of soft tissue sports injuries. J Orthop Nurs 2005;9(2):103–7.
11. Kiningham R, Desmond J, Fox D, Haftel H, McQuillan M, Wojtys E. Knee pain or swelling: acute or chronic. UMHS knee pain guideline. University of Michigan Health System. Aug 2002 [cited 7 Apr 2006]. Available from: http://cme.med.umich.edu/pdf/guideline/knee.pdf.

Clinical Commentary

When the evidence to support the use of ice in musculoskeletal disorders is separated out from the commonly used context of the RICE (Rest, Ice, Compression, Elevation) protocol, it has been claimed that ice alone is effective in relieving pain, reducing oedema and relieving muscle spasm.

- The evidence suggests that ice alone has a local anaesthetic rather than analgesic effect.
- There is contradictory evidence for whether or not ice alone can reduce oedema, but it may be that compression is the most effective component of the RICE protocol for oedema, given that, while compression is effective in reducing oedema, the addition of ice to compression shows no additional benefit.
- No evidence was found in the reviewed literature to support the assertion that ice can relieve muscle spasm, although there is consensus in the research that local heat can.

12. Kraemer WJ, Bush JA, Wickham RB, Denegar CR, Gómez AL, Gotshalk LA et al. Continuous compression is an effective therapeutic intervention in treating eccentric exercise induced muscle soreness. J Sport Rehabil 2001;10(1):11–23.
13. Hubbard TJ, Denegar CR. Does cryotherapy improve outcomes with soft tissue injury? J Athl Train 2004;39(3):278–9.
14. Bleakley C, McDonough S, MacAuley D. The use of ice in the treatment of acute soft-tissue injury: a systematic review of randomized controlled trials. Am J Sports Med 2004;32(1):251–61.
15. Deal DN, Tipton J, Rosencrance E, Curl WW, Smith TL. Ice reduces edema: a study of microvascular permeability in rats. J Bone Joint Surg Am 2002;84(9):1573–8.
16. Ernst E, Fialka V. Ice freezes pain? A review of the clinical effectiveness of analgesic cold therapy. J Pain Symptom Manage 1994;9(1):56–9.
17. Robertson VJ, Ward AR, Jung P. The effect of heat on tissue extensibility: a comparison of deep and superficial heating. Arch Phys Med Rehabil 2005;86(4):819–25.
18. Cosgray NA, Lawrance SE, Mestrich JD, Martin SE, Whalen RL. Effect of heat modalities on hamstring length: a comparison of pneumatherm, moist heat pack and a control. J Orthop Sports Phys Ther 2004;34(7):377–84.
19. Mcintyre P. Muscular contraction cured by moxa. Lancet 1828;9(228):574–5.
20. Robinson VA, Brosseau L, Casimiro L, Judd MG, Shea BJ, Tugwell P et al. Thermotherapy for treating rheumatoid arthritis. Cochrane Database Syst Rev 2002(2).
21. Li J, Liu J, Ma Z, Xiong Y, Feng Y, Xiang S, Zhang J, Peng H. [Clinical observation on treatment of rheumatoid arthritis with cake-separated mild moxibustion combined with Western medicine.] Zhongguo Zhen Jiu 2006;26(3):192–4.
22. Wang T, Xie S. [Effect of moxibustion on the inflammatory reactions of adjuvant arthritic rats.] Zhen Ci Yan Jiu 1990;15(1):44–7.
23. Brosseau L, Yonge KA, Robinson V, Marchand S, Judd M, Wells G et al. Thermotherapy for treatment of osteoarthritis. Cochrane Database Syst Rev 2003(4).
24. Hecht PJ, Bachmann S, Booth RE, Rothman RH. Effects of thermal therapy on rehabilitation after total knee arthroplasty: a prospective randomized study. Clin Orthop Relat Res 1983;178:198–201.
25. French SD, Cameron M, Walker BF, Reggars JW, Esterman AJ. Superficial heat or cold for low back pain. Cochrane Database Syst Revs 2006(1).
26. Shen X, Ding G, Wei J, Zhao L, Zhou Y, Deng H et al. An infrared radiation study of the biophysical characteristics of traditional moxibustion. Complement Ther Med 2006;14(3):213–19.
27. Toguchi M. The complete guide to acupuncture. New York: Frederick Fell Publishers; 1974.
28. Tang Z, Song X, Li J, Hou Z, Xu S. [Studies on anti-inflammatory and immune effects of moxibustion.] Zhen Ci Yan Jiu 1996;21(2):67–70.
29. Matsumoto H, Shimada J, Nagasaka H, Matsumoto I, Hashimoto K Sakagami H. Inhibition by moxa smoke of NO production and iNOS expression in mouse macrophage-like cells. In Vivo 2005;19(2):471–4.
30. Cheng Y, Huang Y, Wang F, Chen Y, Xu W, Zhu W et al. Moxibustion enhances antioxidation activity of the body. World J Acupunct Moxi 1997;7(1):38–40.
31. Chiba A, Nakanishi H, Chichibu S. Thermal and antiradical properties of indirect moxibustion. Am J Chin Med 1997;25(3–4):281–7.