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Thermotherapy for treatment of osteoarthritis (Review)

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[Intervention Review]

Thermotherapy for treatment of osteoarthritis

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ABSTRACT

Background

Osteoarthritis is a degenerative joint disease that affects mostly the weight-bearing joints in the knees and hips. As the affected joint degenerates pain and restriction of movement often occur. Inflammation can also occur sometimes resulting in edema of the joint with OA. Treatment focuses on decreasing pain and improving movement.

Objectives

To determine the effectiveness of thermotherapy in the treatment of OA of the knee. The outcomes of interest were relief of pain, reduction of edema, and improvement of flexion or range of motion (ROM) and function.

Search methods

Two independent reviewers selected randomized and controlled clinical trials with participants with clinical and/or radiological confirmation of OA of the knee; and interventions using heat or cold therapy compared with standard treatment and/or placebo. Trials comparing head to head therapies, such as two different types of diathermy, were excluded.

Selection criteria

Randomized and controlled clinical trials including participants with clinical or radiographical confirmation of OA of the knee and interventions using heat or cold compared to standard treatment or placebo were considered for inclusion.

Data collection and analysis

Study results were extracted by two independent reviewers. Outcomes were continuous in nature (pain, strength, improvement) and were analyzed by weighted mean difference using a fixed effects model. Graphical data were used when table data were not available.

Main results

Three randomized controlled trials, involving 179 patients, were included in this review. The included trials varied in terms of design, outcomes measured, cryotherapy or thermotherapy treatments and overall methodological quality. In one trial, administration of 20 minutes of ice massage, 5 days per week, for 3 weeks, compared to control demonstrated a clinically important benefit for knee OA on increasing quadriceps strength (29% relative difference). There was also a statistically significant improvement, but no clinical benefit

in improving knee flexion ROM (8% relative difference) and functional status (11% relative difference). Another trial showed that cold packs decreased knee edema.

Authors' conclusions

Ice massage compared to control had a statistically beneficial effect on ROM, function and knee strength. Cold packs decreased swelling. Hot packs had no beneficial effect on edema compared with placebo or cold application. Ice packs did not affect pain significantly, compared to control, in patients with OA. More well designed studies with a standardized protocol and adequate number of participants are needed to evaluate the effects of thermotherapy in the treatment of OA of the knee.

PLAIN LANGUAGE SUMMARY

Thermotherapy (heat treatment) for treating osteoarthritis of the knee

To answer this topic, scientists found and analyzed three studies. Over 170 people with osteoarthritis continue to take their medications but used hot, cold or ice packs/towels with or without massage or no treatment. The studies were not of high quality but this Cochrane review provides the best evidence we have today.

What is thermotherapy and how might it help osteoarthritis of the knee?

Osteoarthritis (OA) is the most common form of arthritis that can affect the hands, hips, shoulders and knees. In OA, the cartilage that protects the ends of the bones breaks down and causes pain and swelling. Thermotherapy involves applying heat or cold to joints to improve the symptoms of osteoarthritis and can be done with packs, towels, wax, etc. Heat may work by improving circulation and relaxing muscles, while cold may numb the pain, decrease swelling, constrict blood vessels and block nerve impulses to the joint. Thermotherapy can be used in rehabilitation programmes or at home.

How well does thermotherapy work?

One study showed that massaging with ice for 20 minutes, 5 days a week for 2 weeks, improved muscle strength in the leg, the range of motion in the knee and decreased time to walk 50 feet compared to no treatment.

Another study showed that ice packs for 3 days a week for three weeks improved pain just as well as no treatment.

Another study showed that cold packs for 20 minutes for 10 periods decreased swelling more than no treatment. Hot packs for the same amount of time had the same effect on swelling as no treatment.

How safe is it?

No side effects were reported in the studies, but in general, studies report that thermotherapy is safe when applied carefully.

What is the bottom line?

Since the studies were small and of low quality firm conclusions cannot be made. There is "silver" level evidence that ice massage could be used to improve

range of motion and strength of the knee and function in people with osteoarthritis of the knee. Cold packs may be used to decrease swelling.

BACKGROUND

Osteoarthritis (OA) is a degenerative joint marked by degeneration of the articular cartilage, hypertrophy of bone at the margins, and changes in the synovial membrane (Solomon 1997). It is a

dynamic disease, reflecting the relationship between breakdown of tissue and its subsequent restoration (Solomon 1997). When cartilage softens and breaks down, the underlying bone becomes exposed. This results in bone breakdown, followed subsequently by new bony formation. The new bone, however, is often in the form of prominent osteophytes, which rub together, causing pain and limited motion (Solomon 1997). OA is one of the most common forms of arthritis and affects men and women equally. For many adults OA is one of the most important causes of long-term disability (Solomon 1997, Peyron 1992). Osteoarthritis can affect any joint but usually affects the hips and knees, hands and spine. The knee appears to be the joint most prone to the development of OA. This may be because it is a major weight-bearing joint, and prone to effects of obesity, trauma, as well as some metabolic diseases (Fife 1997). Pain in the knee is exacerbated by movement or weight bearing; stiffness, edema and deformity, reduced function, such as walking are common complaints in patients with OA of the knee.

There is no cure for OA at present, and so objectives of management of symptoms of OA of the knee are to lessen pain and stiffness, maintain or improve mobility, and minimize disability. Treatment options include pharmacologic intervention, exercise therapy, surgery and hot and/or cold therapy (Fife 1997). Different physiotherapy treatments have been shown to help improve clinical symptoms and function of knee OA with fewer adverse effects than medical treatment. Thermotherapy is one such non-invasive therapy.

Cryotherapy is used in rehabilitation to reduce inflammation, pain and edema, which in turn facilitates improvement in mobility. Cold aids pain relief by temporarily numbing the affected area by constricting the blood vessels and blocking nerve impulses in the joint (Arth Found 2003). Techniques for cryotherapy include the application of cold or ice packs, and massage with ice over painful areas or acupoints (Cameron 1999). Heat therapy is also used in rehabilitation to reduce pain and stiffness, and to increase mobility. Heat therapy helps to relax muscles and increase circulation to the affected area, thus reducing pain and stiffness, although there is some concern that this may, in turn, worsen inflammation and edema (Arth Found 2003). Techniques for heat therapy include the application of hot packs, superficial heat and via diathermy (application of electromagnetic energy) (Cameron 1999). Heat and cryotherapy are commonly used in physical rehabilitation for patients with osteoarthritis (OA) to relieve pain (Arth Found 2003, APTA 2001). Both can be self-applied easily by the patient at home (such as the use of heat or ice packs), and may also be combined with other rehabilitation interventions.

OBJECTIVES

The purpose of this review was to determine the effectiveness and safety of hot and cold therapy in patients with osteoarthritis (OA) of the knee.

METHODS

Criteria for considering studies for this review

Types of studies

According to an a priori protocol, eligible studies included randomized controlled trials (RCTs) and controlled clinical trials (CCTs).

Types of participants

Only trials with participants aged 18 years or more with clinical and/or radiological confirmation of OA of the knee were included. Diagnosis of knee OA was defined using the ACR criteria of classification of OA of the knee (Altman 1986). These criteria include knee pain, age over 50, joint stiffness, crepitus, bony tenderness and/or enlargement, osteophytes and no palpable warmth.

Types of interventions

Interventions using heat or cold therapy only were included in this review. Trials that compared thermotherapy with standard treatment and/or placebo were included. Concurrent therapies such as exercise were accepted. Trials comparing head to head therapies, such as two different types of diathermy, were not included in this review, but will be included in a future review on electrotherapeutic measures.

Types of outcome measures

The primary outcome measure was pain relief according to the Outcome Measures in Rheumatology Clinical Trials (OMERACT 3) (Bellamy 1997). In addition, the other outcome measures from OMERACT 3 were also included for potential analysis. These were change in function, number of tender joints, number of swollen joints, and patient and physician global perspective on disease.

Search methods for identification of studies

Published clinical trials of thermotherapy and/or cryotherapy for knee OA, in French or English, were identified through a search of MEDLINE (1966-2002), EMBASE (1975-2002), CINAHL, HEALTHSTAR, Physiotherapy Evidence Database (PEDro), the Cochrane Musculoskeletal Specialized Register, and the Cochrane

Controlled Trial Register (CCTR) Issue 1, 2000, using the sensitive search strategy of the Cochrane Musculoskeletal group modified from work by Dickersin 1994 and Haynes 1994.
Reference lists were hand-searched for further identification of published work, presentation at scientific meetings and personal communications. Content experts were contacted for additional studies and unpublished data (Dickersin 1997).
The search strategy for MEDLINE database used is in Appendix 1 (until December 2002).

Data collection and analysis

The above search strategy identified a set of potentially relevant articles which were subsequently retrieved for review. These trials were assessed by two independent reviewers (BL,LL). Studies were selected to include in the review according to the inclusion criteria. From each included trial, we collected information regarding the trial design, patient characteristics, dosages and treatment periods, baseline and end of study outcomes. Data concerning details of the studied population, intervention and outcomes were extracted using pre-determined extraction forms by two independent reviewers (BL,LL). Differences in data extraction were resolved by referring back to the original article and establishing consensus. A third reviewer (CB) was consulted to help resolve differences. When necessary, information was sought from the authors of the primary studies.
This review was originally conducted to develop clinical practice guidelines for OA. They were adopted by a Panel of Experts: The Ottawa Panel on March 2003
Statistic analysis
Outcomes were continuous in nature (pain, ROM and strength). Where pooling of data from different trials was possible, these outcomes were analyzed by a weighted mean difference (WMD) using a fixed effects model. For dichotomous data, relative risks were used. The effect measured in an individual trial is weighted by the amount of variability about the mean (measured by the standard deviation) in that study for that outcome. Graphical data were used in cases where table data were not available.
Grading the strength of the evidence
The common system of grading the strength of scientific evidence for a therapeutic agent that is described in the CMSG module scope and in the Evidence-based Rheumatology BMJ book (Tugwell 2003) was used to rank the evidence included in this systemtic review. Four categories are used to rank the evidence from research studies: Platinum, Gold, Silver, and Bronze. The ranking is included in the synopsis of this review.

RESULTS

Description of studies

The literature search and handsearching identified eleven potential articles. Of these three RCTs were included in the systematic review. Eight trials (Aix-les-Bains 1980, Lehmann 1954, Marks 1997, Oosterveld a 1994, Oosterveld b 1994, Pegg 1969, Walker 1991, Weinberger 1988) were excluded for several reasons: 1) no control group (Aix-les-Bains 1980, Marks 1997, Pegg 1969), 2) sample of patients with periarthritis post-trauma, fractures, sclerosis (Lehmann 1954); 3) mixed population with OA in minority (Oosterveld b 1994, Walker 1991); 4) literature reviews with no statistical data (Oosterveld a 1994, Weinberger 1988). The included RCTs involved 179 patients with OA (Hecht 1983, Yurtkuran 1999, Clarke 1974). One included RCT (Hecht 1983) examined the effects of the application of hot towels or cold packs versus control for the reduction of edema and pain, and effect on ROM. A second RCT compared the application of ice massage with control for effect on pain relief, stiffness, 50-foot walking time, quadriceps strength and ROM (Yurtkuran 1999). The third included RCT assessed the effects of the application of ice packs versus control on pain, stiffness, tenderness and edema (Clarke 1974).

Risk of bias in included studies

The quality of the studies was assessed by the two independent reviewers (BL, LL). The quality assessment addressed the extent to which the RCT design, data collection and statistical analysis minimized or avoided biases in its treatment comparisons (Moher 1995). A validated scale (Jadad 1996, Clark 1999) was used to perform the quality assessment. This scale includes items pertaining to description of randomisation, appropriateness of blinding, dropouts and consideration of withdrawals and follow-ups with regard to possible effects on data analysis, with a possible total score of 5. Differences in scoring were resolved by consensus. A third reviewer (CL) was consulted when necessary. The median methodological quality of these RCTs was 2. No trial scored full points for randomisation, nor for double blinding, and only one (Clarke 1974) reported withdrawals or dropouts.

Effects of interventions

Effectiveness of ice massage compared to control
Massaging with ice for 20 minutes per session, 5 sessions per week, for 2 weeks, resulted in a clinically important benefit on increasing quadriceps strength (29% relative difference) versus control. This result was also statistically significant (WMD = 2.30, 95%CI: 1.08 to 3.53; p = 0.0002) (Yurtkuran 1999). This study also assessed changes in knee flexion (ROM), and functional status (time to walk 50 feet). It found that ice massage statistically significantly improved both ROM (WMD = 8.80 degrees 95% CI: 4.57,13.03; p=0.00005), time to walk 50 feet (WMD = -9.70

sec , 95% CI: -12.40,-7.00; p<0.00001), compared with control. There was, however, no clinically relevant benefit of ice massage on either ROM (8% relative difference in change from baseline, nor walking time (-11% relative difference in change from baseline).
There is a clinically important benefit of cold vs control for knee OA on increasing quadriceps strength (29% relative difference). No clinical benefit for improving knee flexion ROM (8% relative difference) and functional status (11% relative difference). No important benefit was shown for knee edema as measured by knee circumference.

Effectiveness of cold or hot packs compared to control

Ten sessions of a 20-minute application of cold or hot packs placed anterior and posterior to the affected knee (Hecht 1983), were studied for effect on change in knee circumference (edema). After the first cold pack application there was no statistically significant difference (WMD = 1.01, 95% CI: -0.20 to 2.22; p=0.10) compared with control on edema. There was, however, a statistically significant difference (WMD = -1.0, 95% CI: -1.98 to -0.02; p= 0.04) after 10 treatment sessions in favour of the application of cold at reducing edema. Clinical importance could not be calculated due to lack of data. With regard to the effect of the application of hot packs on change in edema, no clinically important difference was found when compared with control. Finally, when comparing the application of hot packs with the application of cold packs, it was found that at the end of 10 treatment sessions, there was a statistically significant reduction in knee circumference in patients who received cold packs (WMD = 2.01, 95% CI: 0.92 to 3.10; p=0.0003). Once again, clinical importance could not be calculated due to lack of data.

Effectiveness of ice packs compared to control

Three treatment sessions per week, for three weeks, of ice packs or control (unspecified duration of therapy) (Clarke 1974) were studied for their effect on pain. After three weeks of treatment there was almost a statistically significant difference (WMD = -2.70, 95% CI: -5.52 to 0.12; p=0.06) between the application of ice packs compared with control. There was no statistically significant difference in pain (WMD = -1.60, 95% CI: -4.53 to 1.33; p=0.3) after 3 months of follow-up between the application of ice packs compared with control. There was also no clinically important benefit on pain of the use of ice packs over control. No other outcomes were reported.

Subgroup Analysis

No subgroup analysis was undertaken as none of the studies examined the same type of intervention (or did not report enough information with regard to application) or used similar treatment schedules. Similarly, one study treated patients who had received arthroplasty, while the other two did not. Because of the small number of trials, the remaining pre-planned subgroup analyses (treatment duration, type of application, patient characteristics, disease characteristics and design considerations) were not conducted and publication bias was not assessed.

DISCUSSION

Statistically significant results favouring ice massage over a control group were found in patients with OA of the knee after approximately two weeks of treatment. Improvements were reported in objective measures of ROM in knee flexion, function (time to walk 50 feet) and quadriceps strength. These improvements ranged from 8 to 29% greater improvement relative to the control group (Yurtkuran 1999). However, there was no significant effect of ice over control on pain relief after three weeks of treatment (Clarke 1974). Statistically significant results favouring cold packs over a control group and over hot packs were found in patients with OA of the knee after 10 treatment sessions for knee edema (change in knee circumference). No significant effects of hot packs were reported for any objective measures, including edema, when compared with control or alternate therapy (Hecht 1983).

Cold application has been shown to have significant physiologic effects in musculoskeletal indications (Cameron 1999, Knight 1995). Vasoconstriction and metabolic activity, as a result of cold application, produce decreased local blood flow and help control swelling (Luckmann 1987) and reduce pain (Knight 1995), thus leading to possible improvement in range of motion and function. The application of cold, however, needs to be carefully monitored. When cold application is initiated vasoconstriction occurs. However after prolonged application of cold (longer than 20 minutes) the "hunting reaction" may occur when vasodilation is thought to occur as part of the homeostatic mechanism for temperature regulation (Knight 1995). Should such a reaction take place, pain may recur in the joint being treated (Luckmann 1987). The non-beneficial effects of ice application did not reflect such a phenomenon.

The variation found in the results might be explained in part by the relatively low methodological quality of the included studies. The small sample size involved in the included studies affects the statistical power. The median score for these studies was two, with no study scoring a possible full five points. The studies also involved a variety of thermotherapy applications and treatment schedules, and inadequate and varied duration of trials. There are several reasons none of the studies achieved a full quality score. The difficulty of randomising appropriately and of carrying out adequate double blinding is a prime factor. The RCTs provided inadequate information about the treatment assignment procedure. True blinding of the patient is difficult, if not impossible, to achieve due to the sensory differences between hot or cold treatment application and placebo; a true placebo is hard to achieve with physical interventions (Morin 1996). Inadvertent information-divulging communication between patient and evaluator is also likely (Deyo 1990). Only one study gave information regarding withdrawals and loss to follow-up (Clarke 1974). These shortcomings lower quality assessment scores.

The included studies also measured a variety of outcomes. All three studies assessed the effect of thermotherapy on pain; two

addressed knee swelling (Hecht 1983, Clarke 1974); two, stiffness (Yurtkuran 1999, Clarke 1974); and two, ROM (Yurtkuran 1999, Hecht 1983). This sort of variation resulted in an inability to pool the data, and hence limit the generalizability of the results. It is also impossible to pool results of hot or cold pack application to patients who had undergone knee arthroplasty (Hecht 1983) with results from studies assessing treatment in patients with OA prior to joint replacement (Yurtkuran 1999; Clarke 1974). There is also a possibility of bias being introduced by choosing publications published only in English or French, and in only certain journal databases.

The patients enrolled had a diagnosis of OA of the knee but were heterogeneous in disease characteristics (stage, severity, and length of time with OA of the knee, pre and post operative), which could also have contributed to differences in response to therapy (Morin 1996). Disease duration was specified as greater than six months, for example, and one study included patients who had recently undergone total joint replacement (Hecht 1983). This heterogeneity could account for differences in outcomes, especially as the total number of patients included in some studies was relatively small: 31 in Hecht 1983, and 41 in Clarke 1974. Demographic details of the patients enrolled (including lifestyle, comorbid diseases, concomitant medication, weight), details that may affect results, were incomplete. Other population characteristics that should be considered in interpretation of the data include age (overall range was from 41 to 81) and gender (2 to 10 times more women participated in the included studies). Such confounding variables may have contributed to the lack or ambiguity of treatment outcome (Carroll 2002) in the studies reviewed. Finally, length of follow-up in these studies varied considerably (from none to three months) and the long term effect has not been well explored. It is important that such details be addressed in studies of thermotherapy treatment and reported consistently in published studies.

Some of the characteristics of the thermotherapy application that can affect effectiveness are type of therapy (such as hot packs, cold packs, and ice packs - administered with or without massage), duration of treatment application, length and schedule of treatment. These parameters varied between the included trials: cold packs or hot packs for 20 minutes a session, for ten sessions (unspecified length of time over which these 10 sessions took place) (Hecht 1983); ice (no details of mode or duration of application) given three times a week for three weeks (Clarke 1974); or ice massage for 20 minutes daily for five days a week for two weeks (Yurtkuran 1999).

The method of reporting data should ideally also be consistent among the included RCTs. Means and standard deviations of all outcomes should be provided, which was not the case for every included trial in this review. The use of statistical approximation derived from the p-value to estimate the standard deviation and the borderline significant values of the upper and lower limits of the confidence interval could affect the conclusion on efficacy of thermotherapy in two of the included studies (Clarke 1974, Yurtkuran 1999). Furthermore, some studies expressed their results using the difference between baseline values and end-of-treatment values, and one failed to discuss how some outcomes were measured. It is possible that when data are modified for comparison purposes, interpretation of the results may change (Philbrick 1985).

No adverse effects of the treatments were reported in the included trials. This is probably due to the reported overall safety of carefully applied thermotherapy, which has been suggested as a benefit of the use of hot or cold therapy as an adjunct to pain treatment in this patient population. The present studies do not fully reflect the current practice in physical rehabilitation. In the clinical setting thermotherapy is used as an adjunct therapy combined with others, such as exercise, and potential benefit in these other settings need to be further studied.

AUTHORS' CONCLUSIONS

Implications for practice

Ice massage showed a significant benefit in improving ROM and function, in the treatment of knee OA. The effectiveness of ice on relieving pain is unclear. The application of an ice pack did not relieve pain any better than a control, although when applied using massage ice had a significant benefit on pain relief compared with control. Application of cold packs resulted in significant reduction in knee edema when compared with control or heat.

A heterogeneity does exist, however, in the results from studies with different methodological quality scores and different administration. Ice massage may be used as an adjunct for pain relief in OA of the knee due to its easy, noninvasive application and few adverse events. Cold packs may be used to lessen knee edema in OA of the knee. Due to the low methodological quality of the small number of included trials, and mixed results, no firm conclusions can be drawn.

Implications for research

Well designed studies are needed before any conclusions about the effectiveness of thermotherapy, including hot and cold therapy in the treatment of knee OA can be made. The studies should be two-arm, randomized, controlled trials with duration of treatment long enough to detect a difference (at least six weeks). A regulated study protocol should be developed to standardize the application methods according to characteristics of therapeutic application, population sample, disease process significant outcome measures and other methodological considerations such as duration and schedule of treatment applications (Morin 1996). The outcome measures should be standardized and contain appropriate subjective and objective outcomes. Application of these recommendations would produce more reliable and comparable studies.

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Solomon. In: Kelly WN, Harris ED Jr, Ruddy S, Sledge CB editor(s). 5th Edition. Vol. **2**, Philadelphia: WB Saunders, 1997:1383–93.

* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Clarke 1974

Methods	Randomized, parallel, single-blinded trial 48 patients Gr1:Ice (n:15) Gr2:Short-Wave (n:17) Gr3: Control (n:16)
Participants	Inclusion: Referred to orthopaedic clinics because of painful knee joints. Exclusion: Acute inflammatory arthritis requiring rest, splintage or other therapy; peripheral circulatory deficits; sensory abnormalities; hip or spinal disorder causing pain in or around the knee; metal protheses in or near the knee; sickle-cell disease or cold agglutinins; obvious psychological disorders. Age: Gr1: 64 Gr2: 57 Gr3: 63 Gr1: 4M / 11F Gr2: 6M / 11F Gr3: 4M / 11F
Interventions	Gr1: ice administered according to standard practice Rx given 3x/wk for 3wks Gr2: Short-wave diathermy administered according to standard practice Gr3: Untuned short-wave diathermy (placebo)
Outcomes	Pain (0-17 scale; 0=no pain)
Notes	R=1 B=0 W=1

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

Hecht 1983

Methods	Randomized, parallel, open study 31 patients (36 knees) Gr 1 : 10 knees Gr 2 : 13 knees Gr 3 : 13 knees
Participants	Inclusion : Undergoing Total Knee Arthroplasty, preoperative diagnosis of OA 3M/28F (5M knees/31F knees) Mean age (range) : 70 (58-81) years old
Interventions	Gr 1 : Control : Physiotherapy only : total of 10 treatments; 5 repetitions of each : a) 5 s. quadriceps isometric (supine) ; b) active knee flexion and extension (seated) ; c) contract-relax to increase extension (seated) ; d) active knee flexion and extension (prone) ; e) contract-relax to increase flexion (prone) Gr 2 : Heat : Hot packs + Physiotherapy, at knee, 4 layers of towel, 20 minutes duration, total of 10 treatments Gr 3 : Cold : Cold packs + Physiotherapy , at knee, 20 minutes duration, total of 10 treatments
Outcomes	1- Change in midpatellar knee circumference (cm)
Notes	R=1 B=0 W=0

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

Yurtkuran 1999

Methods	Randomized, parallel, single-blinded study (assessor) 100 patients Gr 1 : 25 Gr 2 : 25 Gr 3 : 25 Gr 4 : 25
Participants	Inclusion : durantion of knee pain of 6 months or more, osteoarthritic radiological findings, no gross leg malalignment, no mechanical block to knee motion, no significant concomitant medical problem or bleeding tendency, not undergoing any specific medical or surgical treatment or physical therapy, no cardiac pacemaker Gender : Gr 1 : 0M/25F

	Gr 2 : 3M/22F Gr 3 : 2M/23F Gr 4 : 4M/21F Symptom duration : a) = 0-9 yrs b) = 10-19 yrs c) = 20-40 yrs Gr 1 : a)7, b)11, c)7 Gr 2 : a)15, b)8, c)2 Gr 3 : a)11, b)11, c)3 Gr 4 : a)9, b)10, c)6 Mean age (range) : 58.1 (45-70) years old Gr 1 : (45-69) years old Gr 2 : (45-69) years old Gr 3 : (45-70) years old Gr 4 : (45-69) years old
Interventions	Gr 1 : Ice Massage : ice cubes at knee (4 acupuncture points according to Chinese literature) , 5 minutes each point for total of 20 minutes, 5 days per week for 2 weeks Gr 2 : Control : placebo TENS applied on same 4 points for total of 20 minutes, 5 days per week for 2 weeks Gr 3 : Acupuncture-like TENS : 4 small rubber electrodes, 0.4-2.5 volt intermittent rectangular waveform at 4 Hz and 1000 microsec.,current increased slowly to create muscle contraction, just below pain threshold, 20 minutes, 5 days per week for 2 weeks Gr 4 : Electroacupuncture : stainless steel acupuncture needles inserted to 0.5-1.0 inch depth at the same 4 acupoints, needles connected to electrostimulator and treatment with same parameters as acupuncture-like TENS
Outcomes	1- Strength - Isometric quadriceps (kg) 2- 50 foot walking time (min.) 3- ROM - Knee flexion (degrees)
Notes	R=1 B=0 W=1

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment (selection bias)	Unclear risk	B - Unclear

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Aix-les-Bains 1980	No control group
Lehmann 1954	Periarthritis post-trauma, fractures, sclerosis
Marks 1997	No control group
Oosterveld a 1994	Literature review
Oosterveld b 1994	Mixed population
Pegg 1969	No control group
Walker 1991	Mixed population
Weinberger 1988	Literature review

DATA AND ANALYSES

Comparison 1. Heat vs. Control (End of treatment, Approx. 2 weeks)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Change in midpatellar knee circumference (cm) (decrease=better)	1	23	Mean Difference (IV, Fixed, 95% CI)	1.01 [-0.20, 2.22]

Comparison 2. Cold vs. Control (End of treatment, Approx. 2 weeks)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Strength - Isometric quadriceps (kg)	1	50	Mean Difference (IV, Fixed, 95% CI)	2.30 [1.08, 3.52]
2 ROM - Knee flexion (degrees)	1	50	Mean Difference (IV, Fixed, 95% CI)	8.80 [4.57, 13.03]
3 Change in midpatellar knee circumference (cm) (decrease=better)	1	23	Mean Difference (IV, Fixed, 95% CI)	-1.0 [-1.98, -0.02]
4 50-feet walking time (min)	1	50	Mean Difference (IV, Fixed, 95% CI)	-9.70 [-12.40, -7.00]
5 Pain (0-17scale); 0=no pain)	1	28	Mean Difference (IV, Fixed, 95% CI)	-2.7 [-5.52, 0.12]

Comparison 3. Heat vs. Cold (End of treatment, Approx. 2 weeks)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Change in midpatellar knee circumference (cm) (decrease=better)	1	26	Mean Difference (IV, Fixed, 95% CI)	2.01 [0.92, 3.10]

Comparison 4. Cold vs. Acupuncture-like TENS (End of treatment, Approx. 2 weeks)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Strength - Isometric quadriceps (kg)	1	50	Mean Difference (IV, Fixed, 95% CI)	-3.70 [-5.70, -1.70]
2 ROM - Knee flexion (degrees)	1	50	Mean Difference (IV, Fixed, 95% CI)	-2.0 [-6.02, 2.02]
3 50-feet walking time (min)	1	50	Mean Difference (IV, Fixed, 95% CI)	0.30 [-6.26, 6.86]

Comparison 5. Cold vs. Electroacupuncture (End of treatment, Approx. 2 weeks)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Strength - Isometric quadriceps (kg)	1	50	Mean Difference (IV, Fixed, 95% CI)	-2.80 [-4.14, -1.46]
2 ROM - Knee flexion (degrees)	1	50	Mean Difference (IV, Fixed, 95% CI)	-2.20 [-6.03, 1.63]
3 50-feet walking time (min)	1	50	Mean Difference (IV, Fixed, 95% CI)	6.00 [3.19, 8.81]

Comparison 6. Cold vs Control (Follow-up 3 mo)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain (0-17 scale ; 0=no pain)	1	26	Mean Difference (IV, Fixed, 95% CI)	-1.60 [-4.53, 1.33]

Analysis 1.1. Comparison 1 Heat vs. Control (End of treatment, Approx. 2 weeks), Outcome 1 Change in midpatellar knee circumference (cm) (decrease=better).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 1 Heat vs. Control (End of treatment, Approx. 2 weeks)

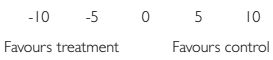
Outcome: 1 Change in midpatellar knee circumference (cm) (decrease=better)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Hecht 1983	13	0.58 (1.69)	10	-0.43 (1.26)		100.0 %	1.01 [-0.20, 2.22]
Total (95% CI)	**13**		**10**			**100.0 %**	**1.01 [-0.20, 2.22]**

Heterogeneity: not applicable

Test for overall effect: Z = 1.64 (P = 0.10)

Test for subgroup differences: Not applicable



Analysis 2.1. Comparison 2 Cold vs. Control (End of treatment, Approx. 2 weeks), Outcome 1 Strength - Isometric quadriceps (kg).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 2 Cold vs. Control (End of treatment, Approx. 2 weeks)

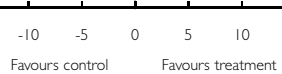
Outcome: 1 Strength - Isometric quadriceps (kg)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Yurtkuran 1999	25	9.3 (2.6)	25	7 (1.7)		100.0 %	2.30 [1.08, 3.52]
Total (95% CI)	**25**		**25**			**100.0 %**	**2.30 [1.08, 3.52]**

Heterogeneity: not applicable

Test for overall effect: Z = 3.70 (P = 0.00021)

Test for subgroup differences: Not applicable



Analysis 2.2. Comparison 2 Cold vs. Control (End of treatment, Approx. 2 weeks), Outcome 2 ROM - Knee flexion (degrees).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 2 Cold vs. Control (End of treatment, Approx. 2 weeks)

Outcome: 2 ROM - Knee flexion (degrees)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Yurtkuran 1999	25	128 (6.9)	25	119.2 (8.3)		100.0 %	8.80 [4.57, 13.03]
Total (95% CI)	**25**		**25**			**100.0 %**	**8.80 [4.57, 13.03]**

Heterogeneity: not applicable

Test for overall effect: Z = 4.08 (P = 0.000046)

Test for subgroup differences: Not applicable

Analysis 2.3. Comparison 2 Cold vs. Control (End of treatment, Approx. 2 weeks), Outcome 3 Change in midpatellar knee circumference (cm) (decrease=better).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 2 Cold vs. Control (End of treatment, Approx. 2 weeks)

Outcome: 3 Change in midpatellar knee circumference (cm) (decrease=better)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Hecht 1983	13	-1.43 (1.08)	10	-0.43 (1.26)		100.0 %	-1.00 [-1.98, -0.02]
Total (95% CI)	**13**		**10**			**100.0 %**	**-1.00 [-1.98, -0.02]**

Heterogeneity: not applicable

Test for overall effect: Z = 2.01 (P = 0.045)

Test for subgroup differences: Not applicable

Analysis 2.4. Comparison 2 Cold vs. Control (End of treatment, Approx. 2 weeks), Outcome 4 50-feet walking time (min).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 2 Cold vs. Control (End of treatment, Approx. 2 weeks)

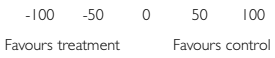
Outcome: 4 50-feet walking time (min)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Yurtkuran 1999	25	19.4 (5.8)	25	29.1 (3.7)		100.0 %	-9.70 [-12.40, -7.00]
Total (95% CI)	**25**		**25**			**100.0 %**	**-9.70 [-12.40, -7.00]**

Heterogeneity: not applicable

Test for overall effect: Z = 7.05 (P < 0.00001)

Test for subgroup differences: Not applicable



Analysis 2.5. Comparison 2 Cold vs. Control (End of treatment, Approx. 2 weeks), Outcome 5 Pain (0-17scale); 0=no pain).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 2 Cold vs. Control (End of treatment, Approx. 2 weeks)

Outcome: 5 Pain (0-17scale); 0=no pain)

Study or subgroup	Cold N	Mean(SD)	Treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Clarke 1974	15	4.8 (3.8)	13	7.5 (3.8)		100.0 %	-2.70 [-5.52, 0.12]
Total (95% CI)	**15**		**13**			**100.0 %**	**-2.70 [-5.52, 0.12]**

Heterogeneity: not applicable

Test for overall effect: Z = 1.88 (P = 0.061)

Test for subgroup differences: Not applicable

Analysis 3.1. Comparison 3 Heat vs. Cold (End of treatment, Approx. 2 weeks), Outcome 1 Change in midpatellar knee circumference (cm) (decrease=better).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 3 Heat vs. Cold (End of treatment, Approx. 2 weeks)

Outcome: 1 Change in midpatellar knee circumference (cm) (decrease=better)

Study or subgroup	Heat N	Mean(SD)	Cold N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Hecht 1983	13	0.58 (1.69)	13	-1.43 (1.08)		100.0 %	2.01 [0.92, 3.10]
Total (95% CI)	**13**		**13**			**100.0 %**	**2.01 [0.92, 3.10]**

Heterogeneity: not applicable

Test for overall effect: Z = 3.61 (P = 0.00030)

Test for subgroup differences: Not applicable

Analysis 4.1. Comparison 4 Cold vs. Acupuncture-like TENS (End of treatment, Approx. 2 weeks), Outcome 1 Strength - Isometric quadriceps (kg).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 4 Cold vs. Acupuncture-like TENS (End of treatment, Approx. 2 weeks)

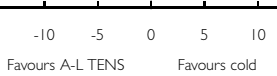
Outcome: 1 Strength - Isometric quadriceps (kg)

Study or subgroup	Cold N	Mean(SD)	A-L TENS N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Yurtkuran 1999	25	9.3 (2.6)	25	13 (4.4)		100.0 %	-3.70 [-5.70, -1.70]
Total (95% CI)	**25**		**25**			**100.0 %**	**-3.70 [-5.70, -1.70]**

Heterogeneity: not applicable

Test for overall effect: Z = 3.62 (P = 0.00029)

Test for subgroup differences: Not applicable



Analysis 4.2. Comparison 4 Cold vs. Acupuncture-like TENS (End of treatment, Approx. 2 weeks), Outcome 2 ROM - Knee flexion (degrees).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 4 Cold vs. Acupuncture-like TENS (End of treatment, Approx. 2 weeks)

Outcome: 2 ROM - Knee flexion (degrees)

Study or subgroup	Cold N	Mean(SD)	A-L TENS N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Yurtkuran 1999	25	128 (6.9)	25	130 (7.6)		100.0 %	-2.00 [-6.02, 2.02]
Total (95% CI)	**25**		**25**			**100.0 %**	**-2.00 [-6.02, 2.02]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.97 (P = 0.33)

Test for subgroup differences: Not applicable

Analysis 4.3. Comparison 4 Cold vs. Acupuncture-like TENS (End of treatment, Approx. 2 weeks), Outcome 3 50-feet walking time (min).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 4 Cold vs. Acupuncture-like TENS (End of treatment, Approx. 2 weeks)

Outcome: 3 50-feet walking time (min)

Study or subgroup	Cold N	Mean(SD)	A-L TENS N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Yurtkuran 1999	25	19.4 (5.8)	25	19.1 (15.7)		100.0 %	0.30 [-6.26, 6.86]
Total (95% CI)	**25**		**25**			**100.0 %**	**0.30 [-6.26, 6.86]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.09 (P = 0.93)

Test for subgroup differences: Not applicable

Analysis 5.1. Comparison 5 Cold vs. Electroacupuncture (End of treatment, Approx. 2 weeks), Outcome 1 Strength - Isometric quadriceps (kg).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 5 Cold vs. Electroacupuncture (End of treatment, Approx. 2 weeks)

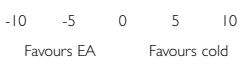
Outcome: 1 Strength - Isometric quadriceps (kg)

Study or subgroup	Cold N	Mean(SD)	EA N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Yurtkuran 1999	25	9.3 (2.6)	25	12.1 (2.2)		100.0 %	-2.80 [-4.14, -1.46]
Total (95% CI)	**25**		**25**			**100.0 %**	**-2.80 [-4.14, -1.46]**

Heterogeneity: not applicable

Test for overall effect: Z = 4.11 (P = 0.000039)

Test for subgroup differences: Not applicable



Analysis 5.2. Comparison 5 Cold vs. Electroacupuncture (End of treatment, Approx. 2 weeks), Outcome 2 ROM - Knee flexion (degrees).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 5 Cold vs. Electroacupuncture (End of treatment, Approx. 2 weeks)

Outcome: 2 ROM - Knee flexion (degrees)

Study or subgroup	Cold N	Mean(SD)	EA N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Yurtkuran 1999	25	128 (6.9)	25	130.2 (6.9)		100.0 %	-2.20 [-6.03, 1.63]
Total (95% CI)	**25**		**25**			**100.0 %**	**-2.20 [-6.03, 1.63]**

Heterogeneity: not applicable

Test for overall effect: Z = 1.13 (P = 0.26)

Test for subgroup differences: Not applicable

Analysis 5.3. Comparison 5 Cold vs. Electroacupuncture (End of treatment, Approx. 2 weeks), Outcome 3 50-feet walking time (min).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 5 Cold vs. Electroacupuncture (End of treatment, Approx. 2 weeks)

Outcome: 3 50-feet walking time (min)

Study or subgroup	Cold N	Mean(SD)	EA N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Yurtkuran 1999	25	19.4 (5.8)	25	13.4 (4.2)		100.0 %	6.00 [3.19, 8.81]
Total (95% CI)	**25**		**25**			**100.0 %**	**6.00 [3.19, 8.81]**

Heterogeneity: not applicable

Test for overall effect: Z = 4.19 (P = 0.000028)

Test for subgroup differences: Not applicable

Analysis 6.1. Comparison 6 Cold vs Control (Follow-up 3 mo), Outcome 1 Pain (0-17 scale ; 0=no pain).

Review: Thermotherapy for treatment of osteoarthritis

Comparison: 6 Cold vs Control (Follow-up 3 mo)

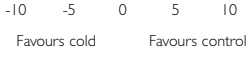
Outcome: 1 Pain (0-17 scale ; 0=no pain)

Study or subgroup	Cold N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Clarke 1974	14	4.1 (3.8)	12	5.7 (3.8)		100.0 %	-1.60 [-4.53, 1.33]
Total (95% CI)	**14**		**12**			**100.0 %**	**-1.60 [-4.53, 1.33]**

Heterogeneity: not applicable

Test for overall effect: Z = 1.07 (P = 0.28)

Test for subgroup differences: Not applicable



APPENDICES

Appendix 1. MEDLINE search strategy

1 exp osteoarthritis/
2 osteoarthritis.tw.
3 osteoarthrosis.tw.
4 degenerative arthritis.tw.
5 exp arthritis, rheumatoid/
6 rheumatoid arthritis.tw.
7 rheumatism.tw.
8 arthritis, juvenile rheumatoid/
9 caplan's syndrome.tw.
10 felty's syndrome.tw.
11 rheumatoid.tw.
12 ankylosing spondylitis.tw.
13 arthrosis.tw.
14 sjogren$.tw.
15 or/1-14
16 heat/tu
17 (heat or hot or ice).tw.
18 cryotherapy.sh,tw.
19 (vapocoolant or phonophoresis).tw.
20 exp hyperthermia, induced/
21 (hypertherm$ or thermotherapy).tw.
22 (fluidotherapy or compression).tw.
23 or/15-22
24 clinical trial.pt.
25 randomized controlled trial.pt.
26 tu.fs.
27 dt.fs.
28 random$.tw.
29 placebo$.tw.
30 ((sing$ or doubl$ or tripl$) adj (masked or blind$)).tw
31 sham.tw.
32 or/24-31
33 23 and 32

WHAT'S NEW

Date	Event	Description
10 November 2008	Amended	Converted to new review format. CMSG ID: C091-R

CONTRIBUTIONS OF AUTHORS

KAY was responsible for writing the manuscript.

BL, LL and CL were responsible for extracting and analyzing the data and selecting trials for the initial review.

LB was the primary investigator of the project.

LB and VR participated in data extraction, updating the reference list, the analysis, and the interpretation of the results.

JM developed the search strategy.

GW and PT participated in the data analysis and the interpretation of the results

MJ provided assistance with final edits of this review.

DECLARATIONS OF INTEREST

None known.

INDEX TERMS

Medical Subject Headings (MeSH)

Cryotherapy [*methods]; Hyperthermia, Induced [*methods]; Osteoarthritis, Knee [*therapy]; Randomized Controlled Trials as Topic

MeSH check words

Humans