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KNEE JOINT OSTEOARTHRITIS

Introduction

Knee osteoarthritis (OA) is a common complaint managed by physiotherapists and the need for effective management is clear. Physiotherapy encompasses a variety of interventions such as manipulative therapy, therapeutic exercise, electro-physical modalities, foot orthotics, braces and education. The efficacy of these and other interventions is important as evidence-based practice becomes increasingly important. While some randomised controlled trials (RCTs) have listed the various interventions as stand-alone treatments, many of the more recent RCTs have listed a treatment program of combined interventions which is more aligned to usual clinical practice and which is in line with results of systematic reviews and clinical guidelines. The purpose of this paper is to review the scientific evidence for the efficacy of physiotherapy in the management of knee OA.

The knee OA evidence-based clinical statement provides a collation of the evidence for physiotherapy management of knee OA and recommendations for clinical practice based on this evidence. It has included Level I and II evidence as defined by the Australian National Health and Medical Research Council as these are the strongest when considering treatment efficacy. Level I evidence is that obtained from systematic reviews and Level II is from randomised controlled trials.

Methods

The original APA knee OA position statement was released in 2001. This document has formed the basis of this statement, and literature pertaining to knee OA from 2001 to the present has been included. Searches were conducted for the period 2001 – April 2005 of the PEDro, Medline, Cinahl and Cochrane databases and relevant articles in English were retrieved. The new literature has been combined with the earlier knee OA position statement to produce the following document. Evidence from 2000 onwards is presented in this report.

This knee OA evidence-based clinical statement consists of two documents. These are a summary of the specific recommendations for each intervention and a more detailed technical report. This details the evidence base for management of knee OA and presents a collation of available Level I and Level II evidence. Within-subject randomized controlled trials have been included under Level II evidence. The PEDro database http://www.pedro.fhs.usyd.edu.au/index.html was used as a reference for the rating of methodological quality of the clinical trials. The recommendations made in the following summary have considered all the previous evidence, especially that since 2000. In addition to the Level I and II evidence, clinical practice guidelines were retrieved and a summary of their findings has also been included.

Recommended treatments

Recommended treatments are those for which there is clear Level I or II evidence for their effect. Based on the review, these are:

Exercise Therapy

Summary of Evidence
There is evidence to support the use of exercise therapy in knee OA. All recent clinical guidelines recommend the use of exercise. Five recent systematic reviews conclude that exercise reduces pain and improves physical function. Although the most efficacious exercise regimen has yet to be determined, the Level 1 evidence currently suggests that aerobic exercise is as effective as strengthening exercise and that supervised group programs are as effective as individual treatments. Home programs may be less effective than supervised exercise sessions for pain relief.

APA recommendations
Exercise therapy is recommended for the treatment of knee OA.

Combined interventions

Summary of Evidence
There is evidence to support the use of a combined intervention approach to knee OA. There is evidence from a recent RCT that exercise combined with dietary weight loss is more effective than either combination alone in overweight patients. Two RCTs showed that a combined physiotherapy program comprising strengthening exercise and manual therapy leads to reductions in pain and improvements in function.

APA recommendations
Multimodality treatment is recommended for the treatment of knee OA.

Acupuncture

Summary of Evidence
There is Level I evidence to support the use of acupuncture for osteoarthritic knee pain. Two recent high quality large scale RCTs comparing acupuncture to placebo found that acupuncture is more effective in improving pain and function.

APA recommendations
Acupuncture is recommended for the treatment of pain in knee OA.

TENS

Summary of Evidence
Clinical guidelines recommend TENS for knee OA. There is Level I evidence demonstrating that pain relief from TENS is significantly greater than placebo. Beneficial effects appear similar irrespective of the mode of TENS settings although a small recent RCT suggests that 40 minutes may be the optimal treatment duration compared to 20 and 60 minutes.

APA recommendations
TENS is recommended for the treatment of pain in knee OA.

Recommended under certain circumstances

Recommended treatments under certain circumstances are those for which there is some question regarding their efficacy. There may be mixed results in the literature, limited amount of trials or poor quality of the trials

Knee Taping

Summary of Evidence
No Level I evidence found. One large RCT and smaller within-subject RCTs demonstrate that physiotherapist-applied knee tape is effacious in the immediate and short-term reduction of knee pain in OA patients. However, from two RCTs where taping was part of a multimodality treatment package and applied by the patient, little benefit of the overall treatment was found.

APA recommendations
Knee taping appears to be beneficial when applied by a trained physiotherapist.

Bandaging

Summary of Evidence
No Level I evidence found. There are a limited number of studies evaluating elastic bandaging or knee sleeves for knee OA. Two studies demonstrate small short-term beneficial effects.

APA recommendations
Elastic bandaging or knee sleeve should not be used as a stand alone treatment for knee OA and should only be used with evidence of improvement in subjective and objective outcomes.

Bracing

Summary of Evidence
Most clinical guidelines recommend bracing for knee OA. One Level I review located one RCT and concluded that there is limited evidence that bracing offers additional benefit over medical treatment alone. This RCT demonstrated that in those with varus deformity, a brace was more effective than a knee sleeve. A recent small within-subject RCT did not evaluate the effect of bracing on patient focused outcomes such as pain or function. Beneficial effects were noted on knee proprioception.

APA recommendations
Bracing should not be used as a stand alone treatment for knee OA and should only be used with evidence of improvement in subjective and objective outcomes.

Foot orthotics

Summary of Evidence
Most clinical guidelines recommend laterally wedged insoles for medial knee OA. One Level I review concluded that there is limited evidence for the use of laterally wedged insoles in knee OA. One RCT demonstrated reduced use of anti-inflammatory drugs and improved patient compliance with laterally wedges insoles compared to neutral insoles. Three RCTs show that strapped wedged insoles are more effective than traditional wedged insoles. Within-subjects RCTs demonstrate immediate reductions in knee joint loading with inserted lateral wedges.

APA recommendations
Laterally wedged insoles should not be used as a stand alone treatment for knee OA and should only be used with evidence of improvement in subjective and objective outcomes.

Gait aids

Summary of Evidence
Most clinical guidelines recommend gait aids for knee OA. No Level I evidence was located. There is one small within-subject RCT which found a walking stick improved gait parameters. Patient-focused outcomes were not assessed.

APA recommendations
Unable to clearly state benefits of gait aids for knee OA.

Weight loss

Summary of Evidence
Clinical guidelines recommend weight loss for knee OA. No Level I evidence was

located. The outcomes of one high quality RCT reported in several papers demonstrate that modest weight loss achieved by moderate exercise and dietary restriction results in improvements in pain and function in overweight or obese patients with knee OA.

APA recommendations
Weight loss should be part of a management program for overweight and obese patients with knee OA.

Ice therapy

Summary of Evidence
A Level I review of a limited number of RCTs reported that ice massage has beneficial effects on knee range, function and muscle strength and that cold packs are effective in reducing swelling. Ice therapy does not significantly alter pain.

APA recommendations
Ice therapy can be used in patients where swelling is a problem.

Laser

Summary of Evidence
Level I summary and results from recent RCTs provide conflicting evidence about the benefits of laser therapy. The effects may depend upon the wavelength and dosage.

APA recommendations
Unable to clearly state benefits of laser for knee OA.

Electromagnetic field therapy

Summary of Evidence
Level I evidence suggests small to moderate effects of electromagnetic field therapy but the clinical relevance of these effects is questionable. Three more recent placebo controlled RCTs demonstrate reductions in pain in knee OA patients when wearing either magnetic bracelets or magnetic knee sleeves. While one recent RCT demonstrated the superiority of electromagnetic field therapy to sham therapy on symptoms, two others failed to find between group differences.

APA recommendations
Magnetic bracelets or sleeves may be a useful adjunct to other treatments for knee OA whilst benefits are unable to be clearly stated regarding other methods of delivering electromagnetic fields.

Neuromuscular electrical stimulation therapy

Summary of Evidence
No Level I evidence. Two small recent RCTs showed small benefits for knee pain and quadriceps strength although the long-term benefits of this intervention are unknown.

APA recommendations
Unable to clearly state benefits of neuromuscular electrical stimulation for knee OA.

Not recommended

Treatments that are not recommended are those for which there is Level I or II evidence of no effect of the treatment.

Ultrasound

Summary of Evidence
Level I and II evidence demonstrates no benefit of ultrasound therapy over placebo or shortwave diathermy in people with hip or knee OA.

APA recommendations
The use of ultrasound therapy is not supported by the evidence and therefore not recommended as a treatment for knee OA.

Shortwave therapy

Summary of Evidence
Level II evidence demonstrates no benefit of shortwave therapy over placebo in people with knee OA.

APA recommendations
The use of shortwave therapy is not supported by the evidence and therefore not recommended as a treatment for knee OA.

No evidence found

No Level I and II evidence was found for interferential therapy, massage and mobilisation techniques. Therefore no evidence-based comments can be made on the use of these interventions

Conclusions

The majority of research in the area of physiotherapy management of knee OA has focused on exercise therapy. There is Level I evidence to support the effectiveness of exercise for reducing pain and improving function in people with knee OA. Different modes of exercise appear to be equally effective although home programs may be less effective for pain relief than supervised exercise sessions. There is evidence to support the use of acupuncture and TENS. Less research has focused on combined interventions but current studies suggest that exercise combined with weight loss or manual therapy is effective. There needs to be further research into other commonly used physiotherapy interventions including knee taping, bracing, foot orthotics, gait aids and specific electrotherapy modalities. Ultrasound and shortwave are not recommended in the treatment of knee OA as research has failed to demonstrate benefits.

Technical Report

The following technical report details the evidence for physiotherapy management of knee osteoarthritis. It consists of an initial summary of the clinical guidelines retrieved. The evidence for each intervention is then presented.

Glossary and abbreviations

- ADL – activities of daily living
- Adelaide activities profile – a measurement of lifestyle activities of the elderly
- AIMS – arthritis impact measurement scale: a measure of the health status of patients with arthritis
- AQoL – Assessment of Quality of Life
- BMI – body mass index
- EuroQol – European Quality of Life index
- HAQ – health assessment questionnaire
- Lequesne Index – a measure of pain, locomotion and activities of daily living
- NMES – neuromuscular electrical stimulation
- NSAIDs – non steroidal anti inflammatory drugs
- OA – osteoarthritis
- PEMF – pulsed electromagnetic field
- RCT – randomised controlled trial
- SF-12 – medical outcomes study 12-item short form: measure of health status
- SF-36 – medical outcomes study 36-item short form: measure of health status
- TENS – Transcutaneous electrical stimulation
- VO_2max – maximum volume of oxygen uptake: indicator of aerobic fitness
- WOMAC – Western Ontario and McMaster Universities Osteoarthritis Index: measures pain, stiffness and physical function. Developed specifically for hip and knee OA

Clinical Practice Guidelines

The European League Against Rheumatism (Jordan et al 2003) has published recommendations for the management of knee OA, using an evidence-based medicine and expert opinion approach. A systematic literature search was performed for all trials that assessed the effects of treatment for knee OA on pain and/or function, identifying 33 individual treatment modalities. Methodological design of each study was scored and treatment effect size estimated where possible. The strength of recommendation for an intervention was graded and an expert panel used to propose a set of 10 recommendations. For optimal management, combined pharmacological and non-pharmacological treatment modalities are recommended, and treatment should be individually tailored to the patient. Numerous non-pharmacological treatment strategies are recommended including education, exercise, gait aids, shoe insoles, knee braces and weight reduction.

The American College of Rheumatology (2000) has also developed recommendations for the medical management of knee and hip OA. These guidelines state that the goal of managing the patient with OA is to control pain, improve function and health-related quality of life, and avoid if possible toxic effects of therapy. A variety of non-pharmacologic strategies are recommended including patient education, self-management programs, social support, weight loss, exercise, physical therapy, gait aids, patellar taping, footwear and shoe insoles and bracing.

The Royal Dutch Society for Physical Therapy has developed clinical practice guidelines for physical therapy in patients with hip or knee OA (Vogels et al 2003). The guidelines, which provide recommendations for diagnosis, history taking, assessment, analysis and treatment planning, are based on a systematic review of the literature by a monodisciplinary working group. The overall goal is to describe optimal physical therapy treatment (effectiveness, efficiency, and tailored care) for patients with health problems related to hip or knee OA.

The American Academy of Orthopaedic Surgeons (Stocks et al 2003) has developed clinical guidelines for treating knee OA in skeletally mature individuals. The guidelines are divided in two phases, where Phase I addresses issues faced by first contact physicians and Phase II addresses management by musculoskeletal specialists (licensed medical doctors with musculoskeletal training). A variety of nonpharmacologic treatments are recommended including physical therapy.

An American Geriatrics Society Panel on Exercise and Osteoarthritis (Katz et al 2001) developed consensus practice recommendations for exercise prescription for older people with osteoarthritic pain. The practice recommendations were derived from a literature search of *Index Medicus* and MEDLINE and by consensus among a multidisciplinary panel of experts. The panel concluded that regular moderate-level exercise does not exacerbate OA pain or accelerate the pathological process of OA. Increasing the level of physical activity in OA patients reduces pain and morbidity. Exercise programs should be individualized to the patient and should focus on controlling pain, increasing flexibility, and improving muscle strength and endurance.

A Philadelphia Panel developed evidence-based clinical practice guidelines in 2001 for selected rehabilitation interventions for knee pain. A systematic and rigorous methodology was employed to identify and synthesise evidence from randomised controlled trials and observational studies. An expert panel developed criteria for grading the strength of the evidence and recommendations were based on evidence of clinically-important benefit in patient-important outcomes. The panel concluded that transcutaneous electrical stimulation and therapeutic exercises were beneficial for knee OA. For several interventions (e.g. thermotherapy, massage etc) there was a lack of evidence regarding efficacy.

Roddy et al (2005a) used the Delphi technique to provide evidence-based consensus recommendations for the role of exercise for hip and knee OA. The first round of the Delphi process produced 123 propositions. This was reduced to 10 after four rounds. These related to aerobic and strengthening exercise, group versus home exercise, adherence, contraindications and predictors of response. The literature search identified

57 intervention trials relating to knee OA and 73 to adherence. The evidence to support each proposition is presented.

Efficacy for individual physiotherapy interventions

Exercise

Level I: Systematic Reviews

Brosseau et al (2003a) conducted a Cochrane review to evaluate the effectiveness of therapeutic exercise of differing intensities on objective and subjective measures of disease activity in people with OA. They found only one study involving 39 participants that met the inclusion criteria. From this study, both high and low intensity aerobic exercise appear to be equally effective in improving functional status, gait, pain and aerobic capacity in people with knee osteoarthritis. Further studies with larger numbers and involving a control group are needed.

Roddy et al (2005b) conducted a systematic review of aerobic walking and home based quadriceps strengthening for knee OA. Outcome data were abstracted for pain and self reported disability and the effect size calculated for each outcome. 13 trials were identified which met inclusion criteria and provided data suitable for further analysis. Pooled effect sizes for pain were 0.52 for aerobic walking and 0.39 for quadriceps strengthening. For self-reported disability, pooled effect sizes were 0.46 for aerobic walking and 0.32 for quadriceps strengthening. They concluded that both aerobic walking and home based quadriceps strengthening exercise reduce pain and disability from knee osteoarthritis but no difference between them was found on indirect comparison.

Pelland et al (2004) performed a meta-analysis to evaluate the effectiveness of strengthening exercises for OA. They found 22 randomised controlled trials with 2325 patients undergoing various forms of strengthening. They found improvements for strength, pain, function and quality of life. There was no evidence that the type of strengthening exercise influenced outcome. Better outcomes were seen for specific strengthening exercise in combination with general strength, flexibility and functional outcome.

Brosseau et al (2004a) performed a meta-analysis to examine the efficacy of aerobic exercise for individuals with knee OA. They located 12 trials with patients undergoing a variety of aerobic physical activities including walking, aquatic exercises, jogging in water and T'ai Chi. The results indicated that aerobic exercise is general is more beneficial for patients with OA than no exercise and is superior or equivalent to strengthening exercise. The most efficacious exercise regimen has yet to be determined.

Fransen et al (2002) conducted a systematic review to determine whether land based exercise is beneficial for people with hip or knee osteoarthritis. Fourteen studies provided data on 1633 participants with knee osteaoarthritis but only 9 of these studies were considered to be of high methodological quality. For pain, results revealed a mean moderate beneficial effect while for self-reported physical function there was a mean

small beneficial effect. In an update to this review, Fransen et al (2005) found a total of 17 studies with data on 2562 participants. Results for pain and physical function were similar to the previous review. Supervised group programs appeared to be as effective as treatments provided on a one-to-one basis.

Strength training – Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Huang et al (2003)	132 patients Group1: Isokinetic strengthening exercise Group 2: Isotonic strengthening exercise Group 3: Isometric strengthening exercise Group 4: Control	6	Muscle strength Lequesne index Gait speed Self reported function	Isotonic exercise recommended for initial strengthening Isokinetic exercise recommended for improving joint stability or walking endurance at a later time
Penninx et al (2001)	250 subjects initially free of ADL disability 18 month intervention Group 1: Aerobic exercise program Group 2: Resistance exercise program Group 3: Attention control	6	Incident ADL disability: Difficulty transferring from a bed to a chair, eating, dressing, using toilet, bathing	Both aerobic and resistance exercise may reduce the incidence of ADL disability in older persons with knee OA
Gur et al (2002)	23 subjects Interventions: Thrice weekly for 8 weeks Group 1: 12 concentric contractions of each knee extensor and flexor muscles. Group 2: 6 concentric and 6 eccentric contractions of each knee muscle group using a spectrum of angular velocities	6	Functional capacity: rising from chair, walking, stair climbing and descending Pain Muscle strength Muscle cross-sectional area	With isokinetic resistance training it is possible to improve functional capacity and decrease pain in patients with knee OA. Extensive training involving high repetition numbers and eccentric contractions are safe, effective and well tolerated
Messier et al (2000b)	103 subjects 18 month intervention Thrice weekly sessions Group 1: 40 minutes aerobic walking Group 2: Resistance exercises. 2 sets of 10-12 reps Group 3: Monthly presentation (months 1-3) then regular phone calls	6	Force platform static balance measures Balance time. (Measured under 4 test conditions: single/double leg stance, eyes open/closed)	Long-term weight training and aerobic walking programs significantly improve postural sway in older, osteoarthritic adults
Topp et al (2002)	102 subjects 3x weekly training sessions for 16 weeks Group 1: Isometric resistance training Group 2: Dynamic resistance training Group 3: Control	6	Timed stair climb Time to get down and up off the floor WOMAC Pain	Dynamic and isometric resistance training improves functional ability and reduces knee joint pain in patients with knee OA
Sevick et al (2000)	439 subjects 18 month intervention, (3 month facility-based, 15 month home-	6	Self-reported activity score 6 minute walk distance	Compared with education control, resistance exercise is more cost effective than

	based) 3 x 60 min sessions weekly Group 1: Aerobic exercise Group 2: Strength training, (2 sets of 10-12 reps) Group 3: Monthly 90 minute video presentation then regular phone contact		Stair climb Lifting and carrying task Car task Pain	aerobic exercise in improving physical function in seniors with knee OA. The difference however is small
Miyaguchi et al (2003)	20 subjects with joint effusion 12 week intervention Group 1: Isometric quads exercise (straight leg raise x 90 repetitions daily) Group 2: Control	n/a	Pain Joint fluid analysis Muscle strength Thigh circumference	Isometric quadriceps exercise resulted in significant changes in joint fluid biochemical parameters. These changes may explain, at least in part, the ameliorative effect of muscle exercise
Baker et al (2001)	46 subjects 4 month intervention Group 1: Progressive strength training program Group 2: Nutrition education program	n/a	WOMAC Clinical knee examination Muscle strength Physical performance measures Quality of life	High intensity, home based strength training can produce substantial improvements in strength, pain, physical function and quality of life

Aerobic Exercise: Walking – Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Penninx et al (2001)	250 subjects initially free of ADL disability. 18 month intervention Group 1: Aerobic exercise program (walking 40 mins thrice weekly) Group 2: Resistance exercise program Group 3: Attention control	6	Incident ADL disability: Difficulty transferring from a bed to a chair, eating, dressing, using the toilet, bathing	Aerobic and resistance exercise may reduce the incidence of ADL disability in older persons with knee OA, prolonging autonomy
Penninx et al (2002)	439 persons 18 month intervention. Group 1: Resistance exercise Group 2: Aerobic exercise Group 3: Health education	5	Depressive symptoms Disability Walking speed Pain	Aerobic and resistance exercise both significantly reduced disability and pain and improved walking speed. Aerobic exercise significantly lowered depressive symptoms over time. There was no similar effect with resistance exercise
Dias et al (2003)	50 subjects 12 week intervention Group 1: exercise and walking protocol Education session Group 2: Education session only	5	Lequesne Index HAQ SF-36	The exercise and walking program had a positive effect on the quality of life
Messier et al (2000b)	103 subjects 18 month intervention Thrice weekly sessions Group 1: 40 mins aerobic walking Group 2: Resistance exercises. 2 sets of 10-12 reps Group 3: Monthly presentation (months 1-3) then regular phone contact	5	Force platform static balance measures Balance time (measured under 4 test conditions: single/double leg stance, eyes open/closed)	Long-term weight training and aerobic walking programs significantly improve postural sway
Evcik and Sonel (2002)	90 subjects 3 month intervention Group 1: Home based exercise program Group 2: Regular walking program thrice weekly commencing at 10 minutes duration Group 3: Control	n/a	Pain WOMAC Quality of life	A simple home-based exercise therapy and regular walking program were equally effective in treating the symptoms of knee OA
Talbot et al (2003)	34 subjects Group 1: 12 hours of the Arthritis Self-Management Program over 12 weeks Group 2: As for control plus use of a pedometer, with the goal of increasing step count by 30%.	n/a	Physical activity: daily step count, total activity vector Muscle strength Functional performance tasks: 100 foot walk-turn-walk, timed stair climb, timed chair rise Pain	The home based pedometer driven walking program increases walking, with subsequent improvements in muscle strength and walking performance

Combined exercise types – Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Van Baar et al (2001)	201 subjects with hip or knee OA Group 1: General practitioner treatment including education and drugs Group 2: As per control plus 12 weeks exercise treatment from a physiotherapist in primary care and 24 weeks follow-up	8	Pain Drug use (NSAIDs) Disability questionnaire Physical activity questionnaire 5 m walk time Stand-to-sit time Stand-to-recline time Quality of movement	The beneficial effects of exercise decline over time and eventually disappear
Thomas et al (2002)	786 men and women aged 45+ years with self-reported knee pain 2 year trial Group 1: exercise therapy. (20-30 mins daily lower limb exercise) Group 2: Monthly telephone contact Group 3: Exercise and telephone contact +/- placebo health food tablet Group 4: Placebo health food tablet	7	WOMAC SF-36 Isometric muscle strength tests Psychological outlook	A simple home exercise program can significantly reduce knee pain. The lack of improvement with regular telephone contact, suggests that the exercise effect is not a psychosocial one mediated by therapist contact
Ravaud et al (2004)	2957 subjects 24 week intervention. Group 1: 4x weekly home exercise program guided by videotape and booklet. Non-steroidal anti-inflammatory drugs Group 2: Drugs	6	Pain WOMAC Patient assessment of quality of care	Although patient's assessment favoured the exercise program, the study failed to demonstrate a short term symptomatic effect of the exercise regime
McCarthy et al (2004)	214 subjects Group 1: Home exercise program plus twice weekly group exercise classes for 8 weeks Group 2: Home exercise program	5	WOMAC Walking pain Assessment of locomotor function	The supplementation of home exercise program with group exercise classes led to clinically significant superior improvement that was still evident 12 months later
Patrella & Bartha (2000)	179 subjects 8 week intervention Group 1: Progressive home exercise program (10 mins range of motion and resistance exercise) and NSAIDs Group 2: NSAIDs	5	WOMAC Pain Timed walk Timed stair climb Knee range of motion	Addition of an exercise program to a protocol of NSAID medication can improve function and activity related pain above the level due to medication alone
Kuptniratsaikul et al (2002)	392 subjects 8 week intervention Group 1: Twice weekly group exercise sessions Group 2: Control	n/a	Range of motion Muscle strength 6-minute walking distance	Group exercise produces significant improvements in strength and walking ability that require ongoing diligence to be maintained

Hydrotherapy – Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Foley et al (2003)	105 subjects 6 week intervention Group 1: Thrice weekly hydrotherapy (walking and strengthening exercises) Group 2: Thrice weekly gym program (cycling and strengthening exercises) Group 3: Control (Fortnightly telephone calls)	8	6 minute walk test Muscle strength WOMAC Total drug use SF-12 Adelaide activities profile Arthritis self-efficacy scale	Functional gains were achieved with both exercise programs compared to the control group Gym program was more effective at improving muscle strength
Wyatt et al (2001)	46 subjects 6 week intervention Group 1: Thrice weekly aquatic exercise (walking and resistance exercise in the pool) Group 2: Thrice weekly land-based exercise (walking and resistance exercise in a gym)	6	Knee range of motion Thigh girth Pain Time for 1 mile walk	Both aquatic and land-based exercise programs are beneficial to patients with osteoarthritis

T'ai Chi – Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Hartman et al (2000)	33 subjects with hip or knee OA 12 week intervention Group1: Twice weekly T'ai Chi Group 2: Control	5	Arthritis self-efficacy scale AIMS Single-leg standing balance 50-foot walking-speed Time to rise from a chair	A moderate T'ai Chi intervention can enhance arthritis self-efficacy, QOL and functional mobility. It is a safe and effective complementary therapy
Song et al (2003)	72 subjects 12 week intervention Group 1: sun-style T'ai Chi daily exercise program Group 2: Control	5	BMI WOMAC Standard fitness test Muscle strength	Older women with OA were able to safely perform the 12 forms of sun-style T'ai Chi exercises for 12 weeks. This was effective in improving their arthritic symptoms, balance and physical functioning

Combined interventions

Level I: Systematic Reviews

There are no systematic reviews evaluating the efficacy of combined interventions in knee osteoarthritis

Combined interventions - Level II evidence

Combination	Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Exercise and Diet	Messier et al (2004)	316 subjects 18 month intervention Group 1: healthy lifestyle (Monthly 1 hour videotape presentation for 3 months then regular phone contact) Group 2: Dietary restriction only Group 3: Exercise only (Thrice weekly hour long session of aerobic and resistance exercise) Group 4: Diet plus exercise	8	WOMAC 6 minute walk distance Timed stair-climb Weight loss Radiographic joint space width	Combination of modest weight loss and moderate exercise provides greater improvements in self-reported pain and function, and greater improvements in functional performance than either intervention alone. No effect was seen on joint space width
Exercise and Manual Therapy	Deyle et al (2000)	83 subjects Twice weekly intervention for 4 weeks Group 1: Manual therapy as required to knee, hip, lumbar spine and ankle Standardised knee exercise program in clinic and at home (range of motion exercises, lower limb stretches, resistance exercise, stationary bike) Group 2: sub-therapeutic ultrasound	7	WOMAC 6 minute walk distance Joint replacement surgery in following 12 months	Combined manual therapy and exercise regime improves function and may delay or eliminate the need for surgical intervention compared with placebo
Exercise, Manual Therapy and Electrotherapy	Fransen et al (2001)	126 subjects 8 week intervention Group 1: Weekly individual physiotherapy treatment (electrotherapy plus manual therapy or exercise)	7	WOMAC SF-36 Muscle strength Gait analysis	Both individually- and small group-delivered physiotherapy are equally effective in reducing pain and improving function

		Group 2: Small group format physiotherapy treatment (1 hour, twice weekly session including knee taping plus home exercise program) Group 3: waiting list			
Exercise, Manual Therapy, Massage and Taping	Bennell et al (2005)	140 subjects 12 week intervention Group 1: Individual physiotherapy treatment (8 sessions) Group 2: Placebo physiotherapy (sham ultrasound and application of atherapeutic gel)	n/a	Pain WOMAC Global assessment of change SF-36 AQoL Muscle strength Balance test	Both physiotherapy and placebo groups reported significant reductions in pain and improved function but there was no difference between the two
Exercise and Diet	Messier et al (2000)	24 subjects BMI 28+ kg/m^2 24 week intervention Diet: weekly sessions with a nutritionist. Exercise: Combined weight training and walking for 1 hour, thrice weekly Group 1: Diet and Exercise Group 2: Exercise alone	5	Functional performance inventory Pain Muscle strength Gait analysis Synovial fluid analysis	Weight loss can be achieved and maintained over 6 months through exercise and diet. Both interventions improved pain, disability and performance. The addition of dietary weight loss to exercise may improve gait parameters more than exercise alone
Exercise and TENS	Cheing and Hui-Chan (2004)	62 subjects 20 sessions over 4 weeks Group 1: TENS Group 2: placebo stimulation Group 3: Exercise training Group 4: TENS and exercise training	n/a	Muscle strength Gait parameters Knee range during walking	No significant differences found
Exercise, Taping and Education	Quilty et al (2003)	87 patients with predominant patellofemoral joint disease Group 1: 9x30min physiotherapy sessions over 10 weeks (Education, quadriceps and functional exercises, patellar taping, advice)	n/a	Pain WOMAC Muscle strength	Treatment produced small improvements in knee pain and quadriceps strength as measured at 10 weeks post intervention. These were not maintained at 12 months

		Group 2: Standard non-physiotherapy OA treatment			
Exercise and Cognitive-Behavioural Strategies	Keefe et al (2004)	72 married OA patients with persistent knee pain and their spouses 12 week intervention Group 1: Weekly two-hour session for training in pain coping and couples skills Group 2: Supervised thrice weekly 60 minute exercise session Group 3: Combination of the above two	n/a	VO_2 peak Muscle strength Pain coping Arthritis self-efficacy scale and spouse version Marital adjustment AIMS	An intervention that combines spouse-assisted coping skills training and exercise training can improve physical fitness, strength, pain coping, and self efficacy
Exercise and Diet	Rejeski et al (2002)	316 subjects 18 month intervention Group 1: Dietary weight loss Group 2: Dietary weight loss and exercise Group 3: Healthy lifestyle	n/a	SF-36 Satisfaction with body function and appearance	Combined exercise and diet had the most consistent, positive effect on health-related quality of life compared with the control group

Acupuncture

Level I, systematic reviews

Ezzo et al (2001) conducted a systematic review on the efficacy of acupuncture for knee OA. Seven trials representing 393 patients were included. For pain and function, there was limited evidence that acupuncture is more effective than being on a waiting list or receiving treatment as usual. For pain, real acupuncture is more effective than sham acupuncture. Insufficient evidence exists to determine if the efficacy of acupuncture is similar to that of other treatments.

Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Vas et al (2004)	97 subjects 12 week intervention. Group 1: Weekly acupuncture plus diclofenac Group 2: Placebo acupuncture plus diclofenac	9	Pain WOMAC Quantity of diclofenac taken during the treatment period	Acupuncture plus diclofenac is more effective than placebo acupuncture plus diclofenac for symptomatic treatment of knee OA
Berman et al (2004)	570 subjects 26 week intervention Group 1: True acupuncture Group 2: Sham acupuncture Group 3: Education-attention control	7	WOMAC SF-36 Patient global assessment 6 minute walk time	Acupuncture provides improvement in function and pain relief compared to sham acupuncture and education control groups
Tillu et al (2001)	44 subjects Group 1: Acupuncture to the most affected knee only Group 2: Acupuncture to both knees	7	Symptoms	Unilateral acupuncture is as effective as bilateral acupuncture in increasing function and reducing the pain associated with knee OA
Sangdee et al (2002)	193 subjects 4 week intervention Group 1: Electroacupuncture thrice weekly Group 2: Diclofenac analgesia Group 3: Electroacupuncture plus Diclofenac Group 4: Placebo	6	Pain WOMAC Lequesne functional index 50 feet walk time Orthopedist's and patient's opinion of change	Electroacupuncture is significantly more effective than placebo and diclofenac in the symptomatic treatment of knee OA. The combination of electroacupuncture and diclofenac was more effective than electroacupuncture alone
Ng et al (2003)	24 subjects 2 week intervention Group 1: 20 minutes electroacupuncture Group 2: 20 minutes TENS Group 3: Education	n/a	Pain Timed up and go	Both TENS and electroacupuncture reduced OA-associated knee pain. Electroacupuncture additionally enhanced timed up and go performance
Tukmachi et al (2004)	30 subjects 5 week intervention Group 1: Acupuncture alone Group 2: Acupuncture and symptomatic medications Group 3: Symptomatic medications only for 5 weeks prior to acupuncture course	n/a	Pain WOMAC	Manual and electroacupuncture cause significant improvement in knee OA symptoms. At 1 month post treatment, its effects are undiminished

Transcutaneous electric nerve stimulation

Level I, systematic reviews

Osiri et al (2005) conducted a Cochrane Review evaluating the effectiveness of TENS in the treatment of knee OA. Seven trials of one year or longer were included. Pain relief from TENS was significantly better than placebo treatment, as was knee stiffness. Different modes of TENS settings all demonstrated a significant benefit in pain relief over placebo.

Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Cheing & Hui-Chan (2004)	62 subjects 4 week intervention Group 1: 60 minutes of TENS. Group 2: 60 minutes of placebo stimulation Group 3: Isometric exercise training Group 4: Exercise and TENS	6	Muscle strength Spatiotemporal gait parameters Range of knee movement	No significant differences were found between the four treatment groups, but the addition of TENS to exercise training tended to produce the best overall improvement in physical outcomes
Cheing et al (2003)	38 subjects 2 week intervention. Group 1: 20 minutes of TENS Group 2: 40 minutes of TENS Group 3: 60 minutes of TENS Group 4: 60 minutes placebo TENS	n/a	Pain	40 minutes is the optimal treatment duration of TENS in terms of both the magnitude of pain reduction and the duration of post-stimulation analgesia
Cheing et al (2002)	62 subjects 4 week intervention Group 1: 60 minutes of TENS Group 2: 60 minutes of placebo stimulation Group 3: Isometric exercise training Group 4: Exercise and TENS	n/a	Pain	The study failed to demonstrate a significant difference in knee OA pain following TENS, exercise, or exercise and TENS over placebo control
Law et al (2004)	39 subjects 2 week intervention Group 1: TENS at 100 Hz Group 2: placebo TENS	n/a	Pain Timed up and go test Range of knee motion	TENS resulted in a greater increase in knee range than the placebo group. Changes in pain and timed up and go were not different between the groups
Law & Cheing (2004)	34 subjects 2 week intervention Group 1: TENS at 2 Hz Group 2: TENS at 100 Hz Group 3: TENS at an alternating frequency of 2 Hz and 100 Hz Group 4: placebo TENS	n/a	Pain Range of knee motion Timed up and go test	The three active TENS groups, but not the placebo, significantly reduced knee pain. Two weeks of repeated applications of TENS at 2 Hz, 100 Hz or 2/100 Hz produced similar treatment effects
Ng et al (2003)	24 subjects 2 week intervention Group 1: 20 minutes electroacupuncture Group 2: 20 minutes TENS Group 3: Education	n/a	Pain Timed up and go test	Both TENS and electroacupuncture reduced OA-associated knee pain. Electroacupuncture additionally enhanced timed up and go performance

Knee taping

Level I, systematic reviews

There are no systematic reviews evaluating the efficacy of knee taping for knee osteoarthritis

Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Hinman et al (2004)	A within-subject study (n = 18) and RCT (n = 87) Three week intervention Group 1: Therapeutic tape (patellar realignment and soft tissue unloading) Group 2: Placebo tape (non-rigid tape with no realignment nor unloading) Group 3: No tape	n/a	Knee joint position sense Muscle strength EMG quadriceps onset during stair descent	Neither immediate application nor continuous use of tape for 3 weeks appears to influence sensorimotor function
Hinman et al (2003a)	87 subjects Three week intervention Group 1: Therapeutic tape (patellar realignment and soft tissue unloading) Group 2: Control tape (non-rigid tape with no realignment nor unloading) Group 3: No tape	8	Pain Participant perceived rating of change WOMAC SF-36	Therapeutic taping reduces pain and improves physical function
Hinman et al (2003b)	18 subjects Immediate effect of tape tested using within-subjects design Condition 1: Therapeutic tape (patellar realignment and fat pad unloading) Condition 2: Control tape (non-rigid tape with no realignment nor unloading) Condition 3: No tape	n/a	Pain Walking speed Timed up and go test Step test	Therapeutic tape is effective in immediately reducing pain but has no immediate impact upon observed disability associated with knee OA

Bandaging

Level I, systematic reviews

There are no systematic reviews evaluating the efficacy of bandaging for knee osteoarthritis

Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Hassan et al (2002)	68 subjects Effect of bandaging tested using within-subjects design Condition 1: Standard elastic knee bandage Condition 2: Looser elastic bandage	6	Pain Postural sway Knee proprioception	The loose bandage reduced pain and improved postural sway but did not affect proprioception, whilst the standard bandage had no effect on any outcome
Pajareya et al (2003)	8 week intervention Group 1: Acetaminophen, education and daytime elastic knee sleeve Group 2: Acetaminophen and education.	n/a	Aggregated functional performance time	This study demonstrated small short-term beneficial effects of the knee sleeve in patients with knee OA in cases with an acute exacerbation
Mazzuca et al (2004)	52 subjects 4 weeks intervention Group 1: Heat-retaining knee sleeve Group 2: Standard cotton/elastane sleeve	6	WOMAC	Whilst WOMAC scores improved in both groups, there was no significant difference in outcome between them. This pilot study was insufficiently powered as a definitive clinical trial

Bracing and orthotics

Level I, systematic reviews

Brouwer et al (2005) conducted a Cochrane review to evaluate the effectiveness of a brace or orthosis in the treatment of knee OA. They found only four studies (one brace, three orthoses) involving 444 participants that met the inclusion criteria. There is limited evidence that a brace has additional beneficial effect for knee OA over medical treatment alone. There is limited evidence that a laterally-wedged insole decreases anti-inflammatory intake and is associated with improved patient compliance than a neutral insole. A strapped insole has more adverse effects than a lateral wedge insole.

Bracing- Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Birmingham et al (2001)	20 subjects Immediate effect of brace tested using within-subjects design Condition 1: Valgus unloading brace Condition 2: No brace	n/a	Knee proprioception Postural control	Proprioception was improved with application of the brace, however the functional importance of the small changes observed is questionable. The brace had no effect on postural control

Foot orthoses- Level II evidence

Author	Subjects and intervention	PEDro score (1-10)	Primary outcome measures	Conclusions
Kerrigan et al (2002)	15 subjects Immediate effect of insoles tested using a within-subjects design Condition 1: Without an insole Condition 2: With an even-thickness control insole Condition 3: With a 5-degree laterally wedged insole Condition 4: With a 10-degree laterally wedged insole.	n/a	Peak external knee varus torque during gait	Both wedge insoles were effective in reducing the varus torque during walking. This implies that the wedged insoles should reduce loading of the medial compartment in individuals with medial knee OA. Although the effect of the 5-degree wedge was smaller, it may be more comfortable to wear
Maillefert et al (2001)	156 subjects 6 month intervention Group 1: Laterally wedged insoles Group 2: Neutral insoles	n/a	Patient's overall assessment of disease activity WOMAC Concurrent treatments	The study failed to demonstrate a short-term symptomatic effect for the use of laterally wedged insoles in the treatment of medial knee OA. However NSAID usage was significantly reduced with lateral wedges compared to neutral insoles, suggesting an indirect benefit

Maly et al (2002)	12 subjects Immediate effects of orthoses tested using within-subjects design Condition 1: routine footwear Condition 2: Valgus heel wedge Condition 3: Modified orthotic	n/a	Peak adduction moment and centre of pressure during walking Radiographic knee alignment	No difference between conditions with regard to most of the measures. Reduction in centre of pressure displacement in the anterior-posterior direction was observed with the orthotic, suggesting an alteration of foot position
Pham et al (2004)	156 subjects 2 year intervention Group 1: Laterally wedged insoles Group 2: Neutrally wedged insoles	n/a	Patient's overall assessment of disease activity WOMAC Concurrent treatments Joint space narrowing on X-ray	The study failed to demonstrate either symptomatic or structural improvements with the laterally wedged insoles for the treatment of medial compartment knee OA. However anti-inflammatory usage was reduced in the laterally wedged group
Toda et al (2004)	66 female subjects 6 month intervention Group 1: Wedged insole with subtalar strapping Group 2: Traditional wedged sole insert	n/a	VAS Lequesne index score Femorotibial angle on X-ray	The strapped insert produced clinical improvements compared to the traditional insert. A correction in the femorotibial angle was also observed with the strapped insole
Toda & Segal (2002)	88 female subjects. 8 week intervention Group 1: Lateral wedged insole with elastic subtalar strapping Group 2: Ankle supporters with a lateral wedged heel insert	n/a	Femorotibial angle on X-ray Lequesne Index	The lateral wedged insole with subtalar strapping induced correction of the femorotibial angle and resulted in symptomatic relief
Toda et al (2001)	90 female subjects 8 week intervention Group 1: lateral wedge insole with elastic strapping of the subtalar joint Group 2: Traditional wedge insole	n/a	Femorotibial angle and talar tilt angle on X-ray Pain	The strapped insole leads to valgus angulation of the talus, thus correcting the varus femorotibial angle deformity. Pain scores were significantly improved with the strapped insole compared to the traditional insole

Gait aids

Level I, systematic reviews

There are no systematic reviews evaluating the efficacy of gait aids for knee OA.

Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Chan et al (2005)	14 subjects. Immediate effect of a gait aid tested using a within-subjects design Condition 1: Walking unaided Condition 2: Walking with cane held in hand ipsilateral to the arthritic knee Condition 3: Walking with cane held in hand contralateral to the arthritic knee	n/a	Hip/knee frontal/sagittal plane moments during walking Walking speed Cadence Stride length	Contralateral cane placement is the most efficacious for persons with knee OA, leading to a significant reduction in some knee moments. No cane may be preferable to ipsilateral cane usage as the latter resulted in the highest knee moments of force, a situation which may exacerbate pain and deformity

Weight loss

Level I, systematic reviews

There are no systematic reviews evaluating the efficacy of weight loss in knee osteoarthritis

Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Messier et al (2004)	316 subjects 18 month intervention Group 1 (control): healthy lifestyle (Monthly 1 hour videotape presentation for 3 months then regular phone contact) Group 2: Dietary restriction only Group 3: Exercise only (Thrice weekly hour long session of aerobic and resistance exercise) Group 4: Diet plus exercise	8	WOMAC 6 minute walk distance Stair-climb time Weight loss Radiographic joint space width	The combination of modest weight loss and moderate exercise provides greater improvements in self-reported measures of pain and function, and greater improvements in functional performance than either intervention alone
Messier et al (2000a)	24 subjects with BMI 28+ kg/m^2 24 week intervention Diet: weekly sessions with a nutritionist. Goal to lose 15lb over 6 months Exercise: Combined weight training and walking for 1 hour, thrice weekly Group 1: Diet and Exercise Group 2: Exercise alone	5	Functional performance inventory Pain Muscle strength Gait analysis Synovial fluid analysis	Weight loss can be achieved and maintained over 6 months through a combination of exercise and diet. Both interventions improved pain, disability and performance. The addition of dietary weight loss to exercise may improve gait parameters more than exercise alone
Nicklas et al (2004)	316 subjects with BMI 28+ kg/m^2 18 month intervention Group 1: Diet- weekly session with dietician Group 2: Exercise-3x weekly 1 hr session of weight training and walking Group 3: Diet plus exercise Group 4: Healthy lifestyle	5	Blood concentrations of: C-reactive protein, interleukin 6, soluble tumour necrosis factor alpha	Dietary intervention designed to elicit weight loss reduces overall inflammation in older, obese persons. A similar influence of exercise was not detected
Christensen et al (2005)	80 patients with knee OA, mean BMI 35.9 (5.1) kg/m^2 8 week intervention Group 1: Low energy diet Group 2: Conventional hypo-energetic, high protein diet	n/a	Body weight Body composition WOMAC Pain	A weight reduction of 10% improved function by 28%. Low energy diet may be of advantage in the treatment of knee OA in obese people because of the rapidity of weight loss and a more significant loss of body fat
Rejeski et al (2002)	316 subjects 18 month intervention Group 1: Dietary weight loss Group 2: Dietary weight loss and exercise Group 3: Healthy lifestyle	n/a	SF-36 Satisfaction with body function and appearance	Combined exercise and diet had the most consistent, positive effect on quality of life compared with the control group

Thermotherapy

Level I, systematic reviews

Brosseau et al (2003b) conducted a Cochrane Review to determine the effectiveness of thermotherapy (heat or cold therapy) in the treatment of knee OA. Three trials involving 179 patients were included. Ice massage compared to control had a beneficial effect on range of motion, 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 with control. More well designed studies are needed.

Laser therapy

Level I, systematic reviews

Brosseau et al (2004b) conducted a Cochrane Review to assess the effectiveness of low level laser therapy for the treatment of OA. Five trials were included, totalling112 patients allocated laser therapy and 85 patients allocated placebo laser. Some studies demonstrated beneficial effects with laser whilst the pooled estimate of three trials showed no statistically different effect on pain. For OA, the results are conflicting in different studies and may depend on the method of laser application.

Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Gur et al (2003)	90 subjects with knee OA 14 week intervention Group 1: Low power laser therapy for 5 minutes (3J total dose) plus exercise. Group 2: Low power laser therapy for 3 minutes (2J total dose) plus exercise. Group 3: Placebo laser treatment plus exercise.	n/a	Pain Active range of knee flexion Duration of morning stiffness Painless walking distance/duration WOMAC	Both low power laser therapy dosages were safe and effective adjuncts to exercise in the treatment of knee OA
Tascioglu et al (2004)	60 subjects. 2 week intervention Group 1: Laser at a dosage of 3J per painful point Group 2: Laser at a dosage of 1.5J per painful point Group 3: Sham laser	n/a	WOMAC Pain	Low-level laser at the doses used in this study had no effect upon knee OA pain

Electromagnetic field therapy

Level I, systematic reviews

Hulme et al (2002) conducted a Cochrane Review on the effectiveness of pulsed electric stimulation and to assess the most effective and efficient method of applying an electromagnetic field for the treatment of OA, either through pulsed electromagnetic field or through electrical stimulation. Only three studies involving 259 OA patients were included. Electrical stimulation therapy had a small to moderate effect on outcomes for knee OA when compared to placebo but the clinical significance of these effects is doubtful. Current evidence suggests that electrical stimulation therapy may provide benefits for knee OA but further studies are required.

Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Harlow et al (2004)	194 subjects with OA of hip or knee 12 week intervention Group 1: Standard strength bipolar magnetic bracelet Group 2: Weak strength bipolar magnetic bracelet Group 3: Non-magnetic bracelet	8	WOMAC Pain	Pain of hip or knee OA decreases when wearing a magnetic bracelet. It is uncertain whether this is due to specific or to placebo effects
Pipitone & Scott (2001)	75 subjects 6 week intervention Group 1: Low frequency pulsed electromagnetic field Group 2: Placebo electromagnetic field	n/a	Pain WOMAC Lequesne Index SF-36 EuroQol	Although there were no significant differences between the groups after treatment, paired analysis on each patient showed improvements in the active group with respect to WOMAC and EuroQol scores at the end of treatment compared to baseline
Hinman et al (2002)	43 subjects 2 week intervention Group 1: Wore pads containing magnet Group 2: Wore placebo pads	n/a	WOMAC Timed 15 metre walk	The application of static magnets over painful knee joints appears to reduce pain and to enhance functional movement
Jacobson et al (2001)	176 subjects 2 weeks intervention Group 1: Low amplitude, low frequency magnetic field Group 2: Sham magnetic field	n/a	Pain	Low amplitude, extremely low frequency magnetic fields are superior to treating knee pain compared to sham
Nicolakis et al (2002)	36 subjects 6 week intervention self-administered in home Group 1: Pulsed magnetic field Group 2: Sham magnetic field	n/a	WOMAC Gait speed Stride length Strength	No difference between groups for WOMAC but PEMF was superior to sham PEMF with regards to secondary impairment measures
Wolsko et al (2004)	29 subjects 6 week intervention Group 1: High-strength static-magnet knee sleeve Group 2: Placebo-magnet knee sleeve	n/a	WOMAC	Magnets showed a statistically significant efficacy in reducing pain after 4 hours under rigorously controlled conditions

Neuromuscular electrical stimulation (NMES)

Level I, systematic reviews

There are no systematic reviews of neuromuscular electrical stimulation for the treatment of knee OA.

Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Gaines et al (2004)	38 subjects 12 week intervention Group 1: Home based NMES of the quadriceps plus education Group 2: Education only	n/a	McGill pain questionnaire AIMS Pain diary	Home based NMES reduces arthritic knee pain 15 minutes after treatment
Talbot et al (2003)	34 subjects 12 week intervention Group 1: Home based NMES of the quadriceps plus education Group 2: Arthritis self help course	n/a	Peak isometric quadriceps force Daily step count Total activity vector magnitude 100 foot walk-turn-walk Timed stair climb Timed chair rise McGill pain questionnaire	NMES increases quadriceps strength without exacerbating painful knee OA symptoms

Ultrasound

Level I, systematic reviews

Robinson et al (2001) conducted a Cochrane Review to assess the effectiveness of therapeutic ultrasound therapy for treating OA. Three trials including 294 participants with hip or knee OA were included. Only one trial compared therapeutic ultrasound to placebo. This trial showed no difference in range of motion, pain or gait velocity after four weeks of treatment. Two trials compared therapeutic ultrasound to an active therapy and showed no difference between ultrasound, galvanic current or short wave diathermy for the outcomes of pain and participant assessed improvement. Ultrasound therapy appears to have no benefit over placebo or short wave diathermy for people with hip or knee OA.

Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Kozanoglu et al (2003)	60 subjects 10 treatment sessions of 5 minute duration Group 1: Gel containing 5% ibuprofen Group 2: Normal ultrasound gel	n/a	WOMAC Pain 20 metres walk time Knee range of motion Global assessments of disease activity and treatment efficacy by the investigator and by the patients	Both modalities were effective and generally well tolerated. Ibuprofen phonophoresis conferred no benefit over normal ultrasound therapy

Short-wave therapy
Level II evidence

Authors	Subjects and intervention	PEDro score (1-10)	Primary outcomes	Conclusions
Laufer et al (2005)	103 subjects 3 weeks intervention Group 1: Pulsed short-wave diathermy (thermal) Group 2: Pulsed short-wave diathermy (athermal) Group 3: Sham therapy	n/a	WOMAC Timed up-and-go test 3 minute walk Stair climbing	The study failed to demonstrate any efficacy of pulsed short-wave diathermy as it is utilized in the clinical setting for the treatment of knee OA

Interferential therapy

Level I, systematic reviews
There are no systematic reviews of interferential therapy for knee OA.

Level II evidence
There is no level II evidence for interferential therapy for knee OA.

Massage therapy

Level I, systematic reviews
There are no systematic reviews of massage therapy for knee OA.

Level II evidence
There is no level II evidence for massage therapy for knee OA.

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Authors: Kim Bennell and Rana Hinman

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Australian Physiotherapy Association
PO Box 6465, St Kilda Rd Central
Victoria 8008
Phone: +61 3 9534 9400
Fax: +61 3 9534 9199
Email: national.office@physiotherapy.asn.au
Web site: www.physiotherapy.asn.au

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