

PHYSIOTHERAPY TREATMENTS FOR PATELLOFEMORAL PAIN

Introduction

Patellofemoral pain is a musculoskeletal complaint that is common in active and general populations. Prospective cohort studies have identified that approximately 10% of active individuals will develop patellofemoral pain (Milgrom et al 1996, Witvrouw et al 2000). It is the most common single diagnosis presenting to sports medicine/physiotherapy practices, accounting for 2–7.4 % of patients (Devereaux and Lachmann 1984, Kannus et al 1987, Baquie and Brukner 1997). Currently the specific pathological process associated with patellofemoral pain is not known. However, patellofemoral pain is associated with stereotypical symptoms, namely anterior or retropatellar pain aggravated by activities that repetitively load the patellofemoral joint. These activities include stair-climbing, sitting, squatting and kneeling. Thus, this condition impacts on many aspects of daily life including the ability to perform work-related or health-related activities pain free.

Patellofemoral pain is not a self-limiting condition and as such it is important to identify interventions that can reduce the pain and disability associated with this common condition. Physiotherapy is the mainstay of treatment for patellofemoral pain. Most physiotherapy interventions attempt to restore the biomechanics of the patellofemoral joint through quadriceps (specifically the vastus medialis obliquus) and hip strengthening and/or patellar realignment procedures (tape, brace, mobilisation, stretching). These treatments appear to be based on sound theoretical rationale and have attained widespread acceptance. Some clinical trials have examined a combination of interventions, which mostly reflects clinical practice, but does not enable the assessment of different intervention efficacies. Other trials have examined different interventions in isolation, or have compared two different types of interventions (e.g. different exercise regimes). This review evaluates the evidence to support physiotherapy intervention for patellofemoral pain.

Method

Physiotherapy research aims to determine the most efficacious treatment for patellofemoral pain. In order to do this, many physiotherapists have undertaken research investigating the practice of physiotherapy. Most of the research into patellofemoral pain syndrome is subjected to peer-review and has been approved by ethics committees.

The Australian National Health and Medical Research Council (NHMRC) have issued guidelines on how to evaluate the effectiveness of treatment interventions (NHMRC 1999). The NHMRC have suggested that the strongest evidence for treatment efficacy is obtained from a systematic review of all relevant randomised controlled trials (RCTs). This is termed Level I evidence by the NHMRC. Level II evidence is defined as 'evidence obtained from at least one properly designed randomised controlled trial'. Less stringent levels of evidence, down to Level IV, have been defined (NHMRC 1999). Due to the paucity of systematic reviews and randomised controlled trials, this review includes systematic reviews (Level I) randomised controlled trials (Level II) and controlled clinical trials (Level III).

It is important that individual interventions are not confused with the professional practice of physiotherapy. Indeed the professional practice of physiotherapy encompasses a wide variety of interventions. Hence, in this paper, the specific nature of the physiotherapy intervention is recorded.

A summary of the Level II and III evidence of interventions used in the management of patellofemoral pain syndrome is presented in the technical report. Systematic searches were conducted until February 2005 of the PEDro, MEDLINE, CINAHL and the Cochrane databases and relevant articles were retrieved and reviewed. Articles were excluded if they were not available in English, if they were pilot studies or if they were mechanistic in nature (i.e. they evaluated the effects of treatment on a physical feature, not on pain or disability). The PEDro database was used as a reference for the rating of the methodological quality of the clinical trials. Where there was not a PEDro rating available, a rating scale from a Cochrane review was used where available. Four systematic reviews, three Cochrane reviews and 23 randomised/controlled clinical trials that investigated physiotherapy interventions for patellofemoral pain are included in this review. The methodological quality of the trials varied, with PEDro scores ranging from 9 to 2 (out of possible 10), and only four of the 23 trials rating greater than 6 out of 10. Three Clinical Practice Guidelines were found, and their recommendations are summarised in the report.

Results

The evidence to support the use of physiotherapy interventions in the management of patellofemoral pain is limited. There appears to be a consistent improvement in short-term pain and function due to physiotherapy treatment. However, studies that have evaluated interventions in isolation are inconclusive.

Recommended treatments

Recommended treatments are those for which there is clear Level I or II evidence for their effect.

Combined interventions (Physiotherapy)

Summary of Evidence

Physiotherapy interventions for patellofemoral pain have mostly focused on retraining the vastus medialis obliquus (VMO) without increasing the load on the patellofemoral joint. Traditionally, standard quadriceps strengthening consisted of isometric contraction, inner range (non weight-bearing) contractions and straight leg raises. Often these were progressed through incremental increases in resistance. By exercising the quadriceps in the inner range (30° - 0°), load on the patellofemoral joint was minimised, thus avoiding aggravation of pain. An Australian physiotherapist (McConnell 1986) proposed that retraining the VMO would be more effective in a weight-bearing position, thus enabling motor retraining in activities that are more functional and relevant. In McConnell's paper, the addition of patellar taping, patella mobilisation and stretching were used in conjunction with the VMO retraining to reduce pain and enhance VMO activation. This treatment approach has gained widespread acceptance in Australia and increasingly internationally. Currently, physiotherapy in clinical practice generally includes a number of components (VMO training, stretching, mobilization, massage, general conditioning, taping/bracing, foot orthoses, balance

training, hip muscle training). Therefore it is appropriate to test a combined intervention.

Five trials have examined combined interventions for patellofemoral pain. Of these, three trials are methodologically sound. These trials indicate a positive benefit for a combined physiotherapy intervention. The Level I reviews also support the use of combined interventions. Therefore, there is Level I evidence for the use of a combined intervention.

APA recommendations

A combined approach to the treatment of patellofemoral pain is recommended. This should include an exercise component (including vasti retraining and hip muscle training) and patellar taping or stretching.

Exercise therapy – quadriceps strengthening exercises

Summary of Evidence

Quadriceps strengthening exercises that were implemented in the absence of other physiotherapy interventions (e.g. mobilisation, soft tissue techniques, taping) are described as exercise therapy. There is Level I evidence supporting different types of exercise therapy to be equally effective for the management of patellofemoral pain. Six trials have investigated exercise therapy, mostly comparing one type of quadriceps strengthening exercise to another. Generally, these studies are of lower methodological quality, often utilising too small sample sizes. While all exercise therapy results in improvements in pain and disability, it has not been assessed, in isolation, against a placebo control.

APA recommendations

Exercise therapy (quadriceps strengthening exercises) is recommended. There is inconclusive evidence to support the use of one form of exercise therapy (quadriceps strengthening) over another.

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.

Patellar bracing or taping

Summary of Evidence

Patellar bracing or taping interventions are designed primarily to reposition the patella. A large number of within-subject design studies have identified an immediate reduction in pain in response to patellar brace or taping, but the mechanism behind the pain relief is unclear. Level I evidence is inconclusive. While the results of clinical trials are primarily negative, patellar braces and taping require further investigation.

APA recommendations

There is insufficient evidence to support or refute the use of patellar bracing or taping. These interventions may be used, provided there is evidence of improvement in subjective and objective outcomes.

Manual techniques

Summary of Evidence

Manual techniques are often used as an adjunct to exercises for patellofemoral pain. These include massage and mobilisation. Specific physiotherapy manual techniques have not been studied for patellofemoral pain. One study has investigated acupuncture and two studies have evaluated chiropractic mobilisation. These were included in this review, as the techniques may be used by similar to those used by some physiotherapists. The Level I evidence is inconclusive.

APA recommendations

Further studies are required to evaluate the usefulness of manual techniques in the management of patellofemoral pain.

Electrical modalities

Summary of Evidence

There is a paucity of studies evaluating electrical modalities in the management of patellofemoral pain. Level I evidence indicated that low-level laser was not effective, but that no conclusion could be made regarding the use of ultrasound.

APA recommendations

Further studies are required to evaluate the usefulness of electrical modalities in the management of patellofemoral pain.

In-shoe foot orthoses

Summary of Evidence

In-shoe foot orthoses are used by physiotherapists as an adjunct to treatment for patellofemoral pain. Level I evidence suggests that while foot orthoses are promising for patellofemoral pain, further studies are required.

APA recommendations

In-shoe foot orthoses can be used provided there is evidence of improvement in subjective and objective outcomes.

Conclusions

There is Level I evidence to support the role of physiotherapy in the management of patellofemoral pain. Physiotherapy comprises a combination of interventions include patellofemoral joint mobilisation, patellar taping or bracing, quadriceps and hip strengthening exercises and activity modification.

Many of the trials have focused on assessing one intervention in isolation, or testing individual interventions, which might be used concurrently, against each other. These trials suffer from lower methodological quality. In particular, they often have insufficient power to detect the effects obtained by isolated (or competing) interventions. If researchers and clinicians wish to identify which interventions are the most suitable for specific individuals, or sub-groups of individuals, then research should be directed towards the identification of subgroups and determining predictors of outcomes.

Evidence supporting physiotherapy

Combined interventions for patellofemoral pain
Quadriceps strengthening exercises (no difference between different delivery methods)

Further research required before we can draw conclusions

Superiority of one type/mode of quadriceps strengthening
Patellar bracing
Patellar taping
Manual techniques
Electrical modalities
In-shoe foot orthoses

Technical report

The following report details the evidence that currently exists for the efficacy of physiotherapy treatments for patellofemoral pain. It includes an initial summary of the clinical guidelines that are available. This is followed by summary of the available evidence for each intervention for patellofemoral pain. Due to the paucity of systematic reviews and randomised-controlled trials, the three levels of evidence that have been chosen for this review are: (1) systematic reviews (2) randomised controlled trials that have been published in peer-reviewed journals and (3) controlled clinical trials that have been published in peer-reviewed journal. Appendix 1 is a reference list of trials that were considered for this document, but excluded because they were not in English, were pilot studies, trials of anterior knee pain (including diagnoses other than patellofemoral pain, e.g. patellar tendinopathy), or mechanistic in nature.

Glossary and abbreviations

- Anterior Knee Pain Scale: 13-item knee-specific instrument designed to measure anterior knee pain
- Cincinnati Knee Rating System: system for assessing the functional outcomes of knee ligament surgery and treatment
- Functional Index Questionnaire: a multiple-choice questionnaire with 8 activities, where a score of 0 indicates inability to perform the activities and 16 represents no problems performing any of the activities.
- McGill Pain Questionnaire: designed to measure all dimensions of pain meaningful to patients.
- NRS -101: 101-point numerical rating scale
- Patient Specific Functional Scale: patient-specific self report disability measure which asks the patient to specify activities that are of concern to them
- PEDro: Physiotherapy Evidence Database methodological rating scale: www.pedro.fhs.usyd.edu.au
- Short Form 12 or 36 – Medical Outcomes Study short-form health survey. Measure of generic health status.
- VAS – visual analogue scale of pain intensity. Pain Measurement tool
- 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 Clinical Practice Guidelines for patellofemoral pain are limited. The National Health and Medical Research Council (Australia) published clinical guidelines on the management of anterior knee pain (NHRMC, 2004). An expert panel reviewed the scientific literature and concluded that: (i) staying active; (ii) corrective in-shoe orthoses plus quadriceps strengthening exercises; (iii) quadriceps retraining exercises (some exercises are more effective than others and knee taping may be useful); and (iv) patellofemoral joint mobilisation may be effective for reducing anterior knee pain.

A Philadelphia panel developed evidence-based clinical practice guidelines in 2001. Systematic literature searches of MEDLINE, EMBASE, Current Contents, Cochrane and PEDro were conducted. One trial was selected for patellofemoral pain. The panel

concluded that there was a lack of evidence at present regarding whether to include or exclude the use of thermotherapy, therapeutic massage, EMG biofeedback, therapeutic ultrasound, electrical stimulation, and combined rehabilitation interventions in the daily practice of physical rehabilitation for knee pain.

Herring et al (2003) published a consensus statement for team physicians regarding issues that were specific to the female athlete. The expert panel of medical practitioners compiled guidelines for the optimal care for the female athlete with patellofemoral pain. This statement highlighted that the team physician should understand non-operative management for patellofemoral pain, including patient education, activity modification, rehabilitation, bracing, orthoses and medications.

Combined interventions

Level I: Systematic Reviews

A Cochrane review (Heintjes et al 2003) searched the Cochrane Musculoskeletal Injuries Group and Cochrane Rehabilitation and Related Therapies Field specialised registers, the Cochrane Controlled Trials Register, the Physiotherapy Evidence Database (PEDro), MEDLINE, EMBASE, CINAHL until 2001 for all controlled trials. They identified all trials that had compared exercise therapy with control groups or compared different exercise therapies. While this review included trials that used combined interventions (e.g. Clark et al 2000), the review was focused on the effect of exercise on patellofemoral pain and grouped all studies together. They concluded that an intervention that included an exercise therapy component was more effective in treating patellofemoral pain than no exercise (see Exercise Therapy).

Bolga and Malone (2005) located studies that evaluated the effectiveness of exercise for patellofemoral pain using MEDLINE, CINAHL and SPORTDiscus. Only two trials were included in the review of combined interventions. The authors concluded that the combined interventions had positive results, but that further research was required to investigate the effectiveness of combined interventions (exercise/taping/biofeedback/mobilisation) compared with other interventions.

Bizzini et al (2003) searched MEDLINE, CINAHL and the Web of Sciences databases for randomised controlled trials that investigated non-operative interventions for patellofemoral pain. They used a scale based on criteria in the Cochrane Collaboration Handbook to critically appraise the methodology. Twenty clinical trials were included in their review, four that investigated combined interventions. They commented that the combined interventions enable the concurrent treatment of a number of impairments associated with patellofemoral pain. The authors concluded that in light of the evidence and quality scores of the studies that there is evidence for the use of a combined treatment approach in the management of patellofemoral pain.

Crossley et al (2001) conducted a systematic search of computerised bibliographic databases (MEDLINE, Current Contents, CINAHL) for clinical trials investigating physical interventions for patellofemoral pain. They reviewed 16 trials, 8 of which pertained to physiotherapy. The authors concluded that the evidence indicates that combined interventions (referred to as "Physiotherapy") can reduce the pain associated with patellofemoral pain, but that there was inconclusive evidence to support the superiority of one physiotherapy intervention compared with others.

Combined Interventions

Level II and III: Controlled clinical trials

Authors	PEDro (1-10) Score	Specific Intervention Group 1 = combined interventions	Participants	Primary outcomes	Conclusions
Whittingham et al 2004	n/a	Group 1: patellar taping/ quadriceps (VMO) retraining Group 2: placebo taping/quadriceps (VMO) retraining Group 3: no tape /quadriceps (VMO) retraining Daily physiotherapy treatments, 4 weeks	N = 30 6 females; 24 males	VAS (pain) Step test Functional Index Questionnaire	A combination of daily patellar taping and quadriceps (VMO) muscle retraining for 4-weeks was superior to a regime of placebo taping and exercise or exercise alone. No long-term follow-up
Crossley et al 2002	9	Group 1: quadriceps and hip muscle training, patellofemoral mobilisation, patellar taping and a home program Group 2: sham ultrasound and tape 6 physiotherapy treatments (once weekly) for 6-weeks	N = 71 46 females; 25 males	VAS (pain) Perceived clinical change Functional Index Questionnaire Anterior Knee Pain Scale	A 6-treatment combined physiotherapy intervention was superior to sham taping and sham ultrasound for the alleviation of patellofemoral pain. Three-month follow-up only available in Group 1
Clark et al 2000	7	Group 1: quadriceps and hip exercises, patellar taping and education Group 2: patellar taping and education Group 3: Quadriceps and hip exercises and education Group 4: education only	N = 81 36 females; 45 males	Patient satisfaction VAS (pain) WOMAC	Combined physiotherapy treatment, incorporating strengthening and stretching, has a beneficial effect at three months to permit discharge from physiotherapy. These benefits are maintained at one year.
Harrison et al 1999	5	Group 1: comprehensive program: focussed on specific muscle retraining, patellar taping, mobilisation and biofeedback Group 2: home strengthening and stretching Group 3: similar program to Group 2, but supervised by a physiotherapist	N = 113 68 females; 45 males	Functional Index Questionnaire VAS (pain) Perceived clinical change Anterior Knee Pain Scale Step test	Individuals in Group 1 reported greater improvements in pain and function scores than Groups 2 or 3 at one month. In the long-term the results of Group 1 were similar to Group 3. The more comprehensive program may result in faster improvements in those with PFP, but over the longer term the treatment effects were similar.

Eburne and Bannister 1996	2	Group 1 = patellar taping, quadriceps (VMO) retraining, Group 2 = standard quadriceps exercises Both groups given stretches and home program Monthly treatments until 3 months	N = 75	Pain during isometric quadriceps contractions at various knee flexion angles	Both the McConnell regimen and isometric quadriceps exercise groups improved patellofemoral pain by 50%. The McConnell regimen demonstrated slight but significantly greater reduction in pain during isometric contractions
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Exercise Therapy

Level I: Systematic Reviews

A Cochrane review (Heintjes et al 2003) searched the Cochrane Musculoskeletal Injuries Group and Cochrane Rehabilitation and Related Therapies Field specialised registers, the Cochrane Controlled Trials Register, the Physiotherapy Evidence Database (PEDro), MEDLINE, EMBASE, CINAHL until 2001 for all controlled trials. They identified all trials that had compared exercise therapy with control groups or compared different exercise therapies. They included 12 controlled clinical trials for review. This review concluded that there was limited evidence that exercise therapy was more effective in treating patellofemoral pain than no exercise. There was strong evidence that open and closed kinetic chain exercises were equally effective. The authors stated that further research is required to substantiate the efficacy of exercise therapy compared to a non-exercising control group.

Bizzini et al (2003) searched MEDLINE, CINAHL and the Web of Sciences databases for randomised controlled trials that investigated non-operative interventions for patellofemoral pain. They used a scale based on criteria in the Cochrane Collaboration Handbook to critically appraise the methodology. The authors identified two trials for review. They noted that there was moderate evidence that non-weight bearing, weight-bearing, isometric and eccentric exercises may be useful in the management of patellofemoral pain, but that no single approach has been demonstrated to be superior to another.

Exercise Therapy

Level II and III: Controlled clinical trials

Authors	PEDro (1-10) score	Specific Intervention Group 1 = Combined interventions	Participants	Primary outcomes	Conclusions
Witrouw et al 2004	n/a	Group 1: closed kinetic chain quadriceps exercises Group 2: open kinetic chain quadriceps exercise 5 year follow-up	N = 60 40 females; 20 males	VAS (pain) Anterior Knee Pain Scale Functional outcome assessment (3 tests)	At the 5 year follow-up, both groups demonstrated maintenance of good subjective and functional immediate outcomes. No differences were observed between groups. Both programs resulted in equal long-term good functional outcomes.
Witrouw et al 2000	n/a high†	Group 1: closed kinetic chain exercises Group 2: open kinetic chain exercises Both Groups: stretching 5-weeks	N = 60 40 females; 20 males	VAS (pain) Anterior Knee Pain Scale Functional outcome assessment (3 tests)	Both Groups lead to an improved subjective and clinical outcome in those with anterior knee pain Few significantly better outcomes in functional tests for Group 1
Schneider et al 2001	n/a	Group 1: PNF exercises Group 2: progressive resistance brace 8-weeks (16 treatments)	N = 40 28 females; 12 males	VAS (pain) Pain scale Peak quadriceps torque Radiological alignment	Individuals in Group 2 recorded significantly greater reductions in pain than those in Group 1
Timm 1998	4	Group 1: progressive resisted quadriceps training using a brace Group 2: control group 4-week intervention	N = 100 40 females, 60 males	VAS (pain) Radiological assessment of patellofemoral alignment	This exercise treatment (brace deigned to provide progressive resistance to knee flexion and extension) had an effect on patellofemoral pain, radiological alignment and functional impairment as compared with the (no treatment) control.
Thomee 1997	5	Group 1: isometric muscle strengthening Group 2: eccentric muscle strengthening All exercise sessions conducted by physiotherapists Both groups education 12 week interventions	N = 40 Females only	Physical activity level VAS (pain) Pain during activities	The physiotherapy exercise interventions resulted in reduced pain and improved activity and muscle function. However, no differences were found in treatment effects between the two intervention groups studied. Further study is required with a control group
Steine et al, 1996	n/a low†	Group I: isokinetic quadriceps training Group II: closed kinetic chain exercises 8-weeks, 3	N = 23 14 females; 9 males	Functional step test Isokinetic testing Subjective rating	Closed kinetic chain quadriceps training may be more effective than joint isolation isokinetic exercises in restoring function in patients with patellofemoral

		sessions/week			disorders. Considerable methodological issues
McMullen et al, 1990	n/a low†	Group I: standard quadriceps exercises progressive resistance / flexibility Group II = isokinetic quadriceps training Group III = control group	N = 29 13 females, 16 males	Manual muscle tests ROM Functional tests	Both standard and isokinetic exercise groups improved significantly compared with a no treatment control, but there was no significant difference between the two exercise groups in functional scales, quadriceps strength or hamstring range of motion.

†methodological rating by Heintjes et al (2003)

Patellar Bracing or Taping

Level I: Systematic Reviews

A Cochrane review (D'Hondt et al 2002) searched the Cochrane Musculoskeletal Injuries Group and Cochrane Rehabilitation and Related Therapies Field specialised registers, the Cochrane Controlled Trials Register, the Physiotherapy Evidence Database (PEDro), MEDLINE, EMBASE, CINAHL until 2000 for all controlled trials. They identified all trials that had examined knee orthoses for patellofemoral pain syndrome. Five trials were included in the review. The authors concluded that the strength of retrieved evidence was limited, such that it would be inappropriate to make clinical recommendations concerning the use of knee orthoses in the conservative management of patellofemoral pain.

Bizzini et al (2003) searched MEDLINE, CINAHL and the Web of Sciences databases for randomised controlled trials that investigated non-operative interventions for patellofemoral pain. They used a scale based on criteria in the Cochrane Collaboration Handbook to critically appraise the methodology. This study identified three trials for review and concluded that there was not adequate evidence to support or refute the use of patellar bracing or taping in the management of patellofemoral pain.

Crossley et al (2001) conducted a systematic search of computerised bibliographic databases (MEDLINE, Current Contents, CINAHL) for clinical trials investigating physical interventions for patellofemoral pain. Four trials were included in the review (two for braces and two for taping). The authors noted that further research was required to establish whether the short-term pain relief noted with patellar taping results in additional benefits for subgroups of individuals with patellofemoral pain. Furthermore, they concluded that there was no evidence to support the use of patellofemoral braces in the military setting, but that they had not been evaluated in other populations.

Patellar Bracing or Taping

Level II and III: Controlled clinical trials

Authors	PEDro (1-10) score	Specific Intervention Group 1 = Combined interventions	Participants	Primary outcomes	Conclusions
Brace – patellar realignment					
Finestone et al 1993	2	Group 1: elastic sleeve Group 2: patellar realignment brace Group 3: no treatment	N = 59	Pain rated on a four point scale	Treatment with a patellar brace is no better than no treatment. The lower rates of recovery in the brace groups and the side effect of skin abrasions suggest that this is not a good form of initial treatment
Miller et al 1997	4	Group 1: infrapatellar strap Group 2: patellar realignment brace Group 3: no treatment All groups: physical therapy (VMO retraining & flexibility)	N = 54	VAS (pain) Radiographic findings	There was no difference in change of pain or radiographic findings between the patellar realignment brace and no brace groups in a military trainee population.
Brace- infrapatellar strap					
Miller et al 1997	4	Group 1: infrapatellar strap Group 2: patellar realignment brace Group 3: no treatment All groups: physical therapy (VMO retraining and flexibility)	N = 54	VAS (pain) Radiographic findings	There was no difference in change of pain or radiographic findings between the infra patellar strap and no brace groups in a military trainee population.
Patellar taping					
Clark et al 2000	7	Group 1: quadriceps & hip strength, patellar taping and education Group 2: patellar taping and education Group 3: quadriceps & hip strength & education Group 4: education only	N: 81 36 females; 45 males	Patient satisfaction VAS (pain) WOMAC	The addition of patellar taping does not influence the outcome of physiotherapy treatment
Kowall et	3	Group 1: patellar	N = 25	VAS (pain)	There is no beneficial effect

al 1996		tape Group 2: no tape Both Groups: stretching and quadriceps muscle strengthening 4-week, twice weekly interventions			of adding patellar taping (worn only during exercise sessions) to a standard physical therapy program. Larger prospective studies are warranted to support this opinion.
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Manual Techniques (mobilisation/manipulations)

Level I: Systematic Reviews

Bizzini et al (2003) searched MEDLINE, CINAHL and the Web of Sciences databases for randomised controlled trials that investigated non-operative interventions for patellofemoral pain. They used a scale based on criteria in the Cochrane Collaboration Handbook to critically appraise the methodology. They identified four trials (three manual therapy and one acupuncture). The authors concluded that, despite the lower quality score of the study, there may be some usefulness for manual therapy and that acupuncture appears to be effective.

Crossley et al (2001) conducted a systematic search of computerised bibliographic databases (MEDLINE, Current Contents, CINAHL) for clinical trials investigating physical interventions for patellofemoral pain. The authors reviewed four trials and concluded that the available evidence did not support the use of isolated techniques (such as mobilisation or acupuncture).

Manual techniques (mobilisation/manipulations)

Level II and III: Controlled clinical trials

Authors	PEDro (1-10) score	Specific Intervention Group 1 = Combined interventions	Participants	Primary outcomes	Conclusions
Acupuncture					
Jenson et al 1999	4	Group 1: individualised acupuncture Group 2: no treatment 4-weeks, twice weekly	N = 75 44 females; 31 males	Pain (VAS) Cincinnati Rating System Functional hopping test	The acupuncture group had significantly lower pain scores than the (no treatment) control group at 12 months after inclusion. No placebo group was included to control for this effect.
Chiropractic patellar mobilisation					
Taylor & Brantingham 2003	n/a	Group 1: patellar mobilization / manipulation Group 2: patellar mobilization / manipulation + exercises 4 week (8 treatments) intervention	N = 12 Unknown gender frequency	McGill Pain Questionnaire Numerical Pain Scale Patient Specific Functional Scale Algometer	There were no differences between groups for all, except one, of the primary outcomes. Small sample sizes, eligibility criteria and standardisation of treatments may have affected results
Rowlands & Brantingham, 1999	4	Group 1: patellar mobilisation Group 2: sham ultrasound 4-week, 8 treatments	N = 30	Short-form McGill Pain Questionnaire NRS-101 questionnaire (pain) Patient Specific Functional Scale	No significant difference between the chiropractic patellar mobilisation group and placebo control group for functional scales and for most of the pain scales. Group 1 demonstrated a greater reduction in tenderness (measured with the algometer)

Electrotherapy (electrical modalities)

Level I: Systematic Reviews

A Cochrane review (Brosseau et al 2001) searched the Cochrane Musculoskeletal Injuries Group and Cochrane Rehabilitation and Related Therapies Field specialized registers, the Cochrane Controlled Trials Register, MEDLINE, EMBASE, HealthSTAR, Sports Discus, CINAHL and PEDro until 2000 for all controlled trials, case-control and cohort studies. They identified one trial that had compared therapeutic ultrasound against placebo or another active intervention in those with patellofemoral pain. The author's reported that no conclusion could be made concerning the use, or non-use of ultrasound therapy was for treating people with patellofemoral pain.

Bizzini et al (2003) searched MEDLINE, CINAHL and the Web of Sciences databases for randomised controlled trials that investigated non-operative interventions for patellofemoral pain. They used a scale based on criteria in the Cochrane Collaboration Handbook to critically appraise the methodology. The authors identified two trials for review and concluded that low-level laser was probably not effective for patellofemoral pain.

Crossley et al (2001) conducted a systematic search of computerised bibliographic databases (MEDLINE, Current Contents, CINAHL) for clinical trials investigating physical interventions for patellofemoral pain. The authors included reviewed one trial and noted that there was no evidence to support the use of low-level laser for patellofemoral pain.

Electrotherapy (electrical modalities)

Level II and III: Controlled clinical trials

Authors	PEDro (1-10) score	Specific Intervention Group 1 = Combined interventions	Participants	Primary outcomes	Conclusions
Biofeedback					
Dursun et al 2001	5	Group 1: biofeedback training during isometric contractions Group 2: quadriceps strengthening (VMO) exercises Flexibility exercises	N= 60 48 females; 12 males	VAS (pain) Functional Index Questionnaire	A combination of EMG biofeedback with conventional exercises resulted in no additional gains in pain or function.
Electrotherapy					
Rogvi-Hansen et al 1991	8	Group 1: low-level laser Group 2: sham laser 5-weeks, 8 interventions	N= 40	VAS (pain)	No significant difference was found between real and sham use of low-level laser for the symptoms of patellofemoral pain
Electrical Stimulation					
Callaghan et al 2004	n/a	Group 1: mixed frequency quadriceps stimulation Group 2: uniform constant frequency quadriceps stimulation 6-weeks, 1 hr daily	N= 80 47 females; 33 males	VAS (pain) Anterior Knee Pain Scale Clinical tests Muscle strength	Participants in both groups showed improvements in all measures. No significant difference was found between real and sham use of low-level laser for the symptoms of patellofemoral pain.

In-Shoe Foot Orthoses

Level I: Systematic Reviews

A Cochrane review (D'Hondt et al 2002) searched the Cochrane Musculoskeletal Injuries Group and Cochrane Rehabilitation and Related Therapies Field specialised registers, the Cochrane Controlled Trials Register, the Physiotherapy Evidence Database (PEDro), MEDLINE, EMBASE, CINAHL until 2000 for all controlled trials. They identified one trial that had examined foot orthoses for patellofemoral pain syndrome. The authors concluded that the strength of retrieved evidence was limited, such that it would be inappropriate to make clinical recommendations concerning the use of foot orthoses in the conservative management of patellofemoral pain.

Bizzini et al (2003) searched MEDLINE, CINAHL and the Web of Sciences databases for randomised controlled trials that investigated non-operative interventions for patellofemoral pain. They used a scale based on criteria in the Cochrane Collaboration Handbook to critically appraise the methodology. The authors found one trial and concluded the use of soft foot orthotics in patients with excessive foot pronation appeared to be useful in decreasing pain, but they noted that this trial did not meet the minimum level of quality required.

Crossley et al (2001) conducted a systematic search of computerised bibliographic databases (MEDLINE, Current Contents, CINAHL) for clinical trials investigating physical interventions for patellofemoral pain. Only one trial was included in the review and the authors noted that further studies are required to evaluate the appropriate use of corrective foot orthoses, but until such time orthoses may provide a useful adjunct to treatment, especially for those involved in weight-bearing activities.

Arroll et al (1997) systematically searched MEDLINE and some smaller databases for randomised controlled trials that investigated non-operative interventions for patellofemoral pain. They reviewed one trial. The authors concluded that the use of prostheses for specific foot structural problems is promising in the short-term.

In-Shoe Foot Orthoses

Level II and III: Controlled clinical trials

Authors	PEDro (1-10) score	Specific Intervention Group 1 = Combined interventions	Participants	Primary outcomes	Conclusions
Eng and Pierrynowski 1993	3	Group 1: foot orthoses Group 2: flat insoles Both Groups: standard strengthening program 8-weeks, twice weekly	N= 20 Females only	VAS (pain) on six activities	In females with documented forefoot varus and PFP, the addition of foot orthoses was found to reduce pain to a greater extent than an exercise program alone.
Wiener-Ogilvie and Jones 2004	n/a	Group 1: exercise therapy Group 2: foot orthoses Group 3: combined exercise and foot orthoses 4 week intervention	27 males and females	VAS Physical function scale	At eight weeks, primary outcomes were not statistically significantly different between the three treatment groups. There was a non significant trend towards a better result in Group III. Further (larger) studies are required

References

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prospective randomized study. *American Journal of Sports Medicine* 28(5): 687-694.

Appendix 1

Reference list of articles that were considered for this review, but excluded because they were not in English, pilot studies, trials of anterior knee pain (including diagnoses other than patellofemoral pain, e.g. patellar tendinopathy), or they were mechanistic in nature.

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