2016 Patellofemoral pain consensus statement from
the 4th International Patellofemoral Pain Research
Retreat, Manchester. Part 2: recommended physical
interventions (exercise, taping, bracing, foot
orthoses and combined interventions)

Kay M Crossley, 1 Marienke van Middelkoop, 2 Michael J Callaghan, 3, 4
Natalie J Collins, 5 Michael Skovdal Rathleff, 6 Christian J Barton 1

INTRODUCTION
Patellofemoral pain affects physically active and seden-
tary individuals, accounting for 11–17% of knee pain
presentations to general practice 1 2 and 25–40% of all knee problems seen in a sports injury clinic. 3 4 Patellofemoral pain is characterised by
anterior knee pain associated with activities such as
squatting, rising from sitting and stair ambulation.
While traditionally viewed as self-limiting, increas-
ing research data suggest that patellofemoral pain is
often recalcitrant and can persist for many years, 5–8
and may cause a decline in sports participation. 9

Despite its high prevalence among active individu-
als 9–12 and frequent presentations for treatment,
there are few published guidelines to help clinicians
choose the appropriate evidence-based treatment for
patellofemoral pain. The most recent and relevant
paper from Barton and colleagues 13 combined sys-
tematic review findings with qualitative interviews
from expert clinicians to provide a clinically relevant
syndrome or dysfunction). 17 To narrow the search
to identify systematic reviews, these diagnostic
terms were combined with the keyword reviews.

To narrow the search to identify any contempor-
ary randomised trials, diagnostic terms were com-
bined with (controlled trial or clinical trial) and
additional searching was completed in the
Physiotherapy Evidence Database (PEDro).
Additionally, all authors on this consensus
statement were consulted to identify any missing
papers. To be included, randomised trials were
required to evaluate one or more conservative
intervention compared with a control or alternative
intervention, using an outcome measure related to
pain (eg, pain visual analogue scale (VAS)) or patient-reported improvement, and
using a randomised method for group allocation.

Data were extracted from each included paper.
Where multiple systematic reviews were available
for the same intervention from the same time
period, findings from moderate–high quality
reviews were used in preference to low-quality
reviews. If no systematic reviews were available, all
published RCTs related to the intervention were
included. Findings from included reviews and trials
were used to generate a summary table, which
included study methodology, relevant outcomes
and effect sizes.

The methodological quality of meta-analyses and
systematic reviews was graded with the Assessment
of Multiple Systematic Reviews (AMSTAR) tool;
and RCTs were graded with the PEDro rating scale.
Rating was completed by two independent
reviewers (CJB and MvM), and discrepancies
resolved through a consensus meeting. A third
reviewer (KMC) was available to settle any dis-
agreement but was not required.

Quality of evidence
For systematic reviews, the following allocation was
applied based on AMSTAR scores:
High quality (HQ): ≥7
Moderate quality (MQ): 4–6
Low quality (LQ): ≤3

For RCTs, the following allocation was applied based on PEDro scores:
High quality (HQ): ≥7
Moderate quality (MQ): 4–6
Low quality (LQ): ≤3

Expert panel
The patellofemoral pain expert panel was composed of 35 of the 50 attendees at the 2015 International Patellofemoral Research Retreat (Manchester). All attendees were actively researching patellofemoral pain and included physiotherapists, doctors, podiatrists, biomechanists, epidemiologists and sports therapists.

Recommendations

Available systematic reviews and available evidence
This included 13 (5 moderate; 1 high quality) reviews related to exercise therapy, 2 (1 moderate quality) related to combined interventions, 5 (3 moderate; 1 high quality) related to foot orthoses, 4 (2 moderate; 1 high quality) related to patellar taping and bracing, and 7 (2 moderate quality) related to other adjunctive interventions. AMSTAR ratings for each of these systematic reviews and the search date included in their methods are outlined in table 1.

Additional RCT evidence
Subsequent searching for RCTs since 2010 revealed an additional 1631 citations. After taking into account the literature covered by included systematic reviews, 36 of these were considered for inclusion. Of these 36, an additional 7 randomised trials were identified. These included 1 on exercise therapy, 2 on combined interventions, 2 on foot orthoses, 1 on patellar taping and 1 on other adjunctive interventions. PEDro ratings for each of these trials are outlined in table 2.

Recommendations

Exercise therapy
1. Exercise is recommended to reduce pain in the short, medium and long term, and improve function in the medium and long term.
2. Combining hip and knee exercises is recommended to reduce pain and improve function in the short, medium and long term, and this combination should be used in preference to knee exercises alone.

Combined interventions
1. Combined interventions are recommended to reduce pain in adults with patellofemoral pain in the short and medium term.

Foot orthoses
1. Foot orthoses are recommended to reduce pain in the short term.

RESULTS
The initial literature search for systematic reviews yielded 586 citations. Following screening for eligibility, a total of 22 systematic reviews were identified. Consultation with consensus authors did not yield any additional reviews. The interventions were grouped into the following: (i) exercise therapy (with separate sections for exercise therapy targeting specific bodily regions, ie, knee or hip); (ii) combined interventions (combining two or more of exercise therapy, patellar taping, mobilisation or foot orthoses); (iii) foot orthoses (in-shoe orthotic devices); (iv) patellar taping and bracing and (v) other adjunctive interventions (eg, acupuncture, mobilisation, electrophysical agents). Some of the reviews covered several interventions.

Voting and scoring
A 10-point scale (0–9, where 0 is ‘not appropriate’ and 9 is ‘appropriate’) was used to evaluate the appropriateness of each intervention. This scale was based on one previously used to generate the Osteoarthritis Research Society International (OARSI) guidelines for the non-surgical management of knee osteoarthritis.¹⁴

<table>
<thead>
<tr>
<th>Not appropriate</th>
<th>Appropriate</th>
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<tbody>
<tr>
<td>0</td>
<td>1</td>
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<tr>
<td>2</td>
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<td>4</td>
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A pooled score provided a median appropriateness score for each intervention. A score of 0–3 was considered ‘inappropriate’, 4–6 ‘uncertain’ and 7–9 ‘appropriate’.

Final recommendations
Final recommendations were made on interventions where the outcome was consistent between voting and the evidence associated with this statement.

Other adjunctive interventions
1. Patellofemoral, knee and lumbar mobilisations may not improve outcomes.
2. Electrophysical agents may not improve outcomes.

DISCUSSION
The International Patellofemoral Research Retreat Consensus meeting resulted in six evidence-based recommendations. These recommendations will guide medical and health practitioners when they treat patients with patellofemoral pain. Recommendations may also be taken up by patients, other care providers, and government agencies and other organisations responsible for funding patellofemoral pain treatment. The recommendations are not intended to standardise patient care, but to be used in combination with individualised assessments of patient’s needs, preferences and presentations, and clinical expertise to inform patient-centred management.

Six recommendations from the expert panel
The six recommendations were as follows:
1. Exercise-therapy is recommended to reduce pain in the short, medium and long term, and improve function in the medium and long term.
2. Combining hip and knee exercises is recommended to reduce pain and improve function in the short, medium and long term, and this combination should be used in preference to knee exercises alone.
3. Combined interventions are recommended to reduce pain in adults with patellofemoral pain in the short and medium term.
4. Foot orthoses are recommended to reduce pain in the short term.
5. Patellofemoral, knee and lumbar mobilisations are not recommended.
6. Electrophysical agents are not recommended.
Our recommendations differ from those described in the ‘Best Practice Guide to Conservative Management of Patellofemoral Pain’. The best practice guide did not recommend exercise therapy as a stand-alone treatment, but recommended consideration of acupuncture, and provided no recommendations regarding treatments which may improve outcomes. These differences likely reflect the qualitative input from clinicians in the paper. In contrast, the consensus voting that led to our recommendations involved some researchers who had a clinical role and some who did not. For example, it appears that clinicians have a stronger preference for combined interventions (using a combination of exercise therapy, targeting knee and hip musculature, patellofemoral taping, mobilisation and foot orthoses), which was a recommendation from our consensus, than for stand-alone treatments, such as exercise therapy. However, exercise therapy has been evaluated considerably within the scientific literature and remains a recommendation as a stand-alone treatment from our consensus based on the strength of evidence supporting it. In contrast, interventions such as acupuncture have very limited supporting evidence. Appropriateness of acupuncture was voted as uncertain, and hence was not recommended in the current consensus meeting. However, acupuncture is frequently used by clinicians who treat patellofemoral pain, and this highlights a nexus between evidence and practice which requires high-quality clinical trials. The consensus meeting has also made recommendations against interventions such as mobilisation and electrotherapy, which current evidence indicates are ineffective. The consensus meeting was also unable to make any recommendations related to patient education in isolation, due to a paucity of research in this area. Considering the perceived importance of providing patient education from clinicians, further research and development on patient education interventions is encouraged.

**Exercise therapy:**

Exercise therapies had the most statements in support of their short-term, medium-term and long-term use, reflecting the large body of evidence underpinning this treatment. Exercise therapy was the only intervention tested in isolation to be supported by the expert group. The evidence clearly shows that exercise therapy is effective, regardless of the type of exercise (eg, in weight bearing or not; targeting hip or knee). There was also support for emerging but convincing evidence that combining a hip-focused with knee-focused exercise therapy regimen resulted in superior outcomes to isolated knee-focused exercise therapy. This is consistent with results from the combined intervention studies, which have included hip-focused and knee-focused exercise therapies. The uncertainty around the superiority of hip-focused when compared head-to-head with knee-focused treatments may reflect lack of clarity regarding implementation of targeted exercise therapies, and the potential for the reported exercise therapy regimens to truly only target either the hip or the knee. For example, knee-focused programmes including single-leg squatting or stair climbing activities will also target the hip, while standing exercises to target the hip with resistance will also involve a knee focus on the weight-bearing limb.

### Table 2 PEDro quality assessment of included RCTs

<table>
<thead>
<tr>
<th>Study</th>
<th>Score per PEDro item</th>
<th>Total score</th>
</tr>
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<tbody>
<tr>
<td>Exercise therapy</td>
<td>i† ii iii iv v vi vii viii ix x xi</td>
<td>5</td>
</tr>
<tr>
<td>Ferber et al†</td>
<td>1 1 1 0 0 0 0 0 1 1 1</td>
<td>5</td>
</tr>
<tr>
<td>Combined intervention</td>
<td>1 1 1 0 0 0 0 0 1 1 1</td>
<td>4</td>
</tr>
<tr>
<td>Foot orthoses</td>
<td>1 1 1 1 0 1 1 1 1 1 1</td>
<td>9</td>
</tr>
<tr>
<td>Patellar taping and bracing</td>
<td>1 1 1 0 0 0 0 0 0 1 1</td>
<td>4</td>
</tr>
<tr>
<td>Other adjunctive interventions</td>
<td>0 1 1 1 0 1 1 1 1 1 1</td>
<td>9</td>
</tr>
</tbody>
</table>

†Eligibility criteria item does not contribute to total score. 0, no; 1, yes; PEDro, Physiotherapy Evidence Database; RCTs, randomised controlled trials.

**Figure 1** Synthesis of current evidence with consensus voting and recommendations for exercise therapy. First quartile=left whisker; second quartile=yellow box; median=yellow and green box intersection; third quartile=green box; fourth quartile=right whisker.
The terms ‘exercise’ and ‘exercise therapy’ were discussed at length at the meeting. There is distinct lack of clarity regarding the taxonomy and reporting of exercise therapy treatments. Even when well reported, the type of exercise in the current evidence base varies with respect to the targets of the exercise (eg, strength, cardiovascular fitness, coordination/neuromuscular retraining). Furthermore, measurement of the effectiveness of such interventions to achieve their target, such as increasing strength, endurance and neuromuscular coordination, was rarely undertaken. Perhaps most importantly, the lack of detailed description of the exercise therapy interventions limits the translation of the research findings into clinical practice. This lack of reporting rigour for exercise therapy extends to other interventions described in this consensus statement. As a result of this discussion, a recommendation was made to adopt minimum reporting standards for patellofemoral pain studies, similar to those published for groin pain studies, and these standards are published by Morrisey et al.

Combined interventions

Combined interventions (combining exercise therapy, targeting knee and hip musculature, patellofemoral taping, mobilisation and foot orthoses) were considered appropriate for patients with patellofemoral pain, which is consistent with the strongest recommendation from the ‘Best Practice Guide.’ A combined approach to management best reflects clinical practice and provides the treating practitioner with the scope to address a number of contributing factors (not just one in isolation). However, an important recommendation made in the ‘Best Practice Guide’ regarding combined interventions is the need to...

**Figure 2** Synthesis of current evidence with consensus voting and recommendations for hip combined with knee targeted exercise therapy. First quartile=left whisker; second quartile=yellow box; median=yellow and green box intersection; third quartile=green box; fourth quartile=right whisker.

**Figure 3** Synthesis of current evidence with consensus voting and recommendations for hip targeted exercise therapy. First quartile=left whisker; second quartile=yellow box; median=yellow and green box intersection; third quartile=green box; fourth quartile=right whisker.
individualise treatments to each patient, as not all patients will require all treatments. Current research evidence to guide the tailoring of interventions is very limited, and efforts to address this are encouraged. Uncertainty around the recommendation supporting combined interventions for adolescents with patellofemoral pain most likely reflected the lack of studies, as there is currently only one RCT39 and no systematic reviews. Outcomes for adolescents were consistent with the pooled standardised mean difference (SMD) for a similar intervention in adults, but the overall rates of recovery after treatment may be lower in adolescents than in adults. We welcome further studies investigating treatment options in this group, especially given evidence of symptoms persisting well beyond adolescence.

Foot orthoses

Foot orthoses were recommended for short-term pain relief in people with patellofemoral pain, and this is consistent with the ‘Best Practice Guide’. However, an important consideration is that the average pain reduction facilitated by prefabricated foot orthoses may be considered to lack clinical significance, due to substantial individual variability in response. The key point is that foot orthoses may not be beneficial for all patients with patellofemoral pain, and identifying those most likely to benefit from foot orthoses is important. Published studies have reported clinical features that can be used to predict success with foot orthoses intervention, including greater midfoot mobility, less ankle dorsiflexion and immediate improvements in patellofemoral pain when performing a single-leg squat with foot orthoses.

Patellar taping

Whether patellar taping should be first-line treatment for patellofemoral pain was unclear to this expert panel. This conclusion was consistent with the ‘Best Practice Guide’ findings. Patellar taping approaches vary considerably with respect to the type and duration of taping, and the systematic reviews29–31 that synthesise these studies have dealt with the variability inconsistently. Lack of clarity from systematic reviews may partially explain the uncertainty around the consensus voting and associated recommendations to support patellar taping. Uncertainty around the recommendations for taping might also reflect that greater consideration of individual patient needs may be required. For example, in Barton et al’s13 synthesis, the experts described that targeting the taping to suit individual patient presentations was an important consideration. Patellar taping and bracing could play a role in patellofemoral pain management in combination with other treatments (ie, as part of a combined intervention as described above), but their role in isolation is yet to be fully determined. Other adjunctive treatments, such as joint mobilisations (patella, knee, lumbar), and electro-physical agents were not recommended for use in patellofemoral pain.

Prefabricated foot orthoses:

1. Reduces pain in the short term
   Evidence: High quality23 and moderate quality22 systematic reviews reported small pain reductions with prefabricated foot orthoses when compared with a placebo or control in the short term, and this has been further supported by an additional high quality randomised trial36 comparing prefabricated foot orthoses to wait and see over 6 weeks. One additional contemporary moderate quality randomised trial35 reported no significant difference in pain outcome between a 6mm medially and a 3mm laterally wedged foot orthoses.
   Recommendation: Appropriate

2. Improves function in the short term
   Evidence: High quality22 and moderate quality22 systematic reviews reported small improvements in function with prefabricated foot orthoses when compared with a placebo or control in the short term.
   Recommendation: Uncertain
LIMITATIONS

Our consensus on physical and exercise treatments for patellofemoral pain was limited to the treatments with evidence regarding their usefulness. The inclusion of evidence stemming from moderate-quality and high-quality systematic reviews means that not all potentially valuable interventions were covered. For example, while gait retraining shows emerging evidence supporting its use in patellofemoral pain, more rigorous research is required before it can be considered as a recommended intervention.

Our expert panel self-selected participants who attended the International Patellofemoral Pain Research Retreat. While all participants were active in patellofemoral research and most of the productive researchers worldwide were in attendance, the panel was not specifically chosen, based on their expertise. The inclusion of researchers and clinicians is a strength (ensuring expertise with research methodology and respect for scientific rigour) as well as a limitation (some members have no experience in patient management). Furthermore, there was no patient input into the voting on our recommendations, and we recommend that their values and preferences be considered when applying recommendations clinically.

FUTURE DIRECTIONS

Our consensus group recommended some future directions regarding interventions for patellofemoral pain. We recognised the need for minimum reporting standards for clinical research on patellofemoral pain, similar to that published for groin pain in athletes, which is being undertaken. We recommended that future trials should publish details of the intervention in sufficient detail to enable clinicians to apply these in clinical practice (possibly as supplementary files). We require greater understanding of potential mechanisms underpinning treatment effects. We recognise that there is uncertainty regarding the usefulness of

Other adjunctive interventions:

1. Acupuncture reduces pain in the medium term

   Evidence: One moderate quality systematic review [39] reported acupuncture to reduce pain more than a control at 5 months.

2. PF and knee mobilisation improves pain or functional outcomes in the short term *

   Evidence: One moderate quality systematic review [39] reported no improvements to pain following 2 weeks of PF and knee mobilisation when compared to no intervention; and no added benefits for either knee manipulation or full lower kinetic chain mobilisation when added to exercise and soft tissue treatment at 6 or 14 weeks. One high quality randomised trial [38] reported greater improvements in pain following 35 sessions of retro- and peripatellar ischemic pressure when compared to 15 sessions of ischemic pressure to the hip musculature, but no control group was included.

3. Lumbar mobilisation/manipulation improves pain or functional outcomes in the short term *

   Evidence: One moderate quality systematic review [39] reported there was no significant effect when adding spinal manipulation to patellar mobilisation over 4 weeks.

4. Electro-physical agents (e.g. ultrasound, phonophoresis, laser therapy, etc.) improves pain or functional outcomes in the short term *

   Evidence: One low quality systematic review [30] reported no difference between laser and sham laser; or any evidence to support the use of ultrasound and ice massage, ice bags, phonophoresis, and iontophoresis modalities.

Figure 6 Synthesis of current evidence with consensus voting and recommendations for patellar taping and bracing. First quartile=left whisker; second quartile=yellow box; median=yellow and green box intersection; third quartile=green box; fourth quartile=right whisker.

Figure 7 Synthesis of current evidence with consensus voting and recommendations for other adjunctive interventions. First quartile=left whisker; second quartile=yellow box; median=yellow and green box intersection; third quartile=green box; fourth quartile=right whisker. *Statement worded opposite for voting, that is, based on evidence (eg, does not improve pain).
subgroups, or individualised (clinical reasoning) approaches to optimise treatments. As with all exercise interventions, adherence is paramount, and methods to advance adherence are urgently needed. It is still unclear which specific pain pathways (local and central pain mechanisms) are primarily involved in patellofemoral pain, but it appears that central pain mechanisms may be altered in people with patellofemoral pain. This clearly indicates the need to evaluate non-mechanical interventions to address these factors in some individuals. We recommend future trials investigating interventions for patellofemoral pain across the lifespan (ie, adolescents and those with patellofemoral osteoarthritis).

There was overarching support from the International Patellofemoral Pain Research Retreat for the Enhancing the Quality And Transparency Of health Research (EQUATOR) guidelines (http://www.equator-network.org) for reporting, and we encourage investigators to follow the appropriate reporting guideline in future patellofemoral pain publications.

CONCLUSION
The consensus meeting at the 4th International Patellofemoral Pain Research Retreat (Manchester 2015) provided six recommendations for use in patients with patellofemoral pain: exercise therapy, particularly combining hip and knee exercises, combined interventions and foot orthoses. Patellofemoral, knee and lumbar mobilisations and electrophysical agents were not recommended. The 5th International Patellofemoral Pain Research Retreat is scheduled for Brisbane, Australia, July 2017.

Author affiliations
1 La Trobe Sport and Exercise Medicine Research Centre, College of Science, Health and Engineering, La Trobe University, Melbourne, Victoria, Australia
2 Department of General Practice, Erasmus MC University Medical Center, Rotterdam, The Netherlands
3 Centre for Musculoskeletal Research, University of Manchester, Manchester, UK
4 Department of Health Professions, Manchester Metropolitan University, Manchester, UK
5 School of Health and Rehabilitation Sciences, The University of Queensland, Melbourne, Victoria, Australia
6 Research Unit for General Practice in Aalborg and Department of Clinical Medicine, Aalborg University, Aalborg, Denmark

Twitter Follow Christian Barton at @DrChrisBarton

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