Systematic Review

The effectiveness of post-operative rehabilitation following partial meniscectomy of the knee

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Background: Injuries to the menisci of the knee are a common cause of impairment and functional disability. The prevalence of meniscal injury ranges from 19 to 56% depending on the population studied. Arthroscopic surgery to the meniscus may be required if conservative care has failed. There is still controversy as to the need for routine post-operative rehabilitation to improve function and reduce impairments.

Objectives: The purpose of this paper was to systematically review the literature that evaluated the effectiveness of post-operative exercise programmes to improve function and reduce impairments following partial meniscectomy of the knee.

Methods: A computerized electronic search was performed across seven databases to locate relevant studies. Inclusion criteria consisted of studies that were randomized controlled trials, published in English, in patients who were prescribed exercise programmes and where function and impairment measures after knee arthroscopy were measured. The PEDro tool was used to rate the methodological quality of the studies. Four reviewers independently reviewed the studies.

Results: The database search revealed 319 studies. Twelve studies met the inclusion criteria. The methodological quality of the studies indicated that the level of evidence was limited. There were consistent methodological flaws in assessor blinding, treatment delivery and participant blinding. Significant variation across the interventions in a range of parameters was observed.

Conclusions: There is limited evidence of low to moderate quality for the effectiveness of exercise rehabilitation following partial meniscectomy. Supervised clinic and structured home based programmes are equally effective. Future studies need to address the consistency of exercise interventions and functional outcome measurements and follow-up time frames.

Keywords: Knee arthroscopy, Exercise, Rehabilitation, Physiotherapy, Systematic review

Introduction

Injuries to the menisci of the knee are a common cause of impairment and disability\(^1\)\(^2\) and the costs associated with the treatment and rehabilitation of knee injuries including the meniscus are substantial\(^5\)\(^6\). The prevalence of meniscal injuries varies depending on the population of interest. Englund \textit{et al.}\(^1\) demonstrated a prevalence of 19–56% for middle aged men and women who had a meniscal injury and that these were often associated with osteoarthritis (OA) of the knee joint. In the sporting population, a study by Keene \textit{et al.}\(^2\) reported that 43% of patients with anterior cruciate ligament injuries had an associated meniscal tear.

Strength deficits, altered functional performance, reduced ambulation as well as pain, locking and giving way in the knee have all been observed following meniscal injury.\(^1\)\(^7\) As the menisci of the knee are largely avascular, lesions are not always capable of healing and arthroscopic surgery, particularly partial meniscectomy, is indicated if symptoms persist following a period of conservative management.\(^5\)\(^8\)\(^9\) Despite undergoing this procedure, there are a number of studies that have reported ongoing impairments of the knee in this group of patients. Gapeyeva \textit{et al.}\(^7\) demonstrated that inhibition of quadriceps activity due to effusion, pain, and surgical damage results in muscle atrophy and reduced strength. Deficits in quadriceps strength ranging from 20 to 40% have been reported at 3 weeks post-meniscectomy but also as long as 4 years post-operatively.\(^4\)\(^10\)\(^12\)

Strength deficits in the knee have been associated with OA in the knee. It has been suggested that muscular dysfunction results in reduced shock absorption across the knee joint and that this, combined with an impaired function of the post-operative meniscus to transmit load.
through the joint, is a major reason for the development of OA. In a review of the role of muscle weakness in the development of OA, Hurley commented that quadriceps weakness may predict radiographic arthritic changes and that muscle weakness occurs before the development of the arthritic changes. These findings indicate the importance of restoring muscle function following partial meniscectomy to limit the development of long-term degenerative change and functional loss; however, the effectiveness of post-operative rehabilitation exercise programmes, particularly those led by physiotherapy, to reduce impairment and/or to improve function, in either the short or long term remains unclear.

A critical review of randomized controlled trials (RCTs) undertaken in 2001 by Goodyear-Smith and Arroll evaluated various post-operative rehabilitation regimes including physiotherapy led programs. The authors of this review commented that limited conclusions could not be drawn regarding the efficacy of post-operative rehabilitation regimes due to the weak methodologies of the reviewed studies. However, they did recommend that simple analgesic medication for 1 to 2 days post-operatively alongside a well planned home exercise programme is sufficient to achieve appropriate post-operative outcomes.

In 2003, a New Zealand accident insurance company, the Accident Compensation Corporation, produced an evidence based guideline for the management of soft tissue injuries to the knee. This guideline recommended that physiotherapy post-arthroscopic meniscectomy was not routinely advocated except perhaps in subgroups of patients such as elite athletes who require a more rapid return to sports. The guideline graded the recommendation as A level or ‘good quality’ but this quality grading was based on the review by Goodyear-Smith and Arroll, which quite clearly stated that the evidence at that time was of limited quality and not conclusive. Subsequent to Goodyear-Smith and Arroll’s review, a number of further studies in this area have been undertaken.

Therefore, the aim of this paper was to undertake a systematic review to critically evaluate studies that have examined the effectiveness of post-operative rehabilitation exercise regimes to restore function and/or to reduce impairments following partial meniscectomy of the knee.

**Methodology**

**Literature search strategy**

A search to identify literature relevant to the exercise rehabilitation of patients following partial meniscectomy was conducted using the electronic databases subscribed to by Auckland University of Technology. These included MEDLINE, SPORTDiscus, CINAHL, Health Source: Nursing/Academic Edition, Biomedical Reference Collection & MESH headings.

The keywords used in isolation or combinations were: knee, arthroscopy OR meniscectomy, rehabilitation* OR exercise* OR ‘physical therapy’* OR physiotherapy*, RCT OR random*.

The search was limited to studies written in or translated to English and carried out on human participants. The search was performed in November 2010, and there was no limitation regarding publication date. The references of each paper were also reviewed in order to identify any other relevant studies that might have been missed with the database search.

**Study selection**

**Inclusion criteria**

The following criteria were used to include or exclude retrieved studies:

- **study design**: RCTs comparing two or more exercise interventions relating to the efficacy of post-operative rehabilitation following arthroscopic meniscectomy or partial meniscectomy;
- **type of participant**: participants had to be over the age of 16 years, with isolated meniscal injuries and no coexisting musculoskeletal or underlying rheumatologic, neurological, cardiovascular, or congenital conditions affecting the lower limbs;
- **type of intervention**: trials in which at least one of the interventions was exercise prescribed, administered or supervised by a physiotherapist;
- **outcome measures**: to include at least one of the following: functional outcome measures via a questionnaire or other stated measure of function such as walking, vertical jump or hop, return to work and/or sport status, return to pre-injury or pre-surgery level of activity. Other measures of impairment such as pain rating (e.g. visual analogue scale), swelling, and range of motion (ROM), muscle strength, activation and endurance were also included.

**Data extraction**

Two authors (JR and DR) extracted the data from the selected studies. These data were tabulated under the headings study design, intervention, outcome measures and main findings. Where possible pre- and post-intervention means and standard deviations for the outcome measures were extracted and effect sizes calculated. The effect size is often used to measure the magnitude of a treatment effect. Cohen has defined effect sizes as ‘small’ (0.2), ‘medium’ (0.5)’ and ‘large’ (0.8).

**Review and analysis of methodological quality**

The PEDro scale was utilized to assess each paper. This scale is an 11-item scale developed to rate the methodological quality of RCTs evaluating physical therapy interventions, and is a validated tool. An overall score of methodological quality (quality score) was determined for each paper by the reviewers as a total of scores of 10 of the 11 items. Item one relates to the external validity and is not used to calculate the PEDro score. The various items of the PEDro scale relate to differing aspects of RCT.
analysis including internal and external validity, statistical analysis and generalizability. All four authors independently assessed the studies using this scale. Any discrepancies in the scores were discussed and a final score agreed by mutual decision.

van Tulder et al.\textsuperscript{23} recommends the analysis specifically of internal validity to make quantitative analysis of an evidence base. Maintenance of internal validity is crucial for the ability of a study to show a cause and effect relationship between variables while defending against source of bias. The PEDro scale contains seven items that relate to internal validity (items 2, 3, 5, 6, 7, 8, and 9).

Because of a lack of homogeneity of the included studies, a meta-analysis to provide an overall effect estimate was not appropriate;\textsuperscript{23} however, Ellis et al.\textsuperscript{24} and Reid and Rivett\textsuperscript{25} have suggested that when a review consists of heterogeneous studies that the scores for the items related to internal validity can be added to allow a qualitative assessment of the evidence. Thus, an internal validity score (IVS) was calculated for each study by adding the seven items of the PEDro scale that relate to internal validity. The following levels of evidence were used to interpret the overall strength of the evidence:\textsuperscript{24,25}

- level 1: strong evidence — when provided by generally consistent findings in multiple RCTs of high quality (IVS=6–7);
- level 2: moderate evidence — when provided by generally consistent findings in one RCT of high quality (IVS=6–7) and one or more lower quality RCTs (IVS \leq 5);
- level 3: limited evidence — when provided by generally consistent findings in one RCT of moderate quality (IVS=4–5) and one or more low quality RCT (IVS \leq 3);
- level 4: insufficient evidence — when provided by generally consistent findings of one or more RCTs of limited quality (IVS \leq 3), no RCTs available, or conflicting results.

‘Consistent findings’ were defined as >75% of the trials reporting the same trend in findings across each of the main variables.\textsuperscript{26}

**Results**

**Selection of studies**

The search yielded 319 potentially eligible studies. Following the exclusion process 12 RCTs met the selection criteria (see Fig. 1).
**Methodological quality**

The methodological quality of each paper, as assessed by the PEDro and IVS rating scales, are detailed within Table 1. The mean quality score for the reviewed studies was 6.3/10 (range 5–8). All of the studies reviewed satisfied the items of the PEDro scale relating to random allocation of subjects, the results of between group comparisons being present for at least one key outcome, and both point measures and measures of variability for at least one key outcome. In addition, all of the studies ensured that groups were similar at baseline in regard to important prognostic indicators, demonstrating control for this potential form of bias. However, all 12 RCTs failed to meet criteria 5 and 6, relating to subject and therapist blinding and only four studies met the criteria for assessor blinding. Only five studies dealt with drop-outs via an intention to treat analysis.

There was limited, or level 3 evidence, for the effectiveness of post-operative rehabilitation to improve function and reduce impairment following partial meniscectomy. This result is based on the qualitative scoring system above whereby five studies were of moderate quality (IVS ≥ 4) and seven where of low quality (IVS < 3) (see Table 1). Fifty per cent of the studies were in favour of the intervention and 50% concluded no difference between the intervention group and the control. Therefore, overall the literature reviewed did not meet the 75% or more consistent trend in findings favouring the intervention or control.

**Effect size**

The effect sizes for key variables in the reviewed studies ranged from a small effect (0.27) to a large effect (2.4) for the intervention groups. The effect size for at least one main outcome could only be calculated for six of the 12 studies due to the means and standard deviations of key measurement outcomes not being presented in such way to allow calculation of the effect size (see Table 2). Therefore no recommendations can be made regarding the magnitude of the treatment effect.

**Study characteristics**

The key characteristics of the studies are displayed in Table 2.

**Participants**

A total of 665 participants were recruited in the trials. The participants were recruited directly from the surgical list except for those participants in Ericsson et al.’s study who were recruited between 1 and 6 years post-arthroscopy. The mean age of participants ranged from 32.1 to 47.1 years with a range between 16 and 65 years. The greater majority of these participants were males (range 55–100%).

**Interventions**

The majority of the studies (11/12) were designed to compare a structured physiotherapy programme in an inpatient hospital department with a home exercise programme. The duration of the programmes ranged from 1 to 16 weeks (mean = 4.0; SD = 4). The overall result indicates structured programmes were equally as effective as the home exercise programme.

The exercise programmes across the studies were highly variable. Some were standard post-operative programmes (that were not described in the studies) while others were broad programme concepts (such as functional programmes), and others contained detailed sets and repetitions of key exercises per day. The main intent of the programmes was to restore muscle strength via progressive resisted exercises to the quadriceps and hamstrings, and ROM to the knee joint via active movement or cycling. The lack of detail in conjunction with the types of intervention provided meant that quantitative analysis was unable to be performed. Similarly, a qualitative comparison across the programmes was challenging.

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**Table 1 PEDro scores of randomized controlled trials investigating the efficacy of post-operative exercise rehabilitation following partial meniscectomy**

<table>
<thead>
<tr>
<th>Study</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>Total (QS/10)</th>
<th>IVS (7)</th>
</tr>
</thead>
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<tr>
<td>Goodwin et al. (2003)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Birch et al. (1993)</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Kelin et al. (2009)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>0</td>
<td>0</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Vervest et al. (1999)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>7</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Moffett et al. (1994)</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>0</td>
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<td>0</td>
<td>1</td>
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<td>7</td>
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</tr>
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<td>0</td>
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<td>1</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>3</td>
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<tr>
<td>St-Pierre et al. (1992)</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Jokl et al. (1989)</td>
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<td>1</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>3</td>
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<tr>
<td>Levitt et al. (1995)</td>
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<td>1</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
<td>1</td>
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<td>3</td>
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<tr>
<td>Williams et al. (1986)</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>1</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Forster and Frost (1982)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>3</td>
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<tr>
<td>Kinnap et al. (2005)</td>
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<td>1</td>
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<td>1</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>2</td>
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</tbody>
</table>

**Note:** IVS, internal validity score; QS, quality score.
<table>
<thead>
<tr>
<th>Author</th>
<th>Participant demographic</th>
<th>Intervention</th>
<th>Control</th>
<th>Outcome measures</th>
<th>ES Exp and Cont</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goodwin et al. (2003)</td>
<td>N=84</td>
<td>N=44</td>
<td>N=40</td>
<td>Hughston Clinic Questionnaire, SF-36, EuroQol EQ-5D, number of days to return to work, kinematic analysis of knee function, horizontal and vertical hop</td>
<td>Insufficient data to calculate ES</td>
<td>No significant differences found between groups for any outcome measure</td>
</tr>
<tr>
<td>Birch et al. (1993)</td>
<td>N=120</td>
<td>Two intervention arms</td>
<td>N=47</td>
<td>Noyes Knee Rating Questionnaire</td>
<td>Exp PT=2.27</td>
<td>No significant differences between groups at follow-up</td>
</tr>
<tr>
<td>Kelln et al. (2009)</td>
<td>N=31</td>
<td>Stationary cycling for six sessions over 2 weeks and home programme</td>
<td>N=16</td>
<td>Knee ROM and girth measures, gait evaluation, self-report questionnaires (IKDC)</td>
<td>Cont=1.97</td>
<td>Significant improvements in gait measures in the intervention group</td>
</tr>
<tr>
<td>Vervest et al. (1999)</td>
<td>N=20</td>
<td>Nine treatments of 30 minutes over 3 weeks consisting of standard treatment and exercise therapy based on dynamic protocol</td>
<td>N=10</td>
<td>Pain (VAS), Tegner and Lysholm scores, jump height and length, satisfaction with treatment, SARS, factor occupational rating scale</td>
<td>Exp=1.7</td>
<td>Significantly better results in horizontal, vertical jump heights SARS for the intervention group at days 14, 21, and 28.</td>
</tr>
<tr>
<td>Moffett et al. (1994)</td>
<td>N=31</td>
<td>N=15</td>
<td>N=16</td>
<td>Maximal isokinetic strength (dynamometer), clinical measures of knee ROM, thigh atrophy, knee effusion, and pain, Lysholm score, Quiklqist scoring scale</td>
<td>Insufficient data to calculate ES</td>
<td>Significant difference in isokinetic strength in the intervention group.</td>
</tr>
<tr>
<td>Author</td>
<td>Participant demographics</td>
<td>Intervention</td>
<td>Control</td>
<td>Outcome measures</td>
<td>No differences between groups in other outcome measures</td>
<td>ES Exp and Cont</td>
</tr>
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<td>-------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Ericsson, et al. (2009)</td>
<td>100% male Supervised physiotherapy consisting of strengthening and a standardized home exercise programme over 3 weeks</td>
<td>Mean age 39.9 N=25</td>
<td>No intervention</td>
<td>Functional performance tests (one-leg hop, one-leg rise, squat jump), end stage knee osteoarthritis outcome score</td>
<td>One legged hop</td>
<td>Exp=0.08</td>
</tr>
<tr>
<td>St-Pierre, et al. (1992)</td>
<td>66% male Supervised functional exercise training 3x a week for 4 months</td>
<td>Mean age 45.7 N=8</td>
<td>No intervention</td>
<td>Isokinetic strength of quadriceps and hamstrings at differing velocities via dynamometer</td>
<td>One legged hop</td>
<td>Exp=0.06</td>
</tr>
<tr>
<td>Jokl, et al. (1989)</td>
<td>81% male Supervised outpatient physiotherapy 4-5 weeks</td>
<td>Mean age 35.8 N=15</td>
<td>Same protocol as intervention group, but delayed to 6 weeks post-operatively</td>
<td>Isokinetic knee strength (60, 120, 180° s⁻¹), range of motion, quadriceps circumference, Functional Questionnaire (degree of pain, swelling and limping, ability to climb stairs, return to work etc.)</td>
<td>No significant differences between early and late intervention groups at 2, 6, and 8 weeks post-operatively</td>
<td></td>
</tr>
<tr>
<td>Levitt, et al. (1995)</td>
<td>77% male Supervised outpatient physiotherapy 4-6 weeks</td>
<td>Mean age 32.1 N=28</td>
<td>Structured home exercise programme</td>
<td>Insufficient data to calculate ES</td>
<td>Insufficient data to calculate ES</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 Continued

<table>
<thead>
<tr>
<th>Author</th>
<th>Participant demographics</th>
<th>Intervention</th>
<th>Control</th>
<th>Outcome measures</th>
<th>No differences between groups in other outcome measures</th>
<th>ES Exp and Cont</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reid et al. Knee injury, meniscectomy, postoperative rehabilitation, physiotherapy</td>
<td>50% Physical Therapy Reviews 2012 Vol. 17 No. 1</td>
<td>Structured home exercise programme</td>
<td>Insufficient data to calculate ES</td>
<td>Insufficient data to calculate ES</td>
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<td>Insufficient data to calculate ES</td>
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</tbody>
</table>

Insufficient data to calculate ES.
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<thead>
<tr>
<th>Author</th>
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<th>Control</th>
<th>Outcome measures</th>
<th>ES Exp and Cont</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 males</td>
<td>Isometric quads + EMG biofeedback 3 × a day, 7 days a week for 2 weeks EMG part of home programme</td>
<td>Isometric quads exercises at home</td>
<td></td>
<td>Exp VL = 0.27</td>
<td>No difference in pain</td>
<td></td>
</tr>
<tr>
<td>Age 18–65</td>
<td></td>
<td></td>
<td></td>
<td>Cont VL = −0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Williams et al. (1986)37</td>
<td>N = 21</td>
<td>N = 13</td>
<td>N = 8 quads, hamstrings isometrics and isotonics without stimulation 3 × a week for 3 weeks</td>
<td>Quads torque and thigh girth via Biodex dynamometer</td>
<td>Exp VM = 0.32</td>
<td>Stimulation group significant increase in quads torque at all speeds and increased thigh girth compared to control</td>
</tr>
<tr>
<td>18 males</td>
<td>Isometric quads + electrical stimulation 5 days a week for 3 weeks</td>
<td></td>
<td></td>
<td>Cont VM = −0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age 18–45</td>
<td>Mean 33</td>
<td></td>
<td></td>
<td></td>
<td>Exp = 0.40</td>
<td></td>
</tr>
<tr>
<td>Forster and Frost (1982)35</td>
<td>N = 86</td>
<td>N = 44</td>
<td>N = 42</td>
<td>Knee ROM, quadriceps circumference, time taken to return to work, days lost from work, days lost through physiotherapy, gait impairment</td>
<td>Cont = 0.23</td>
<td>Insufficient data to calculate ES No significant differences between groups across outcome measures</td>
</tr>
<tr>
<td>100% males</td>
<td>Outpatient physiotherapy 3 × a week for 4 weeks and home programme</td>
<td></td>
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<tr>
<td>Aged between 16 and 45</td>
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</tr>
<tr>
<td>Kimnap et al. (2005)32</td>
<td>N = 40</td>
<td>N = 20</td>
<td>N = 20</td>
<td>MVC of VMO EMG, Lysholm knee score, knee ROM, knee, and thigh circumference</td>
<td></td>
<td>Significant improvement in intervention group in all outcome measures at 2 and 6 weeks</td>
</tr>
<tr>
<td>100% male</td>
<td>EMG biofeedback with home exercise programme 5 × per week over 2 weeks</td>
<td></td>
<td>Home programme without EMG biofeedback</td>
<td></td>
<td>Exp = 2.4</td>
<td></td>
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<tr>
<td>Mean age 34.5</td>
<td></td>
<td></td>
<td></td>
<td>Cont = 0.9</td>
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</tbody>
</table>

Note: EMG, electromyographic; ES, effect size; Exp, experimental group; Cont, control group; IKDC, International Knee Documentation Committee; N = number; NSAID, non-steroidal anti-inflammatory drug; PT, physical therapy; ROM, range of motion; SARS, sports activity rating scale; VAS, visual analogue scale; VL, vastus lateralis; VM, vastus medialis.
Control groups
All 12 RCTs compared the intervention with a control group. Control groups were either given a structured home programme to follow via verbal or written instruction. Only one study had a control group that did not undertake any sort of exercise programme.

Outcome measures
There was a wide range of functional outcome measures and impairment measures used across the studies. The functional outcome measurement instruments ranged from the knee injury and osteoarthritis outcome score, Lysholm knee score, the Noyes knee rating score, the International Knee Documentation Committee, and the SF-36. Other functional outcome measures such as the one-leg hop, horizontal or vertical hop were also used. Quality of life was measured in one study using the EuroQoL. With respect to measures of impairment these were commonly ROM, thigh girth, and pain. In the studies that measured strength changes as an outcome, this was most often undertaken using an isokinetic dynamometer. Again, this variability in measurement adds a challenge.

Discussion
This is the first systematic review undertaken to assess the effectiveness of post-operative exercise rehabilitation programmes on function and impairment. The previous critical review included only eight studies and these were not critiqued for methodological quality using an appraisal tool such as the PEDro. Only five of the eight studies in Goodyear-Smith and Arroll’s review met the inclusion criteria in the current review. The Accident Compensation Corporation knee guidelines did assess the level of evidence, but this was based on the above critical review. Results from the current review indicate that the level of evidence is limited (level 3) based on studies that were of moderate to low quality. Consistent methodological flaws in assessor blinding, treatment delivery and participant blinding were observed. There was significant variation across the interventions in a range of parameters such as functional outcome measures, programme delivery, impairment measurement and treatment duration. Therefore, despite further studies being undertaken since the review of Goodyear-Smith and Arroll, the finding of the current review remain consistent with this previous review.

Functional measurements
Eight of the 12 studies measured functional change via a questionnaire. Only three studies used the same questionnaire, the Lysholm knee score. Of the remaining nine studies, only three studies measured function via physical task such as hopping or vertical jump with two studies demonstrating a positive improvement in function. Both questionnaires and functional tasks are valid measurements of function however future research needs to consider improving the consistency of these functional outcome questionnaires and perhaps consider using questionnaires such as the Cincinnati Knee Rating System that include both physical testing as well as subjective information from the participants regarding functional change.

Measurement of impairment
Eight of the remaining nine studies, only three studies via a questionnaire. Only three studies used the remaining nine studies, only three studies measured impairments such as pain range of ROM and thigh girth. No significant differences were found in improvement of these impairments between the intervention and control groups of these studies.

Strength is a key impairment to address. As stated previously restoring muscle function following partial meniscectomy is important to limit the development of long-term degenerative change and functional loss. In 11 of the 12 studies reviewed, improvements in strength were achieved in both the intervention and control groups. In six of the reviewed studies an explicit measure of strength was used via an isokinetic dynamometer whilst others used EMG or thigh circumference as a measure of improved muscle activation. Of these studies, four found a positive effect on the intervention group compared to the control.

Few of the studies compared the strength measurements to the unaffected leg. This is common in other research related to the rehabilitation of knee injuries such as the anterior cruciate ligament. It is a frequent recommendation that a minimum of 85% of the strength of the unaffected leg is required before an athlete should return to sport. A comparison of the unaffected leg strength pre- and post-operatively with comparison to the operated limb would be of value in future studies.

Duration of programme and follow-up
The mean duration of the exercise programmes was 4 weeks (range 1–16 weeks). Follow-up for the interventions ranged from 2 weeks to 6 months post-intervention. This variation is significant as those programmes with a short duration of intervention and follow-up have little chance of seeing if strength and function are restored and/or if long-term arthritic changes occurred or are minimized. Evidence suggests that any improvements in strength during the initial 1–6 weeks of a strength training programme are as a consequence of improved neural activation and motor unit recruitment. Changes in muscle fibre via hypertrophy take much longer and require an alteration in loading parameters to the muscle.
Therefore, if full strength and muscle bulk and consequently function is to be restored then follow-up and programme delivery need to be longer than 6 weeks. Future strength programmes should include a strengthening regime reflecting high repetitions with low load for the first 6 weeks and then progress to low repetitions with increasing load for a further 6 weeks, to ensure muscle hypertrophy and appropriate functional change occurs.

**Structured versus home programmes**

Recommendations of the previous guidelines and review have suggested that physiotherapy is not routinely required post-meniscectomy for restoring function. However, results from the current review indicate that a supervised programme and a home programme are equally as effective. As home programme are usually set by a physiotherapist the 12 RCTs were in essence comparing different types of physiotherapy intervention with the home programme deemed the ‘control’. The implications of this are clarified by one study in the review that provided no home programme. This RCT demonstrated that the exercise group had a statistically significant improvement in function compared to the control group. Therefore, perhaps a more relevant conclusion is that well planned physiotherapy exercise programmes delivered either in a clinic setting or in the home setting are helpful for this population group.

In the review by Goodyear-Smith and Arroll, it was argued that clinic based therapy was more expensive to deliver than home based therapy. This is likely still the case; therefore, future studies may want to compare the effectiveness and cost effectiveness of a short burst of intensive physiotherapy supervision followed by a home programme and then regular monitoring and progression of that programme over an appropriate time frame. This type of study may help to address some of the cost effectiveness issues without reducing the effectiveness of the intervention. As stated above the need to ensure strength deficits and functional limitations are resolved is important to the future health of the person who has sustained a meniscal injury.

**Limitations**

There are a number of limitations of this review. A meta-analysis was not performed because there was large variability of the study design, the studies were of low to moderate quality and there was a lack of clearly defined and consistent dependent variables. While RCTs were indentified, we did not review unpublished studies, reports or PhD theses. The reviewers were not blinded to the affiliations of the published articles and only those studies written in English were reviewed.

**Conclusions**

There is limited evidence of low to moderate quality for the effectiveness of exercise rehabilitation on function following partial meniscectomy. A well structured physiotherapy prescribed home programme or supervised clinic based programme does demonstrate improvements in strength of the muscles surrounding the knee and functional gains within the first four to six weeks. However, it is unclear if the physiotherapy prescribed rehabilitation exercise interventions prevent the long-term consequences of meniscal injuries such as OA and/or subsequent total knee joint surgery. Further work in this area is required. In particular the consistency of treatment and follow-up time frames, the clarity of the exercise interventions, the time frames of the strengthening interventions, and conformity with functional outcome measures between researchers is required.

**References**

4. Reid et al. Knee injury, meniscectomy, post-operative rehabilitation, physiotherapy