Arthroscopic partial meniscectomy for meniscal tears of the knee: A systematic review and meta-analysis

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Keywords

knee; arthroscopy; meniscus; meniscectomy; arthroscopic; systematic review; meta-analysis; meniscal

Word count:

6641

ABSTRACT

OBJECTIVE

To assess the benefit of arthroscopic partial meniscectomy (APM) in adults with a meniscal tear and knee pain in three defined populations (taking account of the comparison intervention): (A) all patients (any type of meniscal tear with or without radiographic osteoarthritis); (B) patients with any type of meniscal tear in a non-osteoarthritic knee; (C) patients with an unstable meniscal tear in a non-osteoarthritic knee.

DESIGN

Systematic review and meta-analysis.

DATA SOURCES

A search of MEDLINE, Embase, CENTRAL, Scopus, Web of Science, Clinicaltrials.gov and ISRCTN was performed, unlimited by language or publication date (inception to 18/10/2018).

ELIGIBILITY CRITERIA

Randomised controlled trials performed in adults with meniscal tears, comparing APM versus (1) non-surgical intervention; (2) pharmacological intervention; (3) surgical intervention; (4) no intervention;

RESULTS

Ten trials were identified: seven compared to non-surgery, one pharmacological, two surgical. Findings were limited by small sample size, small number of trials and cross-over of participants to APM from comparator interventions.
In group A (all patients) receiving APM versus non-surgical intervention (physiotherapy), at 6-12 months there was a small mean improvement in knee pain (SMD 0.22 [95% CI 0.03 to 0.40]; 5 trials, 943 patients; I^2 48%; GRADE: Low), knee specific quality of life (SMD 0.43 [95% CI 0.10 to 0.75]; 3 trials, 350 patients; I^2 56%; GRADE: Low), and knee function (SMD 0.18 [95% CI 0.04 to 0.33]; 6 trials, 1050 patients; I^2 27%; GRADE: Low). When the analysis was restricted to people without osteoarthritis (group B), there was a small to moderate improvement in knee pain (SMD 0.35 [95% CI 0.04 to 0.66]; 3 trials, 402 patients; I^2 58%; GRADE: Very low), knee specific quality of life (SMD 0.59 [95% CI 0.11 to 1.07]; 2 trials, 244 patients; I^2 71%; GRADE: Low), and knee function (SMD 0.30 [95% CI 0.06 to 0.53]; 4 trials, 507 patients; I^2 44%; GRADE: Very low). There was no improvement in knee pain, function, or quality of life in patients receiving APM compared to placebo surgery at 6-12 months in group A or B (Pain: standardised mean difference, SMD, 0.08 [95% CI -0.24 to 0.41]; 1 trial, 146 patients; GRADE: Low; Function: SMD -0.08 [95% CI -0.41 to 0.24]; 1 trial, 146 patients; GRADE: High; Quality of Life: SMD 0.05 [95% CI -0.27 to 0.38]; 1 trial; 146 patients; GRADE: High). No trials were identified for people in group C.

CONCLUSION

Performing APM in all patients with knee pain and a meniscal tear is not appropriate and surgical treatment should not be considered the first-line intervention. There may, however, be a small-to-moderate benefit from APM compared to physiotherapy for patients without osteoarthritis. No trial has been limited to patients failing non-operative treatment

or patients with an unstable meniscal tear in a non-arthritic joint; research is needed to establish the value of APM in this population.

PROSPERO CRD42017056844

What is already known on this topic

- Arthroscopic partial meniscectomy (APM) is one of the most commonly performed surgical procedures worldwide and rates have risen, particularly in older age groups susceptible to degenerative knee disease.
- Previous systematic reviews have demonstrated undifferentiated knee arthroscopy (lavage, debridement, and/or APM) performed for pain associated with degenerative knee disease is ineffective. The effectiveness of APM specifically, in patients stratified according to the important clinical and radiological patient selection factors, is unknown.

What this study adds

- This systematic review indicates that surgical treatment should not be the first-line treatment intervention for patients with a meniscal tear.
- APM provides a small improvement in all people, and small to moderate improvement in those without osteoarthritis, from reduction in pain and improvement in function and quality of life, compared to physiotherapy, but the clinical importance of these improvements is uncertain.
- Patients meeting the latest, strict, clinical and radiological selection criteria for APM are not represented by the current evidence and no study has been limited to patients who have failed non-surgical treatment. There is an urgent need for trial evidence in this group to inform clinical guidelines and practice.

INTRODUCTION

The meniscus is a fibrocartilaginous structure within the knee joint and is important for load distribution and knee stability.[1,2] More than one third of people over the age of 50 without any radiographic evidence of osteoarthritis have meniscal pathology detectable on MRI imaging, rising to over 60% for individuals with osteoarthritis.[3] Meniscal tears may be stable or unstable mechanically and may be symptomatic or asymptomatic.[3–6] When a meniscal tear is considered the cause of symptoms, surgical treatment to excise the unstable meniscal tissue is frequently recommended.[7] This procedure, arthroscopic partial meniscectomy (APM), has become the most commonly performed orthopaedic surgical procedure worldwide and approximately two million cases are performed each year, with combined costs of several billion US dollars.[8]

Although the rate of knee arthroscopy being performed for osteoarthritis has decreased over the last twenty-years, there has been an overall increase in the rate of APM being performed in patients (with or without osteoarthritis) over the same period.[9–14] The intervention rate has been challenged following the publication of recent clinical effectiveness studies, especially as meniscectomy is not an entirely benign procedure and may be associated with rare but serious complications.[15–20] Some have recommended against arthroscopy in “nearly all patients” with “degenerative knee disease” and suggest that further research is not required.[21] However, given the heterogeneity of the population, others have highlighted the importance of patient selection criteria to achieve treatment success with APM, as symptoms may often be caused by an underlying degenerative process and not the meniscal tear.[3,22,23] In this situation, symptoms would not be expected to be relieved by APM and surgery should only be targeted at meniscal tears that are believed to be the direct cause of pain.[23,24] However, does any evidence exist to suggest that treatment in the latter case would be effective or ineffective?

There is international consensus from specialist knee societies regarding the patient selection factors which are important in the management of patients with meniscal tears in contemporary practice.[23,25] Arthroscopy in patients with significant or end-stage osteoarthritis is not advised.[23,25] APM is now only recommended in patients with an ‘unstable’ pattern of meniscal tear visible on magnetic resonance imaging (MRI) that corresponds with meniscal (‘mechanical’) type symptoms.[23,25] Furthermore, the current recommendation is that in nearly all cases, APM should only be performed in patients who have failed a period of non-surgical treatment.[18,23,26] Previous systematic reviews have evaluated undifferentiated ‘arthroscopy’ (combining lavage, debridement, and APM trials)

for the degenerative knee.[16,27–29] This evidence supports the current view that this approach to treatment is outdated and no longer recommended.[23,25] Nevertheless, specifically for APM, there appears to be some conflict when considering published guidelines: on one side, the view that APM in the right patient is effective, and on the other, the view that APM in all patients with degenerative meniscal tears is ineffective.[21,23]

In light of the differing views and the impact of this clinical condition on such a large number of patients, there is a need to appraise the evidence for APM in the management of meniscal tears with specific emphasis on areas of uncertainty.[30] The aim of this systematic review is to analyse the current evidence regarding the comparative effectiveness of APM with stratification by comparator intervention and the key clinical and radiological assessment criteria.

METHODS

This systemic review was conducted following the methods of the Cochrane Handbook for Systematic Reviews and reported in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) statement.[31,32] The protocol for this review was published on PROSPERO (CRD42017056844) on 22/02/2017.

Study eligibility criteria

Participants

We included studies of adults (18 years of age and older) with meniscal tears of the knee. We excluded studies of individuals with other injuries to the knee (e.g. ACL ligament injury, fracture), previous surgery to the knee (e.g. ligament reconstruction, arthroscopy) or anatomical variants (e.g. discoid meniscus).

Three population groups with knee pain and a meniscal tear were considered: (A) all patients (any type of meniscal tear with or without radiographic osteoarthritis); (B) patients with any type of meniscal tear in a non-osteoarthritic knee; (C) patients without osteoarthritis and with an unstable meniscal tear as defined by symptoms (meniscal or 'mechanical' symptoms – author definition) and the pattern of the meniscal tear on MRI imaging (author definition). These groups were defined based upon consensus statements summarising the important stratification factors relevant to patients with meniscal tears, where group (C) represents the 'ideal candidate' for APM.[23] Severity of osteoarthritis is recognised as a key selection factor and, in accordance with published consensus, osteoarthritis was defined radiographically as Kellgren-Lawrence grade 2 or greater changes on a plain x-ray radiograph of the knee (or equivalent).[16,23,33] Although mechanical symptoms and unstable meniscal tears have been defined and investigated by several groups, there remains some variability in published definitions.[4,23,34–37] Therefore, for the purposes of this review, study author definitions of these terms were accepted for inclusion in group (C). Table 1 summarises the characteristics of the three population groups considered.

Intervention

We included studies of APM as the primary intervention. We excluded studies of open or 'total' meniscectomy.

Comparators

We included studies with the following comparators, which were analysed separately: (1) Non-surgical (e.g. physiotherapy, exercise therapy); (2) Pharmacological (e.g. NSAIDS, intra-articular steroid injection); (3) Surgical (e.g. arthroscopic lavage, diagnostic arthroscopy, sham surgery, placebo surgery); (4) No intervention (e.g. waiting list, active monitoring). We excluded studies with other surgical intervention comparators (e.g. open meniscectomy, meniscal repair, allograft or implant transplantation, chondroplasty). Placebo surgery was defined as diagnostic arthroscopy with omission of partial meniscectomy as the 'critical element'.[24] Sham surgery was defined as a procedure requiring an anaesthetic and surgical skin incision but without any knee arthroscopy procedure (diagnostic, washout, other) being performed.

Outcomes

The primary outcomes assessed were knee function and knee pain, as measured using a validated patient-reported outcome measure (PROM) (e.g. Lysholm knee scale, Knee injury and Osteoarthritis Outcome Score [KOOS] pain scale, respectively).[38] Secondary outcomes assessed, where reported, were knee-specific quality of life (e.g. KOOS quality of life, Western Ontario Meniscal Evaluation Tool [WOMET]) and generic health-related quality of life (e.g. EuroQol five dimensions questionnaire [EQ-5D]), presence of knee 'mechanical symptoms' (e.g. sub-domain Lysholm or Meniscal Symptom Index); and activity level (e.g. Tegner); and number of individuals requiring repeat surgery (e.g. further arthroscopy, knee replacement); number of individuals developing complications (e.g. venous thromboembolism, infection, mortality). Outcomes were assessed at 6 to 12 months (mid-term) follow up. If both 6- and 12-month data were reported, the 12-month data was included in the meta-analysis. In addition, analysis of early (under 6 months) and long term (over 12 months) outcome was performed where data were available.

Information sources and search strategy

A search of MEDLINE, Embase, CENTRAL, Scopus and Web of Science was performed (24/03/2017 and updated 12/04/2018; 18/10/2018), unlimited by language or publication date. The search was designed and performed by an independent librarian; full details are available in Appendix 1. Clinical trial registries (clinicaltrials.gov and ISRCTN) were searched to identify ongoing and recently completed studies. Randomised controlled trials (RCTs) including quasi-randomised) were eligible for inclusion. Cohort studies with a comparator group were also identified but not included in the meta-analysis. When no trial was identified (group C) the cohort evidence was reviewed in this context.

Study selection and data extraction

The title and abstract of the search results was screened by two authors (SA and AM/LB). The full text articles were retrieved for all studies meeting the inclusion criteria. Where there was disagreement on inclusion of a study based on the title and abstract, the full text article was retrieved, and inclusion decided by consensus.

Data were extracted using a previously piloted data extraction form. Data items extracted included study design, study centres and location, length of follow up, funding source and conflicts of interest, inclusion and exclusion criteria, number of randomised participants, number lost to follow up, number analysed, baseline demographics including age and gender, details of the intervention and comparator delivered. Final value outcome data were extracted for the primary and secondary outcomes.

Risk of bias

Studies meeting the inclusion criteria were formally evaluated for risk of bias using the Cochrane 'risk-of-bias tool', assessing for selection bias, performance bias, detection bias, attrition bias, reporting bias, other bias (including baseline imbalance and cross-over).[39] Two authors (SA and SH) assessed each of the included studies and each potential source of bias was graded as high, low or unclear risk of bias; any disagreements were resolved by consensus.[39]

Data synthesis

Meta-analyses were undertaken where studies were considered sufficiently clinically and methodologically similar and reported for the relevant population group. Where studies met criteria for inclusion but published data was inadequate for meta-analysis, study authors were contacted to request appropriate summary or raw data for inclusion. In addition, unpublished sub-group data was requested from the authors of included studies. Data were analysed separately to compare the effects of APM versus each of the main comparator interventions: (1) Non-surgical (e.g. physiotherapy, exercise therapy); (2) Pharmacological (e.g. NSAIDS, intra-articular steroid injection); (3) Surgical (e.g. arthroscopic lavage, diagnostic arthroscopy, sham surgery, placebo surgery); (4) No intervention (e.g. waiting list, active monitoring).

The standardised mean difference (SMD) with 95% confidence intervals (CIs) was used to pool the results of individual trials for continuous outcomes measured using different scales. When interpreting the magnitude of effects

using SMD, we used the index thresholds recommended by Cohen.[40] The mean difference (MD) and 95% CIs were used for pooling continuous outcomes measured using the same scale. When considered appropriate, we used a random effects model to pool for results of comparable groups of trials in a meta-analysis. Scales were transformed if required to ensure that a higher score indicated a better outcome. If the standard deviation (SD) or mean was not reported in the original article, where possible, it was calculated from the reported data, obtained directly from the study authors, or estimated using established methods.[31,41]

Summary of findings tables

A Summary of Findings table was constructed for the two comparisons with more than one trial: APM versus Non-surgical intervention (physiotherapy), and versus Surgical intervention (placebo surgery, sham surgery). The outcomes included were: knee function, knee pain, knee-specific quality of life, and generic quality of life. GRADE (Grading of Recommendations Assessment, Development and Evaluation) considerations (risk of bias, consistency of effect, imprecision, indirectness, publication bias) were assessed and used to summarise the quality of the study evidence that contributed data to each outcome.[42]

RESULTS

The search strategy identified 1854 unique articles for screening. After screening, 34 full text articles were retrieved of which 20 articles (reporting 11 studies) were eligible for evaluation. Ten studies were RCTs (published in 19 articles) and one was a cohort study (1 article). The study selection process is summarised in the PRISMA flow diagram (Figure 1). Excluded studies are listed in Appendix 2. Unpublished data were requested from the authors of all included studies for inclusion in Group B or Group C, with data subsequently provided for Group B by the authors of four studies (Gauffin 2014; Kise 2016; Roos 2018; Van de Graaf 2018).[43–46] The search of clinical trial registries identified three ongoing studies (Appendix 3).[47–51]

Seven RCTs (Herrlin 2007; Katz 2013; Osteras 2012; Yim 2013; Gauffin 2014; Kise 2016; Van de Graaf 2018) compared the effects of APM versus non-surgical interventions.[43,44,46,52–55] One RCT (Vermesan 2013) compared the effects of APM versus pharmacological interventions.[56] Two RCTs (Sihvonen 2013; Roos 2018) compared the effects of APM versus surgical interventions.[44,45] No studies were identified comparing the effects of APM versus no intervention. The characteristics of the included studies are summarised in Table 2. Full details of the inclusion, exclusion criteria, delivery of the intervention and comparator interventions, location and funding are included in Appendix 4

(1) Arthroscopic partial meniscectomy versus non-surgical interventions

Study characteristics

Eight studies (7 RCTs and one cohort study) were identified, including a total of 1186 participants randomised with a mean age of ranging from 47 to 58 years.[43,44,46,52–55] All RCTs included a physiotherapy comparator (intervention delivered for between 6 weeks and 3 months) with follow-up ranging from 3 months to 60 months (Table 2). All seven RCTs were eligible for analysis in group A; data from four RCTs (after receipt of unpublished data) excluding patients with osteoarthritis were eligible for analysis in group B.

Risk of bias

All seven RCTs were rated at high risk of performance and detection bias due to a lack of blinding. The method of random sequence generation was unclear in four RCTs and allocation concealment was unclear in four (Table 2). One

RCT was rated at high risk of attrition bias due to greater than 10% loss to follow up. Five were rated at high risk of bias due to cross-over rates exceeding 10% of non-surgical participants (other bias) (Table 2).

Knee Pain

(A) All patients (any type of meniscal tear with or without radiographic osteoarthritis)

There was a small improvement in knee pain following APM compared to physiotherapy at 6-12 months (SMD 0.22 [95% CI 0.03 to 0.40]; 5 trials, 943 patients; I^2 48%; GRADE: Low) (Figure 2A). This is the equivalent of a mean difference (MD) of 4.10 KOOS [0.74 to 7.46], measured using the KOOS pain scale, where the MCID is estimated to be around 8-10.[57,58] There was no difference at under 6 months (SMD 0.18 [95% CI -0.00 to 0.37]; 2 trials, 434 patients; I^2 0%; GRADE: Very low) but a small improvement at over 12 months (SMD 0.22 [95% CI 0.04 to 0.40]; 3 trials, 484 patients; I^2 0%; GRADE: Very low) (Table 3; Appendix 5).

(B) Patients with any type of meniscal tear in a non-osteoarthritic knee

There was a small to moderate improvement in knee pain following APM compared to physiotherapy at 6-12 months (SMD 0.35 [95% CI 0.04 to 0.66]; 3 trials, 402 patients; I^2 58%; GRADE: Very low) (Figure 2B). This is the equivalent of a mean difference (MD) of 6.91 [95% CI 2.87 to 10.94]; measured using the KOOS pain scale, where the MCID is estimated to be around 8-10.[57,58] There was also no difference at under 6 months (SMD 0.16 [95% CI -0.25 to 0.57]; 2 trials, 306 patients; I^2 68%; GRADE: Very low) or over 12 months (SMD 0.21 [95% CI 0.00 to 0.42]; 3 trials, 368 patients; I^2 0%; GRADE: Very low) (Table 3; Appendix 5).

(C) Patients with an unstable meniscal tear in a non-osteoarthritic knee

One cohort study was identified in patients undergoing physiotherapy, with patients still complaining or unsatisfied on completion of treatment being offered APM.[59] This cohort reported failure of physical therapy in all 50 included patients after a period of 8 weeks due to no significant change in visual analogue pain scores (VAS). All 50 patients subsequently opted to undergo APM and a significant improvement in patient-reported pain was reported at average 12.5 months follow-up.

Knee Function

(A) All patients (any type of meniscal tear with or without radiographic osteoarthritis)

There was a small improvement in knee function following APM versus non-surgical treatment at 6-12 months (SMD 0.18 [95% CI 0.04 to 0.33]; 6 trials, 1050 patients; I^2 27%; GRADE: Low) (Figure 3A), equivalent to a MD 3.36 [95% CI 0.55 to 6.16], measured using the Lysholm scale, where the MCID is estimated to be around 8-10 as measurement properties are similar to KOOS.[57,58,60] There was no difference at under 6 months (SMD 0.08 [95% CI -0.08 to 0.25]; 4 trials, 561 patients; I^2 0%; GRADE: Low) but a small improvement at over 12 months (SMD 0.18 [95% CI 0.04 to 0.33]; 5 trials, 730 patients; I^2 0%; GRADE: Low) (Table 3; Appendix 5).

(B) Patients with any type of meniscal tear in a non-osteoarthritic knee

There was a small to moderate improvement in knee function following APM versus non-surgical treatment at 6-12 months (SMD 0.30 [95% CI 0.06 to 0.53]; 4 trials, 507 patients; I^2 44%; GRADE: Very low) (Figure 3B), equivalent to a MD of 5.31 [95% CI 1.12 to 9.51], measured using the Lysholm scale, where the MCID is estimated to be around 8-10 as measurement properties are similar to KOOS.[57,58,60] There was also no difference at under 6 months (SMD 0.11 [95% CI -0.13 to 0.35]; 3 trials, 411 patients; I^2 33%; GRADE: Low) but a small improvement at over 12 months (SMD 0.19 [95% CI 0.01 to 0.36]; 4 trials, 501 patients; I^2 0%; GRADE: Low) (Table 3; Appendix 5).

(C) Patients with an unstable meniscal tear in a non-osteoarthritic knee

One cohort study was identified with patients undergoing a physiotherapy programme, with patients still complaining or unsatisfied after completion of this treatment being offered APM.[59] In this study, the authors defined an unstable meniscal tear using previously published MRI based radiological criteria and also corresponding positive McMurray test on clinical examination.[4,59] This cohort reported failure of physical therapy in all 50 included patients after a period of 8 weeks due to no significant change in function (Lysholm knee scale). All 50 patients subsequently opted to undergo APM and a significant improvement in patient-reported function was reported at average 12.5 months follow-up.

Knee specific and generic quality of life

(A) All patients (any type of meniscal tear with or without radiographic osteoarthritis)

There was improvement in knee-specific quality of life following APM compared to non-surgical treatment at 6-12 months (SMD 0.43 [95% CI 0.10 to 0.75]; 3 trials, 350 patients; I^2 56%; GRADE: Low) (Figure 4A). This is the equivalent of a mean difference (MD) of 10.36 [95% CI 3.58 to 17.14], measured using the KOOS quality of life scale, where the MCID is estimated to be around 8-10.[57,58] There was also improvement at under 6 months (SMD

0.45 [95% CI 0.10 to 0.80]; 1 trial, 129 patients; GRADE: Low), and a small to moderate improvement over 12 months (SMD 0.30 [95% CI 0.05 to 0.56]; 2 trials, 245 patients; I^2 0%; GRADE: Very low) (Table 3; Appendix 5). There was no difference in generic quality of life following APM versus non-surgical treatment at 6-12 months (SMD 0.01 [95% CI -0.34 to 0.35]; MD 0.00 EQ-5D [95% CI -0.06 to 0.06]; 1 trial, 130 patients; GRADE: Low) but a small to moderate improvement was reported at over 12 months (SMD 0.47 [95% CI 0.10 to 0.85]; MD 0.10 EQ-5D [95% CI 0.02 to 0.18]; 1 trial, 113 patients; GRADE: Very low) (Table 3). For EQ-5D, a MCID of 0.15 is proposed.[61]

(B) Patients with any type of meniscal tear in a non-osteoarthritic knee

There was a moderate to large improvement in knee-specific quality of life following APM compared to non-surgical treatment at 6-12 months (SMD 0.59 [95% CI 0.11 to 1.07]; 2 trials, 244 patients; I^2 71%; GRADE: Low) (Figure 4B). This is the equivalent of a mean difference (MD) of 12.89 [95% CI 3.60 to 22.18], measured using the KOOS quality of life scale, where the MCID is estimated to be around 8-10.[57,58] There was also a moderate to large improvement at under 6 months (SMD 0.52 [95% CI 0.16 to 0.87]; 1 trial, 124 patients; GRADE: Low), and over 12 months (SMD 0.39 [95% CI 0.13 to 0.65]; 2 trials, 231 patients; I^2 0%; GRADE: Low) (Table 3; Appendix 5). There was a no improvement in generic quality of life at 6-12 months (SMD 0.06 [95% CI -0.30 to 0.42]; MD 0.01 ED-5D [95% CI -0.05 to 0.08]; 1 trial; 119 patients; GRADE: Low) but a moderate to large difference was reported at over 12 months (SMD 0.63 [95% CI 0.23 to 1.02]; MD 0.13 EQ-5D [95% CI 0.05 to 0.21]; 1 trial, 105 patients; GRADE: Very low) (Table 3). For EQ-5D, a MCID of 0.15 is proposed.[61]

Other outcomes

See Appendix 6.

(2) Arthroscopic partial meniscectomy versus pharmacological comparators

Study characteristics

One RCT comparing APM to intra-articular steroid injection was identified, including 114 randomised patients with a mean age of 58 (Table 2; Appendix 4).[56] Patients were followed up at 1 month and 12 months and only the Oxford Knee Score (pain and function) and repeat operation data was reported. This RCT included patients with osteoarthritis was therefore only eligible for analysis in group A.

Risk of bias

A summary of the risk of bias assessment is shown in Table 2. This study was rated at high risk of performance and detection bias due to a lack of blinding. The method of random sequence generation and allocation concealment was unclear. The rate of loss to follow up was 14.0% (n=16/114) and therefore the trial was rated at high risk of attrition bias. The trial was also rated at high risk of bias due to a cross-over rate exceeding 10% of non-surgical participants (20.8%; other bias).

Knee pain and function

(A) All patients (any type of meniscal tear with or without radiographic osteoarthritis)

There was no improvement following APM versus intra-articular steroid injection at 6-12 months (SMD 0.38 [95% CI -0.02 to 0.78]; 1 trial; 98 patients; GRADE: Low). This corresponds to a mean difference (MD) of 1.40 [95% CI -0.07 to 2.87], using the Oxford Knee Score from 0 (severe symptoms) to 48 (no symptoms), where a MCID of 5 points is proposed for patients with osteoarthritis.[62] The was a moderate to large improvement at under 6 months (SMD 0.82 [95% CI 0.41 to 1.23]; MD 2.90 Oxford Knee Score [95% CI 1.50 to 4.30]; 1 trial; 98 patients; GRADE: Low).

(B) Patients with any type of meniscal tear in a non-osteoarthritic knee; (C) Patients with an unstable meniscal tear in a non-osteoarthritic knee

No trials were identified.

Other outcomes

See Appendix 6.

(3) Arthroscopic partial meniscectomy versus surgical interventions

Study characteristics

Two RCTs (Sihvonen 2013; Roos 2018) were identified, including a total of 190 participants' randomised with a mean age of 52 and 46 years respectively.[44,45] One RCT (Sihvonen 2013) compared the effect of APM versus placebo surgery (diagnostic arthroscopy).[63] The other RCT (Roos 2018) compared the effect of APM versus sham surgery (skin incisions only) (Table 2).[45] Available study data for both RCTs excluded patients with osteoarthritis and were eligible for analysis in group A and group B.

Risk of bias

A summary of the risk of bias assessment for the included studies is shown in Table 2. One study (Roos 2018) was rated at high risk of bias due to a high proportion (36%) of patients randomised to the comparator intervention 'crossing-over' to undergo APM before final follow up (other bias).

Knee Pain

(A) All patients (any type of meniscal tear with or without radiographic osteoarthritis);

(B) Patients with any type of meniscal tear in a non-osteoarthritic knee

There was no improvement in knee pain in those patients who received APM compared to those who received placebo surgery at 6-12 months (SMD 0.08 [95% CI -0.24 to 0.41]; 1 trial, 146 patients; GRADE: Low). This is the equivalent of a mean difference (MD) of 2.00 [95% CI -5.69 to 9.69] measured using the KOOS pain scale from 0 (worse) to 100 (better) where a minimum clinically important difference (MCID) is estimated to be around 8-10.[57,58] There was also no improvement in knee pain in comparison to sham surgery at under 6 months (SMD 0.26 [95% CI -0.41 to 0.93]; 1 trial; 35 patients; GRADE: Low). At over 12 months, there was a moderate to large improvement in patients receiving APM in comparison to sham surgery (SMD 0.72 [95% CI 0.02 to 1.42]; 1 trial, 34 patients; GRADE: Low) equivalent to a mean difference of 17.50 [95% CI 1.16 to 33.84] measured using the KOOS pain scale. There was no improvement in comparison to placebo surgery (SMD 0.00 [95% CI -0.33 to 0.33]; MD 0.00 KOOS pain [95% CI -8.35 to 8.35]; 1 trial; 144 patients; GRADE: Low) or combining the placebo and sham surgery trials (SMD 0.29 [95% CI -0.40 to 0.99]; 2 trials, 178 patients; I^2 70%; GRADE: Very low) (Table 4; Appendix 5).

(C) Patients with an unstable meniscal tear in a non-osteoarthritic knee

No trials were identified.

Knee Function

(A) All patients (any type of meniscal tear with or without radiographic osteoarthritis); (B) Patients with any type of meniscal tear in a non-osteoarthritic knee

There was no improvement in knee function following APM compared to placebo surgery at 6-12 months (SMD -0.08 [95% CI -0.41 to 0.24]; 1 trial, 146 patients; GRADE: High); equivalent of a MD of -1.55 [95% CI -7.95 to 4.66] measured using the Lysholm scale from 0 (worse) to 100 (better), where the MCID is estimated to be around 8-10 as measurement properties are similar to KOOS.[57,58,60] There was also no improvement versus sham surgery at under 6 months (SMD 0.07 [95% CI -0.60 to 0.73]; 1 trial; 35 patients; GRADE: Low). At over 12 months, there was no improvement in participants receiving APM in comparison to sham surgery (SMD 0.63 [95% CI -0.06 to 1.32]; MD 12.2 Lysholm [95% CI -1.16 to 25.6]; 1 trial, 34 patients; GRADE: Low) or placebo surgery (SMD -0.18 [95% CI -0.51 to 0.14]; MD -3.49 Lysholm [95% CI -9.89 to 2.72]; 1 trial; 144 patients; GRADE: Low). Combining placebo and sham surgery trials, there was no difference at over 12 months (SMD 0.16 [95% CI to -0.62 to 0.95]; 2 trials, 178 patients; I^2 77%; GRADE: Very low) (Table 4; Appendix 5).

Knee-specific and generic quality of life

(A) All patients (any type of meniscal tear with or without radiographic osteoarthritis); (B) Patients with any type of meniscal tear in a non-osteoarthritic knee

There was no improvement in knee-specific quality of life following APM compared to placebo surgery at 6-12 months (SMD 0.05 [95% CI -0.27 to 0.38]; 1 trial, 146 patients; GRADE: High). This is the equivalent of a mean difference (MD) of 1.10 [95% CI -5.64 to 7.84] measured using the KOOS quality of life scale from 0 (worse) to 100 (better), where the MCID is estimated to be around 8-10.[57,58] There was also no difference at under 6 months in comparison to sham surgery (SMD 0.25 [95% CI -0.42 to 0.91]; 1 trial; 35 patients; GRADE: Low). At over 12 months, there was no improvement in participants receiving APM in comparison to sham surgery (SMD 0.65 [95% CI -0.04 to 1.35]; MD 16.50 KOOS quality of life [95% CI -0.27 to 33.27]; 1 trial, 34 patients; GRADE: Low) or placebo surgery (SMD -0.01 [95% CI -0.34 to 0.32]; MD -0.20 KOOS quality of life [95% CI -6.27 to 5.87]; 1 trial; 144 patients; GRADE: Low). Combining placebo and sham surgery trials, there was no difference at over 12 months (SMD 0.25 [95% CI -0.39 to 0.88]; 2 trials, 178 patients; I^2 65%; GRADE: Very low) (Table 4; Appendix 5). There was no improvement in generic health-related quality of life following APM versus placebo surgery at 6-12 months (SMD 0.23 [95% CI -0.09 to 0.56]; 1 trial, 146 patients; GRADE: High), equivalent to a mean difference (MD) of 0.02 [95% CI -0.01 to 0.05], measured using EQ-5D, where the MCID is estimated to be around 0.15.[61] There was

no improvement versus sham surgery at under 6 months (SMD 0.37 [95% CI -0.30 to 1.04]; 1 trial; 35 patients; GRADE: Low) or over 12 months (SMD 0.69 [95% CI -0.01 to 1.38]; 1 trial; 34 patients; GRADE: Low).

Other outcomes

See Appendix 6.

(4) Arthroscopic partial meniscectomy versus no intervention.

No trials were identified for inclusion in this group.

DISCUSSION

This systematic review examined the effectiveness of APM with a methodology that stratified trials by comparator intervention, and patients by the important clinical and radiological findings as defined by international consensus groups, for the first time.[23,64] Findings were limited by small sample size, small number of trials and cross-over of participants to APM from comparator interventions. At 6-12 months, in trials with a non-surgical comparator, there was a small benefit in favour of APM for pain, knee-specific quality of life, and function in studies including patients with osteoarthritis. Excluding patients with osteoarthritis, there was a small to moderate benefit in pain, knee-specific quality of life, function. The clinical importance of these differences is, however, uncertain. In one trial of APM versus a pharmacological comparator (intra-articular steroid injection), no difference in pain and function was detected. In trials of APM versus surgical comparators (placebo or sham surgery), no mean difference was detected. In the one trial with a placebo surgery comparator, the mean difference did not exceed a threshold for clinical importance. In the one trial with a sham surgery comparator, no mean difference was detected, confidence intervals were wide but the mean difference in favour of APM exceeded the threshold for clinical importance in pain, function, and knee-specific quality of life at 24 months. No trial has compared APM to no intervention.

Prior reviews of knee arthroscopy included trials of interventions such as knee lavage or debridement for advanced osteoarthritis alongside trials of APM for meniscal tears.[16,27–29] For example, the aim of the recent review by Thorlund *et. al.* was to determine the "benefits and harms of arthroscopic knee surgery for middle aged or older patients with knee pain and degenerative knee disease".[16] Our systematic review is more specific, including only trials of APM performed for meniscal tears. Our analysis confirms, however, that outcomes after APM surgery are inferior in patients with osteoarthritis and that APM should not be considered a first-line treatment option, especially in those with non-specific "knee pain".

In comparison to non-surgical interventions, the greatest improvement in pain and quality of life was seen in patients with knee pain and a meniscal tear but without osteoarthritis. In this group, APM was associated with improvement in pain and knee-specific quality of life in comparison to non-surgical treatment, at a level that, as discussed later, may exceed the MCID. Effect estimates were limited, however, by small study numbers, large numbers of patients 'crossing-over' to undergo APM after being randomised to comparator interventions, a lack of blinding in those studies without a surgical comparator, and wide confidence intervals. It should be noted, however, that the physiotherapy delivered by the included trials was intensive, generally including a progressive combination of muscle

strength, endurance, flexibility and balance exercises with gym sessions 2-3 times per week for 3-12 weeks. The associated outcomes may not be generalizable to clinical practice and the cost-effectiveness of the intervention requires evaluation in comparison to, for example, a less costly unsupervised home exercise programme. Further studies are needed to determine the effectiveness of APM when applied to patients who fail to respond to non-surgical treatment.

No trial has been performed, or been registered, with inclusion criteria limited to patients meeting the clinical and radiological criteria required for APM to be recommended in current practice – that is, an unstable pattern of tear with symptoms that are considered to be likely to be "meniscal" in origin rather than non-specific knee pain.[23,64] Previous trials have not used or recorded these specific criteria in individual patients and therefore no meaningful sub-group data was available for analysis.

It remains unknown whether APM performed in a population with more focussed indications (excluding patients with osteoarthritis) may be beneficial to pain and quality of life, especially in patients who fail to respond to non-surgical treatment.[65,66]. Our review only identified one cohort study, which provides low quality evidence that APM may provide some benefit in pain relief in this population.[59] The authors of the four most recent trials provided supplementary sub-group data for inclusion in our review (Gauffin 2014; Kise 2016; Roos 2018, Van de Graaf 2018).[43–46], which showed some improvement in mean outcomes when patients with osteoarthritis were excluded.

Up to 30% of patients randomised to non-surgical treatment 'crossed over' to undergo APM before final follow up, which is a serious limitation of the current trial evidence.[43,44,46,53,55,56,67] This issue was not limited to studies with a non-surgical comparator, and also observed in up to 36% of comparator patients in studies with a surgical comparator and 21% with a pharmacological comparator.[45,56] These patients were not blinded, and the outcome of these individuals had they not undergone APM is unknown, but the high cross-over rate confounds the non-surgical intention-to-treat analysis, particularly at longer term follow up.[68] For many years now, there have been calls for all patients with meniscal tears to be treated non-surgically in the first instance, with APM being reserved for those patients failing to improve with this treatment strategy.[18,23,26,65,66] None of the included trials restricted inclusion to patients who had failed a specific non-surgical treatment programme and future RCTs should aim to evaluate the effects of APM for this patient population.

Two RCTs have been performed of APM versus a surgical comparator and interpretation of these studies requires careful consideration.[45,63] In the larger, placebo-controlled study (Sihvonen 2013), no difference was reported between the APM and placebo surgery (arthroscopic lavage) groups, while considerable improvement was noted from baseline to follow up in both groups.[63] As the trial lacked a non-surgical control arm, and patients had not undergone a period of structured physiotherapy before randomisation, it is not clear what underlies this improvement.[66] In contrast, the other study (Roos 2018) had a true sham surgery comparator, with patients receiving an anaesthetic but skin incisions only.[45] Thirty-six percent of patients in the sham group crossed-over to undergo APM, yet the mean difference between groups in the intention-to-treat analysis was still suggestive of a better outcome in the APM group at over 12 months.[45] Confidence intervals were wide in this small study but the authors concluded that "a clinically relevant difference could not be excluded".[45] These conflicting results lead to uncertainty regarding the efficacy of APM and the 'critical surgical element' in the recruited patients.[24] Meniscal tears may be asymptomatic and pain and mechanical symptoms may be caused by other knee pathology.[3,69,70] Therefore, it is essential that clinical and radiological features correspond before arthroscopy is recommended over alternative non-surgical treatments.[23] In the majority of RCTs, patients were eligible for inclusion if they had knee pain localised to a joint line and any pattern of meniscal tear. In the one study (Sihvonen 2013) where knee arthroscopy was performed in all patients, 27% had full thickness cartilage loss and 47% had partial thickness cartilage degeneration, despite minimal radiographic evidence of osteoarthritis prior to surgery.[71] For these individuals, partial resection of the meniscus is unlikely to be the critical surgical element to induce a treatment effect in comparison to a placebo effect or any other effect, for example, from the joint lavage performed in both the intervention and control groups of this particular study.[24]

No trials have been performed with inclusion criteria limited to the current consensus led indications for APM: with appropriate meniscal symptoms corresponding with an unstable meniscal lesion visible on MRI as the treatment target.[23] Although authors have attempted to report outcomes in underpowered sub-samples of patients with either unstable meniscal tears or with mechanical symptoms, no attempt has, so far, been made to relate the symptoms with the pathology.[72] As a result, the efficacy of APM in this group is unknown, despite a single cohort data supporting the usefulness of the treatment after failure of physiotherapy.[59] No other systematic review has attempted to address this question and clearly more evidence is required to define the efficacy of APM in these patients.

Strengths and limitations

This review is the first to specifically focus on the effectiveness of APM in patients with meniscal tears, stratified according to the important clinical and radiological patient selection criteria.[23] The analysis was bolstered by the provision of unpublished data by the authors of four trials. Only randomised controlled trials were included in the pooled analysis due to the risk of selection bias in cohort studies. The review search strategy was, however, highly sensitive and designed to also identify cohort studies and on-going studies, to provide context and narrative when no completed trial evidence was available. The current evidence does have a number of limitations including small numbers of trials and study numbers, risk of bias and high rates of cross-over of participants to APM from comparator interventions in both unblinded and blinded studies.

To ease interpretation, all outcomes were converted to familiar PROM instruments in the Summary of Findings tables. When considering the magnitude of the effect from APM reported, it must be noted that the minimal clinically important difference (MCID)) and patient acceptable symptom state (PASS) in PROM scores for patients with meniscal tears is unknown.[38,60] Although generally not designed for use in patients with meniscal tears, attempts have been made to validate a number of PROMs for use in this population. The validation evidence is, however, poor quality and incomplete, with the lack of a known MCID a major limitation.[38] Nevertheless, to ease interpretation of our study, a MCID threshold of 8-10 was used to attribute potential clinical relevance for outcomes measured on the 0-100 KOOS scale, as proposed by the developers of the tool.[57,58] As Lysholm is measured on the same scale and has otherwise comparable measurement properties in similar patient groups, the same tentative threshold was applied to interpreting functional differences measured on the Lysholm scale.[60] For generic quality of life, one estimate of a MCID of 0.15 on the EQ-5D has been suggested for patients with osteoarthritis.[61] Even for osteoarthritis of the knee, however, MCID estimates vary widely from 4 to 20 for KOOS pain and 3 to 9 for KOOS-ADL.[61] The thresholds for interpretation are therefore intended as a tentative guide only, as the true MCID and PASS for the population of patients with meniscal tears remains unknown.[38,60] For reference, we have also included a summary of the magnitude of effect based upon the SMD guide thresholds suggested by Cohen.[40]

Another important limitation to the interpretation of the current evidence is that the treatment preferences of patients with meniscal tears are currently unknown. In general, any benefit from APM in comparison to non-surgical treatment is seen in the early (under 6 months) and mid-term (6-12 months) was not detected in the longer term (over 12 months). The relative patient preference for a potentially more rapid improvement in pain and quality of life following APM, in comparison to avoiding surgery but a slower rate of improvement with non-surgical treatment, has not been

evaluated. Furthermore, only one trial has evaluated outcomes at greater than two years following APM in comparison to physiotherapy, and therefore the longer-term outcomes of APM, including rates of progressive osteoarthritis, in comparison to alternative treatments remains relatively uncertain. The high rate of cross-over of non-surgically treated patients to APM may also influence treatment decisions.

Meaning of study

This review highlights the importance of stratifying the trial evidence to specific populations of patients with meniscal tears, by the key clinical and radiological findings. Performing APM in all patients with knee pain and a meniscal tear, without initial non-surgical treatment, is not appropriate, especially in patients with concurrent osteoarthritis where outcomes are inferior. However, in trials reporting the 'cross-over' of patients randomised to non-surgical treatment, up to 30% of patients subsequently chose to undergo APM due to a reported lack of improvement in their symptoms. Further research is required but the findings broadly suggest that APM should be reserved for patients with persisting symptoms, correlating with a meniscal tear, after completion of intensive, appropriately structured, non-surgical treatment (physiotherapy).

Unanswered questions and future research

Perhaps the most important conclusion of this review is that the current trial evidence should be interpreted with care due to limitations from non-specific selection of patients (without stratification) and the overall small numbers of included patients. The available evidence suggests that surgical treatment should not be the first-line intervention for patients with meniscal tears. Outcomes are improved in patients without osteoarthritis but, crucially, no trial has been limited to individuals failing to respond to non-surgical treatment, and patients meeting the strictest clinical and radiological indications for APM are not represented by the current evidence. There is an urgent need for a high-quality randomised controlled trial in this population.

Acknowledgements

The authors would like to thank Eli Harriss, Bodleian Health Care Libraries, University of Oxford for work designing and running the search strategy for this review. The authors would also like to thank Nina Jullum Kise (Martina Hansens Hospital), Håkan Gauffin (Linkoping University), Ewa Roos (University of Southern Denmark), and Victor van de Graaf (OLVG Amsterdam), along with their co-authors, for kindly agreeing to provide unpublished study data.

Change between the protocol and published review

Following data extraction, as the majority of studies reported patient-reported pain separately from function, rather than reporting complete composite scores (for example, KOOS-5), we modified our analysis plan to more comprehensively report pain, function, and quality of life outcomes separately. Similarly, the majority of studies reported either 6-month or 12-month outcome data (not both) and defined long-term follow up as greater than 12 months. Therefore, to provide a more complete picture of early, medium, and long-term outcomes, we modified the time point at which outcomes were reported to: under 6 months, 6-12 months, and over 12 months respectively. One included study did not perform magnetic resonance imaging in all patients prior to randomisation (Gauffin 2014).

Details of contributors

SA: concept, methodology, study selection, analysis, writing and editing paper, guarantor.

SH: concept, methodology, analysis, writing and editing paper.

AM: study selection, editing paper.

LB: study selection, editing paper.

DB: concept, writing and editing paper.

AP: concept, methodology, writing and editing paper.

Transparency declaration

The lead author (SA) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and registered) have been explained.

Competing interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Funding

This report is independent research supported by the National Institute for Health Research (NIHR Doctoral Research Fellowship, Mr Simon Abram, DRF-2017-10-030) and Oxford NIHR Biomedical Research Centre. The views expressed in this publication are those of the authors and not necessarily those of the NHS, the National Institute for Health Research or the Department of Health.

Ethical approval

Not required.

Data sharing

Dataset available from the corresponding author.

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Tables

Table 1: Characteristics of population groups evaluated

Group	Severity of radiographic osteoarthritis (OA)	Type of meniscal tear	Corresponding symptoms
(A)	Any (K-L 0-4)	Any	Pain
(B)	Without OA (K-L 0-1)	Any	Pain
(C)	Without OA (K-L 0-1)	Unstable (author definition)	Meniscal (author definition)

K-L=Kellgren-Lawrence grade

Table 2: Study characteristics and risk of bias assessment

Risk of bias assessment (Cochrane Collaboration risk-of-bias tool).[39]

Further details including a full description of the intervention and comparator treatments, funding and location, may be found in Appendix 4.

Comparator group:	**(1) Non-surgical**							**(2) Pharmacological**	**(3) Surgical**	
	Herrlin 2007[52,67]	Katz 2013[53,73,74]	Østeras 2012[75,76]	Yim 2013[55]	Gauffin 2014[43,77]	Kise 2016[44]	Van de Graaf 2018[46]	Vermesan 2013[56]	Sihvonen 2013[37,63,72,78,79]	Roos 2018[45]
Comparator (control)	Physiotherapy	Physiotherapy	Physiotherapy	Physiotherapy	Physiotherapy	Physiotherapy	Physiotherapy	Steroid injection	Placebo APM	Sham APM
Sample (randomised)	99	351	17	108	150‡	140‡	321	114	146	44‡
Sample (analysed)	90	320	17	102	130‡	129‡	289	98	146	42‡
Lost to follow up (%)	9 (9.1%)	31 (8.8%)	0 (0%)	6 (5.6%)	20 (13.3%)	11 (7.9%)	13 (4.0%)	16 (14.0%)	0 (0%)	2 (4.5%)
Number of centres	Single	Multiple	Multiple	Single	Single	Multiple	Multiple	Single	Multiple	Multiple
Age mean (SD) (controls)	55 (5.5)	58 (6.8)	47 (10.4)	58 (11)	54 (6)	50 (6.2)	57.3 (6.8)	58 (7.8)	52 (7)	46 (5.7)
Female % (controls)	37%	57%	11%	77%	25%	39%	50.3%	46%	38%	61%
Minimum symptom duration	2 months	4 weeks	3 months	6 weeks	3 months	2 months	NR	NR	3 months	2 months
Osteoarthritis grade	Ahlbäck 0-1	K-L 0-3	K-L 0-2	K-L 0-1	K-L 0-2‡	K-L 0-3‡	K-L 0-2‡	NR	K-L 0-1	K-L 0-2‡
Intervention	APM	APM	APM	APM	APM	APM	APM	APM	APM	APM
Outcome measures (PROMs)	KOOS Lysholm VAS Pain Tegner	WOMAC (physical) SF-36 (physical) KOOS Pain	KOOS VAS Pain	Lysholm VAS Pain	KOOS EQ-5D	KOOS-4 SF-36 (physical) SF-36 (mental)	IKDC VAS Pain SF-36 (physical) EQ-5D (NR) Tegner	OKS	Lysholm WOMET 15D VAS Pain	KOOS EQ-5D SF-36 (physical) SF-36 (mental)
Endpoints (months)	6, 24, 60	6, 12	3	3, 6, 12, 24	12, 36	3, 12, 24	3, 6, 12, 24	1, 12	6, 12, 24	3, 24
Cross-over* %	28.2%	30.2%	NR	1.9%	21.3%	18.6%	29.0%	20.8%	6.6%	36.0%
Risk of Bias (Cochrane Collaboration risk-of-bias tool)[39]										
Random sequence generation (selection bias)	Unclear	Low	Unclear	Unclear	Unclear	Low	Low	Unclear	Low	Low
Allocation concealment (selection bias)	Unclear	Low	Unclear	Unclear	Low	Low	Unclear	Unclear	Low	Low
Blinding of participants and researchers (performance bias)	High	High	High	High	High	High	High	High	Low	Low
Blinding of outcome assessment (detection bias)	High	High	High	High	High	High	High	High	Low	Low
Incomplete outcome data (attrition bias)	Unclear	Low	Low	Low	High	Low	Low	High	Low	Low
Selective reporting (reporting bias)	Unclear	High	Unclear	Unclear	Unclear	High	Unclear	Unclear	Low	Low
Other bias (cross-over*, baseline imbalance)	High	High	Unclear	Low	High	High	High	High	Low	High

K-L=Kellgren-Lawrence grade; OKS=Oxford Knee Score; IKDC=International Knee Documentation Committee *= Underwent APM intervention after randomisation to control treatment; ‡ = Previously unpublished sub-group data (K-L 0-1) received; NR = Not reported.

Table 3: Summary of Findings: APM versus non-surgical comparators

Outcome	Endpoint	Participants (RCTs)	Standardised MD (95% CI)	MD (95% CI)	I^2	GRADE Quality*
(A) All patients (any type of meniscal tear with or without radiographic osteoarthritis)						
Pain	Under 6 months	434 (2 RCTs)	0.18 [-0.00, 0.37]	(KOOS pain) 4.46 better [0.22, 8.71]	0%	⊕◯◯◯ VERY LOW [c,d]
	6 - 12 months	943 (5 RCTs)	0.22 [0.03, 0.40]	4.10 better [0.74, 7.46]	48%	⊕⊕◯◯ LOW [c]
	Over 12 months	484 (3 RCTs)	0.22 [0.04, 0.40]	4.43 better [0.72, 8.14]	0%	⊕◯◯◯ VERY LOW [c,d]
Function	Under 6 months	561 (4 RCTs)	0.08 [-0.08, 0.25]	(Lysholm scale) 1.38 better [-1.54, 4.31]	0%	⊕⊕◯◯ LOW [c]
	6 - 12 months	1050 (6 RCTs)	0.18 [0.04, 0.33]	3.36 better [0.55, 6.16]	27%	⊕⊕◯◯ LOW [c]
	Over 12 months	730 (5 RCTs)	0.18 [0.04, 0.33]	2.59 better [0.29, 4.89]	0%	⊕⊕◯◯ LOW [c]
Knee-specific QoL	Under 6 months	129 (1 RCT)	0.45 [0.10, 0.80]	(KOOS QoL) 9.59 better [2.34, 16.84]	NA	⊕⊕◯◯ LOW [c]
	6 - 12 months	350 (3 RCTs)	0.43 [0.10, 0.75]	10.36 better [3.58, 17.14]	56%	⊕⊕◯◯ LOW [c]
	Over 12 months	245 (2 RCTs)	0.30 [0.05, 0.56]	6.92 better [1.33, 12.52]	0%	⊕◯◯◯ VERY LOW [c,d]
Generic QoL	Under 6 months	None	NA	(EQ-5D VAS) NA	NA	NA
	6 - 12 months	130 (1 RCT)	0.01 [-0.34, 0.35]	0.00 better [-0.06, 0.06]	NA	⊕⊕◯◯ LOW [c]
	Over 12 months	113 (1 RCT)	0.47 [0.10, 0.85]	0.10 better [0.02, 0.18]	NA	⊕◯◯◯ VERY LOW [c,d]
(B) Patients with any type of meniscal tear in a non-osteoarthritic knee						
Pain	Under 6 months	306 (2 RCTs)	0.16 [-0.25, 0.57]	(KOOS pain) 3.28 better [-4.33, 10.90]	68%	⊕◯◯◯ VERY LOW [b,c,d]
	6 - 12 months	402 (3 RCTs)	0.35 [0.04, 0.66]	6.91 better [2.87, 10.94]	58%	⊕◯◯◯ VERY LOW [a,b,c]
	Over 12 months	368 (3 RCTs)	0.21 [0.00, 0.42]	4.15 better [0.14, 8.16]	0%	⊕◯◯◯ VERY LOW [c,d]
Function	Under 6 months	411 (3 RCTs)	0.11 [-0.13, 0.35]	(Lysholm scale) 1.93 better [-2.40, 6.26]	33%	⊕⊕◯◯ LOW [c]
	6 - 12 months	507 (4 RCTs)	0.30 [0.06, 0.53]	5.31 better [1.12, 9.51]	44%	⊕◯◯◯ VERY LOW [c,d]
	Over 12 months	501 (4 RCTs)	0.19 [0.01, 0.36]	2.69 better [-0.65, 6.03]	0%	⊕⊕◯◯ LOW [c]
Knee-specific QoL	Under 6 months	124 (1 RCT)	0.52 [0.16, 0.87]	(KOOS QoL) 10.42 better [3.36, 17.48]	NA	⊕⊕◯◯ LOW [c]
	6 - 12 months	244 (2 RCTs)	0.59 [0.11, 1.07]	12.89 better [3.60, 22.18]	71%	⊕⊕◯◯ LOW [c]
	Over 12 months	231 (2 RCTs)	0.39 [0.13, 0.65]	8.40 better [2.86, 13.95]	0%	⊕⊕◯◯ LOW [c]
Generic QoL	Under 6 months	None	NA	(EQ-5D VAS) NA	NA	NA
	6 - 12 months	119 (1 RCT)	0.06 [-0.30, 0.42]	0.01 better [-0.05, 0.08]	NA	⊕⊕◯◯ LOW [c]
	Over 12 months	105 (1 RCT)	0.63 [0.23, 1.02]	0.13 better [0.05, 0.21]	NA	⊕◯◯◯ VERY LOW [c,d]

MD: mean difference; Qol: quality of life; CI: confidence interval; I^2: heterogeneity. SMD in function was translated and re-expressed as a MD in the Lysholm knee scale, using the standard deviation of 19.4 reported for patients with isolated meniscal tears.[80]

***GRADE rating explanations**[42]

[a.] Imprecision (very serious): Wide confidence interval including no benefit and potential MCID (benefit).

[b.] Inconsistency (very serious): High level of heterogeneity (>50%) between studies.

[c.] Risk of bias (very serious): No blinding of participants.

[d.] Imprecision (serious): Wide confidence interval including potential MCID (benefit) with MD less than MCID.

Table 4: Summary of Findings: APM versus surgical comparators

Outcome	Endpoint	Participants (RCTs)	Standardised MD (95% CI)	MD (95% CI)	I^2	GRADE Quality*
(A) All patients (any type of meniscal tear with or without radiographic osteoarthritis) & (B) Patients with any type of meniscal tear in a non-osteoarthritic knee						
Pain	Under 6 months	35 (1 RCT)	0.26 [-0.41, 0.93]	(KOOS pain) 5.30 better [-7.89, 18.49]	NA	⊕⊕◯◯ LOW [a]
	6 - 12 months	146 (1 RCT)	0.08 [-0.24, 0.41]	2.00 better [-5.69, 9.69]	NA	⊕⊕◯◯ LOW [a]
	Over 12 months	178 (2 RCTs)	0.29 [-0.40, 0.99]	7.28 better [-9.62, 24.19]	70%	⊕◯◯◯ VERY LOW [a,b]
Function	Under 6 months	35 (1 RCT)	0.07 [-0.60, 0.73]	(Lysholm scale) 1.36 better [-11.64, 14.16]	NA	⊕⊕◯◯ LOW [a]
	6 - 12 months	146 (1 RCT)	-0.08 [-0.41, 0.24]	-1.55 worse [-7.95, 4.66]	NA	⊕⊕⊕⊕ HIGH
	Over 12 months	178 (2 RCTs)	0.16 [-0.62, 0.95]	3.10 better [-12.03, 18.43]	77%	⊕◯◯◯ VERY LOW [a,b]
Knee-specific QoL	Under 6 months	35 (1 RCT)	0.25 [-0.42, 0.91]	(KOOS QoL) 4.50 better [-7.37, 16.37]	NA	⊕⊕◯◯ LOW [a]
	6 - 12 months	146 (1 RCT)	0.05 [-0.27, 0.38]	1.10 better [-5.64, 7.84]	NA	⊕⊕⊕⊕ HIGH
	Over 12 months	178 (2 RCTs)	0.25 [-0.39, 0.88]	6.25 better [-9.69, 22.18]	65%	⊕◯◯◯ VERY LOW [a,b]
Generic QoL	Under 6 months	35 (1 RCT)	0.37 [-0.30, 1.04]	(EQ-5D VAS) 0.04 better [-0.03, 0.12]	NA	⊕⊕◯◯ LOW [a]
	6 - 12 months	146 (1 RCT)	0.23 [-0.09, 0.56]	0.02 better [-0.01, 0.05]	NA	⊕⊕⊕⊕ HIGH
	Over 12 months	34 (1 RCT)	0.69 [-0.01, 1.38]	0.11 better [0.00, 0.22]	NA	⊕⊕◯◯ LOW [a]

MD: mean difference; Qol: quality of life; CI: confidence interval; I^2: heterogeneity. SMD in function was translated and re-expressed as a MD in the Lysholm knee scale, using the standard deviation of 19.4 reported for patients with isolated meniscal tears.[80]

GRADE Explanations[42]

[a.] Imprecision (very serious): Wide confidence interval including no benefit and potential MCID (benefit).

[b.] Inconsistency (very serious): High level of heterogeneity (>50%) between studies.

Figures

Figure 1: PRISMA Flow Diagram

Full search strategy may be found in Appendix 1.

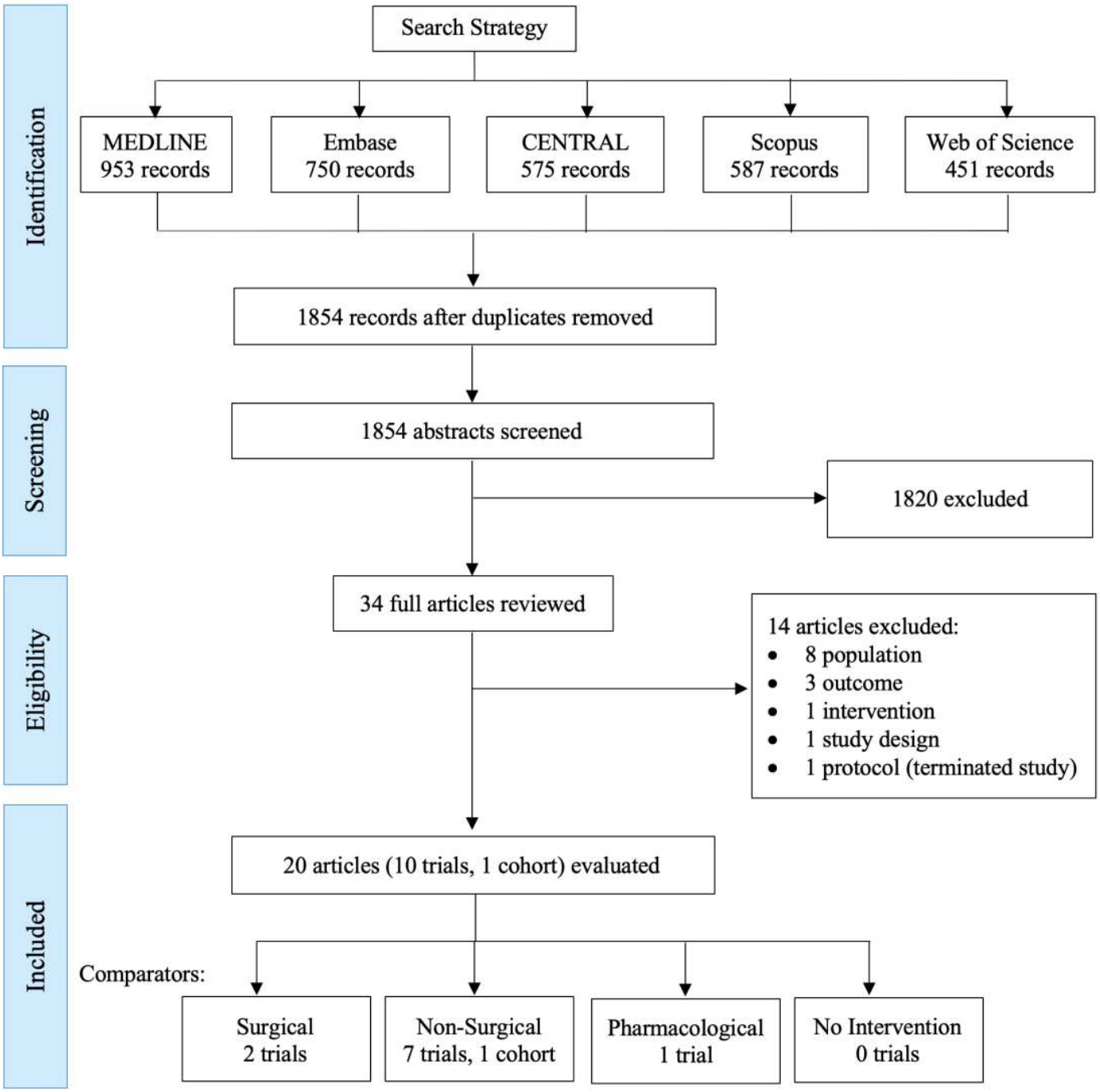
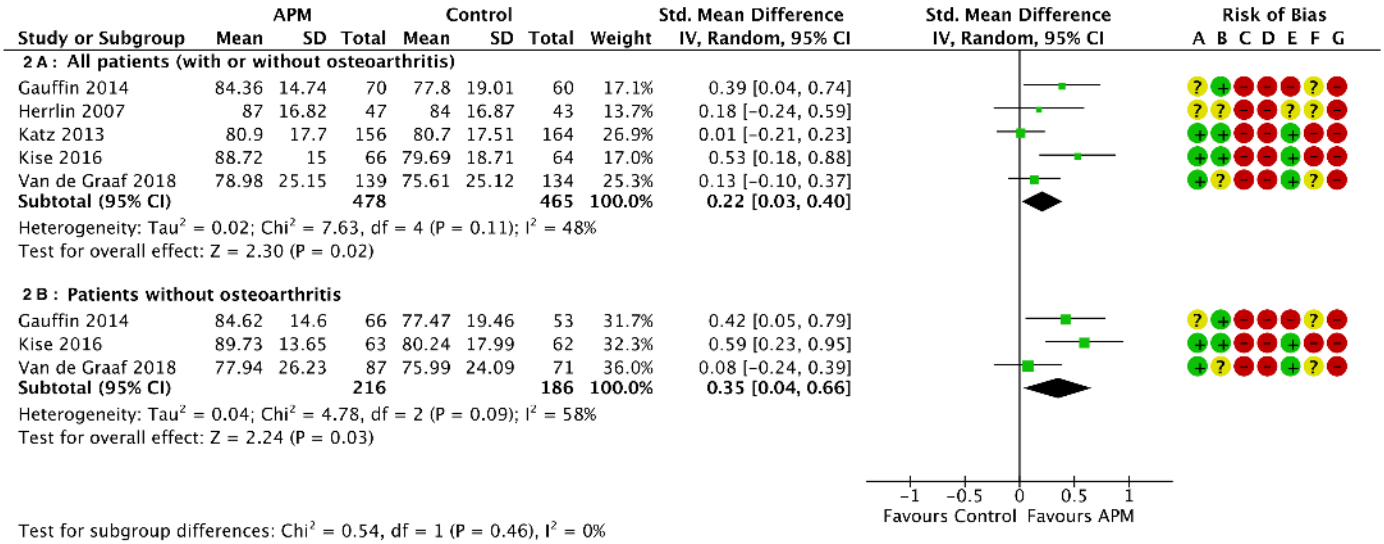


Figure 2: Pain following arthroscopic partial meniscectomy versus non-surgical intervention (6-12 months)

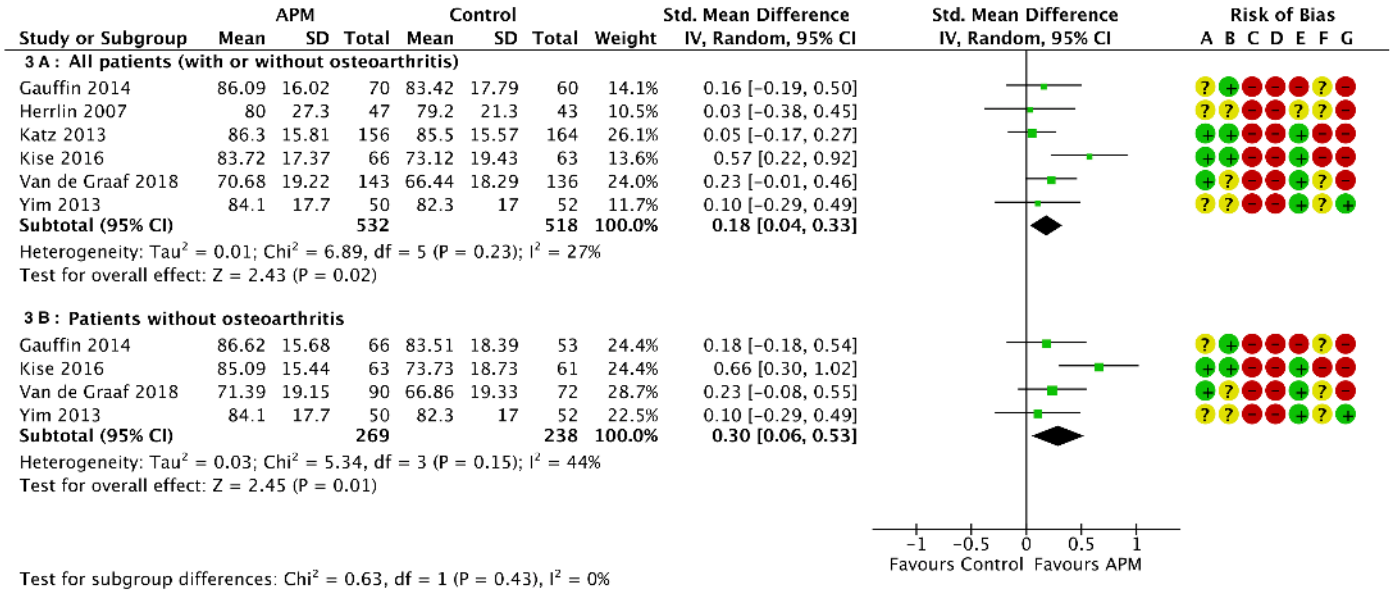


Test for subgroup differences: $Chi^2 = 0.54$, df = 1 (P = 0.46), $I^2 = 0\%$

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Figure 3: Function following arthroscopic partial meniscectomy versus non-surgical intervention (6-12 months)

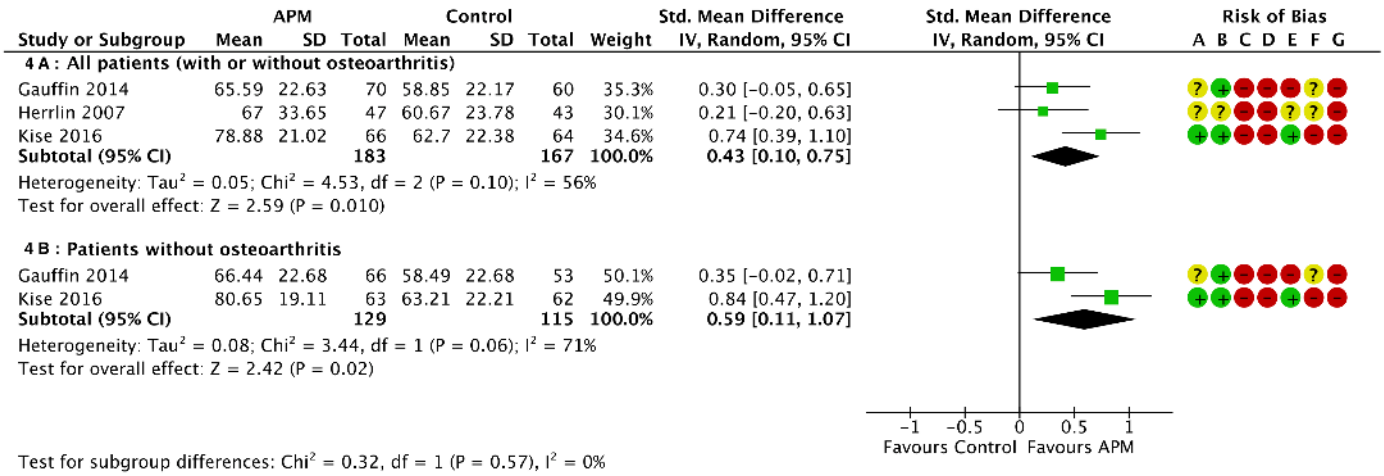


Test for subgroup differences: Chi² = 0.63, df = 1 (P = 0.43), I² = 0%

Risk of bias legend

(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel (performance bias)
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective reporting (reporting bias)
(**G**) Other bias

Figure 4: Knee-specific health-related quality of life following arthroscopic partial meniscectomy versus non-surgical intervention (6-12 months)



Test for subgroup differences: Chi^2 = 0.32, df = 1 (P = 0.57), I^2 = 0%

Risk of bias legend

(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel (performance bias)
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective reporting (reporting bias)
(**G**) Other bias