Arthroscopic surgery for the degenerative knee: A systematic review and meta-analysis of benefits and harms

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Arthroscopic surgery for the degenerative knee: systematic review and meta-analysis of benefits and harms

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ABSTRACT

Objective To determine benefits and harms of arthroscopic knee surgery involving partial meniscectomy and/or debridement for middle-aged or older patients with knee pain and degenerative knee disease.

Design Systematic review and meta-analysis.

Main outcome measures Pain and physical function.

Data sources Systematic searches for benefits and harms were carried out in Medline, EMBASE, CINAHL, Web of Science and the Cochrane Central Register of Controlled Trials (CENTRAL) up till August 2014. Only studies published in 2000 or later were included for harms.

Eligibility criteria for selecting studies Randomized controlled trials assessing benefit of arthroscopic surgery involving partial meniscectomy and/or debridement for patients with or without radiographic signs of osteoarthritis. For search on harms we also allowed cohort studies, register-based studies and case series.

Results Our search identified 9 trials assessing the benefits of knee arthroscopic surgery in middle-aged and older patients with knee pain and degenerative knee disease. The main analysis, combining the primary end-points of the individual trials from 3 to 24 months post-operatively, showed a small difference in favour of interventions including arthroscopic surgery compared with control treatments for pain (ES 0.14 95% CI 0.03 to 0.26). This difference corresponds to a benefit of 2.4 mm (95% CI 0.4 to 4.3 mm) on a 0-100 mm Visual Analogue Scale. When analysed over time of follow-up, interventions including arthroscopy showed a small benefit of 3-5 mm for pain at 3 and 6 months, but not later up till 24 months. No significant physical function benefit was found.
(ES 0.09 95% CI -0.05 to 0.24). 9 studies reporting on harms were identified. Harms included symptomatic deep venous thrombosis (4.13 events per 1000 procedures (95% CI 1.78 to 9.60)), pulmonary embolism, infection, and death.

**Conclusions** The small inconsequential benefit seen from interventions that include arthroscopy for the degenerative knee is limited in time and absent at 1-2 years after surgery. Knee arthroscopy is associated with harms. Taken together, our findings speak against a practise of arthroscopic surgery for middle-aged or older patients with knee pain with or without signs of osteoarthritis.

**Systematic review registration** PROSPERO registration number CRD42014009145

**What this paper adds box**

**What is already known on this subject**

- Although all but one of published randomised trials have shown no added benefit for arthroscopic surgery over that of the control treatment, many specialists are convinced of the benefits of the surgical intervention.
- Arthroscopic knee surgery is frequently and increasingly used to treat middle-aged and older patients with persistent knee pain.
- In support of an appropriate rate of arthroscopic interventions, we did a comprehensive, up-to-date systematic review and meta-analysis of the benefits and harms of arthroscopic surgery for middle-aged and older persons with persistent knee pain with or without signs of osteoarthritis.

**What this study adds**

- We found that interventions that include arthroscopy are associated with a small benefit and with harms. The small benefit is inconsequential and of short duration.
- The benefit is markedly smaller than that seen from exercise therapy as treatment for knee osteoarthritis. This speaks against a practise of arthroscopic surgery as treatment for middle-aged or older patients with knee pain with or without signs of osteoarthritis.
INTRODUCTION

Arthroscopic knee surgery with meniscus resection is common for middle-aged or older individuals with persistent knee pain. The knees of these patients often show ‘degenerative’ lesions of cartilage, meniscus and other tissues, suggestive of osteoarthritis. However, population-based studies using magnetic resonance imaging (MRI) show that incidental findings of such lesions are very common also among those without knee symptoms and among those without plain radiographic signs of osteoarthritis, suggesting that the clinical significance of such findings is unclear. All but one of the nine randomized clinical trials to date of arthroscopic surgery in middle-aged or older individuals with persistent knee pain failed to show an added benefit of interventions including arthroscopic surgery over a variety of control treatments. There is thus uncertainty of the benefit of arthroscopic surgery including meniscus resection for these patients. However, many specialists are convinced of the benefits of the procedure from their expert experience and several recent reports show an increase, or no decrease, in the incidence of arthroscopic knee surgery with meniscus resection during the past decade. The arthroscopic procedures discussed here are reported to be associated with adverse events, including deep venous thrombosis, infections, cardiovascular events, pulmonary embolism, and death.

The balance of benefits and harms weigh importantly in the choice of therapy. To inform the choice of therapy for these patients, we performed a comprehensive, up-to-date systematic review and meta-analysis of the benefits and harms of arthroscopic surgery compared with control treatments for middle-aged and older persons with persistent knee pain. We extend existing knowledge by including more patients, and by presenting outcomes on pain, function, and harms of patients ranging from those with degenerative meniscal tears and no radiographic signs of osteoarthritis, to
those with degenerative meniscal tears and more severe signs of osteoarthritis. We also accounted for the study designs used and, when appropriate, conducted a priori defined subgroup analyses.

METHODS

Protocol: The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement was used as a guideline for this study. The study protocol is registered in PROSPERO, with registration number CRD42014009145 (http://www.crd.york.ac.uk/prospero/).

Eligibility criteria: Randomized controlled trials assessing the benefits (pain and physical function) of arthroscopic surgery involving partial meniscectomy and/or debridement for patients with or without osteoarthritis in comparison to non-surgical treatments such as sham surgery (including lavage), exercise, and medical therapy. Our aim was to include studies on middle-aged and older patients but no restriction on age was applied in the search since degenerative knee disease is rare before middle age. Studies on patients with concomitant cruciate ligament injuries were excluded.

For the search on harms we also allowed cohort studies, register-based studies and case series, again excluding studies on patients with concomitant cruciate ligament injuries.

Literature search and study selection: Systematic searches for benefits and harms were carried out in Medline, EMBASE, CINAHL, Web of Science and the Cochrane Central Register of Controlled Trials (CENTRAL) in April 2014 and updated in August 2014. Due to advances in surgical and anaesthetic procedures over time we only included studies published in 2000 or later for harms. The search strategies were adjusted according to the individual database specifications (see Appendix). No search restrictions were set for follow-up time, patient age, study size or language. Two members of the study team independently assessed all titles and abstracts of identified reports for
eligibility (benefits: JBT and CBJ, harms: JBT and LSL). The full text was obtained if a study was judged eligible by at least one of the reviewers. Reference lists of included studies were reviewed to identify additional studies. Disagreements on inclusion were resolved by consensus.

Data collection: The pre-specified outcomes for benefits were patient-reported pain and physical function. When a report provided data on more than one pain and/or physical function scale a published hierarchy for selection of patient-reported outcomes was used (please refer to the PROSPERO protocol). Outcomes were extracted for all reported follow-up assessments in the included studies. For the primary analysis on pain and physical function we used data from the primary follow-up time as defined in the individual studies, varying from 3 to 24 months. If a study had not explicitly stated a primary follow-up time the longest follow-up time from the initial trial report was included in the primary analysis. The standard deviation was extracted or estimated from the confidence interval, the p-value, inter-quartile range or other methods recommended by the Cochrane Handbook for Systematic Reviews. If necessary, means and measures of dispersion were approximated from figures in the included studies.

In addition to the outcomes specified above we extracted: number of subjects allocated to intervention and control group, distribution of sex, mean age at baseline, body mass index (BMI) at baseline, baseline pain (transformed into a VAS pain scale from 0-100 mm) and interventions performed in the intervention and control group. We also extracted data on the presence or absence of radiographic knee osteoarthritis in the study populations. As some studies included both patients with and without radiographic knee osteoarthritis we divided the studies into 3 sub-groups based on the population included:

A. No radiographic knee osteoarthritis population (i.e. all patients had Kellgren & Lawrence (K/L) grade 0 or 1).
B. Radiographic knee osteoarthritis population (i.e. all patients had K/L grade 2 or higher)

C. Mixed population (some patients with and some without radiographic knee osteoarthritis)

In studies using the Ahlbäck scale for defining radiographic knee osteoarthritis a grade of 0 was considered as no radiographic knee osteoarthritis, whereas grade 1 or higher was considered as radiographic knee osteoarthritis.

Adverse events extraction: We extracted all adverse events reported. However, a priori we had decided only to perform meta-analysis on the following adverse events: deep-vein thrombosis (DVT), pulmonary thromboembolism (PE), venous thromboembolism (VTE), infection and death (all cause mortality). These adverse events were chosen based on a preliminary search and the seriousness and frequency. If a study did not report rate of VTE but reported both DVT and PE the latter two (DVT and PE) were combined to generate a VTE variable for meta-analysis.

In addition to adverse events the following were registered: study design, mode of reporting (i.e. per patient or procedure), sample size, period of adverse events collection, types of adverse events and number of adverse events. Customised forms were used to independently extract all data for benefits (JBT, CBJ) and harms (JBT, CBJ, LSL).

Synthesis of results: For the analysis on benefits the effect size (ES) in the individual studies was calculated as standardized mean difference (SMD) allowing pooling and comparison of the various outcomes assessed in the individual trials. The SMD was estimated as the difference between the mean score of the intervention and control groups divided by the pooled standard deviation (SD) of the final score. This estimate of the effect size using SMD has a slight bias overestimating the effect size and a correction factor was applied to convert the effect size to Hedges g. Meta-analysis was applied to combine the individual study results using the STATA software package (Version 13.0;
Stata Corp., College Station, TX). We applied the REstricted Maximum Likelihood (REML) method to estimate the combined effect size and the between study variance. Heterogeneity between trials was examined with the Q-tests, and calculated as the \( I^2 \) statistics\(^{33} \) measuring the proportion of variation (i.e. inconsistency) in the combined estimates due to between-study heterogeneity.\(^{34} \) The ES measured in SMD was transformed into a visual analog scale (VAS) ranging from 0 to 100 mm using a published approach.\(^{35} \) Furthermore, we used the formula proposed by Chinn\(^{36} \) in the Cochrane Handbook to estimate the odds ratio and number needed to treat (NNT).\(^{35 37 38} \) The effect of arthroscopic surgery involving partial meniscectomy and/or debridement was analysed for patient-reported pain and physical function. Subgroup analyses were conducted to explore the impact of severity of degenerative knee disease defined by presence of radiographic knee osteoarthritis in the respective study populations (No patients with radiographic knee osteoarthritis, patients with or without radiographic knee osteoarthritis, all patients had radiographic knee osteoarthritis), the effect of partial meniscectomy with or without concomitant debridement, risk of bias, and type of study design. To investigate if the results were dependent on follow-up time, meta-analysis was also conducted on all available follow-up time points with at least two studies available.

In the analysis on harms the numbers of adverse events were transformed into log odds of events allowing pooling of data from the individual studies. Results are reported as number of adverse events per 1 000 procedures with 95% confidence intervals. We applied a REstricted Maximum Likelihood (REML) method to estimate the combined odds of events and the between study variance. Study heterogeneity was assessed with the \( I^2 \) statistics.

Risk of bias assessment: Assessment of risk of bias was conducted independently by two reviewers (JBT and CBJ) using the Cochrane Handbook for Systematic Reviews of Interventions.\(^{29} \) For studies on benefits the two reviewers independently assessed: sequence generation, allocation
Concealment, blinding, incomplete outcomes data addressed, selective outcome reporting and other
bias. For harms each of the included studies were assessed for: intervention description, type of
adverse events reported and loss to follow-up. Each of the domains was scored as ‘adequate’,
‘inadequate’ or ‘unclear’. Disagreements were resolved by consensus. For a full elaboration on the
criteria for each of the bias assessment domains please refer to the study protocol (PROSPERO
registration number CRD42014009145).

Patient involvement: No patient involvement in the present study.

RESULTS

Benefits

The literature search yielded 1 789 reports after exclusion of duplicates. Of these 18 were
considered for inclusion after title and abstract review. After full-text review 6 reports were
excluded because of no or insufficient data on patient reported pain or physical function \(^{39,44}\) and 2
because they were not clinical trial reports. \(^{45,46}\) Ten reports on 9 different trials were included in the
systematic review (Appendix, Figure S1). \(^{7-14,47}\) One report was not included in the final meta-
analysis as it was a secondary trial report and the only providing 5-year follow-up data. \(^{47}\)

Study characteristics: The 9 included trials had randomly allocated 1 270 patients to interventions
including arthroscopic surgery with partial meniscectomy and/or debridement, or a variety of
control treatments ranging from placebo surgery to exercise (Appendix, Table S1). Mean patient
age in the individual trials ranged from 49.7 to 62.8 years. Mean baseline pain in the included
studies ranged from 36 to 63 mm on a 0-100 mm Visual Analogue Scale (VAS). In two trials \(^{8,10}\) all
patients had radiographic knee osteoarthritis (K/L grade 2 or more), in 5 trials \(^{7,9,11,12,15,47}\) some of
the patients had radiographic knee osteoarthritis and in 2 trials \(^{13,14}\) no patients had radiographic
knee osteoarthritis. The follow-up time for the primary end point in the trials varied between 3 and 24 months.

Synthesis of results: Our primary analysis for pain, combining the individual trial’s primary end points ranging from 3 to 24 months, showed a small but statistically significant benefit for interventions including knee arthroscopy compared with control treatments (ES 0.14 95% CI 0.03 to 0.26; $I^2=0.0\%$) (Figure 1 and Appendix Table S5). This effect size corresponds to a difference of 2.4 mm (95% CI 0.4 to 4.3) between treatment groups on a 0-100 mm VAS scale. Evaluating between group differences at different post-operative time points revealed a statistically significant benefit in favour of interventions including knee arthroscopy at 3 months (ES 0.27 95% CI 0.14 to 0.41; $I^2=20.6\%$) and 6 months (ES 0.18 95% CI 0.05 to 0.30; $I^2=0.0\%$), but not at later post-operative times (Figure 2 and Appendix Table S5). For physical function, no significant difference was observed between interventions including knee arthroscopy compared with control treatments (ES 0.09 95% CI -0.05 to 0.24; $I^2=12.0\%$) (Figure 3). When evaluating physical function over time no between group differences where observed at any of the analysed time points (Figure 4).

Risk of bias: Agreement between assessors on risk of bias ranged from 78 to 100% (i.e. kappa values ranging from 0.53 to 1.00). Only one included report was assessed as ‘adequate’ on all domains$^{14}$ (Appendix, Table S2), and only two reports$^{8,14}$ assessed as ‘adequate’ for blinding. The remaining studies$^{7,9-13,15,47}$ were not blinded.

Subgroup analysis: Analysis on the effect of risk of bias showed no differences between studies scored as adequate, unclear or inadequate on any of the domains investigated (Figure 5 and Appendix, Figure S2). Subgroup analyses on the primary endpoint analysis on pain and physical function were also done for study population osteoarthritis status (ranging from no radiographic osteoarthritis at all via a mixed population to all having radiographic osteoarthritis), and for surgery
type (partial meniscectomy with or without concomitant debridement) (Figure 6 and Appendix, Figure S3). These analyses did not change the interpretation of the results from the primary analyses. Subgroup analysis stratified for presence/absence of mechanical symptoms was not possible due to lack of data. In a further subgroup analysis to evaluate the influence of study design, we found no differences between studies with different control interventions (Figure 6).

**Harms**

Titles and abstracts were screened of 2 330 reports after exclusion of duplicates and of these 37 were full text reviewed. This resulted in exclusion of 28 reports, leaving 9 reports for meta-analysis (Appendix, Figure S1).

Study characteristics: 2 randomised trials and 7 observational/registry studies reported on adverse events. (Appendix, Table S3). Quality of reporting of adverse events was frequently low in both observational studies and in randomized clinical trials, and only two of nine arthroscopy trials provided useful information on adverse events.

Synthesis of results: Deep venous thrombosis was the most frequently reported symptomatic adverse event associated with arthroscopic meniscectomy with 4.13 events per 1000 procedures (95% CI 1.78 to 9.60), followed by infection, pulmonary embolism and death (Table 1 and Appendix Table S5). Heterogeneity of all the estimates was high (Table 1).

Risk of bias: Only one study was assessed as ‘adequate’ on all three domains. All reports sufficiently described the surgical intervention but 7 of 9 studies only reported few types of adverse events in the same report (Appendix, Table S4).
DISCUSSION

Principal findings. In this meta-analysis, where the primary endpoint of each of the included nine randomized trials ranged from 3 to 24 months after surgery, we found a small but statistically significant pain relief from interventions including arthroscopic surgery compared with control treatments corresponding to a 2.4 mm between group difference on a 0-100 mm VAS scale. When pain was analysed for different post-operative time points, the benefit favouring arthroscopic surgery was present only at three and six months, but not at later time points. We found no between group differences for self-reported physical function in any of the analyses. Deep venous thrombosis was the most frequently reported symptomatic adverse event, followed by infection, pulmonary embolism and death.

Strengths and weaknesses. Previous systematic reviews have investigated the benefits of knee arthroscopy in patients with established knee osteoarthritis or no/mild knee osteoarthritis. To the best of our knowledge the present report is the first systematic review and meta-analysis to include both benefits and harms of arthroscopic surgery and to include the whole continuum of degenerative knee disease, ranging from patients with degenerative meniscal tears without radiographic changes to patients with meniscal tears and other joint changes combined with more severe radiographic changes. We included all identified randomised controlled trials of arthroscopic surgery for the degenerative knee comparing interventions including arthroscopic surgery with control treatments. To facilitate interpretation of pain and function results we base our analysis on patient-reported pain and function. Composite measures of “knee function”, aggregating arbitrarily weighted more or less correlated items into one score, are notoriously difficult to interpret, and were therefore not included. We also searched the literature for information on harms associated with this intervention, and included observational studies published from year 2000 and later. The individual
trials from different countries and populations showed consistent results, with low heterogeneity for benefit, while heterogeneity for harms was large.

Only two of the nine arthroscopy trials were adequate for blinding, and these trials included a control group with sham surgery. Many of the other trials, being inadequately blinded and using control groups with various non-invasive treatments, were according to the Cochrane Collaboration criteria assessed as having a high risk for bias. Given that invasive procedures have a stronger placebo effect than non-invasive, the resulting bias from inadequate or absent blinding would be expected to favour the treatment arm including arthroscopic surgery.

The focus of 5/9 trials was by study design on the additional benefit from arthroscopic surgery when the same non-surgical intervention was provided to both the intervention and comparator group. The exercise therapy component, applied both in the intervention and in the comparator arms, was in many cases of inadequate dose for an optimal efficacy, or poorly described. In light of our incomplete understanding of the possible interaction between exercise therapy and a surgical intervention and their resulting combined efficacy, compared with the efficacy of exercise therapy in isolation, the resulting direction of bias is uncertain.

The randomised controlled trials of arthroscopic surgery were small, limiting their usefulness in assessing harms, and the majority of them provided no useful information on adverse events. We therefore included observational studies to obtain information on harms associated with arthroscopic surgery involving meniscectomy and/or debridement. The heterogeneity for assessing harms was high, reflecting differences in study size, design and quality of reporting of adverse events. Generally, the terminology and consistency in reporting of adverse events was poor. We did not systematically search the literature for harms associated with the control treatments, notably exercise. However, serious adverse events appear rare while minor events related to joint
pain and muscle soreness are commonly reported from resistance training, including from knee OA
patients.88

Meaning of the study The overall additional benefit on pain from arthroscopic surgery, using the
primary endpoint of each trial, was small (ES 0.14) and limited in time. This benefit is comparable
to the small pain-relieving effect on knee pain seen from paracetamol (ES 0.14), less than that of
non-steroidal anti-inflammatory drugs (ES 0.29),89 and markedly smaller than the moderate to large
pain relieving effect seen from exercise therapy as treatment for knee OA (overall SMD 0.50
regardless of type or dose, or exercise performed 3 times a week SMD 0.68).86 A previous
systematic review and meta-analysis of benefits of arthroscopy suggested that a clinically relevant
improvement for arthroscopic surgery in this patient group would correspond to an SMD of 0.45.81
Effect sizes can be difficult to interpret and we therefore converted them to mm on a 0-100 visual
analogue scale. The effect size of 0.14 corresponds to difference of 2.4 mm. This is a negligible
difference on a 0-100 scale and much smaller than the 15-20 mm commonly suggested to represent
a clinically relevant difference for pain.90 Claims of benefit in subgroups of patients are not
supported by published evidence.

We observed a substantial improvement in the intervention group receiving surgery, corresponding
to the clinical impression of many surgeons.16-19 Accordingly, recent reports show an increase, or no
decrease, in the incidence of arthroscopic knee surgery in middle-aged or elderly with persistent
knee pain.3 20-23 However, the improvements in the control groups were similarly impressive with
no clinically relevant between-group differences at any time point. This is in line with a recent
systematic review of the use of placebo controls in the evaluation of surgery, with considerable
improvement in placebo arms of randomized trials, with similar or only marginally superior benefit
from surgery in half of the included studies.91 92
Arthroscopic meniscectomy is associated with short-term risk of harms of which the most common was deep venous thrombosis, and in rare cases death. Arthroscopic meniscus resection may also be associated with long-term harms. Resection of the meniscus increases local contact pressures in the knee, increasing the risk for development of osteoarthritis. In support, patients with previous knee surgery undergo total knee arthroplasty at a significantly younger age than patients without previous knee surgery.

Arthroscopic surgery in the middle-aged and older population with knee pain represents the majority of all arthroscopies, and is routinely performed on the basis of a suspected meniscal tear by clinical examination or as diagnosed by magnetic resonance imaging, reasoning that the pain is associated with the meniscal tear. However, meniscal tears and other structural abnormalities (e.g. osteophytes, cartilage damage, bone marrow lesions) are characteristics of knee osteoarthritis, often co-exist, and are common findings in painful knees but also commonly occur in pain free knees in the middle-aged and older. Such joint damage is often present without a history of distinct trauma but considered to be of ‘degenerative’ nature and indicative of early knee osteoarthritis. Thus, middle-aged patients with knee pain and meniscal tears should be considered having early stage osteoarthritis and be treated according to clinical guidelines of knee osteoarthritis starting with information, exercise and often weight loss.

Unanswered questions & future research. Available evidence thus supports the reversal of a common medical practise. However, disinvestment of commonly used procedures remains a challenge, and arthroscopy usage appears undiminished, in analogy with use of vertebroplasty following the publication of trials showing absence of benefit of this procedure. Surgeon confirmation bias in combination with financial aspects and administrative policies may be factors more powerful than evidence in driving practise patterns.
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Role of authors

JBT, CBJ, EMR and LSL all participated in the conception and design of the study. JBT, CBJ and LSL were responsible for acquisition of data. CBJ conducted the analysis and JBT, EMR and LSL took part in the interpretation of the analysis. JBT and LSL drafted the manuscript. All authors critically revised the manuscript for important intellectual content and approved the final version of the manuscript. LSL is guarantor.

Competing interests

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author). LSL declares having received personal fees from: Össur, Flexion Therapeutics, Medivir, Teijin, MerckSerono, Allergan and Galapagos, and is editor-in-chief of Osteoarthritis and Cartilage. EMR declares having received personal fees for lectures and royalties for books from: Össur, Finnish Orthopedic Society, Studentlitteratur and Munksgaard, and is an associate editor of Osteoarthritis and Cartilage. JBT and CBJ declare no support from any company or institution for the submitted
work; no financial relationships with any companies or institutions that might have an interest in the
submitted work in the previous 3 years; no other relationships or activities that may appear to have
influenced the submitted work.

**Ethical approval**

Not required.

**Transparency declaration**

The lead author (JBT) affirms that this 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, if relevant, registered) have been explained.

**Data sharing**

Statistical code and dataset available from the corresponding author.
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surgery beneficial in treating non-traumatic, degenerative medial meniscal tears? A five year


Figure legends

Figure 1: Results of the primary analysis on the benefit on patient-reported pain of interventions including arthroscopic knee surgery compared with control interventions (follow-up time range: 3-24 months).

Figure 2: Effect of interventions including arthroscopic knee surgery compared with control interventions on patient-reported pain presented as difference in mm on a 0-100 mm Visual Analogue Scale (VAS) with 95% confidence interval error bars. Table below shows number of studies and patients included in the analyses at the different follow-up time points with estimated difference between interventions calculated as effect size (ES) with estimates of heterogeneity (I²).

*Data from 2 months follow-up from Osteraas et al. and Sihvonen et al. are included in the 3 months estimate.

Figure 3: Results of the main analysis on the benefit on patient-reported physical function of interventions including arthroscopic knee surgery compared with control interventions (follow-up time range: 3-24 months).

Figure 4: Effect of interventions including arthroscopic knee surgery compared with control interventions on patient-reported physical function presented as difference in mm on a 0-100 mm Visual Analogue Scale (VAS) with 95% confidence interval error bars. Table below shows number of studies and patients included in the analyses at the different follow-up time points with estimated difference between interventions calculated as effect size (ES) with estimates of heterogeneity (I²).
*Data from 2 months follow-up from Osteraas et al. and Sihvonen et al. are included in the 3 months estimate.

**Figure 5:** Evaluation of risk of bias in the primary analysis on pain. *P*-value indicates difference between studies dependent on risk of bias scoring (i.e. adequate, inadequate and unclear).

**Figure 6:** Subgroup analysis on the primary analysis on pain stratified by study population knee OA status, surgery type (i.e. arthroscopic partial meniscectomy (APM) without or with concomitant debridement) and study design. *P*-value indicates difference between the different sub-groups.
# TABLES

## Table 1: Summary of meta analysis on harms of arthroscopic meniscectomy

<table>
<thead>
<tr>
<th>Number of studies (number of patients/procedures)</th>
<th>Number of AE, per 1 000* (95% CI)</th>
<th>(I^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVT 5 (432 663)</td>
<td>4.13 (1.78 to 9.60)</td>
<td>98.3%</td>
</tr>
<tr>
<td>PE 6 (736 823)</td>
<td>1.45 (0.59 to 3.54)</td>
<td>98.6%</td>
</tr>
<tr>
<td>VTE 6 (571 793)</td>
<td>5.68 (2.96 to 10.9)</td>
<td>99.3%</td>
</tr>
<tr>
<td>Infection 4 (946 230)</td>
<td>2.11 (0.80 to 5.56)</td>
<td>99.6%</td>
</tr>
<tr>
<td>Death 2 (106 967)</td>
<td>0.96 (0.04 to 23.9)</td>
<td>90.3%</td>
</tr>
</tbody>
</table>

AE = Adverse events, CI = Confidence interval, DVT = Deep-vein thrombosis, PE = Pulmonary thromboembolism, VTE = Venous thromboembolism. *Mix of studies reporting per patient and per procedure.
FIGURES

Figure 1

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>ES (95% CI)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chang</td>
<td>1983</td>
<td>-0.07 (-0.77 to 0.63)</td>
<td>2.74</td>
</tr>
<tr>
<td>Mosely</td>
<td>2002</td>
<td>0.07 (-0.26 to 0.40)</td>
<td>12.36</td>
</tr>
<tr>
<td>Herrlin</td>
<td>2007</td>
<td>0.18 (-0.23 to 0.60)</td>
<td>7.78</td>
</tr>
<tr>
<td>Kirkley</td>
<td>2008</td>
<td>0.13 (-0.18 to 0.43)</td>
<td>14.56</td>
</tr>
<tr>
<td>Østerås</td>
<td>2012</td>
<td>-0.45 (-1.42 to 0.52)</td>
<td>1.43</td>
</tr>
<tr>
<td>Katz</td>
<td>2013</td>
<td>0.22 (0.01 to 0.44)</td>
<td>28.52</td>
</tr>
<tr>
<td>Sihvonen</td>
<td>2013</td>
<td>0.08 (-0.24 to 0.41)</td>
<td>12.67</td>
</tr>
<tr>
<td>Yim</td>
<td>2013</td>
<td>-0.06 (-0.45 to 0.33)</td>
<td>8.87</td>
</tr>
<tr>
<td>Gauffin</td>
<td>2014</td>
<td>0.35 (0.00 to 0.70)</td>
<td>11.07</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td>0.14 (0.03 to 0.28)</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Original weight displayed. Largest to smallest ratio 19.98
Figure 2

Difference in pain at 3 to 24 month follow-up

Favouring interventions incl. surgery

Favouring control interventions

<table>
<thead>
<tr>
<th>Time (months)</th>
<th>No. of trials</th>
<th>No. of patients</th>
<th>Interventions incl. surgery vs control interventions, ES (95% CI)</th>
<th>P² (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>9</td>
<td>1 270</td>
<td>0.37 (0.14 to 0.61)</td>
<td>0.00</td>
</tr>
<tr>
<td>3*</td>
<td>9</td>
<td>1 162</td>
<td>0.18 (0.05 to 0.41)</td>
<td>0.00</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>1 002</td>
<td>0.66 (-0.06 to 0.18)</td>
<td>0.00</td>
</tr>
<tr>
<td>12</td>
<td>7</td>
<td>1 049</td>
<td>0.61 (-0.32 to 0.13)</td>
<td>0.00</td>
</tr>
<tr>
<td>18</td>
<td>7</td>
<td>308</td>
<td>0.66 (-0.13 to 0.25)</td>
<td>0.00</td>
</tr>
<tr>
<td>24</td>
<td>3</td>
<td>434</td>
<td>0.66 (-0.13 to 0.25)</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Figure 3

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>ES (95% CI)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chang</td>
<td>1993</td>
<td>0.13 (-0.57 to 0.83)</td>
<td>3.55</td>
</tr>
<tr>
<td>Mosely</td>
<td>2002</td>
<td>-0.08 (-0.41 to 0.25)</td>
<td>15.97</td>
</tr>
<tr>
<td>Herrlin</td>
<td>2007</td>
<td>-0.13 (-0.54 to 0.29)</td>
<td>10.11</td>
</tr>
<tr>
<td>Kirkley</td>
<td>2008</td>
<td>0.02 (-0.28 to 0.33)</td>
<td>18.91</td>
</tr>
<tr>
<td>Katz</td>
<td>2013</td>
<td>0.24 (0.03 to 0.46)</td>
<td>36.94</td>
</tr>
<tr>
<td>Gauflin</td>
<td>2014</td>
<td>0.17 (-0.17 to 0.52)</td>
<td>14.52</td>
</tr>
</tbody>
</table>

Overall effect (remt) (I-squared = 11.9%, p = 0.502)

0.09 (-0.05 to 0.24) 100.00

Original weights displayed. Largest to smallest ratio 8.10

Favouring control interventions  Favouring interventions incl. surgery
Figure 4

Difference in physical function at 3 to 24 month follow-up

Favouring interventions incl. surgery

Favouring control interventions

<table>
<thead>
<tr>
<th>No. of patients</th>
<th>Interventions incl. surgery vs control interventions, ES (95% CI)</th>
<th>I^2(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>999</td>
<td>0.10 (-0.28 to 0.28)</td>
<td>40.0</td>
</tr>
<tr>
<td>894</td>
<td>0.05 (-0.14 to 0.24)</td>
<td>36.6</td>
</tr>
<tr>
<td>754</td>
<td>0.01 (-0.13 to 0.15)</td>
<td>0.0</td>
</tr>
<tr>
<td>798</td>
<td>0.00 (-0.23 to 0.23)</td>
<td>0.0</td>
</tr>
<tr>
<td>308</td>
<td>0.02 (-0.23 to 0.20)</td>
<td>0.0</td>
</tr>
<tr>
<td>331</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 5

![Figure 5: Diagram showing the effect size (ES) with 95% CI for different factors such as sequence generation, concealment of allocation, blinding, incomplete data addressed, and selective outcome report. The diagram compares interventions favoring control interventions versus interventions including surgery.](https://mc.manuscriptcentral.com/bmj)
Figure 6
Difference in pain at 3 to 24 month follow-up

<table>
<thead>
<tr>
<th>Months</th>
<th>No. of trials</th>
<th>No. of patients</th>
<th>Interventions incl. surgery vs control interventions, ES (95% CI)</th>
<th>P (NS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>9</td>
<td>1270</td>
<td>0.27 (0.14 to 0.41)</td>
<td>0.006</td>
</tr>
<tr>
<td>3*</td>
<td>9</td>
<td>1162</td>
<td>0.18 (0.05 to 0.30)</td>
<td>0.006</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td>1002</td>
<td>0.06 (-0.06 to 0.18)</td>
<td>0.006</td>
</tr>
<tr>
<td>12</td>
<td>7</td>
<td>1049</td>
<td>0.01 (-0.02 to 0.03)</td>
<td>0.006</td>
</tr>
<tr>
<td>18</td>
<td>2</td>
<td>308</td>
<td>0.06 (-0.13 to 0.25)</td>
<td>0.006</td>
</tr>
<tr>
<td>24</td>
<td>3</td>
<td>434</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

346x218mm (72 x 72 DPI)
340x235mm (72 x 72 DPI)
Difference in physical function at 3 to 24 month follow-up

Visual Analogue Scale (VAS)

Favouring interventions incl. surgery

Favouring control interventions

| No. of trials | No. of patients | Numbers (95% CI) |
|---------------|-----------------|
| 6             | 0.15 (0.05 to 0.25) |
| 4             | 0.05 (0.04 to 0.15) |
| 5             | 0.01 (0.01 to 0.02) |
| 2             | 0.00 (0.00 to 0.02) |
| 2             | -0.02 (-0.02 to 0.00) |

335x207mm (72 x 72 DPI)
<table>
<thead>
<tr>
<th>Studies P-value</th>
<th>Degree of knee osteoarthritis</th>
<th>ES (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No radiographic knee osteoarthritis</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Some with radiographic knee osteoarthritis</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Radiographic knee osteoarthritis</td>
<td>2, 425</td>
</tr>
<tr>
<td>Type of intervention</td>
<td>APM</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>APM and debridement</td>
<td>7, 44</td>
</tr>
<tr>
<td>Study design</td>
<td>Surgery vs. exercise</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Surgery vs. sham surgery/lavage</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Surgery in addition to exercise vs. exercise</td>
<td>5, 313</td>
</tr>
</tbody>
</table>

339x235mm (72 x 72 DPI)