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Arthroscopic surgery for degenerative tears of the meniscus: a systematic review and meta-analysis

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Abstract

Background: Arthroscopic surgery for degenerative meniscal tears is a commonly performed procedure, yet the role of conservative treatment for these patients is unclear. This systematic review and meta-analysis evaluates the efficacy of arthroscopic meniscal débridement in patients with knee pain in the setting of mild or no concurrent osteoarthritis of the knee in comparison with nonoperative or sham treatments.

Methods: We searched MEDLINE, Embase and the Cochrane databases for randomized controlled trials (RCTs) published from 1946 to Jan. 20, 2014. Two reviewers independently screened all titles and abstracts for eligibility. We assessed risk of bias for all included studies and pooled outcomes using a random-effects model. Outcomes (i.e., function and pain relief) were dichotomized to short-term (< 6 mo) and long-term (< 2 yr) data.

Results: Seven RCTs (n = 805 patients) were included in this review. The pooled treatment effect of arthroscopic surgery did not show a significant or minimally important difference (MID) between treatment arms for long-term functional outcomes (standardized mean difference [SMD] 0.07, 95% confidence interval [CI] –0.10 to 0.23). Short-term functional outcomes between groups were significant but did not exceed the threshold for MID (SMD 0.25, 95% CI 0.02 to 0.48). Arthroscopic surgery did not result in a significant improvement in pain scores in the short term (mean difference [MD] 0.20, 95% CI –0.67 to 0.26) or in the long term (MD –0.06, 95% CI –0.28 to 0.15). Statistical heterogeneity was low to moderate for the outcomes.

Interpretation: There is moderate evidence to suggest that there is no benefit to arthroscopic meniscal débridement for degenerative meniscal tears in comparison with nonoperative or sham treatments in middle-aged patients with mild or no concomitant osteoarthritis. A trial of nonoperative management should be the first-line treatment for such patients.

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Arthroscopic meniscal débridement is one of the most commonly performed procedures in orthopedic surgery. More than 700 000 such procedures are performed each year in the United States, and more than 4 million are performed each year worldwide, with substantial economic and social burdens.[1–6] Many patients who undergo arthroscopic meniscal débridement have concurrent osteoarthritis, and orthopedic surgeons are often challenged to determine the true cause of patients' symptoms: the meniscal tear, osteoarthritis or a combination of both.[7]

Although 2 well-designed randomized controlled trials (RCTs)[8,9] have shown a lack of efficacy for arthroscopic surgery in patients with severe and advanced knee arthritis, many patients present with degenerative meniscal tears and mild or minimal concurrent osteoarthritis.[10] Patients with degenerative meniscal tears in the setting of mild osteoarthritis may experience functional improvement or pain relief with arthroscopic surgery,[11–14] but the role of conservative treatment is unclear.[15–17] Arthroscopic surgery involves the potential for complications, which must be weighed against the prognosis for relief from presenting symptoms.[6,18]

The objective of this systematic review and meta-analysis was to evaluate the efficacy of arthroscopic meniscal débridement in comparison with nonoperative or sham treatments in patients with degenerative meniscal tears and knee pain with regard to function and pain relief in the short term (< 6 mo) and long term (< 2 yr).

Methods

We conducted this study according to the methods of the *Cochrane Handbook for Systematic Reviews of Interventions*.[19] The findings are reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[20]

Eligibility criteria

We included RCTs that 1) involved patients of any age or sex with degenerative meniscal tears and mild or no concurrent osteoarthritis presenting with knee pain, and 2) compared arthroscopic meniscal débridement (with or without concurrent articular débridement) with nonoperative treatments.

No restriction was made regarding publication date, language, presence or absence of cointerventions, specific nonoperative intervention or length of follow-up. We excluded case reports, case series, prospective and retrospective cohort studies, editorials, reviews and basic science papers.

Identification of trials

We used multiple strategies to identify potential eligible trials. MEDLINE, Embase and the Cochrane databases were systematically searched in Ovid up to and including Jan. 20, 2014. A health sciences librarian experienced in the conduct of systematic reviews assisted in developing and performing the search. We used medical subject headings, and Emtree headings and subheadings in various combinations, and supplemented with free text to increase sensitivity (Appendix 1, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.140433/-/DC1). The search strategy was adapted in PubMed to search for articles published online ahead of print. Abstracts from recent major orthopedic and sports medicine conferences were reviewed. We consulted with experts in the field, manually reviewed the reference lists of articles that fulfilled the eligibility criteria and used the "related articles" feature in PubMed. Ongoing trials were identified from ClinicalTrials.gov.

Screening and assessment of eligibility

Two reviewers with methodologic and content expertise (M.K. and N.E.) independently screened all titles and abstracts for eligibility using a piloted electronic database (Microsoft Excel). All discrepancies were resolved by consensus. Duplicate articles were manually excluded. Both reviewers reviewed the full text of all studies identified by title and abstract screening to determine final eligibility.

Assessment of risk of bias

The same reviewers independently performed duplicate outcome-specific assessment of risk of bias using the Cochrane Collaboration's tool for risk-of-bias assessment.[19] When the issues bearing on the risk of bias were identical across outcomes, we made a single risk-of-bias assessment across outcomes.[21]

Extraction of data

Data were extracted independently and in duplicate by both reviewers using a piloted electronic data extraction form. If important data were unclear or not reported, attempts were made to contact the study authors for clarification.

Critical outcomes were determined to be patient-important outcomes related to pain, function and postintervention complications.[22,23] Functional outcomes were measured by various disease-specific assessment scales.[24–28] Postintervention pain was assessed using a visual analogue scale.[29]

Statistical analysis

We calculated interobserver agreement for reviewer's assessments of study eligibility with the Cohen κ coefficient.[30] Interobserver agreement for assessments of methodologic quality was calculated with the intraclass correlation coefficient. The κ and intraclass correlation coefficients were calculated using SPSS software (version 21.0, SPSS Inc.).

We used standardized mean differences (SMDs) to summarize outcome instruments that measured similar constructs.[19] We pooled SMDs from individual trials to obtain the pooled estimate of effect for each outcome. The SMDs were weighted by sample size using the random effects model based on the inverse variance method.[19] We transformed scores when required to ensure that higher scores indicated improved function in all cases.[19] When standard deviations (SDs) were not available, they were calculated from alternative measures or were otherwise estimated from trials within the same comparison with similar scales, outcomes and periods.[19,31] We extracted data from graphical representations when required. When knees were randomized in trials, they were treated as individual participants.

To improve interpretability, we converted SMD results to the Knee Injury and Osteoarthritis Outcome Score (KOOS).[32,33] The KOOS evaluates patient outcomes over 5 domains. These include pain frequency and severity; symptoms; difficulty with activities of daily living; difficulty experienced with sport and recreational activities; and knee-related quality of life. This scoring system has been used extensively in this patient population, and has been validated and shown to be reliable and responsive to change.[34] The minimal important difference (MID) (i.e., the smallest difference that an informed patient would perceive as important enough to justify a change in management) is estimated to be 10 for the KOOS, which was converted to units of SD using the KOOS median SD.[27] The approximation of the SMD as a KOOS is carried out through the following formula: mean difference (KOOS units) = SMD × (median SD of KOOS).[32] A zone of clinical equiv-

alence based on the converted MID was projected onto the forest plots to aid interpretability.

Outcomes were dichotomized to short-term (< 6 mo) and long-term (< 2 yr) data. We pooled sham surgery and nonoperative treatment given the similar underlying conservative nature of the procedures. Complications were tabulated and presented descriptively.

To assess for publication bias, we constructed funnel plots that examined sample size versus exposure effect across included trials for functional outcome at 2-year follow-up.[19] The forest and funnel plots were created with RevMan 5.2 (The Cochrane Collaboration).

Evaluation of heterogeneity and sensitivity analyses

We quantified heterogeneity using the χ^2 test for heterogeneity and the I^2 statistic.[19] The I^2 statistic estimates the proportion of total variability between studies due to heterogeneity rather than chance alone. We considered I^2 less than 25% to indicate low heterogeneity and I^2 greater than 75% to indicate considerable heterogeneity.[19] We developed a priori hypotheses to explore both potential artifactual and real differences of treatment effect across trials.[35] We planned for subgroup analysis based on year of study to account for potential evolution of surgical technique. Sensitivity analyses were planned for studies to investigate the effects of missing data and those trials at high risk of bias.[36]

Results

Search results and study characteristics

The literature search identified 946 potentially relevant studies: 944 from the electronic search and 2 from the manual search. Seven RCTs (n = 805 patients) were eligible for inclusion in this review[37–43] (Figure 1). No non-English articles were identified. The κ for overall agreement between reviewers for the final eligibility decision was 0.92 (95% confidence interval [CI] 0.85 to 1.00).

Of the 7 trials, 5 were conducted in Europe, 1 in the US[39] and 1 in South Korea.[41] Four of the included trials were single-centre trials[37,38,41,43] and 3 were multicentre trials[39,40,42] (Table 1).

All eligible trials included patients with degenerative meniscal tears, documented by magnetic resonance imaging (MRI) or arthroscopy, in the setting of mild or no osteoarthritis. Sample sizes ranged from 8 to 330, and the total sample included 811 knees (805 patients). The mean age of patients was 56 (± 3.2) years. Age eligibility criteria from included studies ranged from 35 to 65 years when reported.[37–40,42]

Two trials[37,41] did not report crossovers to the surgical arm. Of the trials that did report crossover, Herrlin and colleagues[38] reported 27%, Katz and colleagues[39] reported 30%, Østerås and colleagues[42] reported 0%, Vermesan and colleagues[43] reported 17%, and Sihvonen and colleagues[40] reported 7%. Six trials[37–42] documented patients who declined to participate, with rates ranging from 5%[39] to 40%.[38] Reasons for nonparticipation when described included preference for arthroscopic or conservative management, lack of symptoms while on surgical wait list and refusal due to time commitment.

Three trials specifically documented that no other surgical co-interventions were performed during the arthroscopic débridement procedure.[39–41] Five of the 7 included studies documented similar nonoperative rehabilitation programs between groups undergoing operative and nonoperative interventions.[37–41]

Risk of bias

Only 1 included study was found to have a low risk of bias.[40] The remainder of the included trials were found to have uncertain to high risk of bias (Figure 2). Agreement between reviewers in the assessment of risk of bias was high (intraclass correlation coefficient 0.93, 95% CI 0.88 to 0.96). Appendix 2 (available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.140433/-/DC1)

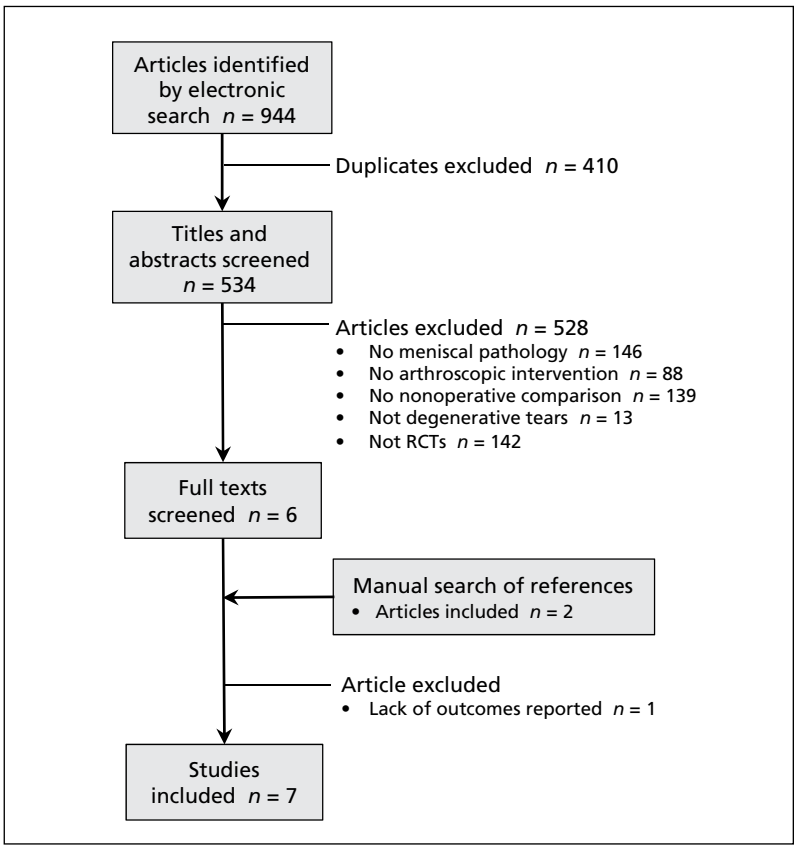

Figure 1: Selection of randomized controlled trials (RCTs) for inclusion in the meta-analysis.

presents a summary of findings providing outcomes along with an evaluation of the quality of evidence based on the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.[21]

Function

Arthroscopic débridement resulted in a significant improvement in short-term function across 6 trials[37,39–43] involving a total of 805 patients (SMD 0.25, 95% CI 0.02 to 0.48) with moderate hetero-

Table 1: Studies included in the meta-analysis

Study	Year	Country	Patient characteristics		Treatment arm, no. of patients and description of treatment*		Major outcome measures	OA inclusion	Loss to follow-up
			Mean age, yr	Male sex, %	Conservative	Surgical			
Herrlin et al.[37]	2007	Sweden	55	61	43 Standardized exercise program for 8 wk	47 Arthroscopic meniscal débridement	KOOS, Lysholm Knee Scoring Scale, Tegner Activity Scale, VAS scores at 8 wk, 6 mo	Ahlbäck criteria grade 0–1	NR
Herrlin et al.[38]	2013	Sweden	55	60	49 Standardized exercise program for 8 wk	47 Arthroscopic meniscal débridement	Lysholm Knee Scoring Scale, Tegner Activity Scale, VAS scores (at rest and with activity) at 24, 60 mo	Ahlbäck criteria grade 0–1	C: 2/49 S: 2/47
Katz et al.[39]	2013	United States	58	43	169 Land-based, individualized physical therapy with progressive home exercise	161 Arthroscopic meniscal débridement	WOMAC-pf, KOOS pain scale, SF-36 physical activity scores at 3, 6, 12 mo	Kellgren–Lawrence grade 0–3	C: 2/169 S: 1/161
Østerås et al.[42]	2012	Norway	50	76	9 Exercise program 3 times/wk for 3 mo	8 Arthroscopic meniscal débridement	KOOS, VAS, HAD scores, quadriceps muscle strength at 3 mo	Kellgren–Lawrence grade 0–2	0
Sihvonen et al.[40]	2013	Finland	52	61	76 Sham surgical procedure	70 Arthroscopic meniscal débridement	Lysholm Knee Scoring Scale, WOMET, VAS, 15D, patient satisfaction scores at 2, 6, 12 mo	Kellgren–Lawrence grade 0–1	0
Yim et al.[41]	2013	South Korea	56	21	52 NSAIDs, 3 wk supervised physical exercise followed by 8 wk home exercise program	50 Arthroscopic meniscal débridement	Lysholm Knee Scoring Scale, VAS, patient satisfaction, Tegner Activity Scale scores at 3, 6 mo, 1, 2 yr	Kellgren–Lawrence grade 0–1	C: 2/54 S: 4/54
Vermesan et al.[43]	2013	Romania	58	23	60 knees Interarticular steroid injection	60 knees Arthroscopic meniscal débridement	Oxford Knee Score at 1 mo, 1 yr	Kellgren–Lawrence grade 0–1	0

Note: 15D = a health-related quality-of-life scale made up of 15 dimensions on a scale of 0 (death) to 1 (full health), C = conservative treatment arm, HAD = Hospital Anxiety and Depression, KOOS = Knee Injury and Osteoarthritis Outcome Score, NR = not reported, NSAIDs = nonsteroidal anti-inflammatory drugs, OA = osteoarthritis, S = surgical treatment arm, SF-36 = Short Form 36, VAS = visual analogue scale, WOMAC-pf = Western Ontario and McMaster Universities Osteoarthritis Index — physical function, WOMET = Western Ontario Meniscal Evaluation Tool.
*Conservative to surgical crossover: Herrlin et al.,[37] NR; Herrlin et al.,[38] 27%; Katz et al.,[39] 30%; Østerås et al.,[42] 0%; Sihvonen et al.,[40] 7%; Yim et al.,[41] NR; Vermesan et al.,[43] 17%.

geneity ($p = 0.04$, $I^2 = 56\%$). This is equivalent to an estimated KOOS mean difference of 5.6 (95% CI 0.45 to 10.8). The KOOS was included from 3 trials,[37,39,42] and scores from the Western Ontario Meniscal Evaluation Tool,[40] the Lysholm Knee Scoring Scale,[41] and the Oxford Knee Score[43] were included from 1 trial each. This treatment effect failed to exceed the threshold of patient importance based on the MID (Figure 3).

We conducted an a priori subgroup analysis to evaluate trials reporting identical outcome measures and to evaluate trials by type of conservative treatment. Trials that used the KOOS (2 trials,[37,42] $n = 107$ patients) did not show significant improvement in short-term function (SMD 0.03, 95% CI –0.35 to 0.41) and had low heterogeneity ($p = 0.86$, $I^2 = 0\%$). Removal of a study in which intra-articular steroid injection was given[43] in comparison with arthroscopic débridement decreased heterogeneity substantially (56% to 0%), which potentially accounts for the significant between-study variability with no effect on the pooled treatment effect (SMD 0.16, 95% CI 0.01 to 0.31).

Five trials[38–41,43] involving a total of 794 patients or knees that evaluated long-term function following arthroscopic débridement did not show a significant improvement in function (SMD 0.07, 95% CI –0.10 to 0.23). Heterogeneity was low ($p = 0.28$, $I^2 = 20\%$). Scores from the Lysholm Knee Scoring Scale were pooled from 3 trials;[38,40,41] KOOS[39] and Oxford Knee Score[43] values were pooled from the remaining 2 trials in this analysis (Figure 4). The result is equivalent to an estimated KOOS mean difference of 1.6 (95% CI –2.2 to 5.2), which failed to exceed the threshold of patient importance based on the MID.

Trials presenting scores from the Lysholm Knee Scoring Scale (3 trials,[38,40,41] $n = 344$ patients) did not report significant results (SMD 0.00, 95% CI –0.22 to 0.21) and had low heterogeneity ($p = 0.46$, $I^2 = 0\%$).

Pain

Arthroscopic treatment did not improve short-term pain across 4 trials[37,40–42] that reported short-term visual analogue scores from 355 patients (mean difference [MD] 0.20, 95% CI –0.67 to 0.26) with low heterogeneity ($p = 0.36$, $I^2 = 6\%$). Similarly, long-term pain after arthroscopic débridement across 3 trials[38,40,41] involving 344 patients did not show a significant improvement in pain scores (MD –0.06, 95% CI –0.28 to 0.15) and had low heterogeneity ($p = 0.75$, $I^2 = 0\%$).

Adverse events

Two trials reported on adverse events: Sihvonen and colleagues[40] reported 1 infection in the group undergoing arthroscopic meniscal débridement as compared with a sham procedure. Katz and colleagues[39] reported 3 serious adverse events in the group undergoing arthroscopic meniscal débridement and 2 in the group undergoing physical therapy.

Sensitivity analysis

We conducted a sensitivity analysis to investigate the effects of estimated missing SDs on long-term function and pain through the removal of studies that required estimated SDs. The results were not significant[41] (SMD 0.10, 95% CI –0.09 to 0.29), and heterogeneity was low ($p = 0.23$, $I^2 = 31\%$). Sensitivity analysis related to sample size did not show a significant effect[42] (SMD 0.26, 95% CI 0.02 to 0.51), and heterogeneity was substantial ($p = 0.03$, $I^2 = 64\%$).

Interpretation

Arthroscopic surgery for degenerative meniscal tears in the setting of mild or no concurrent osteoarthritis in middle-aged patients may have little, if any, effect on short-term (< 6 mo) and long-term (< 2 yr) outcomes in comparison with nonoperative management (Appendix 2).

The results of this meta-analysis are similar to those of recent trials by Moseley and colleagues[8] and Kirkley and colleagues,[9] which showed no

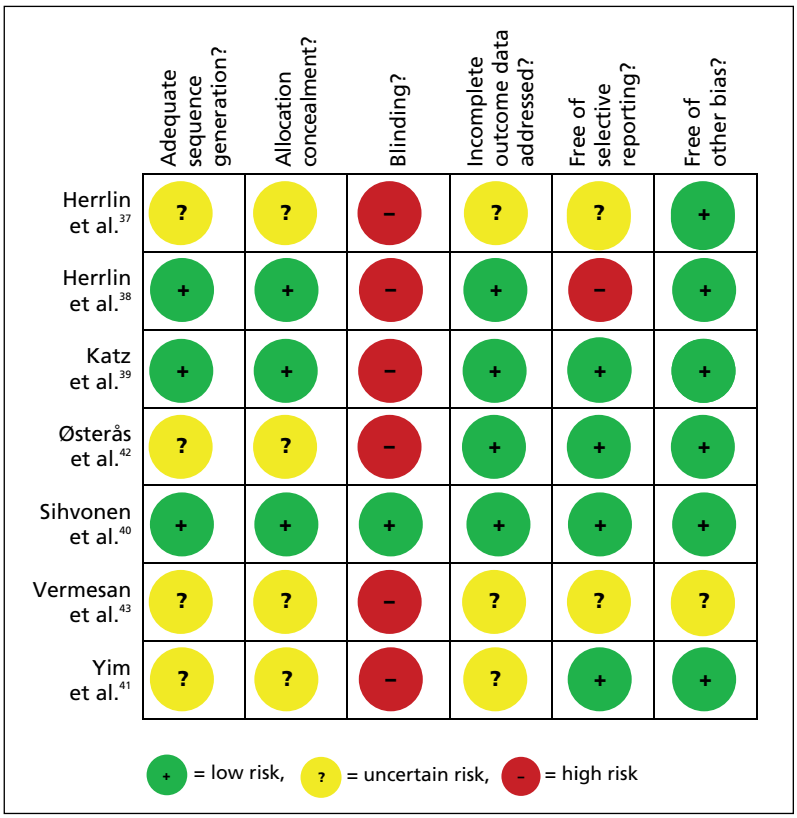

Figure 2: Risk-of-bias assessment of randomized controlled trials included in the meta-analysis.

benefit of arthroscopic débridement or lavage for osteoarthritis. Our findings extend the evidence to show a lack of clinical efficacy in surgical débridement of meniscal tears in the setting of mild or no osteoarthritis.

The results of our investigation indicate that arthroscopic management did not exceed the MID in comparison with nonoperative management in both the short and long term. The MID is the smallest effect that an informed patient would perceive as valuable enough to justify a change in therapeutic management when weighing the anticipated benefits against the possible harms of an intervention.[44,45] The MID concept has also been referred to as the minimal clinically important difference or the minimal clinically important improvement.[45] It can be estimated with an anchor-based approach (which correlates the score of interest with a known measure of clinical change) or a distribution-based approach (which suggests that one-half of an SD of a continuous outcome score constitutes a clinically meaningful difference).[23] Although not without limitations, this tool aids clinicians in evaluating therapeutic options and determining whether significant outcomes will have clinically meaningful implications.[23] A limitation of this approach is that MIDs may be context-specific and may not be applicable across treatments or populations. Minimal important differences must therefore be defined for specific populations to provide useful guidance to users of these instruments.[45] The MID has not been clearly defined for the KOOS, and an estimated 10-point change in the scale is considered the MID based on half-SD methods, although research is ongoing.[27,46–48] Future research is required to define a range of MID values for various clinical contexts to accurately identify true clinically important differences for all instruments measuring quality of life. Given these current limitations, the MID should be used as a supplementary tool for clinicians in determining the relevance of study findings.[45]

	Surgical treatment		Conservative treatment		
Study	Mean ± SD	No. patients or knees	Mean ± SD	No. patients or knees	SMD (95% CI)
Herrlin et al.[37]	80 ± 27.3	47	79.2 ± 21.3	43	0.03 (–0.38 to 0.45)
Katz et al.[39]	78.9 ± 18.1	161	74.8 ± 18.6	169	0.22 (0.01 to 0.44)
Østeråas et al.[42]	59.1 ± 23.1	8	60.3 ± 25.9	9	–0.05 (–1.00 to 0.91)
Sihvonen et al.[40]	82 ± 20.9	70	79 ± 20.5	76	0.14 (–0.18 to 0.47)
Vermesan et al.[43]	42.8 ± 3.1	60	39.9 ± 3.9	60	0.82 (0.44 to 1.19)
Yim et al.[41]	84.1 ± 17.7	50	82.3 ± 17	52	0.10 (–0.29 to 0.49)
Overall		396		409	0.25 (0.02 to 0.48)
Heterogeneity: I^2 = 56%					

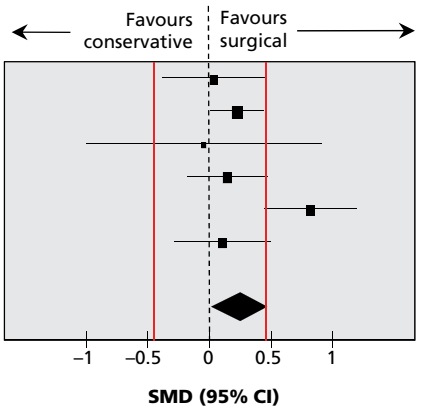

Figure 3: Pooled short-term functional outcomes of conservative and surgical treatment. Red lines show a zone of clinical equivalence based on a minimal important difference of 10 on the Knee Injury and Osteoarthritis Outcome Score.[37,39,40–43]
Note: CI = confidence interval, SD = standard deviation, SMD = standardized mean difference.

	Surgical treatment		Conservative treatment		
Study	Mean ± SD	No. patients or knees	Mean ± SD	No. patients or knees	SMD (95% CI)
Herrlin et al.[38]	93.5 ± 20	47	90 ± 11.9	49	0.21 (–0.19 to 0.61)
Katz et al.[39]	80.9 ± 17.8	161	80.7 ± 17.9	169	0.01 (–0.20 to 0.23)
Sihvonen et al.[40]	82.2 ± 16	70	83.4 ± 13.8	76	–0.08 (–0.40 to 0.24)
Vermesan et al.[43]	36.1 ± 3.6	60	34.7 ± 3.8	60	0.38 (0.01 to 0.74)
Yim et al.[41]	83.2 ± 12	50	84.3 ± 10.5	52	–0.10 (–0.49 to 0.29)
Overall		388		406	0.07 (–0.10 to 0.23)
Heterogeneity: I^2 = 20%					

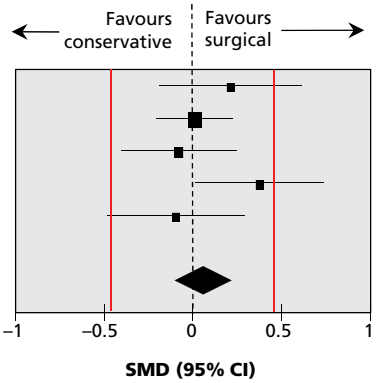

Figure 4: Pooled long-term functional outcomes of conservative and surgical treatment. Red lines show a zone of clinical equivalence based on a minimal important difference of 10 on the Knee Injury and Osteoarthritis Outcome Score.[38–41,43]
Note: CI = confidence interval, SD = standard deviation, SMD = standardized mean difference.

Limitations

When data were unavailable despite attempts to contact the authors, we estimated SDs based on similar studies. A sensitivity analysis confirmed that this was unlikely to change the results of our study. Various outcome measures were combined in the pooled analysis; however, given their disease-specific similarities, we believe this was justified. Heterogeneity was low except for in the pooled SMD scores for functional outcomes at 6 months, which is potentially explained by variation in methods of conservative treatment. A funnel plot analysis suggested a low risk of publication bias (Appendix 3, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.140433/-/DC1). A subgroup analysis related to year of publication was not required, because all included trials were conducted within the last 6 years.

Implications for practice and research

In the context of limited health care resources, clinicians must carefully select patients with degenerative meniscal pathology who would benefit from surgical intervention.[2,49] Certain prognostic factors have been identified in the literature; for example, high levels of pain at baseline correlate with inferior patient-reported outcomes after arthroscopy.[16,50] Assessment of a patient's quality of life is essential, given that abnormalities in anatomy and on MRI are not always correlated with symptoms.[7,51] With limited evidence supporting arthroscopic meniscal débridement for degenerative meniscal tears in the setting of mild or no concomitant osteoarthritis, an initial trial of nonoperative interventions should play a large role for middle-aged patients.

Limited reporting outcomes and methods are highlighted in this review and have been identified as an important problem in the surgical literature.[52,53] Five trials are currently registered on ClinicalTrials.gov, with 4 ongoing[54–57] and 1 listed as completed[58] but unpublished. Results of these trials when available will further improve our confidence in the effect of treatment.

We identified a number of patients who declined to participate or who crossed over to a different treatment arm, which may have confounded results. Future research will be important to identify the prognosis of these patients. Additionally, economic evaluation is required to assess direct and indirect costs associated with arthroscopic meniscal débridement in comparison with various options for nonoperative treatment.[59]

Future investigation into the impact of cartilage status, mechanical alignment, extent of meniscal damage, duration, severity and characteristics of symptoms, body mass index and baseline functional outcome scores may allow clinicians to further determine who may benefit from arthroscopy in this population. Comparison of various rehabilitation protocols, adjunct modalities and injections will further define optimal initial nonoperative management. Studies into novel biological treatment options are in progress and may provide additional options for clinicians.[60]

Conclusion

This systematic review and meta-analysis showed moderate evidence to suggest that there is no benefit to arthroscopic meniscal débridement for degenerative meniscal tears in comparison with nonoperative or sham treatment options for middle-aged patients with mild or no concomitant osteoarthritis. Future research is required to identify how indications and patient selection influence outcomes following surgical and conservative treatment.

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