Position Statement from the Australian Knee Society on Arthroscopic Surgery of the Knee, including reference to the presence of Osteoarthritis or Degenerative Joint Disease
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In preparing the following evidence based document, the Australian Knee Society, on behalf of the Australian Orthopaedic Association, has combined the individual clinical expertise of its members with published randomized controlled trials from a systematic review of the literature.

Part 1: Position Statement

Arthroscopic debridement, and / or lavage, has been shown to have no beneficial effect on the natural history of osteoarthritis, nor is it indicated as a primary treatment in the management of osteoarthritis. However, this does not preclude the judicious use of arthroscopic surgery, when indicated, to manage symptomatic coexisting pathology, in the presence of osteoarthritis or degeneration. Partial medial meniscectomy is not indicated as an initial treatment for atraumatic tears of degenerative menisci, excluding bucket handle tears and surgeon assessed locked or locking knees.

Arthroscopic Surgery in the Presence of Osteoarthritis or Degeneration

There are certain clinical scenarios in which arthroscopic surgery, in the presence of osteoarthritis, may be appropriate. These include, but are not necessarily limited to, the following:

- known or suspected septic arthritis
- symptomatic non-repairable meniscal tears after failure of an appropriate trial of a structured rehabilitation program
- symptomatic loose bodies
- surgeon assessed locked or locking knees
- traumatic or atraumatic meniscal tears that require repair
- inflammatory arthropathy requiring synovectomy
- synovial pathology requiring biopsy or resection
- large unstable chondral pathology causing surgeon assessed locking or locked knee
- as an adjunct to, and in combination with, other surgical procedures as appropriate for osteoarthritis: for example high tibial osteotomy and patello-femoral realignment
- diagnostic arthroscopy when the diagnosis is unclear on MRI or MRI is not possible, and the symptoms are not of osteoarthritis

The decision to proceed with arthroscopic surgery in the presence of osteoarthritis or degeneration should be made by the treating orthopaedic surgeon:

- *after careful review of the clinical scenario: particularly the assessment of the relative contributions of the osteoarthritis, and the arthroscopically treatable pathology, to the patient's symptoms*
- *with knowledge of the relevant evidence base, as listed in this document*
- *after an appropriate trial of* structured rehabilitation
- *and after thoughtful discussion with the patient about the relative merits and risks of the procedure versus ongoing non-operative treatment*
- **with an understanding that the benefits and role of arthroscopic meniscectomy after a period of failed non-operative management remain uncertain**

Definitions

Osteoarthritis, or degenerative joint disease, is a progressive clinical disorder of joints characterized by gradual diffuse loss of articular cartilage, effects on the underlying bone, and secondary compromise of joint function. This should be distinguished from focal articular cartilage pathology in an otherwise normal joint.

There is a spectrum of severity of osteoarthritis from minor partial thickness articular cartilage abnormalities to large areas of full thickness loss. Clinical decision making requires careful assessment of the degree of arthritis, its likely contribution to the symptoms, and the potential contribution of additional pathology to those symptoms.

The concepts of degenerative versus traumatic, in regard meniscal pathology and tearing, is arbitrary (1). No universally accepted definition of degeneration or degenerative change exists, and commonly used clinical diagnostic descriptors lack validity.

Assessment and Interpretation of MRI Scanning

Whilst plain radiography is the preferred initial imaging modality, MRI remains excellent adjunct both to clinical decision making, and to guiding the use of surgery. In particular, it can be used to more accurately assess the degree of arthritis, and to look for and assess additional pathology that may correlate with a patient's symptoms. MRI reports should be interpreted carefully by the treating surgeon, in combination with direct review of the imaging, when determining the clinical relevance of the findings. MRI descriptions of meniscal tearing, degeneration, and pathology in the absence of trauma, lack validity. Further information on the appropriate radiological investigation of knee osteoarthritis can be obtained in the "Radiological Investigation Joint AKS-AMSIG Submission to the Australian Commission on Quality and Safety in Healthcare on the Radiological Investigation of Knee Osteoarthritis (http://www.kneesociety.org.au/resources/Joint-AKS-AMSIG-submission-ACQSH-investigation-knee-osteoarthritis.pdf).

Part 2: Systematic Review. Arthroscopic Surgery in the Presence of Osteoarthritis

Introduction

Our aim was to examine the evidence of effectiveness, inclusion and exclusion criteria, the effects of age and adverse events, in existing knee arthroscopy randomized controlled trials, with a view to the formulation of clinical indication guidelines based on ICD – 10 codes for knee arthroscopy in the presence of degeneration or osteoarthritis.

Methods

The PRISMA statement for systematic reviews was utilized for this review (2).

Literature search and Study Selection
A systematic search for clinical indications in Medline, Embase, CINAHL, and the Cochrane Central Register of Controlled Trials (CENTRAL) was undertaken in August 2018. The keywords "arthroscopy" and "knee", or variations of them were used. Limitations to clinical trials and human studies were applied. No search restrictions for follow-up time or study size were set.

Eligibility criteria

Inclusion criteria:
1. Randomised controlled trials (RCT) assessing the effectiveness of non-reconstructive arthroscopic knee surgery involving meniscal surgery, debridement, chondroplasty, loose body removal or any combinations, with or without clinical or radiographic osteoarthritis, compared with non-surgical treatments, sham surgery or lavage.
2. English language reports.
3. Publication in a peer reviewed journal.

Exclusion criteria:

All criteria had to be satisfied for inclusion and other systematic reviews or meta-analyses were excluded.

Data Extraction
Titles and/or abstracts of studies that were retrieved using the search strategy were screened independently by two review authors to identify studies that potentially met the inclusion criteria. The full texts of these potentially eligible studies were retrieved and independently assessed for eligibility by the two review team members. Any disagreement over the eligibility of a particular study was resolved through consensus with the addition of a third reviewer.

A standardised form was used to extract data from the included studies for assessment of study quality and evidence synthesis. Extracted information included: study population; primary diagnosis, inclusion criteria, exclusion criteria, details of the intervention; details of the comparator; study methodology; outcomes and times of measurement, and power analysis. Two review authors extracted the data independently.

If two separate studies with the same authors and the same intervention had overlapping dates of patient enrolment, then only one study was included. In this situation, the reviewer selected the study with the longer follow-up. If a different data analysis or sub-analysis was undertaken, then the supplemental study was included.

ICD 10 Diagnosis Matching
International Classification of Disease 10th Revision Clinical Modification (ICD-10-CM) codes or Procedure Coding System (ICD-10-PCS) codes were matched by two review authors to the inclusion & exclusion criteria of all matched studies. ICD-10-CM codes were developed by the Centers for Disease Control and Prevention in conjunction with the National Center for Health Statistics (NCHS), for outpatient medical coding and reporting, as published by the World Health Organization. ICD-10-PCS codes were developed by the Centers for Medicare and Medicaid Services (CMS) as a system of classification of procedural codes to classify all health interventions by medical professionals (3).

Results

Knee Arthroscopy Outcomes Studies

19 RCTs of arthroscopic knee surgery (Table 1) fulfilled the search criteria (Figure 1) in three different primary clinical ICD – 10 diagnosis categories (Table 2). In six papers, the primary clinical diagnosis was osteoarthritis (4)(5)(6)(7)(20)(21) (OA Papers) (ICD – 10 Code M17.9). In one paper, Hubbard et al (8) the primary clinical diagnosis was of a single medial femoral condyle degenerative articular lesion, however not enough information was provided by the authors to allow classification of the degenerative chondral lesion as clinical osteoarthritis.

In ten papers the primary clinical diagnosis was a symptomatic degenerative atraumatic medial meniscal tear (9)(1)(10)(11)(12)(13)(14)(15)(19)(22) (MMT Papers) (ICD -10 Code M23.2) in the presence of chondral degeneration of various degrees. However in another study, Va de Graaf et al 2018 (23) made no distinction between traumatic and degenerative medical meniscus tears because of the uncertainty differentiating the two. In another paper, Kettunen et al (16) the primary clinical diagnosis was patellofemoral pain (PF Pain Group) (ICD- 10 M22.4).

Five RCTs were assessed as having inadequate power for the primary outcomes measure. Østerås et al (15) examined arthroscopic partial medial meniscectomy in the presence of knee osteoarthritis compared to physical therapy. They included a power analysis, however the final number of patients in their study was less than stated to achieve adequate power. Chang et al(6) lacked a power analysis, however a Post Hoc Power Analysis using G-Power (17) revealed the paper was inadequately powered (power < 0.8) to confirm the self described meaningful improvement of a reduction of >1 cm from the baseline VAS score. Sihvonen et al (14) is a post-hoc sub group analysis of patients from their original 2013 RCT(1) who suffered self-described mechanical symptoms, defined as catching and clicking excluding locked or recently locked knees. The authors

state that the sub-group analysis was underpowered. Gauffin et al (9) found arthroscopic surgery to be favourable at 12 months but not statistically different from the non-surgery group at 3 years; however, the author states the analyses may be underpowered based on sample size calculations and the results should be interpreted with caution. Finally, Roos et al (22) had an under-powered study but found a greater improvement in ROOS scores from arthroscopic partial meniscectomy compared to sham surgeries at 24 months, however it also not statistically significant.

Five papers favored arthroscopic intervention at final follow-up, four in the OA - Chondral Degeneration Category (7)(8)(20)(21) and one in the MMT Category (9), the remaining 14 papers reported no outcome difference compared to the control intervention.

Risk of Bias Assessment

Studies were rated for their risk of bias in Table 3. There were no studies with a low risk of bias in all 7 risk domains assessed in the OA - Chondral Degeneration Category and Patellofemoral Pain Category(7). In the MMT studies, there was one study with low risk of bias (1) in all domains.

MMT Papers Exclusions

In the eleven papers with a primary clinical diagnosis of medial meniscal tearing, eight papers excluded surgeon assessed locked or locking knees(13)(1)(9)(15)(14)(19)(22)(23) and one excluded loose bodies (10), with Vermesan et al (12) not stating any exclusion criteria (Table 4). The Sihvonen et al (19) and Sihvonen et al (14) trial protocol excluded surgeon assessed locked or recently locked knees and major chondral flaps but included knees with patient reported catching and locking symptoms. Yim et al(11) & Katz et a(13) also included patients with mechanical symptoms.

A history of traumatic onset was an exclusion criterion in eight MMT papers (1)(10)(12)(14)(15)(19)(11)(22), with Vermesan et al(12) not stating any exclusion criteria. No paper included meniscal repair as a management intervention and meniscal repair was an exclusion criteria in three papers (1)(11)(14). Eight of the eleven MMT Papers reported cross-over into the surgical group from the control, with rates of between 2% - 36%.

No study included diagnostic arthroscopy. Inflammatory joint disorders were excluded in two papers (9)(10), or not an inclusion criteria in the remainder.

OA Papers - Exclusion Criteria

Merchan and Galindo(7) excluded patients with pain greater than six months, males with a weight over 85 kg, females greater 70 kg, instability or an angular deformity greater than 15 degrees. Hubbard et al(8) excluded any other intra-articular lesion except for symptomatic medial femoral condyle degenerative lesions in patients with no radiographic osteoarthritis. Moseley et al(4) added the Kellgren and Lawrence score for each compartment together, excluding the patients with a score of greater than nine. Kirkely et al(5) excluded patients with large meniscal tears, bucket handle tears, prior major knee trauma, inflammatory or post infectious arthritis, deformity > 5 degrees, prior trauma or KL 4 in two compartments. Chang et al(6) excluded those with knee surgery in the past 6 months, total knee replacements, or any other serious concurrent illness that may influence the study such as heart disease. Ouyang et al(20) exclusion criteria comprised participants with a history of knee injuries or pathologies beside ACL rupture and secondary osteoarthritis, and patients with severe dysfunction of major organ systems. Finally, Zhang et al(21) did not specify any exclusion criteria, including participants with clinically diagnosed degenerative knee osteoarthritis.

Types of Medial Meniscal Tear

Only one paper, Yim et al(11), described the MMT pattern, the remainder grouped all MMT patterns together as atraumatic or traumatic degenerative. Sihvonen et al(1) described an atraumatic sudden symptom onset sub-group who did no better with surgical intervention.

Cross Over Into Surgical Group

None of the OA / Chondral Degeneration papers described cross-over of non-surgical participants into the surgical group. Ten of the eleven MMT Papers described cross-over rates of 0% (15), 2%(11), 2.5%(14), 6.6% (1), 19%(19), 25%(9), 30.2% (13), 33%(10), 36% (22) and 29% (23). Reasons for cross over into the surgical group were either those of persistent symptoms (10)(1)(9)(19)(22)(23) or not given(11)(13)(14).

Herrlin et al(10) stated that patients who crossed over into the surgical group had significantly worse symptoms than the remainder of the control group at baseline, however achieved similar outcomes to the control and surgical group. Kise et al(19) found the 19% of patients that had crossed over had no additional benefit at a two year follow-up to those that had been randomized into surgery.

The Effect of Age
Only one paper specifically examined the effect of age on outcome. Gauffin et al(9) reported better outcomes for both rehabilitation and arthroscopic intervention for 55-64 year old patients compared to younger patients aged 45-55 years.

Adverse Events
No paper described a greater rate of adverse events in the arthroscopic group that was statistically significant.

Lateral Meniscal Tears
No study examined outcomes of partial meniscectomy as a treatment for lateral meniscal tears.

Outcomes of Patients with Atraumatic Medial Meniscal Tears Who Have Failed Non-Operative Management
The inclusion criteria for four of the elevent meniscal tears studies included failure of clinician assessed non-specific non-operative management of between 1 & 3 months. No medial meniscal study examined outcomes of patients who had undergone structured rehabilitation program and continued to have had severe self-described symptoms by randomization to operative versus non-operative intervention.

Outcomes of Patients Who Have Self-Reported Mechanical Symptoms
Self-reported mechanical symptoms were common in all papers. One paper(14), a secondary analysis of a previously published RCT, found no difference in patients with atraumatic self–described mechanical symptoms who underwent medial meniscectomy compared to a sham procedure. Similarly, Kirkely et al (5) found no improvement in a sub-group of patients with osteoarthritis and self-described mechanical symptoms compared to rehabilitation. However, Kise et al(19) reported the exercise group had significantly fewer self-reported mechanical problems compared to the physical therapy group after a two year follow-up. Despite this, Gauffin et al(9) surgery produced a statistically significant improvement in patients without mechanical symptoms but not in patients with mechanical symptoms.

Progression of Osteoarthritis After Partial Meniscectomy
Herrlin et al(18), found no difference in osteoarthritis progression 5 years after partial medial meniscectomy compared to physiotherapy. Similarly, Van de Graaf et al (23) also found no statistically difference in the progression of osteoarthritis after 2 years between arthroscopic partial meniscectomy and physiotherapy.

Review Conclusions

All of the studies in the osteoarthritis group were at high risk of bias in at least one domain.

One OA study (4) was at low risk of bias from blinding. In this study, patients who were assessed clinically to have moderate to severe knee osteoarthritis, in the absence of loose bodies or locking, showed no advantage of arthroscopic debridement over lavage or sham surgery.

In a study with a high risk of bias (8), patients with isolated medial femoral condyle degenerative lesions benefited from arthroscopic intervention compared to rehabilitation.

In another study with a high risk of bias (16), arthroscopic patellofemoral chondroplasty did not benefit patients compared to non-operative management.

Two studies (19)(9) with low risk of bias investigated patients with symptomatic and degenerative medial meniscal tears. One of these studies demonstrated exercise therapy alone significantly improved muscle strength for the first 12 months when compared to patients in the surgery group. The other study reported improvements in pain scores for the surgery group for the first 12 months compared to the non-surgical group. However, for both these studies, the statistical difference between outcomes in the intervention and control groups disappeared at 2 and 3 years respectively.

In atraumatic medial meniscal tears (1), in the absence of surgeon assessed locking or a locked knee, or a repairable meniscus tear, a study with a low risk of bias showed no advantage of arthroscopic partial meniscectomy over sham surgery.

In a study (14) with a high risk of bias in one domain, patients with an atraumatic onset of self–described mechanical symptoms, in the presence of a medial meniscal tear, other than surgeon assessed recent locking, a locked knee or symptomatic loose bodies, there was no advantage to arthroscopic partial meniscectomy over sham surgery. Other studies provide conflicting evidence on the benefit of surgery in patients with mechanical symptoms.

In three studies with a low risk of bias (10)(19)(23), patients receiving physical therapy that crossed over to the surgical intervention group displayed similar outcomes to those randomized into surgery, suggesting initial physical therapy prior to surgery may not compromise outcomes.

The role of arthroscopic surgery in lateral meniscal tears remains uncertain, as it has not been subjected to a randomised controlled trial.

The role of subchondral drilling or microfracture undertaken in combination with an osteotomy remains uncertain as no randomised controlled studies exist comparing it to osteotomy alone.

Preservation of the medial or lateral meniscus by repair of the body or root, with or without degeneration of the joint, has not been subjected to a randomised controlled trial.

No study investigated the role of diagnostic arthroscopy in situations where MRI was inconclusive or unable to be performed. The value of MRI in the investigation of atraumatic non-locking knee symptoms in presence of osteoarthritis remains uncertain.

No medial meniscal tear study examined outcomes of patients who failed a structured rehabilitation program by randomization to operative versus non-operative intervention.

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Table 1: Arthroscopic Surgery Outcomes in Randomized Controlled Trials

	Author & Year	Primary Dx	Rx	Inclusions	Ix	n	Control	% Not enrolled	Max XR OA	Joint Specific Exclusions	% X Over	PA	Notes	Outcome
Osteoarthritis & Chondral Degenerative RCTs														
1	Merchan and Galindo[7] 1993	Mild OA with other intra-pathology	Synovectomy; débridement; APM, CPY, E/O osteophytes & PT	Painful "limited" OA, including patients with meniscal tears, loose bodies & synovitis.	XR	73	NSAID. Activity modification.	NS	Ahlbach 0-1,KL 1-2	Duration of pain >6 months, patient body weight >85 kg in men and >70 kg in women, and history of previous surgery. Instability or an angular deformity > 15°. Patellofemoral OA.	NA	N	OM = Modified HSSK Score. APM performed in 31/35. Power > 0.8.	Favoured A/S at 1 - 3 years (mean 25 months)
2	Hubbard et al[8] 1996	Symptomatic single MFC degenerative chondral lesion ObC Grade 3 or 4	Chondroplasty. No APM.	Symptoms > 1 yr, no laxity or no deformity, full ROM, single Medial Femoral Condyle degenerative lesion, OBC Grade 3 or 4, no other intra-articular pathology, normal plain XR, modified Lysholm score < 38/70.	XR	76	A/S Lavage	NS	KL O	Degenerative lesions on other joint surfaces, other intra-articular pathology, radiographic loss of joint space, previous operation, steroid injection for any reason. MMT or tibial degeneration.	NA	N	OM = Binary self-described pain presence/ absence & Modified Lysholm. Power > 0.8.	Favoured A/S at 1 & 5 years
3	Moseley et al[4] 2002	Tricompartmental OA	APM, CPY	< 75 years, moderate Knee pain that had failed 6 months medical management with VAS Pain Score > 3, failed medical Mx and diagnosis of OA based on ACR definitions	XR	180	Sham or Lavage	44	KL 3-4	Scoring > 9 by KL score addition in three compartments	NA	Y	Three arm study. In lavage group, "mechanically important, unstable tears" were debrided. In sham group, joint not entered. OM = bespoke Knee Specific Pain Scale, AIMS2 & SF 36 PF	No difference at 2 years between 3 groups.
4	Chang et al[6] 1993	Osteoarthritis	APM, CPY, Synovectomy	Pain after 3 months after rehabilitation	XR	32 Pts	Needle Lavage	50	KL 1-3	Prior Knee surgery within 6 months, TKA, any concurrent illness that may influence results, OA KL Grade IV.	NS	N	Inadequate power. 50% had KL Grade 3	No difference at 12 months.
5	Kirkley et al[5] 2008	Symptomatic moderate to severe OA	Synovectomy; debridement; APM, CPY, E/O osteophytes & PT	Age >18 yo with idiopathic or secondary OA KL Grade 2-4.	XR & MRI	188	PT	16	KL 0-4	Large meniscal tears, bucket handle tears, prior major knee trauma, inflammatory or post infectious arthritis, deformity > 5 degrees, prior trauma, KL 4 in two compartments.	0%	Y	OM = WOMAC & SF 36	No difference at two years.

6	Ouyang et al[20] 2016	Ruptured ACL with secondary OA	ACL reconstruction, OA debridement, synovectomy, chrondroplasty	>18 but <80, ACL rupture secondary to OA according to American Institute of Rheumatism	CT & MRI	68	NSAID, corticosteroids, calcitonin and closed treatment in acupuncture point of sodium hyaluronate, PT	NS	NS	Knee operations, Hx of knee injuries or pathologies apart from ACL, severe dysfunction in major organs	NS	N	3mth follow-up, OM = GPCYO, Lysholm and modified McGill pain scale, strength and power assessed	Favoured A/S at 3mth
7	Zhang et al[21] 2018	Degenerative OA	Dependent on specific conditions: debridement, grinding the spur, shaping the synovial membrane and removing episome	Any patient who satisfied the clinical diagnostic criteria of degenerative knee osteoarthritis	NS	108	NSAID	NS	NS	NS	NS	N	OM = HSS score and self-reported satisfaction. Analysed adverse events, hospitalisation and recovery time, follow-up ranged from 3 months to 7 y	A/S had significantly higher satisfaction, lower adverse events and lower hospitalisation and recovery time

	Author & Year	Primary Dx	Rx	Inclusions	Ix	n	Control	% Not enrolled	Max XR OA	Joint Specific Exclusions	% X-Over	PA	Notes	Outcome
Atraumatic Degenerative Medial Meniscal Tear RCTs														
1	Yim et al[11] 2013	Symptomatic horizontal degenerative MMT	APM & PT	Horizontal degenerative Medial MT on MRI & daily knee pain on the medial side with mechanical symptoms, failed non-surgical Mx	MRI	108	PT	30	KL 0-1	Definite trauma, ligament deficiency, systemic arthritis, KL 2-4 and osteonecrosis, meniscal repair, abrasion arthoplasty, subchondral drilling, curettage.	2	Y	No meniscal repairs or total meniscectomy undertaken. Outcome measures = VAS, Lysholm and Tegner	Favored A/S at 3 months. No difference at 2 years. MT pattern described.
2	Sihvonen et al[1] 2013	Symptomatic Degenerative MMT confirmed on MRI & at AS	APM & PT	35 to 65 y , knee pain >3 months that was unresponsive to conventional conservative treatment and had clinical findings consistent with a tear of the medial meniscus	XR & MRI	146	Sham surgery & PT	12	KL 0-1	Trauma-induced onset of symptoms, locked or recently locking knee, decreased range of motion, instability , pathology other than degenerative knee disease requiring treatment other than arthroscopic Partial meniscectomy, Meniscal repair, micro-fracture to chondral defect , meniscal repair, major chondral flap, Clinical OA based on ACR CCR. Or KL >1	6.6	Y	No chondroplasty undertaken. OM = VAS, Lysholm and WOMET. Blinded study. MT pattern not described.	No difference at 12 months. " results are directly applicable only to patients with non-traumatic degenerative medial meniscus tears"
3	Gauffin[9] et al 2017	Meniscal symptoms and radiographic OA Grade 0 (Ahlback)	APM, PT	45 to 64 y, >3 month symptoms, imaging of >50% joint space reduction prior PT,	XR	150	PT	16	Ahlback grade 0, KL 1-2	Locked / locking knee. Rheumatic disease.	25	Y	No chondroplasty, OM = KOOS, Blinded study, Pt baseline characteristic and OA severity according to Kellgren-Lawrence classification, intention to treat analysis = no difference in pt characteristic and KOO subscores	Favored A/S at 12mths. No statistical difference at 3 years. Author states based on sample size calculation, study may be underpowered

4	Katz et al[13] 2013	Symptomatic Degenerative MMT with mild to moderate OA	APM, CPY & PT	> 45 y & >1 month symptoms , imaging evidence of mild-to-moderate knee osteoarthritis, symptoms of the following: clicking, catching, popping, giving way, pain with pivot or torque, pain that is episodic, pain that is acute and localized to one joint line), KL 0-3.	XR & MRI	330	PT	75	KL 0-3	Chronically locked knee, KL 4, clinically symptomatic chondrocalcinosis, bilateral symptomatic meniscal tears, prior surgery on same knee	30.2	Y	Similar improvement in WOMAC in failed PT as APM once crossed over APM, Treatment success defined as > 8 point improvement on WOMAC physical function scale. MT pattern not described.	No difference at 12 months. 30% crossed over to APM. Treatment failure 25% in APM Group and 49% in PT Group. Same adverse events between groups.
5	Herrlin et al[10] 2013	MRI- verified degenerative MMT & radiographic AO Grade <2 (Ahlback)	APM ,CPY & PT	Age 45-60, daily medial pain over 2-6 months.	XR & MRI	96	PT	55	Alback 1 , ObB I-IV	History of trauma, OA > Alback 1, Rheumatoid Arthritis, Loose bodies, knee instability, osteochondral defects & tumours, TKA, prior knee surgery in last year	33	Y	No difference in OA progression noted between 2 Groups. OM = KOOS, Lysolm & VAS. Similar PROMs improvement in PT & APM. MT pattern not described.	No difference at 2 & 5 years. 33% of PT Group crossed over into APM with similar benefit to APM Group and rest of PT group at 2 & 5 years. This subgroup had significantly lower PROM scores than rest of PT Group prior APM.
6	Vermesan et al[12] 2013	MRI- verified degenerative medial meniscus tear and radio-graphic osteoarthritis	APM, CPY & PT	Non traumatic symptomatic knees with degenerative lesions medial compartment on MRI	MRI	120	CSI	NS	NS	NS	NS	N	OM = Oxford Knee Score. Post Hoc Power Analysis > 0.8 (d=.0.3 two tailed,p=0.05). MT pattern not described.	Better scores in surgical group at 3 months. No difference at 12 months.
	Author & Year	Primary Dx	Rx	Inclusions	Ix	n	Control	% Not enrolled	Max XR OA	Joint Specific Exclusions	% X-Over	PA	Notes	Outcome
Atraumatic Degenerative Medial Meniscal Tear RCTs														
7	Østeras et al[15] 2013	MRI- verified degenerative MMT and radio- graphic OA	APM	Age 35-60	MRI	17	PT	12	KL 0-2	ACL tears, acute trauma, KL 3-4, heamarthrosis, locking knee	0	Y	Inadequate power based on author's own power analysis. Outcome measures = VAS & KOOS	No difference at 3 months. MT pattern not described.
8	Sihvonen et al[14] 2016	Symptomatic Degenerative MMT confirmed on MRI & at AS. Subgroup analysis of original Sihvonen et al 2013[1] patients with mechanical symptoms	APM & PT	35 to 65 y , knee pain >3 months that was unresponsive to conventional conservative treatment and had clinical findings consistent with a tear of the medial meniscus with mechanical symptoms	XR & MRI	69	Sham surgery & PT	NS	KL 0-1	Trauma-induced onset of symptoms, locked or recently locking knee, decreased range of motion, instability , pathology other than degenerative knee disease requiring treatment other than arthroscopic Partial meniscectomy, Meniscal repair, micro-fracture to chondral defect, meniscal repair, major chondral flap, Clinical OA based on ACR CCR. Or KL >1	2.5	N	No chondroplasty undertaken. OM = VAS, Lysholm and WOMET. Blinded study. MT pattern not described.	No difference at 12 months. Authors state "This subgroup analysis is likely to be underpowered…" Post hoc analyses: The study questions were not included a priori as primary or secondary objectives of the original trial.

9	Kise et al[19] 2016	MRI – verified Symptomatic degenerative MMT, nil to low grade OA	APM & Exercise	35 to 60 y, unilateral knee pain >2 months, MRI confirmed medial degenerative meniscal tear	XR & MRI	140	PT	38	Grade 3 Kellgran-Lawrence	Acute trauma, locked knee, ligament injury, knee surgery in index knee in the previous 2 years	19	Y	1 patient in control had grade 3 OA – unintentionally included. OM = KOOS, Blinded study, strength and power assessed	No clinical difference at 2 years, at 3 and 12 months exercise therapy had statistically significant improved muscle strength, author regrets no sham surgery group
10	Roos et al[22] 2018	MRI – verified MMT without significant trauma and low grade OA	APM & Exercise	35 to 60 y, knee pain >2 months, MRI confirmed MMT without significant trauma	XR & MRI	44	Sham surgery & Exercise	81	Grade 2 Kellgren-Lawrence	High energy trauma, prolonged episodes of inability to fully extend knee, Grade 3-4 OA on Kellgren-Lawrence scale or knee surgery previous 2 years	36	Y	Low statistical power ~60% of estimated power based on author analysis, 32 pts excluded due to nil MRI confirmed MMT, 4% attrition rate, 36% of pts were non-blinded in the course of study OM = KOOS, SF-36, GPE, EQ5D, muscle strength, physical performance	36% cross-over rate in Skin-incision group No statistically significant difference between the 2 groups but there was a greater improvement at 2 years in the Arthroscopic group
11	Van De Graaf et al[23] 2018	MRI – verified non-obstructive MMT and low grade OA	APM	45 to 70 y, knee pain and non-obstructive MMT verified on MRI	XR & MRI	321	PT	NS	Grade 3 Kellgran-Lawrence	Locked knee, prior knee surgery, instability caused by cruciate ligaments, Grade 4 OA on Kellgren-Lawrence scale,	29	Y	PT given to patients if they did not recover as anticipated, no distinction was made between traumatic and degenerative. 20% attrition loss, non-blinded study OM = IKDC, VAS, RAND-36 and Tegner Activity Scale	PT was non-inferior to APM for improving knee function over a 24-mth follow-up period but APM had better OM scores
Patellofemoral Pain RCT														
12	Kettunen et al[16] 2007	PFJ pain and symptoms lasting at least 6 months	PFJ CPY	Age 18 – 40 years Female or male Symptoms lasting at least 6 months. PFJ pain during knee loading physical activity or in prolonged flexion.	NA	56	PT	2%	KL 0	Prior knee surgery, patella dislocation, OCD, Patella tendinopathy, Osteoarthritis, loose bodies, instability.	10	Y	Outcome measures = Kujala score & VAS	No difference at 2 & 5 years.

Footnotes

Abbreviations :
KOOS = Knee Injury and Osteoarthritis Outcome Score
SF-36 = Short-Form 36 item
EQ5D = EuroQol
GPE = Global Perceived Effect
WOMET = Western Ontario Meniscal Evaluation Tool
IKDC = International Knee Documentation Committee
VAS = Visual Analogue Scale
PAS = Physical Activity Scale
SSS = symptom satisfaction scale
OA = Osteoarthritis
PT = Physical Therapy
AS = Arthroscopic
APM = Arthroscopic Partial Meniscectomy
MRI = Magnetic Resonance Imaging
ObC = Outerbridge Classification.
KL = Kellengren Lawrence
OM – Outcome Measure
PFJ = Patellofemoral Joint
ROM = Range of Motion
XR= Radiograph
> = Less than
< = Greater than
Pts = Patients
Mx = Management
NS = Not stated
Y = Yes
N = No
ACR CCC = American Rheumatology Clinical Classification for Osteoarthritis of the Knee
PROM = Patient Recorded Outcome Measures
X-over = Cross - over
Ix = Investigation
n = Number of patients
CPY = Chondroplasty
CSI = Corticosteroid injection
MFC = Medial Femoral Condyle
Rx = Intervention
PA = Power Analysis
TKA = Total knee arthroplasty

Table 2 : Arthroscopic Knee Surgery RCTs Inclusions & Exclusions using ICD 10 Codes

Clinical Diagnoses Included in RCTs

Unilateral Osteoarthritis of Knee(9)(6)(7)
- M17.9 Osteoarthritis of knee, unspecified
- M17.0 Bilateral primary osteoarthritis of knee
- M17.1 Unilateral primary osteoarthritis of knee

Atraumatic Degenerate Tears to Medial Meniscus (12)(1)(10)(14)(19)(22)(23)
- M23.2 Derangement of meniscus due to old tear or injury
- M23.22 Derangement of posterior horn of medial meniscus due to old tear or injury
- M23.30 Other meniscus derangements, unspecified meniscus
- M23.32 Other meniscus derangements, posterior horn of medial meniscus

Patellofemoral Chondropathy(15)
- M22.4 Chondromalacia patella

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Clinical Diagnoses Excluded from RCTs*$

Locking or Locked Knee(7)(1)(10)(14)(22)(23)
- M23.40 Loose Body in Knee(21)(19)(15)
- M21.26 Flexion deformity, knee
- M93.2 Osteochondritis dessicans
- M23.8 Other internal derangements of knee
- S83.21A Bucket-handle tear of medial meniscus, current injury, initial encounter(7)
- S83.205A Other tear of unspecified meniscus, current injury, unspecified knee , initial encounter
- S83.22A Peripheral tear of medial meniscus, current injury, initial encounter
- S83.26A Peripheral tear of lateral meniscus, current injury, initial encounter
- M25.669 Stiffness of unspecified knee, not elsewhere classified

Knee Instability(12)(1)(19)(15)(23)
- M23.60 Other spontaneous disruption of unspecified ligament of knee
- M23.61 Other spontaneous disruption of anterior cruciate ligament of knee
- M23.62 Other spontaneous disruption of posterior cruciate ligament of knee

Internal Derangements of than MMT(1)(19)
- M93.2 Osteochondritis dessicans
- M23.8 Other internal derangements of knee
- M23.25 Derangement of posterior horn of lateral meniscus due to old tear or injury
- M23.26 Derangement of other lateral meniscus due to old tear or injury
- M23.35 Other meniscus derangements, posterior horn of lateral meniscus
- M23.23 Derangement of other medial meniscus due to old tear or injury
- M87.88 Osteonecrosis

Meniscal Cysts(1)
- M23.0 Cystic meniscus

Non Osteoarthritis Arthropathies(9)(7)(6)(12)(1)(10)(14)
- M00.06 Staphylococcal arthritis, knee
- M00.86 Arthritis due to other bacteria, knee
- M02.86 Other reactive arthropathies, knee
- M02.36 Reiter's disease, knee
- M05.76 Rheumatoid arthritis of knee
- M10.06 Idiopathic gout, knee
- M11.06 Hydroxyapatite deposition disease, knee
- M12.26 Villonodular synovitis (pigmented), knee

Traumatic Meniscal Injury(7)(12)(1)(19)(23)

S83.2 Tear of meniscus, current injury
- S83.21A Bucket-handle tear of medial meniscus, current injury, initial encounter
- S83.205A Other tear of unspecified meniscus, current injury, unspecified knee , initial encounter
- S83.22A Peripheral tear of medial meniscus, current injury, initial encounter
- S83.23A Complex tear of medial meniscus, current injury, initial encounter
- S83.24A Other tear of medial meniscus, current injury, initial encounter
- S83.25A Bucket-handle tear of lateral meniscus, current injury
- S83.26A Peripheral tear of lateral meniscus, current injury, initial encounter
- S83.27A Complex tear of lateral meniscus, current injury, initial encounter
- S83.28A Other tear of lateral meniscus, current injury, initial encounter

Traumatic or Secondary Osteoarthritis of Knee(7)
- M17.2 Bilateral post-traumatic osteoarthritis of knee
- M17.3 Unilateral post-traumatic osteoarthritis of knee
- M17.4 Other bilateral secondary osteoarthritis of knee
- M17.5 Other unilateral secondary osteoarthritis of knee

Meniscal Repair(12)(1)
- 0SQC4ZZ Repair Right Knee Joint, Percutaneous Endoscopic Approach
- 0SQD4ZZ Repair Left Knee Joint, Percutaneous Endoscopic Approach

* ”Clinical Diagnoses Excluded from RCTs” does not include non-traumatic osteoarthritis in studies with a primary clinical diagnosis other than osteoarthritis.
$ Diagnoses of conditions external to the knee joint not included.
Osteoarthritis as defined by the ACR

Table 3: Risk Bias Assessment

	Ramdon Sequence Generation	Allocation Concealment	Blinding of Particpants	Blinding of Outcome Assessment	Incomplete Outcome of Data	Selective Reporting	Other Bias
Merchan & Galindo 1993	Low Risk	Unclear	High Risk	High Risk	Low risk	Low risk	Low risk
Chang 1993	Unclear	Unclear	High Risk	High Risk	Unclear	Low risk	Low risk
Hubbard 1996	Low Risk	Low risk	High Risk	High Risk	Unclear	Unclear	Low risk
Moseley 2002	Unclear	Low risk	Low risk	Low risk	High Risk	Low risk	Low risk
Kirkley 2008	Low Risk	Unclear	High Risk	High Risk	Unclear	Low risk	Low risk
Yim 2013	Unclear	Low Risk	High Risk	High Risk	High Risk	Low risk	Low risk
Sihvonen et al 2013	Low	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Gauffin et al 2017	Unclear	Low risk	Low risk	Low risk	Unclear	Low risk	Low risk
Katz 2013	Low	Low risk	High Risk	High Risk	Low	Low risk	Low risk
Herrlin 2013	Unclear	Unclear	High Risk	High Risk	Low	Low	Low risk
Versmesan 2013	Unclear	Unclear	High Risk	High Risk	Unclear	Unclear	Low risk
Kettunen 2012	Low risk	Low risk	High Risk	High Risk	Unclear	Low risk	Low risk
Østeras 2013	Unclear	Unclear	High Risk	High Risk	Low risk	Unclear	Low risk
Sihvonen et al 2016	Low risk	Low risk	Low risk	Low risk	Low risk	High Risk	Low risk
Ouyang et al 2016	Unclear	Unclear	High Risk	High Risk	Unclear	Low risk	Low risk
Zhang et al 2018	Unclear	Unclear	High Risk	High Risk	Low risk	High Risk	High Risk
Kise et al 2016	Low risk	Low risk	Low risk	Low risk	Unclear	Low risk	Low risk
Roos et al 2018	Low risk	Low risk	High Risk	High Risk	Low risk	Low risk	Low risk
Van De Graaf 2018	Low risk	Low risk	High Risk	Low risk	Low risk	Low risk	Low risk

Table 4: Exclusions of Medical Medial Meniscus Tear Randomised Controlled Trials

	Locking or locked	Hx of trauma	Meniscal Repair	Loose bodies	Major Chonral Flap	Other Non Meniscal Pathology
Yim 2013	NS	Yes	Yes	NS	NS	Yes
Sihvonen et al 2013	Yes	Yes	Yes	NS	Yes	Yes
Katz 2013	Yes	NS	NS	NS	NS	Yes
Herrlin 2013	Yes	Yes	NS	Yes	NS	Yes
Versmesan 2013	NS	NS	NS	NS	NS	Yes
Østeras 2013	Yes	Yes	NS	NS	NS	Yes
Sihvonen et al 2016	Yes	Yes	Yes	NS	Yes	Yes
Gauffin et al 2017	Yes	NS	NS	NS	NS	Yes
Kise et al 2016	Yes	Yes	NS	NS	NS	Yes
Roos et al 2018	Yes	Yes	NS	NS	NS	Yes
Van de Graaf 2018	Yes	No	NS	NS	NS	Yes

Figure 1: PRISMA Flow Diagram