Patient-reported outcomes in patients undergoing arthroscopic partial meniscectomy for traumatic or degenerative meniscal tears: A comparative prospective cohort study

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ABSTRACT

Background: Meniscus surgery is a high-volume surgery carried out on 1 million patients annually in the USA. The procedure is conducted on an outpatient basis and the patients leave the hospital a few hours after surgery. A critical oversight of previous studies is their failure to account for the type of meniscal tears. Meniscus tears can be categorised as traumatic or non-traumatic. Traumatic tears (TT) are usually observed in younger, more active individuals in an otherwise 'healthy' meniscus and joint. Non-traumatic tears (NTT) (ie, degenerative tears) are typically observed in the middle-aged (35–55 years) and older population but the aetiology is largely unclear. Knowledge about the potential difference of the effect of arthroscopic meniscus surgery on patient symptoms between patients with traumatic and NTT is sparse. Furthermore, little is known about the natural time course of patient perceived pain, function and quality of life after meniscus surgery and factors affecting these outcomes. The aim of this prospective cohort study is to investigate the natural time course of patient-reported outcomes in patients undergoing meniscus surgery, with particular emphasis on the role of type of symptom onset.

Methods/design: This prospective cohort study enrol patients assigned for meniscus surgery. At the baseline (PRE surgery), patient characteristics are assessed using an email-based questionnaire also comprising several validated questionnaires assessing general health, knee-specific characteristics and patient's expectations of the surgery. Follow-up will be conducted at 12 and 52 weeks after meniscus surgery. The major outcomes will be differences in changes, from before to 52 weeks after surgery, in each of the five domains on the Knee injury and Osteoarthritis Outcome Score (KOOS) between patients undergoing surgery for traumatic compared with non-traumatic meniscus tears.

Dissemination: The study findings will be disseminated in peer-reviewed journals and presented at national and international conferences.

Trial registration number: ClinicalTrials.gov Identifier: NCT01871272.

ARTICLE SUMMARY

Strengths and limitations of this study

- This cohort study collects data on the natural time course of patient reported outcomes in a clinical setting on a large group of patients after arthroscopic meniscus surgery to ensure high external validity.
- As data is collected on a large number of patients in a clinical setting it was not feasible to collect standardised imaging data (ie, MRI or radiographs) on patients, which could have provided valuable information.

INTRODUCTION

Meniscus surgery is a high-volume surgery carried out on 1 million patients annually in the USA.[1] The procedure is conducted on an outpatient basis and patients leave the hospital few hours after surgery. Nevertheless, little is known about the natural time course of patient perceived pain, function and quality of life (QOL) after meniscus surgery and which factors affect these outcomes.[2] The general opinion is that patients recover their muscle strength fully within 6–12 weeks following arthroscopic partial meniscectomy.[3–5] More importantly, however, recent studies have shown substantial patient-reported disability and pain in patients up to 4 years after surgery.[6–8] One explanation for the poor self-reported outcomes may be that the loss of meniscal function triggers other events that may cause knee pain.[9] Complicating the assessment of surgery effectiveness further, surgical procedures have shown to be associated with considerable 'placebo effect'.[10 11]

A critical limitation of previous studies[12–15] is their failure to account for the type of symptom onset (ie, injury mechanism). Meniscus tears can be categorised as either traumatic or non-traumatic. Traumatic tears (TT) are usually observed in younger, active individuals in an otherwise 'healthy' meniscus and joint, and can be attributed to a specific incident (eg, sports-related trauma).[16] TT's are often associated with joint effusion,

reduced knee joint range of motion (ROM) together with catching/locking of the knee. Non-traumatic tears (NTT) are typically observed in the middle-aged (35–55 years) and older population.[17] These tears are associated with meniscal calcification[18] and risk factors for these tears include, presence of Heberdens's and Bouchard nodes, knee malalignment[19] and occupational kneeling[20]; however, the aetiology is largely unclear.[16] NTT's are often referred to as degenerative tears and have been shown to be associated with incipient knee osteoarthritis (OA) in the middle-aged or elderly population.[21–23] Evidence from four well-designed trials demonstrated that arthroscopic interventions[10 24] and meniscectomy[25–27] were no better or provided no additional effect, than the comparator (ie, sham surgery, physical therapy or a combination of physical and medical therapy) to relieve pain and improve function in the middle-aged patients with knee OA or early signs of knee OA. No corresponding randomised trials exist specifically for TT but an observational study showed that patients with degenerative meniscus lesions (ie, NTT) self-report worse function and QOL compared to individuals with TT at follow-up 14 years after meniscectomy.[28] Thus, it is conceivable, but currently unproven, that arthroscopic meniscus surgery is more effective in resolving symptoms of a meniscus tear of traumatic aetiology compared with non-NTT in the middle-aged population.

In patients with TT, repair of the meniscus may be an alternative to resection. In contrast, repair is rarely an option for middle-aged patients with NTT due to the degenerative state of the meniscus. A recent retrospective observational study suggested a reduced risk of later knee OA and less activity level loss in patients (~32 years at time of surgery) undergoing repair compared with resection (ie, favouring repair).[29] This indicates that patients with TT should be stratified into subgroups on the basis of type of arthroscopic intervention (ie, repair (TT_{REP}) and resection (TT_{RES})) since this may influence the patient-perceived outcomes after surgery.

Aims and hypotheses

The primary aims of this observational cohort are to

1. Investigate if improvements in patient self-reported pain, symptoms, function and QOL differ after arthroscopic meniscus surgery for non-traumatic meniscus tears in middle-aged patients, compared with surgery in patients with traumatic tears (ie, NTT vs TT). We hypothesise that in middle-aged patients with NTT arthroscopic surgery is less effective in relieving self-reported pain, symptoms, function in sports and recreation (Sport/Rec) and QOL (ie, change in KOOS scores), compared with younger patients undergoing surgery for TT.
2. Investigate the effect of meniscus repair (TT_{REP}) compared to meniscus resection (TT_{RES}) on change in self-reported pain, symptoms, function in Sport/Rec and QOL in patients with TT. We hypothesise that arthroscopic surgery is less effective in relieving pain, symptoms, function in Sport/Rec and QOL (ie, change in KOOS scores) in patients undergoing TT_{RES} compared with those undergoing TT_{REP}.

METHODS AND ANALYSIS

Design

In this prospective cohort study we will assess patient-reported outcomes (PROs) using email-based questionnaires prior to surgery and at 12 and 52 weeks follow-up postsurgery (see figure 1).

Participants

All patients assigned for arthroscopy on suspicion of a meniscus tear at Lillebælt Hospital (located in the cities Vejle and Kolding, Denmark) and Odense University Hospital, Denmark (incl. Svendborg Hospital) from 1 February 2013 to 31 January 2014.

General cohort eligibility criteria

Inclusion criteria: patients ≥18 years of age assigned for arthroscopy on suspicion of a medial and/or lateral meniscus tear by the examining orthopaedic surgeon based on clinical signs and MRI (if available), having an email address and able to read and understand Danish.

Exclusion criteria: patients who will or previously have undergone surgical reconstruction of the anterior or posterior cruciate ligament (ACL or PCL) in either knee, experienced fracture(s) to the lower extremities (ie, hip, leg or foot) in either leg within the last 6 months at time of recruitment and patients not

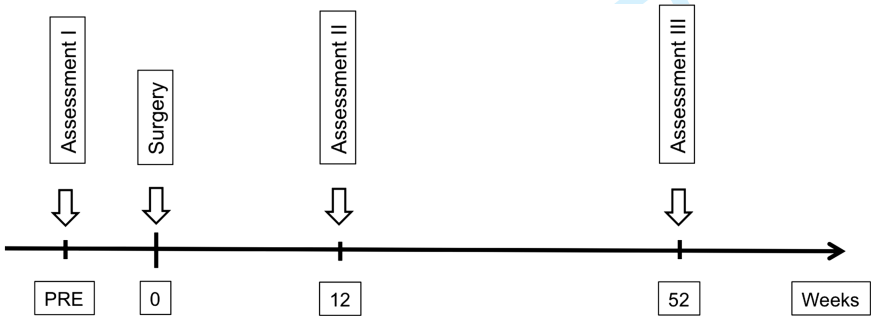

Figure 1 Overview of collection of outcomes during the first year in the Knee Arthroscopy Cohort Southern Denmark.

mentally able to reply the questionnaire. Please refer to figure 2 for an overview of the recruitment flow.

The patients with reconstructed ACL and PCL cannot be included as these patients are being followed in another cohort study.

Inclusion and exclusion criteria, aim 1 (NTT vs TT)

There is no consensus on how to classify patients as having a NTT or TT. In this study, patients undergoing meniscus surgery will be classified as having either TT or NTT according to an algorithm based on age, duration of knee symptoms and a question about injury mechanism (see below). This represents the information that is available prior to surgery.

Injury mechanism question

'How did the knee pain/problems for which you are now having surgery develop (choose the answer that best match your situation)?'

Response alternatives

A. The pain/problems have slowly evolved over time.
B. As a result of a specific incident (ie, kneeling, sliding and/or twisting of the knee or the like).
C. As a result of a violent incident (ie, during sports, a crash, collision or the like).

TT

Inclusion: all patients between 18 and 34 years and all patients between 35 and 55 years replying 'C' on the injury mechanism question.

NTT

Inclusion: all patients between 35 and 55 years replying 'A' or 'B' on the injury mechanism question and having knee symptoms >6 months.

In addition, the general eligibility criteria also apply. For aim 1, the upper age limit is set to include patients with degenerative meniscus tears (ie, NTT) but without severe features of knee OA.[30] Furthermore, patients whose responses do not fit the TT and NTT criteria will also be excluded.

Inclusion and exclusion criteria, aim 2 (TT_{RES} vs TT_{REP})

All patients classified as TT according to the specific Knee Arthroscopy Cohort Southern Denmark (KACS) eligibility criteria for aim 1 will be further divided in patients having either meniscus resection (TT_{RES}) or

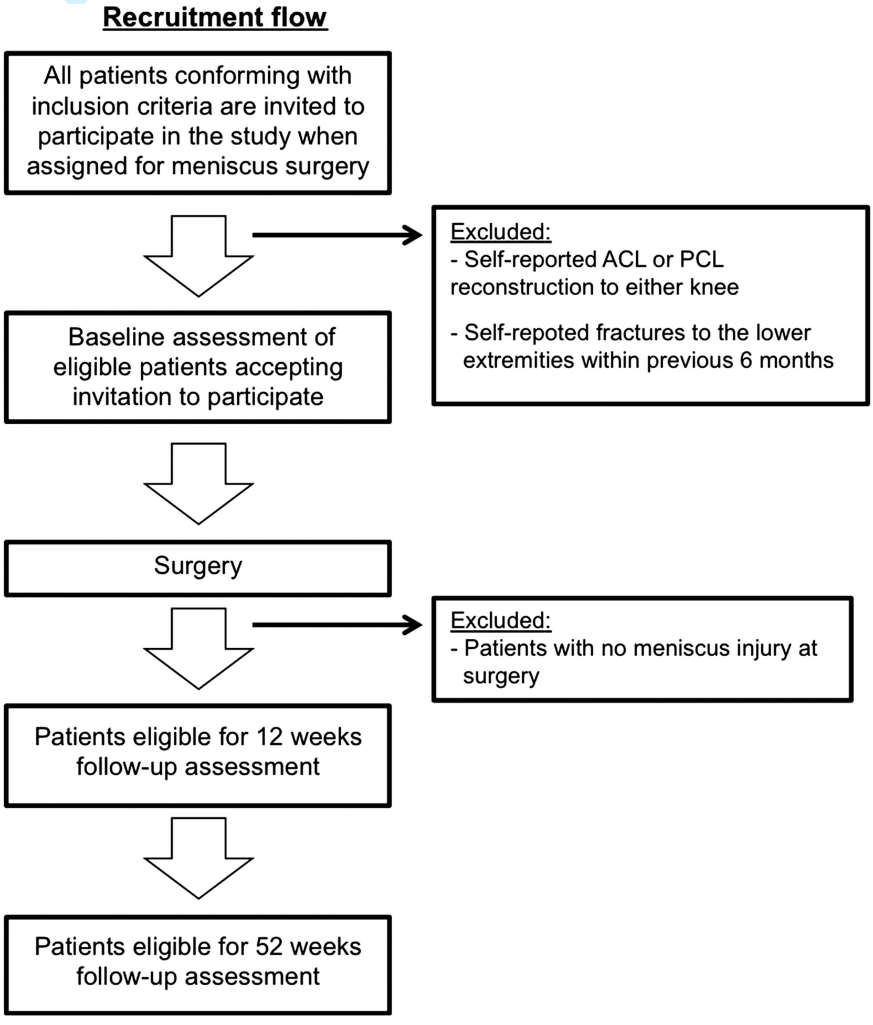

Figure 2 Overview of the recruitment flow in the Knee Arthroscopy Cohort Southern Denmark.

repair (TT_{REP}) according to the type of surgery they receive to answer study aim 2.

Patient characteristics

At baseline, self-report information about: educational level, employment, civil status, smoking habits, comorbidities,[31] physical activity level[32] and self-reported knee and foot alignment[33] will be collected together with information on height and weight. Surgery documentation will be collected using a modified version of the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS) classification of meniscal tears questionnaire,[34] which is filled out by the operating surgeon. Additional surgery information not pertaining to the meniscus is also collected from surgery reports.

Major outcomes

Knee injury and Osteoarthritis Outcome Score (KOOS)

All 5 domains (ie, subscales) on the KOOS[35 36] at the 1-year follow-up. The five KOOS domains are pain, symptoms, function during daily activities (ADL), Sport/Rec function and QOL. The KOOS score is ranging from 0 to 100 (0 indicating extreme symptoms and 100 indicating no symptoms). The KOOS score has been validated and previously used to assess self-reported outcomes in patients undergoing meniscus surgery.[6 8 25 27 35 36] In addition, it has been shown to perform well in the entire continuum from very early changes of knee OA to knee arthroplasty.[37] All outcomes included in the study are listed in table 1.

Minor outcomes

Patient Acceptable Symptom State (PASS) and Treatment Failure (TF)

One question regarding PASS will be used to assess how many patients consider themselves well after surgery (as opposed to feeling better).[38] PASS is assessed as a dichotomous outcome (y/n) to the question: "Considering your knee function, do you feel that your current state is satisfactory? With knee function you should take into account all activities you have during your daily life, Sport/Rec activities, your level of pain and other symptoms, and also your knee related QOL".

In addition, patients replying 'no' to the PASS question will also be asked to answer (y/n) the following question: "Would you consider your current state as being so unsatisfactory that you think the treatment has failed?" Patients replying, 'yes' to the second question will be defined as experiencing 'treatment failure' (TF).

Medical outcomes study 36-item short form health survey (SF-36)

The SF-36 will be used to assess general physical function. The SF-36 consists of eight subscales: physical function, role physical, bodily pain, general health, vitality, social function, role emotional and mental health. The SF-36 is self-explanatory, takes 10 min to complete and is scored from 0 to 100 (0 indicating extreme problems and 100 indicating no problems). The Acute Danish version of the SF-36 was used.[39 40]

Table 1 Collection of patient characteristics, outcome measures and explanatory variables

Variable	PRE	Surgery	12 Weeks	52 Weeks
Height	X			
Weight	X		X	X
Civil status	X			
Educational level	X			
Employment	X			
Smoking	X			
Comorbidities	X			
Alignment	X			X
Physical activity level	X			
ISAKOS questionnaire		X		
Knee joint stability	X		X	X
Expectations for surgery	X			
SF-36	X		X	X
KOOS	X		X	X
PASS			X	X
TF			X	X
GPE			X	X
AE			X	X

AE, adverse events; GPE, global perceived effect; ISAKOS, International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine—classification of meniscal tears questionnaire; KOOS, knee injury and osteoarthritis outcome score; PASS, patient acceptable symptom state; SF-36, medical outcomes study 36—Item Short Form Health Survey; TF, treatment failure.

Exploratory outcomes

- Questions regarding patient's expectations of surgery.[41]
- Questions concerning knee joint stability/laxity. One question regarding the frequency of symptoms and one question about the influence of symptoms (ie, sense of instability during daily activities).
- Questions regarding postoperative rehabilitation (ie, participation, type, frequency and degree of supervision).
- Questions regarding global perceived effect (GPE) to explore minimal clinical important change in PROs. GPE is evaluated on a seven-step global rating scale after surgery (ranging from better, an important improvement; somewhat better, but enough to be an important improvement; very small change, not enough to be an important improvement; about the same; very small change, not enough to be an important worsening; somewhat worse, but enough to be an important worsening; worse, an important worsening). A two-step change in GPE is considered clinically important.[42]

Adverse events

Adverse events (not necessarily implying causality to the surgery), defined as self-reported symptoms after surgery causing limitations in daily activities, Sport/Rec activities or work limitations together with symptoms causing patients to seek medical care or having re-surgery will be collected by self-report and patient record review.

Data management

All self-reported data are collected using email-based questionnaires. The participant-submitted responses are automatically registered in a secured database. At all data collection points an email reminder is sent to participants if they do not answer the email-based questionnaire within 3–4 days. In addition, participants who do not reply after the reminder will be called by phone to ensure a high follow-up rate.

Information registered by surgeons on the modified ISAKOS questionnaire following surgery will be transferred from paper format to electronic format using automated forms processing. This method is a validated alternative to double entry of data.[43]

Statistical analysis

The cohort will recruit all eligible patients from 1 February 2013 to 31 January 2014. Conservatively estimated we expect to recruit 450 patients to the KACS cohort within this time frame. For an overview of the expected distribution of patients recruited between 18 and 55 years, please refer to figure 3.

The minimal clinically important change on the KOOS subscale is considered to be 8–10 points.[37] Thus, with the estimated recruitment flow and distribution (figure 3); we will have a power of 0.99 for a two-sample pooled t test of a normal mean difference with a two-sided significance level of 0.05 ($p \leq 0.05$), assuming a common SD of 15 KOOS points to detect a mean difference of 8 KOOS points between NTT and TT (primary study aim 1).

In addition, we will have a power of 0.88 for a two-sample pooled t test of a normal mean difference with a two-sided significance level of 0.05 ($p \leq 0.05$), assuming a common SD of 15 KOOS points to detect a mean difference of 10 KOOS points between TT_{RES} and TT_{REP} (study aim 2).

If we are not able to reach sufficient numbers within the 1 year timeframe, recruitment will continue until the numbers specified in the a priori sample size calculation are reached.

Descriptive results will be given as means with SDs (or medians with IQR) and as percentages. Between-group comparisons of the KOOS and SF-36 scores at the 52 weeks of follow-up will be analysed with the use of ANalysis of COVAriance (ANCOVA), stratified by site and adjusted for the preoperative score level, sex, age and body mass index (BMI). PASS and TF will be analysed using χ^2 test. Multiple logistic regression will be applied to estimate ORs for dichotomous outcomes. Mixed linear effects models with patient as random factor and sex, age and BMI as fixed factors will be used to explore change over time (ie, baseline, 12 weeks and 52 weeks of follow-up) in KOOS and SF-36 scores. Results will be presented with 95% CIs. No interim analysis will be performed. All reported p values are two-sided and will not be adjusted for multiple comparisons. All data analyses will be carried out according to the pre-established analysis plan. All descriptive statistics and tests will be reported in accordance to the recommendations of the 'Enhancing the QUAlity and Transparency Of health Research' (EQUATOR) network: the STROBE statement.[44]

Full analysis set

To qualify for the 'full analysis set' recruited patients must reply to the baseline questionnaire and have the surgery performed to their meniscus. Please refer to figure 4, for an overview of the full analysis set. In case of missing data a non-responder imputation will be applied (ie, baseline observation carried forward). Further for sensitivity, the effect that any missing data might have on results will be assessed through sensitivity analyses of augmented data sets.

Planned sensitivity analysis

Sensitivity analysis will be conducted to explore whether the degree of cartilage defects (score: 0–4), and plica presence (y/n) have any impact on the outcome after surgery. Furthermore, we will construct a dichotomous outcome on whole knee OA (y/n) to explore the effect of presence of knee OA. Whole knee OA will be defined as; participants with cartilage defects International Cartilage Repair Society grade >2 in either of the patellofemoral, medial tibiofemoral or lateral tibiofemoral compartment excluding participants with TT (according to previous definition) and symptoms <6 months. In

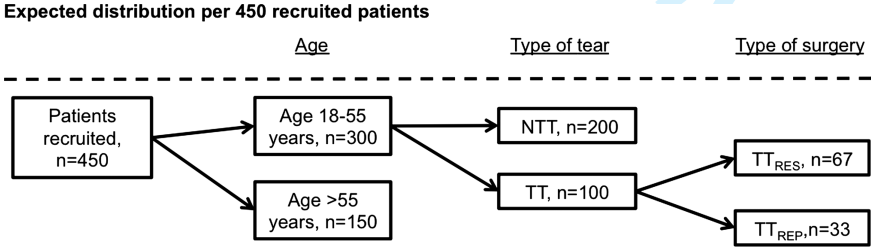

Figure 3 Expected distribution per 450 patients recruited, divided by age, type of tear and type of surgery. NTT, non-traumatic tear; TT, traumatic tear; TT_{RES}, traumatic tear resected; TT_{REP}, traumatic tear repaired.

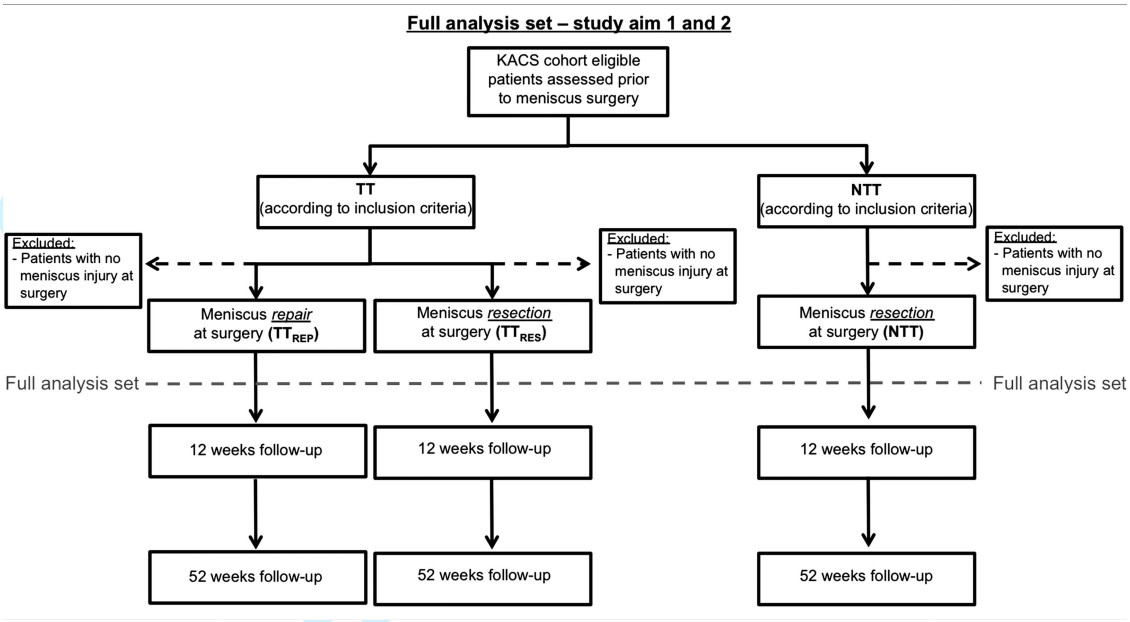

Figure 4 Overview of the full-analysis set for study aims 1 and 2. NTT, non-traumatic tear; TT, traumatic tear; TT_{RES}, traumatic tear resected; TT_{REP}, traumatic tear repaired.

addition, the effect of differences in patient characteristics between groups reported in table 1 with a p value ≤0.10 will be tested in a fully adjusted model.

ETHICS AND DISSEMINATION

The Regional Scientific Ethics Committee of Southern Denmark has reviewed the outline of this cohort study. The committee waived the need for ethical approval as study is the only pertaining questionnaire and register data. Such studies can be implemented without permission from the Ethics Committee according to Danish legislation (Committee Act § 1, paragraph 1).

The study findings will be disseminated in peer-reviewed journals and presented at national and international conferences.

DISCUSSION

Arthroscopic meniscus surgery is a high-volume surgery.[1] Little is known about the natural time course of PROs after meniscus surgery and which factors affect these outcomes. This prospective cohort will collect data from a large number of patients on the natural time course of PROs prior and following arthroscopic meniscus surgery. Our results will enable analysis of the dependence of postsurgery outcome on the type of meniscus tear (ie, TT vs NTT in middle-aged patients). Further, it will be possible to investigate the dependence of postsurgery outcome on the type of surgery in the subgroup of patients with TT (ie, TT_{RES} vs TT_{REP}). In contrast, other on-going randomised placebo controlled trials are investigating the effect of meniscus surgery for patients with degenerative tears.[45 46]

In this study a pragmatic clinical approach was chosen to categorise meniscus tears as either TT or NTT (ie, degenerative). The advantages of this approach are that it is simple, cheap, can be determined prior to surgery (in contrast to histology or arthroscopic observation) and feasible in a routine clinical setting. Thus, this information can be used to form an algorithm based on information available prior to surgery to select those patients who benefit most from surgery, which can be implemented in clinical practice. The definition of TT and NTT are similar but not identical to what has previously been used in other studies. Camanho *et al*[12] divided the patients into three groups; traumatic, degenerative and fatigue. In the present study the NTT group will include degenerative as well as fatigue as defined by Camanho *et al* as the focus of this study is on the traumatic versus non-traumatic initiation of the meniscal tear. Others have based their definition on sports participation.[47]

A limitation to this study is that patients are included based on the main reason for surgery (ie, suspicion of a meniscus tear). However, meniscus surgery may also be performed in relation to surgery for other knee pathologies. Those patients will not be included in the KACS. This should be taken into account when interpreting the cohort data. On the other hand, this makes it more likely that patient symptoms in the KACS cohort are primarily caused by the meniscus injury. Furthermore, we expect the age to be different in the TT compared with the NTT groups (ie, NTT group being older), thus all statistical analysis will be adjusted for age. Nevertheless, this should still be taken into consideration when interpreting the results.

Meniscus surgery may not be the answer to improve patient-perceived pain and function in all patients with

meniscus tears. Different factors, such as type of tear, may affect the postoperative outcome. Ultimately the goal of this study is to improve management of patients with meniscus tears through identifying factors associated with no or limited effect of surgery on PROs.

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Contributors JBT and LSL conceived the study. All authors participated in the study design. JBT, RC and LSL drafted the manuscript. All authors participated in critical scrutinising and revision of the manuscript and approved the final version.

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Competing interests None.

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Patient-reported outcomes in patients undergoing arthroscopic partial meniscectomy for traumatic or degenerative meniscal tears: A comparative prospective cohort study

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Abstract

Objectives: To compare patient-reported outcomes from before surgery to 52 weeks after surgery between individuals undergoing arthroscopic partial meniscectomy (APM) for traumatic or degenerative meniscal tears. We hypothesized that participants undergoing APM for traumatic tears would experience larger improvements in patient-reported outcomes.

Design: Comparative prospective cohort study.

Setting: Four public orthopaedic departments in the Region of Southern Demark.

Participants: 397 adults (42% women) aged 18-55 years undergoing APM for a traumatic (n=141, mean age 38.7 SD 10.9 years) or degenerative (n=256, mean age 46.6 SD 6.4 years) meniscal tear, defined by a combination of age and symptom onset.

Interventions: Both participant groups underwent APM for a meniscal tear.

Main outcome measures: Main outcome was the between-group difference in change from baseline prior to APM to 52 weeks on four of five Knee Injury and Osteoarthritis Outcome Score (KOOS) subscales covering pain, symptoms, sport and recreational function and quality of life ($KOOS_4$). A 95% confidence interval (95% CI) excluding differences greater than 10 KOOS-points between groups was interpreted as absence of a clinically meaningful difference.

Results: At 52 weeks after APM, 55 patients (14%) were lost to follow-up. Participants with degenerative meniscal tears displayed a statistically significant larger improvement from baseline to 52 weeks in $KOOS_4$ scores, compared with those having traumatic tears, adjusted between group difference -5.1 (-8.9 to -1.3, 95% CI, p=0.008) KOOS points. However, the difference between groups was at no time point considered clinically meaningful.

Conclusions: Our results question the current tenet that patients with traumatic meniscal tears experience greater improvements in patient-reported outcomes following APM compared with patients with degenerative tears.

Trial registration: ClinicalTrials.gov identifier: NCT01871272

What is already known on this subject

- Arthroscopic partial meniscectomy is routine surgery for both patients with traumatic and degenerative meniscal tears.
- High quality evidence shows only marginal short-term benefit of arthroscopic partial meniscectomy above placebo or non-surgical treatment for middle-aged and older individuals with degenerative meniscal tears but we found no trials for patients with traumatic tears.
- Arthroscopic partial meniscectomy is presumed to improve patient-reported outcomes to a greater extent in individuals with traumatic compared with degenerative tears.

What this study adds

- No clinically meaningful difference was found in improvement in patient-reported outcomes between patients undergoing arthroscopic partial meniscectomy for traumatic compared with degenerative tears.
- Randomised trials are needed comparing the effect of arthroscopic partial meniscectomy for traumatic tears to non-operative treatment or a sham surgery procedure.

Introduction

Knee arthroscopy for a meniscal tear is one of the most commonly performed orthopaedic procedures. Systematic reviews and meta-analyses of randomised trials have found arthroscopic knee surgery to provide no better effect than that of placebo surgery or any added benefit in addition to exercise for middle-aged and older patients with degenerative meniscal tears.[1 2] No corresponding randomised trials were identified comparing non-surgical treatment with arthroscopic knee surgery for patients with meniscal tears of traumatic origin.[2]

Traumatic meniscal tears usually occur in an otherwise 'healthy' meniscus in younger sports active individuals and can be attributed to a specific event such as a sports-related trauma.[3] In contrast, degenerative (non-traumatic) tears are typically observed in the middle-aged and older population[4] and associated with incipient knee osteoarthritis (OA).[5-7] Such tears are associated with mucoid degeneration,[8] meniscal calcification[9] and risk factors include age,[4] high body mass index (BMI),[4 10] knee malalignment[11] and occupational kneeling,[12] though the etiology is not entirely clear.[3] Despite differences in symptom onset, meniscal tissue quality and age distribution of patients with traumatic and degenerative tears, the same treatment – arthroscopic partial meniscectomy (APM) – has typically been offered for patients with both tear types.

In most observational studies, meniscal tear type (i.e. traumatic or degenerative) has rarely been taken into account.[13 14] Early reports from the beginning of the 1980´ies suggest poorer results in individuals with 'degenerative' changes undergoing arthroscopic meniscectomy.[15-17] More recent studies investigating difference in outcome between individuals with traumatic or degenerative tears report conflicting results. One study, including participants less than 40 years of age with isolated horizontal tears (a rare tear type in this population) reported similar outcome in individuals with traumatic and non-traumatic tears of this type 2 years after surgery.[18] Another study observed similar outcome at 1 year after surgery but poorer outcome in individuals with degenerative tears

compared to traumatic tears 4 years after either meniscectomy or meniscal repair.[19] However, both studies were retrospective and included a limited number of participants.[18 19] Lastly, one larger study reported better outcome in individuals with traumatic compared with degenerative meniscal tears 4 years after surgery. However, this was assessed at clinical visits or by telephone interview and not validated patient-reported outcomes measures.[20] Taken together, solid evidence from larger prospective studies using validated outcomes is lacking to confirm the current presumption that individuals with traumatic tears experience larger improvements in patient-reported outcomes after APM than those with degenerative tears.

Thus, we aimed to compare patient-reported outcomes from before surgery up to 52 weeks after surgery between individuals undergoing APM for traumatic tears compared with tears of degenerative origin. We hypothesised that individuals undergoing APM for traumatic tears would experience larger improvements in patient-reported pain, symptoms, function and quality of life compared with individuals with degenerative tears.

Methods

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline was followed for reporting of this comparative prospective cohort study.[21] The study has been registered at ClinicalTrials.gov (ClinicalTrials.gov identifier: NCT01871272).

Participants

Participants from Knee Arthroscopy Cohort Southern Denmark (KACS) were included for this study.[22] KACS is a prospective cohort following adults undergoing knee arthroscopy for meniscal tears recruited at four different public hospitals in Denmark between February 1st 2013 and January

31st 2014 and one hospital (i.e. one of the original four hospitals) in the period from February 1st 2014 to January 31st 2015.

The KACS cohort inclusion criteria were: ≥18 years of age, referred for knee arthroscopy on suspicion of a meniscus tear by an orthopaedic surgeon (i.e. based on clinical examination, injury history and MRI if considered necessary), able to read and understand Danish and having an email address.

Exclusion criteria were: No meniscal tear at surgery, previous or planned anterior or posterior cruciate ligament (ACL or PCL) reconstruction surgery in either knee, fracture(s) to the lower extremities within the last 6 months prior to recruitment or not able to reply to the questionnaire because of mental impairment.

For the present analysis only participants aged 55 years or younger at baseline and undergoing meniscal resection (i.e. not repair) at surgery were included. These age criteria were set to minimize the proportion of participants with more advanced stages of osteoarthritis. Written informed consent were obtained from all participants, although The Regional Scientific Ethics Committee of Southern Denmark waived the need for ethical approval.[22]

Patient-reported outcomes and symptom descriptions

Participant characteristics and information about symptoms was collected using online questionnaires prior to surgery (median 7 days, interquartile range 3-10 days), 12 and 52 weeks after surgery.

Knee Injury and Osteoarthritis Outcome Score (KOOS). The KOOS consists of 5 subscales covering pain, symptoms, function during daily activities (ADL), sport and recreational function (Sport/Rec) and quality of life (QOL). Each KOOS subscale ranges from 0-100 points with 0 representing extreme knee problems and 100 representing no knee problems.[23] The KOOS was

developed with involvement of patients and is intended for individuals with knee injuries that can result in post-traumatic OA such as meniscus injury, anterior cruciate ligament (ACL) injury and chondral injury.[23] $KOOS_4$ is the mean score of four of the five KOOS subscales (i.e. excluding the ADL subscale). The KOOS questionnaire has been validated in individuals undergoing APM,[23-25] and the $KOOS_4$ has been used in trials assessing the effect of knee surgery.[26-28]

The main outcome, in the present study, was the between-group difference in change from baseline to 52 weeks in the mean score on the $KOOS_4$. In the study protocol and trial registration it was stated that change from baseline to 52 weeks on all five KOOS subscales was the main outcome.[22] However, prior to analysis we decided to use the $KOOS_4$ to simplify interpretation by having only *one* main outcome. To assist the clinical interpretation of our main outcome (i.e. $KOOS_4$) all five subscales of the KOOS were included as secondary outcomes.

Patient Acceptable Symptom State (PASS) and Treatment Failure (TF). Additional secondary outcomes were PASS and TF 52 weeks after surgery. Satisfaction with current knee function (i.e. PASS) was assessed with the question ("yes"/"no"): "When you think of your knee function, will you consider your current condition as satisfying? By *knee function*, you should take into account your activities of daily living, sport and recreational activities, your pain and other symptoms and your quality of life". This question has been used to assess patient acceptable symptom state (PASS)[29] in individuals with knee injury.[30] Participants not satisfied with current knee function at 52 weeks after surgery (i.e. replying "no" to the PASS question) were asked to complete a second single-item question, relating to treatment failure: ''Would you consider your current state as being so unsatisfactory that you consider the treatment to have failed?'' (response options: "yes"/"no").[30]

Symptom onset. This was assessed with the question "How did the knee pain/problems for which you are now having surgery develop (choose the answer that best matches your situation)?", with the response options; "The pain/problems have slowly evolved over time", "As a result of a specific

incident (i.e. kneeling, sliding and/or twisting of the knee or the like, i.e. semi-traumatic onset)", or "As a result of a violent incident (i.e. during sports, a crash, collision or the like, i.e. traumatic onset)".

Symptom duration. This was assessed with the question "How long have you had your knee pain/knee problems for which you are now having surgery?".

Mechanical symptoms. Presence and frequency of mechanical symptoms (i.e. the sensation of catching or locking of the knee) was assessed with the question "How often have you experienced catching or locking of the knee, which is about to undergo surgery?" with five response options ranging from "never" to "daily".

Structural pathology

Information about meniscal tear type, tear placement (medial/lateral compartment), meniscal tissue quality (non-degenerative or degenerative) and cartilage defects was recorded by the operating surgeon at arthroscopy using a modified version of the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS) classification of meniscal tears questionnaire[31] including scoring of cartilage using the International Cartilage Repair Society (ICRS) grading system[32]. ICRS cartilage score ranges from 0-4 with 0 representing normal cartilage and 4 representing very severe cartilage lesions. The inter-rater reliability for meniscal tear type and tissue quality has been reported to be good to moderate (κ coefficients of 0.72 and 0.47, respectively)[31] and good for ICRS cartilage grading (ICC 0.83).[33] ICRS cartilage grade scoring from each knee joint compartment was added together to a 0-12 score for use as a covariate in the sensitivity analysis. Information registered by surgeons on the modified ISAKOS questionnaire was transferred from paper format to electronic format using automated forms processing. This method has been validated as an alternative to double entry of data.[34]

Categorisation of traumatic vs. degenerative meniscal tears

Traumatic meniscal tear: Participants aged 18-34 years and replying that symptoms evolved as a result of a 'specific incident' or 'violent incident' AND participants aged 35-55 years replying symptoms evolving as a result of a 'violent incident'.

Degenerative meniscal tear: Participants aged 18-34 years and replying that symptoms 'evolved slowly over time' AND participants aged 35-55 years replying symptoms evolving as a result of a 'specific incident' or 'evolved slowly over time'.

This definition was slightly changed prior to analysis as some participants between 18-55 years of age were not categorised as having either a traumatic or degenerative tear by the previous definition outlined in the study protocol.[22] Furthermore, the criterion on duration of symptoms was relaxed as it turned out that this was likely to be influenced by referral time to the orthopaedic department.

Statistics

Descriptive statistics are presented as means with standard deviations (SDs), medians with interquartile ranges and as numbers/percentages as appropriate.

As reported in the study protocol a participant flow with 200 participants in the degenerative group and 100 participants in the traumatic group would provide 0.99 power to detect an 8-point difference in $KOOS_4$ assuming a common SD of 15 and a significance level of 0.05.[22] The main outcome, between-group difference in change in $KOOS_4$ from baseline to 52 weeks was analysed using a repeated measures mixed linear model (Restricted Maximum Likelihood Estimation – REML) with subject nested within surgery site as random effects, and group (traumatic vs. degenerative) and time (baseline, 12 weeks and 52 weeks) as fixed effects.[35] The main analysis was changed to the current analysis as compared with the protocolled ANalysis of COVAriance

(ANCOVA) approach as the mixed model approach (including all available data at all time points) using REML is considered a valid option to create unbiased parameter estimates and standard errors and takes into account that repeated measures are non-independent.[22]

Adjusted models included age, sex and body mass index (BMI) as covariates as these were pre-specified as being potential confounding factors. The same analysis approach was used for all secondary KOOS subscales analyses. For the main outcome (i.e. $KOOS_4$) the interaction between group and time was also tested to assess the difference in change over time including all time points. For all models, residual plots of fixed effects were used to assess the normal distribution of residuals and independence of predicted values. Plots of Best Linear Unbiased Predictions (BLUPs) were used to assess model assumptions of random effects. Results are reported as mean group scores and differences, with 95% confidence intervals (95% CI).

The minimal clinically important difference on the KOOS is considered to be 8-10 points.[36] In the present study, a 95% CI excluding differences greater than 10 KOOS-points between groups was interpreted as indicating the absence of a clinically meaningful difference between groups as previously done in randomised trials on knee patients using the $KOOS_4$ as the primary outcome.[26-28]

Sensitivity analysis by adding degree of cartilage defects as a covariate in addition to age, sex and BMI was also conducted for the main outcome (i.e. $KOOS_4$) as well as a sensitivity analysis including all participant characteristics reported in table 1 with a p-value <0.10 and a fully adjusted model. Further sensitivity analyses were conducted to assess the robustness of the results with alternative definitions of traumatic and degenerative meniscal tears. Lastly, sensitivity analyses using a non-responder imputation approach (i.e. baseline observation carried forward) and a best/worst case scenario analysis imputing 25th percentile data from participants with available data at the 12 and 52 weeks follow-up for the degenerative tear group and 75th percentile data for the traumatic tear group (and vice versa) to investigate if this changed the interpretation of the results.

Differences in proportions of participants replying 'yes'/'no' to the PASS question between participants with traumatic and degenerative tears were tested using Chi-squared test and calculation of risk differences with 95% CI. Similar analyses were conducted to test the difference in proportion of participants with traumatic and degenerative meniscal tear that indicated treatment failure ('yes'/'no') of participants replying 'no' to the PASS question. Stata 14.1 was used for all analysis.

Patient involvement

No patients were involved in setting the research question or the outcome measures, nor were they involved in developing plans for recruitment, design or implementation of the study. No patients were asked to advise on interpretation or writing up of results. There are plans to disseminate the results of the study in lay language in press and for patient interest groups.

Results

In total, 641 participants replied to the baseline questionnaire and had a meniscal tear at surgery, constituting the KACS baseline sample (figure 1). Of these, 244 participants were excluded for this analysis due to meniscal repair (n=41) or being 56 years or older (n=203). The remaining 397 participants were defined as having a traumatic (n=141) or degenerative meniscal tear (n=256) according to the pre-specified criteria. At the 52 weeks assessment 55 participants (14%) had been lost to follow-up. Participants lost to follow-up were similar to those retained in the study except that participants with traumatic tears lost to follow-up (n=26) self-reported significantly worse on all KOOS subscales at the baseline assessment prior to surgery (supplementary table 1). Participants with degenerative tears were on average older than participants with traumatic tears, had a higher proportion of medial meniscal tears and more severe cartilage defects in the medial

tibiofemoral compartment compared to those with traumatic tears. Similar levels of self-reported outcomes on all KOOS subscales were observed between groups at baseline prior to surgery (table 1).

In the main analysis, the degenerative tear group had a significantly greater improvement in $KOOS_4$ score from before surgery to 52 weeks after surgery compared with the traumatic tear group, crude mean difference of -5.3 (-9.1 to -1.5 95% CI) and an adjusted mean difference of -5.1 (-8.9 to -1.3 95% CI) (table 2). In the analysis including $KOOS_4$ score at all time points, a significant time-by-group interaction was observed in both the unadjusted (p=0.025) and adjusted analysis (p=0.024), indicating better self-reported outcomes in participants with degenerative tears (figure 2). At no time point did the 95% CI exceed the pre-specified 10 point difference that was considered clinically relevant. Similar findings of no clinically relevant difference were observed for all KOOS subscales except the pain subscale, which crossed the 95% CI in favour of a larger clinical meaningful improvement in the degenerative tear group (table 2).

In sensitivity analysis of the main outcome (i.e. $KOOS_4$) adding degree of cartilage defects as a covariate did not change the interpretation of results, which was similar for analysis including all participant characteristics with a $p<0.10$ and the fully adjusted analysis (supplementary table 2). Further sensitivity analyses testing different definitions of traumatic and degenerative meniscal tears, i.e. either including all participants with 'semi-traumatic' onset as traumatic or degenerative (supplementary tables 3 and 4, respectively) or basing the definition on surgeon assessed meniscal tissue quality alone or in combination with symptom onset (supplementary tables 5 and 6, respectively), did not change the interpretation of data. We also compared the traumatic and degenerative tear groups with participants older than 55 years of age (i.e. those that were excluded in the initial analyses) (Supplementary table 7). Again, no clinically relevant differences between the traumatic, degenerative and older participant group were observed (supplementary figure 1).

Lastly, sensitivity analysis using null responder imputation and assuming best/worst case scenario of participants lost to follow-up did not alter the interpretation of data, though the analysis assuming best case for individuals lost to follow-up in the degenerative tear group and worst case in the traumatic tear group indicated the possibility of a clinically relevant larger improvement in the degenerative tear group (supplementary table 8).

A larger proportion (63% vs. 52%) of participants with degenerative tears were satisfied with their current knee function at the 52 weeks follow-up compared with those with traumatic tears (Table 3). However, a similar proportion (35% vs. 41%) of participants with traumatic and degenerative tears (i.e. of those not satisfied with their knee function at 52 weeks) considered the treatment to have failed (Table 3).

Discussion

Contrary to our hypothesis and the current tenet, that individuals undergoing APM for traumatic meniscal tears experience greater improvements in patient-reported outcomes compared with individuals with degenerative meniscal tears, we found a statistically significant larger improvement in $KOOS_4$ scores indicating better patient-reported outcomes, for participants with degenerative tears. However, the difference was small and did not reach the pre-specified level of a clinically meaningful difference at any time point up to one year, except for the KOOS pain subscale. A larger proportion of participants with traumatic tears were not satisfied with current knee function 52 weeks after APM compared with participants with degenerative tears. Approximately 15% of participants (53/342) were so dissatisfied that they considered the treatment to have failed, with no difference between groups.

Strength and weaknesses

No randomized trials have compared the effects of APM with sham surgery or non-surgical treatment options such as exercise for traumatic meniscal tears.[2] Knowledge on the natural time course of patient-reported outcomes after APM is sparse in these patients as most previous studies failed to account for symptom onset (i.e. traumatic or non-traumatic), patient age or included patients with concomitant anterior cruciate ligament (ACL) injury.[13 14] Early reports suggested better results in the absence of 'degenerative' changes when undergoing APM.[15-17] However, more recent studies show conflicting results but these are limited by poor study quality or small sample size.[18-20 37] In the present study participants were prospectively followed according to a pre-specified protocol[22] using a validated patient-reported outcome measure, enabling us to compare the natural time course of patient-reported outcomes in participants with traumatic and degenerative meniscal tears.

There is no consensus on the definition of 'traumatic' and 'degenerative' tears, and there is a 'grey zone' between the two. Therefore, we conducted several sensitivity analyses testing the robustness of the results by adjusting for meniscal and other structural knee joint pathologies observed at surgery and by applying different definitions of traumatic and degenerative meniscal tears. Even though the level of statistical significance and the direction of the results varied slightly in these analyses, the overall interpretation of no clinically meaningful difference between groups remained (supplementary material).

The present study was powered to detect an 8-point difference in improvement in KOOS scores between groups, as 8-10 KOOS points was considered a clinically relevant difference when the study was planned.[36] However, there is no consensus on the specific value that constitutes a clinically relevant difference/change on the KOOS score. Prior to analysis, we decided to interpret a 95% CI excluding differences greater than 10 KOOS-points between groups as absence of a

clinically meaningful difference between groups, as this cut-off was used in randomised trials comparing surgery to exercise therapy for patients with different knee pathologies.[26-28]

We decided to exclude participants 56 years or older not to enrich the data set with many participants likely to have more advanced stages of knee osteoarthritis. Excluding these participants could potentially lead to better average KOOS scores in the degenerative tear group as older age is associated with worse outcome after knee injury.[38] However, sensitivity analysis showed that the $KOOS_4$ time course did not differ between the degenerative tear group, participants aged 56 years or older or the traumatic tear group (group-by-time interaction, p=0.080).

Some participants were lost to follow-up. At 52 weeks, loss to follow-up was 18% and 11% for participants with traumatic and degenerative tears, respectively. Traumatic tear participants lost to follow-up self-reported markedly poorer on 4 of 5 KOOS subscales at the baseline assessment prior to surgery, compared to those who remained in the study. The direction of the resulting bias due to loss to follow-up of these participants is uncertain. However, sensitivity analyses with null responder imputation or assuming best/worst case scenario for patients lost to follow-up did not change the overall interpretation of data.

Participant age and sex distribution in the KACS cohort is similar to what has been reported for patients undergoing meniscal surgery in Denmark.[39] Nevertheless, participants having meniscal repair at surgery were excluded as we intended to compare patient-reported outcomes of two distinct patient groups receiving the same type of treatment. Thus, the present results only apply to individuals having APM.

Meaning of the study

Participants self-reported substantial impairments on the KOOS questionnaire prior to APM. The levels of self-reported impairments prior to surgery were similar to previous reports on individuals

with meniscal tears.[40] On average, participants reported improved patient-reported outcomes from baseline to 52 weeks follow-up (i.e. effect size > 1.0). However, KOOS scores were still substantially lower at 52 weeks after surgery compared to population-based data from Sweden on individuals aged 18-54 years. In particular, participants in the present study scored more than 25 KOOS points lower in the subscales Sport/Rec and QOL than population-based data.[41]

Studies on the effect of APM for individuals with degenerative meniscal tears have shown similar improvements as in individuals receiving sham surgery,[42] independent of the presence or absence of self-reported mechanical symptoms.[43] Exercise was recently shown to be as effective as APM to improve patient-reported outcomes[28] and systematic reviews and meta-analyses have similarly reported no added benefit of APM or debridement in addition to exercise for individuals with degenerative meniscal tears.[1 2] Acknowledging limitations provided by the observational nature of our study, it is noteworthy that the common presumption of better patient-reported outcomes after surgery for younger individuals with traumatic tears compared with middle-aged individuals with degenerative meniscal tears was not confirmed. We further note that almost half of traumatic tear participants were *not* satisfied with their current knee function one year after APM.

It is unknown if individuals with traumatic meniscal tears would experience similar improvements in self-reported outcomes with exercise therapy as reported for individuals with degenerative meniscal tears.[28] However, a randomized trial on young, active individuals with acute ACL injury, of which many had concomitant meniscal injuries, observed a reduced need for ACL reconstruction in those who received exercise as first line treatment.[27] Avoiding APM could be important in relation to the risk of later development of knee osteoarthritis as a recent observational study reported APM to be associated with greater risk of cartilage loss and incident knee osteoarthritis.[44] Furthermore, patients having had previous knee surgery undergo total knee replacement at significant younger age compared with individuals without previous knee surgery.[45]

Unanswered questions and future research

The common presumption that individuals with traumatic tears experience greater improvements in patient-reported outcomes than those with degenerative tears after APM was not supported by our results. Given the lack of effect of APM compared with placebo surgery for degenerative meniscal tears[42] and the positive effects of exercise for patients with degenerative meniscal tears[28] and ACL injury[27] it is time to investigate the efficacy of APM for traumatic meniscal tears in controlled trials comparing with placebo or non-operative treatment such as exercise.

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Contributors

JBT, RC, LSL and ME conceived and designed the study. NN, UJ and JS participated in the setup of the study, patient recruitment and data collection. JBT and KP conducted the analysis. JBT drafted the first version of the manuscript. All authors helped in revising the manuscript and gave their final approval of the submitted version. JBT is the guarantor.

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Competing interests

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

Transparency declaration

All authors had full access to the data and take responsibility for the integrity of the data and the accuracy of the data analysis. 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 have been explained.

Data sharing

Full dataset to replicate the main analysis is available from the corresponding author on reasonable request.

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Tables

Table 1: Baseline characteristics of participants with traumatic (TT) and degenerative meniscal tears (DT).

	TT group (n=141)	DT group (n=256)	Difference
Age, years (SD)	38.7 (10.9)	46.6 (6.4)	-7.9 (-6.2 to -9.6)
Female, no. (%)	53 (38%)	113 (44%)	-7% (-17% to 3%)
BMI, kg/m^2 (SD)	27.1 (4.9)	27.6 (4.6)	-0.5 (-1.4 to 0.5)
Symptom onset, no. (%)			<0.001
Slowly evolved over time	0 (0%)	122 (48%)	
Semi-traumatic	20 (14%)	134 (52%)	
Traumatic	121 (86%)	0 (0%)	
Mechanical symptoms, no. (%)			0.813
Never	65 (46%)	114 (45%)	
Monthly	24 (17%)	45 (18%)	
Weekly	9 (6%)	24 (9%)	
Several times a week	25 (18%)	38 (15%)	
Daily	18 (13%)	35 (14%)	
Duration of symptoms, no. (%)			<0.001
0-3 months	41 (29%)	45 (18%)	
4-6 months	16 (11%)	78 (30%)	
7-12 months	34 (24%)	55 (21%)	
13-24 months	21 (15%)	40 (16%)	
>24 months	29 (21%)	38 (15%)	
Compartment, no. (%)			<0.001
Medial	81 (57%)	220 (86%)	
Lateral	48 (34%)	25 (10%)	
Both	12 (9%)	11 (4%)	
Tear type, no (%)			0.050
Longitudinal-vertical	36 (26%)	37 (14%)	
Horizontal	9 (6%)	17 (7%)	
Radial	6 (4%)	21 (8%)	
Vertical flap	32 (23%)	64 (25%)	
Horizontal flap	11 (8%)	13 (5%)	
Complex	29 (21%)	78 (30%)	
Root tear	0 (0%)	1 (0%)	
More than one tear type	18 (13%)	25 (10%)	
Meniscal tissue quality, no (%)*			<0.001
Non-degenerative	87 (62%)	99 (39%)	
Degenerative	45 (32%)	151 (59%)	
Undetermined	9 (6%)	5 (2%)	
ICRS cartilage grade, no. (%)**			
Medial compartment			<0.001
Grade 0	65 (47%)	68 (27%)	
Grade 1	36 (26%)	61 (25%)	
Grade 2	21 (15%)	42 (17%)	
Grade 3	13 (9%)	58 (23%)	
Grade 4	2 (1%)	19 (8%)	
Lateral compartment			0.736
Grade 0	73 (53%)	121 (49%)	
Grade 1	46 (34%)	82 (33%)	
Grade 2	12 (9%)	27 (11%)	
Grade 3	5 (4%)	14 (6%)	

Grade 4	1 (1%)	4 (2%)	
Patellofemoral compartment			0.058
Grade 0	71 (52%)	100 (40%)	
Grade 1	38 (28%)	64 (26%)	
Grade 2	15 (11%)	47 (19%)	
Grade 3	11 (8%)	26 (10%)	
Grade 4	2 (1%)	11 (4%)	
KOOS scores (SD)			
$KOOS_4$	46.4 (16.4)	45.5 (15.0)	0.9 (-2.3 to 4.1)
Pain	57.1 (20.6)	54.4 (17.5)	2.7 (-1.2 to 6.5)
Symptoms	59.4 (18.6)	59.4 (18.9)	0.1 (-3.8 to 4.0)
ADL	66.4 (21.0)	63.7 (19.1)	2.7 (-1.4 to 6.8)
Sport/Rec	28.4 (23.8)	26.5 (21.3)	2.0 (-2.6 to 6.6)
QOL	40.6 (16.5)	41.7 (14.8)	-1.1 (-4.3 to 2.1)

no.: Number, SD: Standard Deviation, BMI: Body Mass Index (kg/m^2)
*Missing data on meniscal tissue quality, n=1.
**Missing data on cartilage damage, n=12.

Table 2: Knee Injury and Osteoarthritis Outcome Score (KOOS) at 12 and 52 weeks follow-up for participants with traumatic (TT) and degenerative (DT) meniscal tears, respectively.

	3 month follow-up		Diff. TT vs. DT 3 mth. (95% CI)	12 month follow-up		Diff. TT vs. DT 12 mth. (95% CI)	Diff. TT vs. DT, change baseline to 12 mth. (95% CI)
	TT group (n=136)	DT group (n=245)		TT group (n=115)	DT group (n=227)		
Unadjusted KOOS scores							
$KOOS_4$	57.4 (54.2 to 60.6)	58.7 (56.3 to 61.1)	-1.3 (-5.3 to 2.7)	61.8 (58.5 to 65.2)	66.2 (63.8 to 68.7)	-4.4 (-8.5 to -0.2)	-5.3 (-9.1 to -1.5)
Pain	70.4 (67.1 to 73.7)	71.2 (68.8 to 73.7)	-0.8 (-4.9 to 3.3)	71.5 (68.1 to 75.0)	77.3 (74.8 to 79.8)	-5.7 (-10.0 to -1.4)	-8.4 (-12.4 to -4.4)
Symptoms	67.1 (63.8 to 70.4)	71.0 (68.5 to 73.4)	-3.8 (-7.9 to 0.3)	72.3 (68.8 to 75.7)	76.3 (73.8 to 78.8)	-4.0 (-8.3 to 0.3)	-4.1 (-8.3 to 0.1)
ADL	77.3 (74.1 to 80.5)	78.3 (75.9 to 80.7)	-1.0 (-5.1 to 3.0)	79.9 (76.5 to 83.2)	83.3 (80.8 to 85.7)	-3.4 (-7.6 to 0.7)	-6.1 (-9.7 to -2.5)
Sport/Rec	43.8 (39.3 to 48.2)	41.6 (38.3 to 45.0)	2.1 (-3.4 to 7.7)	49.4 (44.6 to 54.1)	51.5 (48.1 to 54.9)	-2.1 (-7.9 to 3.7)	-4.1 (-9.7to 1.5)
QOL	48.3 (45.0 to 51.7)	51.0 (48.5 to 53.5)	-2.6 (-6.8 to 1.5)	54.5 (51.0 to 58.1)	59.9 (57.3 to 62.4)	-5.4 (-9.7 to 1.0)	-4.3 (-8.7 to 0.1)
Adjusted* KOOS scores							
$KOOS_4$	57.4 (54.3 to 60.5)	58.7 (56.4 to 61.0)	-1.3 (-5.1 to 2.6)	61.9 (58.7 to 65.2)	66.2 (63.8 to 68.5)	-4.2 (-8.3 to -0.2)	-5.1 (-8.9 to -1.3)
Pain	70.4 (67.2 to 73.6)	71.2 (68.8 to 73.5)	-0.8 (-4.7 to 3.2)	71.7 (68.3 to 75.0)	77.2 (74.8 to 79.6)	-5.5 (-9.7 to -1.4)	-8.2 (-12.2 to -4.2)
Symptoms	67.1 (63.8 to 70.3)	70.9 (68.5 to 73.3)	-3.9 (-7.9 to 0.2)	72.3 (68.9 to 75.7)	76.2 (73.8 to 78.7)	-3.9 (-8.2 to 0.3)	-4.0 (-8.2 to 0.2)
ADL	77.3 (74.2 to 80.3)	78.3 (76.0 to 80.5)	-1.0 (-4.8 to 2.8)	80.0 (76.8 to 83.1)	83.2 (80.9 to 85.5)	-3.2 (-7.1 to 0.7)	-5.9 (-9.5 to -2.3)
Sport/Rec	43.7 (39.4 to 48.0)	41.6 (38.4 to 44.8)	2.1 (-3.2 to 7.5)	49.4 (44.9 to 54.0)	51.4 (48.1 to 54.7)	-1.9 (-7.6 to 3.7)	-3.8 (-9.5 to 1.7)
QOL	48.3 (45.0 to 51.6)	51.0 (48.5 to 53.4)	-2.6 (-6.7 to 1.5)	54.6 (51.1 to 58.1)	59.9 (57.3 to 62.4)	-5.3 (-9.6 to -0.9)	-4.2 (-8.5 to 0.2)

ADL: Activities of daily living, Sport/Rec: Sport and recreational activities, QOL: Quality of life
*Adjusted for: Age, sex and BMI.

Table 3: Proportion of participants reporting acceptable symptom state and proportion of participants reporting treatment failure among those with unsatisfactory symptom state at 52 weeks follow-up.

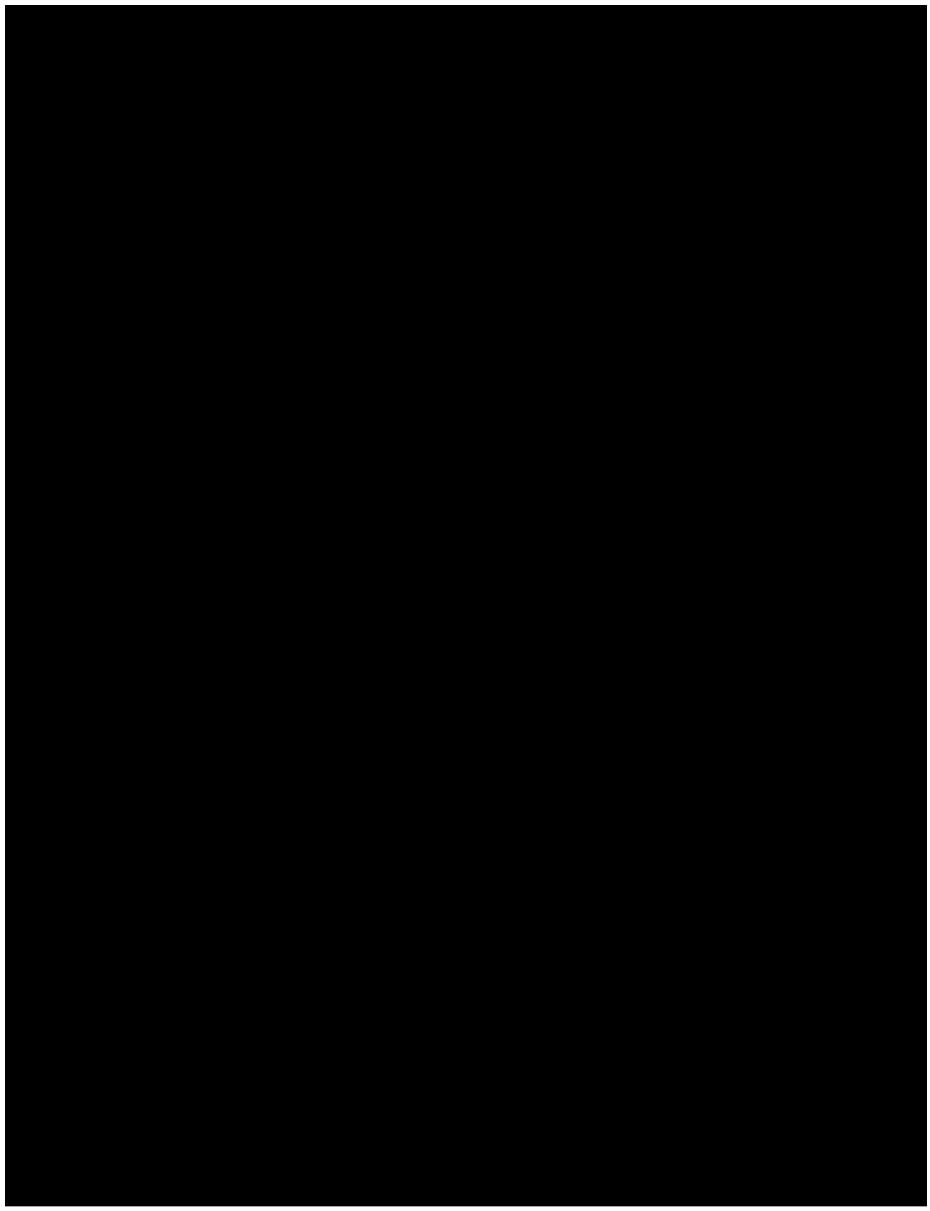
	TT group (n=115)	DT group (n=227)	Risk difference (95% CI)
Satisfied with current knee function (PASS), yes/no (%)	60/55 (52%/48%)	144/83 (63%/37%)	0.11 (0.01 to 0.22)
Treatment failure, yes/no (%)*	19/36 (35%/65%)	34/49 (41%/59%)	-0.06 (-0.23 to 0.10)

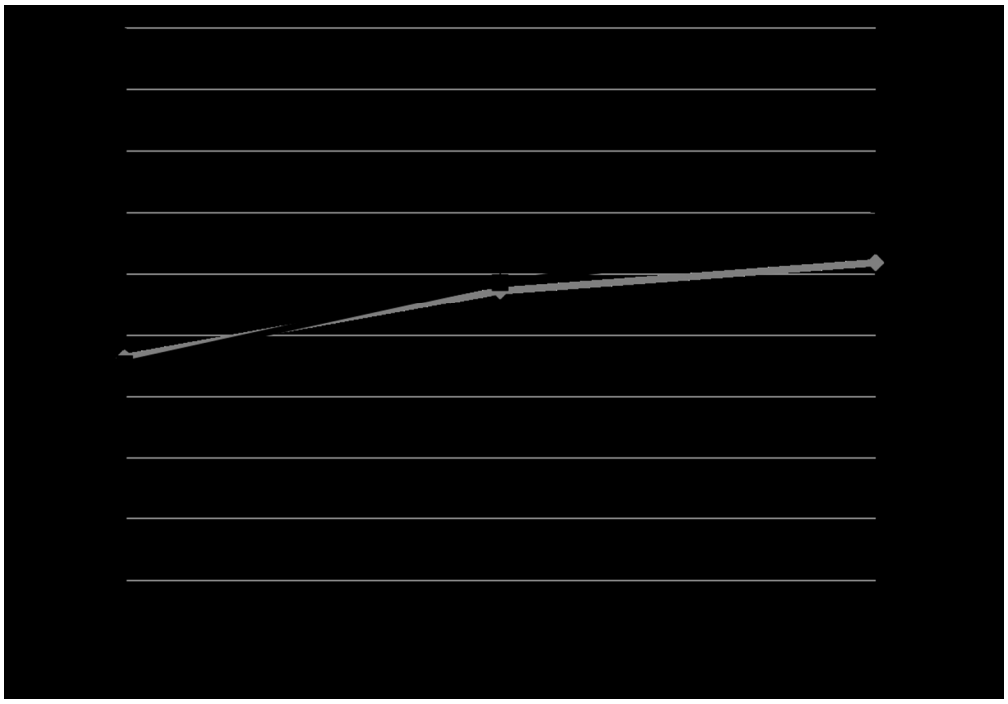
PASS: Patient Acceptable Symptom State
*Self-reported treatment failure among those with unsatisfactory symptom state (i.e. replying "no" to the PASS question)

Figure legends

Figure 1: Participant flow-chart

Figure 2: Mean score on four Knee Injury and Osteoarthritis Outcome Score subscales, covering pain, symptoms, sport and recreational function and quality of life ($KOOS_4$) assessed before (PRE) arthroscopic partial meniscectomy (APM), 12 and 52 weeks after APM for traumatic tear (TT) group and degenerative (DT) group. Data from model adjusted for age, sex and BMI. Bars indicate 95% confidence intervals. Group-by-time interaction from crude (p=0.025) and adjusted analysis (p=0.024).





Supplementary material

Supplementary table 1: Comparison of baseline characteristics of participants with traumatic tears (TT) and degenerative tears (DT) assessed at 52 weeks and patients lost to follow-up at 52 weeks.

	TT assessed at 52 weeks (n=115)	TT lost to follow-up (n=26)	Baseline diff. TT vs. TT_{lost}	DT assessed at 52 weeks (n=227)	DT lost to follow-up (n=29)	Baseline diff. DT vs. DT_{lost}
Age, years (SD)	39.1 (11.0)	36.9 (10.3)	2.2 (-2.4; 6.9)	46.9 (6.0)	44.2 (8.5)	2.8 (0.3; 5.3)
Female, no. (%)	42 (37%)	11 (42%)	0.582	100 (44%)	13 (45%)	0.937
BMI, kg/m^2 (SD)	27.0 (4.8)	27.7 (5.4)	-0.7 (-2.8; 1.4)	27.7 (4.7)	26.8 (3.9)	0.9 (-0.9; 2.7)
Symptom onset, no. (%)			0.846			0.041
Slowly evolved over time	0 (0%)	0 (0%)		103 (45%)	19 (66%)	
Semi-traumatic	16 (14%)	4 (15%)		124 (55%)	10 (34%)	
Traumatic	99 (86%)	22 (85%)		0 (0%)	0 (0%)	
Mechanical symptoms, no. (%)			0.133			0.029
Never	49 (43%)	16 (62%)		108 (48%)	6 (21%)	
Monthly	22 (19%)	2 (8%)		39 (17%)	6 (21%)	
Weekly	9 (8%)	0 (0%)		20 9%)	4 (14%)	
Several times a week	22 (19%)	3 (12%)		29 (13%)	9 (31%)	
Daily	13 (11%)	5 (19%)		31 (14%)	4 (14%)	
Duration of symptoms, no. (%)			0.941			0.462
0-3 months	33 (29%)	8 (31%)		42 (19%)	3 (10%)	
4-6 months	13 (11%)	3 (12%)		70 (31%)	8 (28%)	
7-12 months	29 (25%)	5 (19%)		50 (22%)	5 (17%)	
13-24 months	16 (14%)	5 (19%)		33 (15%)	7 (24%)	
>24 months	24 (21%)	5 (19%)		32 14%)	6 (21%)	
Compartment, no. (%)			0.811			0.542
Medial	67 (58%)	14 (54%)		197 (87%)	23 (79%)	
Lateral	39 (34%	9 (35%)		21 (9%)	4 (14%)	
Both	9 (8%)	3 (12%)		9 (4%)	2 (7%)	
Tear type, no (%)			0.253			0.847
Longitudinal-vertical	26 (23%)	10 (9%)		32 (14%)	5 (17%)	
Horizontal	7 (6%)	2 (2%)		17 (7%)	0 (0%)	
Radial	4 (3%)	2 (2%)		21 (9%)	3 (10%)	
Vertical flap	27 (23%)	5 (4%)		64 (28%)	7 (24%)	
Horizontal flap	11 (10%)	0 (0%)		13 (6%)	1 (3%)	
Complex	23 (20%)	6 (5%)		78 (34%)	9 (31%)	
Root tear	0 (0%)	0 (0%)		1 (0%)	0 (0%)	
More than one tear type	17 (15%)	1 (1%)		21 (9%)	4 (14%)	

Meniscal tissue quality, no (%)*			0.307			0.028
Non-degenerative	68 (59%)	19 (73%)		86 (38%)	13 (46%)	
Degenerative	40 (35%)	5 (19%)		136 (60%)	15 (54%)	
Undetermined	7 (6%)	2 (8%		5 (2%)	0 (0%)	
ICRS cartilage grade, no. (%)**						
Medial compartment			0.343			0.785
Grade 0	53 (47%)	12 (48%)		58 (26%)	10 (34%)	
Grade 1	27 (24%)	9 (36%)		56 (26%)	5 (17%)	
Grade 2	19 (17%)	2 (8%)		37 (17%)	5 (17%)	
Grade 3	12 (11%)	1 (4%)		52 (24%)	6 (21%)	
Grade 4	1 (1%)	1 (4%)		16 (7%)	3 (10%)	
Lateral compartment			0.213			0.594
Grade 0	58 (52%)	15 (60%)		107 (49%)	14 (48%)	
Grade 1	39 (35%)	7 (28%)		75 (34%)	7 (24%)	
Grade 2	11 (10%)	1 (4%)		22 (10%)	5 (17%)	
Grade 3	4 (4%)	1 (4%)		12 (5%)	2 (7%)	
Grade 4	0 (0%)	1 (4%)		3 (1%)	1 (3%)	
Patellofemoral compartment			0.873			0.487
Grade 0	58 (52%)	13 (52%)		87 (40%)	13 (45%)	
Grade 1	32 (29%)	6 (24%)		59 (27%)	5 (17%)	
Grade 2	12 (11%)	3 (12%)		43 (20%)	4 (14%)	
Grade 3	8 (7%)	3 (12%)		21 (10%)	5 (17%)	
Grade 4	2 (2%)	0 (0%)		9 (4%)	2 (7%)	
KOOS scores (SD)						
$KOOS_4$	48.5 (16.0)	37.2 (15.3)	11.3 (4.5; 18.1)	45.7 (15.1)	44.0 (14.0)	1.6 (-4.2; 7.5)
Pain	60.1 (19.2)	43.5 (21.5)	16.7 (8.2; 25.1)	54.5 (17.6)	53.8 (17.5)	0.7 (-6.2: 7.5)
Symptoms	61.5 (17.6)	50.3 (20.5)	11.2 (3.5; 19.0)	59.8 (19.0)	56.2 (17.5)	3.6 (-3.7; 10.9)
ADL	68.5 (20.2)	57.4 (22.4)	11.1 (2.2; 19.9)	63.9 (19.2)	62.3 (18.8)	1.6 (-5.8; 9.1)
Sport/Rec	30.9 (24.1)	17.5 (19.5)	13.4 (3.4; 23.4)	26.5 (21.0)	26.2 (23.5)	0.3 (-8.0; 8.6)
QOL	41.3 (16.1)	37.5 (18.1)	3.8 (-3.3; 10.9)	41.9 (14.7)	39.9 (15.5)	2.0 (-3.7; 7.8)

no.: Number, SD: Standard Deviation, BMI: Body Mass Index (kg/m^2)
*Missing data on meniscal tissue quality, n=1.
**Missing data on cartilage defects, n=12.

Supplementary table 2: Sensitivity analysis 1, 2 and 3 of main analysis on trajectory of Knee Injury and Osteoarthritis Outcome Score ($KOOS_4$) at baseline, 12 and 52 weeks follow-up for participants with traumatic (TT) and degenerative (DT) meniscal tears.

	Baseline			3 months follow-up			12 months follow-up			Diff. TT vs. DT, change baseline to 12 mth. (95% CI)
	TT group	DT group	Diff.	TT group	DT group	Diff.	TT group	DT group	Diff.	
Sensitivity analysis[1]:										
n	137	248		132	237		112	219		
$KOOS_4$	46.5 (43.5; 49.6)	45.1 (42.9; 47.4)	1.4 (-2.4; 5.2)	57.3 (54.3; 60.4)	58.6 (56.3; 60.9)	-1.3 (-5.1; 2.5)	62.2 (58.9; 65.4)	66.3 (63.9; 68.6)	-4.1 (-8.1; -0.1)	-5.5 (-9.4; -1.7)
Sensitivity analysis[2]:										
n	137	247		132	236		112	219		
$KOOS_4$	46.6 (41.2; 52.1)	45.2 (39.6; 50.8)	1.4 (-2.7; 5.6)	57.4 (51.9; 62.9)	58.6 (53.0; 64.2)	-1.2 (-5.4; 2.9)	62.4 (56.8; 68.1)	66.3 (60.7; 71.9)	-3.8 (-8.1; 0.5)	-5.3 (-9.1; -1.4)
Sensitivity analysis[3]:										
n	137	247		132	236		112	219		
$KOOS_4$	46.4 (40.6; 52.1)	44.8 (38.9; 50.8)	1.5 (-2.5; 5.6)	57.2 (51.4; 62.9)	58.3 (52.3; 64.3)	-1.1 (-5.2; 2.9)	62.4 (56.6; 68.3)	66.2 (60.2; 72.2)	-3.8 (-8.0; 0.5)	-5.3 (-9.2; -1.4)

Sensitivity analysis[1], adjusted for: Age, sex, BMI and cartilage defects (continuous variable)
Sensitivity analysis[2], adjusted for: Age, sex, BMI, cartilage defects (continuous variable), duration of symptoms (categorical variable), compartment of tear (categorical variable), tear type (categorical variable), meniscal tissue quality (categorical variable)
Sensitivity analysis[3], adjusted for: Age, sex, BMI, ICRS cartilage grade separately for each knee compartment (categorical variable), mechanical symptoms (categorical variable), duration of symptoms (categorical variable), compartment of tear (categorical variable), tear type (categorical variable), meniscal tissue quality (categorical variable)

Supplementary table 3: Sensitivity analysis 4, effect of alternative of definition of traumatic (TT) and degenerative (DT) tears on results of trajectory on Knee Injury and Osteoarthritis Outcome Score ($KOOS_4$) at baseline, 12 and 52 weeks follow-up.

	Baseline			3 months follow-up			12 months follow-up			Diff. TT vs. DT, change baseline to 12 mth. (95% CI)
	TT group (n=275)	DT group (n=122)	Diff.	TT group (n=265)	DT group (n=116)	Diff.	TT group (n=239)	DT group (n=103)	Diff.	
Unadjusted analysis:										
$KOOS_4$	45.3 (43.0; 47.5)	47.0 (43.7; 50.4)	-1.8 (-5.9; 2.3)	58.4 (56.1; 60.7)	57.8 (54.3; 61.3)	0.6 (-3.5; 4.8)	63.7 (61.4; 66.1)	67.1 (63.5; 70.6)	-3.3 (-7.6; 1.0)	-1.5 (-5.5; 2.4)
Adjusted* analysis:										
$KOOS_4$	45.3 (43.1; 47.5)	47.0 (43.8; 50.3)	-1.8 (-5.7; 2.2)	58.3 (56.1; 60.6)	57.8 (54.5; 61.2)	0.5 (-3.5; 4.5)	63.7 (61.5; 66.0)	67.0 (63.5; 70.4)	-3.2 (-7.4; 0.9)	-1.4 (-5.4; 2.5)

Traumatic tear (TT) definition: Participants aged 18-55 years reporting 'traumatic' or 'semi-traumatic' symptom onset.
Degenerative tear (DT) definition: Participants aged 18-55 years reporting 'slowly' symptom onset.
*Adjusted for: Age, sex and BMI

Supplementary table 4: Sensitivity analysis 5, effect of alternative of definition of traumatic (TT) and degenerative (DT) tears on results of trajectory on Knee Injury and Osteoarthritis Outcome Score ($KOOS_4$) at baseline, 12 and 52 weeks follow-up.

	Baseline			3 months follow-up			12 months follow-up			
	TT group (n=121)	DT group (n=276)	Diff.	TT group (n=116)	DT group (n=265)	Diff.	TT group (n=99)	DT group (n=243)	Diff.	Diff. TT vs. DT, change baseline to 12 mth. (95% CI)
Unadjusted analysis:										
$KOOS_4$	46.2 (42.8; 49.6)	45.6 (43.4; 47.9)	0.5 (-3.5; 4.6)	56.4 (53.0; 59.9)	59.0 (56.8; 61.3)	-2.6 (-6.8; 1.5)	60.8 (57.2; 64.4)	66.4 (64.0; 68.7)	-5.6 (-9.9; -1.2)	-6.1 (-10.1; -2.1)
Adjusted* analysis:										
$KOOS_4$	46.2 (42.9; 49.5)	45.7 (43.5; 47.9)	0.5 (-3.4; 4.5)	56.3 (53.0; 59.7)	59.5 (57.3; 61.7)	-3.2 (-7.2; 0.8)	60.9 (57.4; 64.4)	66.3 (64.1; 68.6)	-5.4 (-9.6; -1.3)	-6.0 (-9.9; -2.0)

Traumatic tear (TT) definition: Participants aged 18-55 years reporting 'traumatic' symptom onset.
Degenerative tear (DT) definition: Participants aged 18-55 years reporting 'semi-traumatic' or 'slowly' symptom onset.
*Adjusted for: Age, sex and BMI

Supplementary table 5: Sensitivity analysis 6, effect of alternative of definition of traumatic (TT) and degenerative (DT) tears on results of trajectory on Knee Injury and Osteoarthritis Outcome Score ($KOOS_4$) at baseline, 12 and 52 weeks follow-up.

	Baseline			3 months follow-up			12 months follow-up			
	TT group (n=186)	DT group (n=196)	Diff.	TT group (n=178)	DT group (n=188)	Diff.	TT group (n=154)	DT group (n=176)	Diff.	Diff. TT vs. DT, change baseline to 12 mth. (95% CI)
Unadjusted analysis:										
$KOOS_4$	45.5 (42.8; 48.3)	46.0 (43.3; 48.7)	-0.5 (-4.3; 3.4)	60.2 (57.4; 63.0)	56.8 (54.1; 59.6)	3.4 (-0.5; 7.3)	66.5 (63.6; 69.5)	63.5 (60.7; 66.2)	3.1 (-1.0; 7.1)	3.5 (-0.2; 7.3)
Adjusted* analysis:										
$KOOS_4$	45.6 (42.9; 48.2)	46.0 (43.4; 48.6)	-0.5 (-4.2; 3.3)	60.3 (57.5; 63.0)	56.7 (54.1; 59.4)	3.6 (-0.2; 7.4)	66.6 (63.8; 69.5)	63.5 (60.8; 66.2)	3.2 (-0.8; 7.1)	3.6 (-0.1; 7.4)

Traumatic tear (TT) definition: Participants aged 18-55 years having non-degenerative meniscal tissue at arthroscopy.
Degenerative tear (DT) definition: Participants aged 18-55 years having degenerative meniscal tissue at arthroscopy.
*Adjusted for: Age, sex and BMI

Supplementary table 6: Sensitivity analysis 7, effect of alternative of definition of traumatic (TT) and degenerative (DT) tears on results of trajectory on Knee Injury and Osteoarthritis Outcome Score ($KOOS_4$) at baseline, 12 and 52 weeks follow-up.

	Baseline			3 months follow-up			12 months follow-up			
	TT group (n=190)	DT group (n=192)	Diff.	TT group (n=185)	DT group (n=181)	Diff.	TT group (n=162)	DT group (n=168)	Diff.	Diff. TT vs. DT, change baseline to 12 mth. (95% CI)
Unadjusted analysis:										
$KOOS_4$	45.7 (42.9; 48.4)	45.9 (43.2; 48.6)	-0.2 (-4.1; 3.6)	59.3 (56.5; 62.1)	57.6 (54.8; 60.4)	1.7 (-2.3; 5.6)	64.8 (61.9; 67.7)	65.0 (62.2; 67.8)	-0.2 (-4.3; 3.8)	0.0 (-3.7; 3.7)
Adjusted* analysis:										
$KOOS_4$	45.7 (43.0; 48.3)	45.9 (43.2; 48.5)	-0.2 (-3.9; 3.6)	59.3 (56.6; 62.0)	57.5 (54.8; 60.2)	1.8 (-2.0; 5.6)	64.8 (62.0; 67.6)	65.0 (62.2; 67.7)	-0.2 (-4.1; 3.8)	0.0 (-3.7; 3.7)

Traumatic tear (TT) definition: Age 18-55 years with "Non-degenerative" meniscal tissue quality and reporting 'traumatic' or 'semi-traumatic' symptom onset and patients aged 18-55 years with "Degenerative" meniscal tissue quality reporting 'traumatic' symptom onset.

Degenerative tear (DT) definition: Age 18-55 years with "Degenerative" meniscal tissue quality and reporting 'semi-traumatic' or 'slowly symptom onset and patients aged 18-55 years with "Non-degenerative" meniscal tissue quality reporting 'slowly' symptom onset.

*Adjusted for: Age, sex and BMI

Supplementary table 7: Baseline characteristics of excluded participants aged 56 years or older (n=203).

Age, years (SD)	63.5 (5.2)
Female, no. (%)	101 (50%)
BMI, kg/m^2 (SD)	27.3 (4.0)
Symptom onset, no. (%)	
Slowly evolved over time	77 (38%)
Semi-traumatic	95 (47%)
Traumatic	31 (15%)
Mechanical symptoms, no. (%)	
Never	120 (59%)
Monthly	25 (12%)
Weekly	10 (5%)
Several times a week	24 (12%)
Daily	24 (12%)
Duration of symptoms, no. (%)	
0-3 months	34 (17%)
4-6 months	78 (38%)
7-12 months	37 (18%)
13-24 months	28 (14%)
>24 months	26 (13%)
Compartment, no. (%)	
Medial	141 (72%)
Lateral	31 (16%)
Both	25 (13%)
Tear type, no (%)	
Longitudinal-vertical	12 (6%)
Horizontal	15 (8%)
Radial	14 (7%)
Vertical flap	49 (25%)
Horizontal flap	8 (4%)
Complex	71 (36%)
Root tear	1 (1%)
More than one tear type	27 (13%)
Meniscal tissue quality, no (%)*	
Non-degenerative	27 (13%)
Degenerative	168 (84%)
Undetermined	6 (3%)
ICRS cartilage grade, no. (%)**	
Medial compartment	
Grade 0	14 (7%)
Grade 1	44 (22%)
Grade 2	51 (26%)
Grade 3	68 (35%)
Grade 4	20 (10%)
Lateral compartment	
Grade 0	34 (17%)
Grade 1	76 (39%)
Grade 2	52 (26%)
Grade 3	26 (13%)
Grade 4	9 (5%)
Patellofemoral compartment	
Grade 0	24 (12%)
Grade 1	62 (31%)

Grade 2	41 (21%)
Grade 3	52 (26%)
Grade 4	18 (9%)
KOOS scores (SD)	
$KOOS_4$	44.0 (14.2)
Pain	52.0 (17.3)
Symptoms	60.2 (17.8)
ADL	59.6 (18.3)
Sport/Rec	22.8 (19.5)
QOL	41.0 (14.8)

no.: Number, SD: Standard Deviation, BMI: Body Mass Index (kg/m^2)
*Missing data on meniscal tissue quality, n=2.
**Missing data on cartilage defects, n=6.

Supplementary table 8: Sensitivity analysis 8, 9 and 10, effect of null responder and best/worst case scenario imputation of missing data in change in Knee Injury and Osteoarthritis Outcome Score ($KOOS_4$) from baseline prior to surgery to 52 weeks follow-up between participants with traumatic (TT) and degenerative (DT) meniscal tears.

	3 month follow-up		Diff. TT vs. DT 3 mth. (95% CI)	12 month follow-up		Diff. TT vs. DT 12 mth. (95% CI)	Diff. TT vs. DT, change baseline to 12 mth. (95% CI)
	TT group (n=141)	DT group (n=256)		TT group (n=141)	DT group (n=256)		
Sensitivity analysis[8]:							
Unadjusted KOOS scores							
$KOOS_4$	57.1 (53.8; 60.3)	58.2 (55.8; 60.6)	-1.1 (-5.1; 2.9)	58.6 (55.4; 61.8)	63.8 (61.4; 66.2)	-5.2 (-9.2; -1.2)	-6.1 (-9.7; -2.5)
Adjusted* KOOS scores							
$KOOS_4$	57.0 (53.9; 60.2)	58.2 (55.9; 60.5)	-1.2 (-5.1; 2.7)	58.6 (55.5; 61.7)	63.8 (61.5; 66.2)	-5.3 (-9.2; -1.4)	-6.1 (-9.7; -2.5)
Sensitivity analysis[9]:							
Unadjusted KOOS scores							
$KOOS_4$	56.8 (53.6; 59.9)	59.2 (56.9; 61.6)	-2.5 (-6.4; 1.4)	60.5 (57.3; 63.6)	68.3 (66.0; 70.6)	-7.8 (-11.7; -4.0)	-8.8 (-12.4; -5.1)
Adjusted* KOOS scores							
$KOOS_4$	56.7 (53.7; 59.8)	59.2 (57.0; 61.5)	-2.5 (-6.3; 1.3)	60.4 (57.4; 63.5)	68.3 (66.1; 70.6)	-7.9 (-11.7; -4.1)	-8.8 (-12.4; -5.1)
Sensitivity analysis[10]:							
Unadjusted KOOS scores							
$KOOS_4$	58.0 (54.8; 61.1)	58.0 (55.7; 60.3)	0.0 (-3.9; 3.9)	66.5 (63.4; 69.6)	64.6 (62.3; 66.9)	1.9 (-2.0; 5.8)	1.0 (-2.8; 4.8)
Adjusted* KOOS scores							
$KOOS_4$	57.9 (54.9; 61.0)	58.0 (55.8; 60.3)	-0.1 (-3.8; 3.7)	66.5 (63.5; 69.5)	64.6 (62.4; 66.9)	1.9 (-1.9; 5.6)	1.0 (-2.8; 4.8)

Sensitivity analysis[8]: Null responder imputation (last observation carried forward)

Sensitivity analysis[9]: Imputation of 75 percentile and 25 percentile $KOOS_4$ value for participants lost to follow-up at 12 and 52 weeks in degenerative tear (i.e. assuming best case) and traumatic tear group (i.e. assuming worst case), respectively**.

Sensitivity analysis[10]: Imputation of 75 percentile and 25 percentile $KOOS_4$ value for participants lost to follow-up at 12 and 52 weeks in traumatic tear (i.e. assuming best case) and degenerative tear group (i.e. assuming worst case), respectively**.

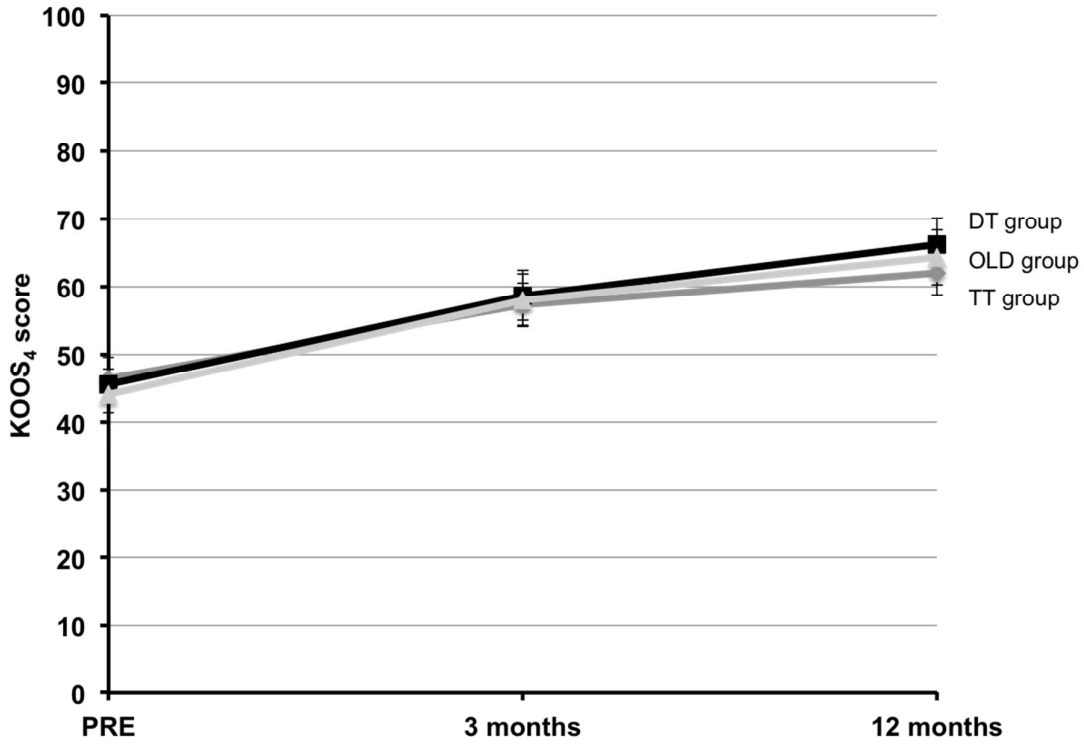
*Adjusted for: Age, sex and BMI.

** 25 and 75 percentile values calculated from participants with available data at 12 and 52 weeks in the degenerative and traumatic tear group, respectively.

Supplementary table 9: Proportion of participants at baseline aged 18-34 vs. 35-55 years and 18-40 vs. 41-55 years in the traumatic (TT) and degenerative tear (DT) group, respectively.

	TT (n=141)	DT (n=256)
18-34 years	56 (40%)	10 (4%)
35-55 years	85 (60%)	246 (96%)
18-40 years	73 (52%)	45 (18%)
41-55 years	68 (48%)	211 (82%)

Supplementary figures



Supplementary figure 1: Mean score on four Knee Injury and Osteoarthritis Outcome Score subscales, covering pain, symptoms, sport and recreational function and quality of life ($KOOS_4$) assessed before (PRE) arthroscopic partial meniscectomy (APM), 12 and 52 weeks after APM including participants aged 56 years or older (OLD) as reference for traumatic (TT) and non-traumatic tear (DT) groups. Data from model adjusted for age, sex and BMI. Bars indicate 95% confidence intervals. Group-by-time interaction for crude model (p=0.080) and model adjusted for age, sex and BMI (p=0.080).