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Change in patient-reported outcomes in patients with and without mechanical symptoms undergoing arthroscopic meniscal surgery: A prospective cohort study

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Abstract

Objective: Patients with degenerative or traumatic meniscal tears are at high risk of developing knee osteoarthritis. We investigated if younger (≤40 years) and older (>40 years) patients with preoperative mechanical symptoms improved more in patient-reported outcomes after meniscal surgery than those without mechanical symptoms.

Design: Patients from Knee Arthroscopy Cohort Southern Denmark (KACS) undergoing arthroscopic surgery for a meniscal tear completed online questionnaires before surgery, and at 12 and 52 weeks follow-up. Questionnaires included self-reported presence of mechanical symptoms (i.e. sensation of catching and/or locking) and the Knee Injury and Osteoarthritis Outcome Score (KOOS). We analyzed between-group differences in change in KOOS from baseline to 52 weeks, using an adjusted mixed linear model.

Results: 150 younger patients (mean age 31 (SD 7), 67% men) and 491 older patients (mean age 54 (SD 9), 53% men) constituted the baseline cohorts. Patients with mechanical symptoms generally had worse self-reported outcomes before surgery. At 52 weeks follow-up, younger patients with preoperative mechanical symptoms had improved more in KOOS scores than younger patients without preoperative mechanical symptoms (adjusted mean difference 10.5, 95%CI: 4.3, 16.6), but did not exceed the absolute postoperative KOOS scores observed for those without mechanical symptoms. No difference in improvement was observed between older patients with or without mechanical symptoms (adjusted mean difference 0.7, 95%CI: -2.6, 3.9). Conclusions: Younger patients (≤40 years) with preoperative mechanical symptoms experienced greater improvements after arthroscopic surgery compared to younger patients without mechanical symptoms. Our observational study result needs to be confirmed in randomized trials.

Keywords: Arthroscopy; meniscal tears; mechanical symptoms; patient-reported outcomes; knee; osteoarthritis
Introduction

Patients with degenerative meniscal tears are considered a patient group with early signs of or at high risk of knee osteoarthritis (OA)\(^1,2\). Traumatic knee injury is also a well-established risk factor for later OA\(^3,4\), but data on patients under 40 years with meniscal tears constituting one such subgroup with traumatic knee injury is scarce. Both patients with degenerative and traumatic meniscal tears are often treated surgically, but recent data suggest that arthroscopic partial meniscectomy may further exacerbate OA risk\(^5\) and the risk of future knee replacement\(^6\).

Systematic reviews and meta-analyses report no better effect of arthroscopic meniscal surgery compared to that of placebo surgery or in addition to exercise therapy for middle-aged and older patients with degenerative meniscal tears\(^7,8\). Nevertheless, patients with mechanical symptoms (i.e. the sensation of knee catching and/or locking) are considered a subgroup to particularly benefit from arthroscopic meniscal surgery\(^9-11\). Torn meniscal tissue is often considered the cause of mechanical symptoms and trimming the torn meniscus is therefore expected to relieve such symptoms. This assumption was recently challenged by a randomized trial subgroup analysis reporting no better effect of arthroscopic partial meniscectomy compared with sham surgery for middle-aged and older patients with degenerative meniscal tears\(^12\). Furthermore, observational data suggest no difference in improvement after arthroscopic surgery in patient-reported outcomes between patients with degenerative meniscal tears with and without pre-operative mechanical symptoms\(^13\).

Symptoms in patients with degenerative tears are likely to result from the multiple and complex processes of OA rather than the meniscal tear per se and are therefore not alleviated by meniscal surgery\(^14\). In contrast, younger patients more often have a traumatic meniscal tear in an otherwise normal joint (e.g. sports-related trauma) and a higher proportion of longitudinal-vertical (i.e. bucket-handle) tears\(^15,16\) that typically are regarded as a main cause of mechanical symptoms\(^17\). Hence, younger patients with meniscal tears and concomitant mechanical symptoms may improve more after arthroscopic meniscal surgery than younger patients without mechanical symptoms.

The primary aim of this study was to compare changes in patient-reported outcomes from before arthroscopic meniscal surgery to 52 weeks after surgery in younger patients (i.e. ≤40 years of age) with and
without mechanical symptoms prior to surgery. We also sought to confirm findings from previous studies, which reported no differences in change in patient-reported outcomes after surgery in middle-aged and older patients (i.e. >40 years of age) with and without mechanical symptoms prior to arthroscopic meniscal surgery.28 29 30 31 32

Method

Study design

This study uses a comparative prospective cohort design and is a secondary analysis of data from the Knee Arthroscopy Cohort Southern Denmark (KACS)18, from which the results of the primary analysis was recently published19. KACS is a prospective cohort study that follows patients undergoing knee arthroscopy for a meniscal tear18. The STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guideline20 was followed to report this study.

Participants

Participants in KACS were consecutively recruited at 4 public hospitals in Denmark between February 1st 2013 and January 31st 2014 and also at 1 of the initial 4 hospitals in the period from February 1st 2014 to January 31st 2015.

Inclusion criteria: 18 years of age or older, assigned for knee arthroscopy on suspicion of a meniscal tear by an orthopedic surgeon (i.e. based on clinical examination, history of injury, and MRI if considered necessary), able to read and understand Danish, and having an e-mail address.

Exclusion criteria: no meniscal tear at surgery, previous or planned anterior or posterior cruciate ligament (ACL or PCL) reconstruction surgery in either knee, fracture(s) in lower extremities within 6 months before recruitment, or inability to reply to online questionnaires because of mental impairment.

In total, 150 patients aged 40 or younger (younger cohort) and 491 patients aged 41 or older (older cohort) who replied to the baseline questionnaire and had a meniscal tear at surgery constituted the baseline cohorts of this study (Fig. 1). At 52 weeks follow-up, 29 (19%) and 47 (10%) patients were lost to follow-up in the younger and older cohort, respectively.
Patients lost to follow-up in the *older* cohort, were similar in all of the variables listed in Table I, whereas patients lost to follow-up in the *younger* cohort self-reported statistically significant worse outcomes on KOOS\textsubscript{4} and most KOOS subscales (Supplementary Table I).

All patients provided written informed consent to participate in the study. The Regional Scientific Ethics Committee waived the need for ethical approval after reviewing the outline of KACS\textsuperscript{18}.

*Patient-reported outcomes and mechanical symptoms*

Information about patient characteristics and symptoms was collected using online questionnaires before surgery (median 7 days, interquartile range 3-10 days) and at 12 and 52 weeks after surgery. The Knee Injury and Osteoarthritis Outcome Score (KOOS)\textsuperscript{21} was used to assess improvement in symptoms and function after arthroscopic meniscal surgery, while one single item from the KOOS symptoms subscale was used to define the presence of mechanical symptoms prior to surgery.

*The KOOS*

KOOS is a knee-specific patient-reported outcome consisting of 5 subscales: pain, symptoms, activities of daily living (ADL), sport and recreation function (Sport/Rec), and knee-related quality of life (QoL). Each subscale ranges from 0 to 100, with 0 representing extreme knee problems and 100 representing no knee problems\textsuperscript{21}. KOOS has been validated in individuals undergoing arthroscopic meniscal surgery\textsuperscript{21-23}.

In this ancillary study, the main outcome was the between-group difference in change from baseline to 52 weeks in the mean score of KOOS\textsubscript{4} between patients with and without preoperative mechanical symptoms. KOOS\textsubscript{4} is an aggregated mean score of 4 of the 5 KOOS subscales (i.e. pain, symptoms, ADL, and Sport/Rec) excluding the ADL subscale, which is known to display ceiling effects in younger and more active populations\textsuperscript{24}. KOOS\textsubscript{4} has been used in previous trials assessing the effect of knee surgery\textsuperscript{25-27}. All 5 KOOS subscales were included as secondary outcomes.
Mechanical symptoms

Mechanical symptoms (i.e. the sensation of knee catching and/or locking) were assessed using a single item from the KOOS symptom subscale\(^ {21}\): “Thinking of your knee symptoms during the last week - Does your knee catch or lock when moving?” with response options ranging from ‘never’ to, ‘always’. Patients were classified as having mechanical symptoms unless replying ‘never’ to this question.

Symptom onset and duration of symptoms

Symptom onset 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 developed over time”, “As a result of a specific incident (i.e. kneeling, sliding, and/or twisting of the knee or the like)”, and “As a result of a violent incident (i.e. during sports, a crash, or collision or the like)”. Duration of symptoms was assessed with the question: “How long have you had your knee pain/problems for which you are now having surgery?” with response options ranging from “0-3 months” to “more than 24 months”.

Structural pathology and unstable tears

Information about meniscal pathology and cartilage damage was recorded by the operating surgeon at arthroscopy. A modified version of the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS) classification of meniscal tears\(^ {28}\) was used for the classification of meniscal pathology (i.e. tear type, tear location, etc.) and the International Cartilage Repair Society (ICRS) grading system\(^ {29}\) was used for classification of cartilage lesions. Data from questionnaires were transferred from paper format to electronic format by automated forms processing, which has been validated as an alternative to double entry of data\(^ {30}\).
Statistical analyses

Descriptive statistics are given as means and standard deviations (SD), or numbers with percentages as appropriate.

The main outcome (between-group difference in KOOS\textscript{4} change score from baseline to 52 weeks for younger patients) was analyzed using a mixed linear model (restricted maximum likelihood estimation (REML)) with patients nested within surgery site as random effects, and group (mechanical symptoms vs. no mechanical symptoms) and time (baseline, 12 and 52 weeks) as fixed effects. Adjusted models included age, sex and body mass index (BMI) as potential confounders. We did not adjust for structural pathology findings at arthroscopy, as these may be part of the causal pathway causing the mechanical symptoms. The same analysis approach was used for all secondary KOOS subscales separately and for the between-group differences in KOOS\textscript{4} and all 5 KOOS subscales for the older patients.

For all models, the underlying assumptions for mixed linear models were assessed using residual plots and kernel density plots.

Sensitivity analyses were conducted to assess the robustness of results using alternative definition for classifying patients with or without mechanical symptoms (i.e. mechanical symptoms if replying “sometimes” to “always” and no mechanical symptoms if replying “rarely” or “never”). In addition, because ceiling and/or floor effects could occur for the chosen outcome, we conducted sensitivity analyses using mixed linear tobit regression with the same random and fixed effects as in the primary analyses to take this into account.

As additional analyses including only patients reporting having mechanical symptoms prior to surgery and with complete data at 52 weeks follow-up, we compared the difference in KOOS\textscript{4} change scores from baseline to 52 weeks between patients having their mechanical symptoms alleviated at 52 weeks and those who did not. This was done for the younger and older cohort separately using the same statistical approach as for the main analyses.

Stata 14.2 was used for all statistical analyses and estimates are given with 95% confidence intervals.

Results
Self-reported mechanical symptoms were present in 89/150 (59%) patients in the younger cohort and 251/491 (51%) patients in the older cohort. Prior to surgery, patients with mechanical symptoms in both the younger and older cohort reported on average lower KOOS4 and KOOS subscale scores than patients without mechanical symptoms (Table I, Fig. 2).

Table I.

At 52 weeks after meniscal surgery, patients with and without mechanical symptoms had all improved in KOOS4, however among younger patients, those with preoperative mechanical symptoms had improved statistically significant more than patients without mechanical symptoms (adjusted mean difference 10.5, 95% CI 4.4 to 16.6) (Table II), resulting in nearly equal absolute KOOS4 scores at 52 weeks (Fig. 2, Supplementary Table II). This was consistent for all KOOS subscales (Table II, Supplementary Table II).

Table II.

Fig. 2.

Among older patients (>40 years), little difference in improvement in KOOS4 score from before surgery to 52 weeks after surgery was observed between patients with and without preoperative mechanical symptoms (Table III), hence the difference in KOOS4 scores observed before surgery remained at 52 weeks between older patients with and without preoperative mechanical symptoms (Fig. 2, Supplementary Table III).

Table III.

Only in the KOOS symptoms subscale, older patients with mechanical symptoms had a significantly greater improvement than those without mechanical symptoms (adjusted mean difference 8.6, 95% CI 5.2 to 12.1) (Table III). In sensitivity analysis, using an alternative cut-point for classifying presence of mechanical symptoms, results only changed marginally and did not alter the overall conclusions (Supplementary Table
IV and V). Also in sensitivity analyses addressing potential ceiling/flooring effects results were similar as for the primary analyses (Supplementary Table VI and VII).

Among patients with preoperative mechanical symptoms and complete follow-up, a larger proportion of older patients compared with younger patients had their symptoms alleviated (136/221 (62%) and 37/71 (52%), respectively). In both the younger and older cohorts, those alleviated of mechanical symptoms at 52 weeks follow-up had greater improvement in KOOS\textsubscript{4} scores from before surgery to 52 weeks after surgery than patients not having their mechanical symptoms alleviated at 52 weeks (adjusted mean difference 20.2, 95% CI 12.7 to 27.8 and 16.4, 95% CI 11.7 to 21.1, respectively) (Fig. 3, Supplementary Table VIII and IX).

**Fig. 3.**

**Discussion**

We investigated if preoperative self-reported mechanical symptoms were associated with greater improvement after arthroscopic meniscal surgery in patients with or at high risk of knee OA\textsuperscript{1-4}. We found that self-reported mechanical symptoms prior to meniscal surgery were common and associated with worse preoperative patient-reported outcomes in both younger and older patients with a meniscal tear. However, for younger patients this preoperative difference in patient-reported outcomes was absent at 52 weeks after arthroscopic meniscal surgery due to greater improvement in KOOS\textsubscript{4} scores in patients having preoperative mechanical symptoms. In contrast, only little difference in improvement in KOOS\textsubscript{4} scores following meniscal surgery was observed between older patients with or without self-reported mechanical symptoms. Knowledge about the natural time course of patient-reported outcomes after meniscal surgery for patients aged 40 or younger with traumatic meniscal tears is scarce, as previous studies have mainly included middle-aged and older patients with degenerative meniscal tears\textsuperscript{8,13}. In this study, younger patients with mechanical symptoms had greater improvements in KOOS\textsubscript{4} and KOOS subscale scores than younger patients without mechanical symptoms, corresponding to a difference of 8 points or more in KOOS scores. Differences of this size are typically considered to be clinically relevant\textsuperscript{31}. Importantly, the improvements for younger patients without preoperative mechanical symptoms were considerably less than the improvements observed in
younger patients with preoperative mechanical symptoms and older patients with and without such symptoms. However, younger patients without mechanical symptoms still reached clinically relevant improvements. Among older patients, preoperative mechanical symptoms were not found associated with greater improvement in patient-reported outcomes, except for the KOOS symptoms subscale. This is generally in line with findings from previous randomized controlled trials and cohort studies on middle-aged and older patients. In fact, one of these studies found preoperative mechanical symptoms to be negatively associated with improvement in pain.

Notably, KOOS scores in both the younger and older patients at 52 weeks after meniscal surgery were still substantially lower than population-based scores from Sweden on individuals aged 18-34 years, 35-54 years, and 55-74 years, especially in the subscales Sport/Rec and QoL.

In this study, older patients mainly had degenerative meniscal tears and approximately half had severe cartilage defects (i.e. ICRS grade 3-4) in at least one compartment, indicative of early or more progressed stages of knee OA. That suggests that in older patients other structures than the meniscal tear per se may be the cause of symptoms. In contrast, younger patients more often had isolated meniscal tears and less severe cartilage defects, making it more likely that meniscal tears are the cause of mechanical and other symptoms in these patients. This may partly explain why we observed patients with preoperative mechanical symptoms having larger improvements among the younger patients and not among the older patients.

Having preoperative mechanical symptoms alleviated at 52 weeks after arthroscopic surgery was associated with substantially larger improvements in patient-reported outcomes in both age groups. However, because older patients without preoperative mechanical symptoms, and thus no potential for being alleviated of such symptoms, had the same improvements as those with preoperative mechanical symptoms, the alleviation of preoperative mechanical symptoms may just be a part of the general improvements in symptoms in these patients.

This study has some limitations. Due to the observational nature we are unable to draw conclusions regarding causality between preoperative mechanical symptoms and the degree of improvement. Hence, the observed larger improvement among younger patients might be a result of greater potential for improvement.
compared to younger patients without mechanical symptoms and/or regression to the mean\textsuperscript{36}

The exposure in this study (i.e. having preoperative mechanical symptoms) was based on the response to a single KOOS symptoms subscale item, which was also a part of the outcome measure (i.e. KOOS\textsubscript{4} and KOOS symptoms subscale). This may have contributed to worse preoperative scores in KOOS symptom subscale and KOOS\textsubscript{4} in patients with mechanical symptoms and thus have had an impact on the difference in improvements between patients with and without preoperative mechanical symptoms. However, as 25 items in total contribute to the KOOS\textsubscript{4} score the influence of one item is likely marginal. Furthermore, worse scores on the 4 other KOOS subscales support the notion that patients with mechanical symptoms truly represent a subgroup with more severe knee problems.

The definition of mechanical symptoms in the literature is vague\textsuperscript{10}, and to our knowledge no gold standard to assess mechanical symptoms, or generally accepted definitions of such symptoms exist. Yet, symptoms such as catching and locking have been suggested to constitute two distinct forms of mechanical symptoms,\textsuperscript{37} hence optimally should have been differentiated between in the present study. In addition, we defined presence of mechanical symptoms using an arbitrary cut-point, which may have affected the outcomes. However, sensitivity analyses using an alternative cut-point did not change the overall interpretation of the results.

At 52 weeks loss to follow-up among the younger and older patients was 19\% and 10\%, respectively.

Younger patients lost to follow-up self-reported significantly poorer on three of the five KOOS subscales before surgery compared to patients who remained in the study. However, the use of mixed linear models including all patients with and without missing data at any time point should give unbiased results under the assumption of missing at random\textsuperscript{38}. We believe our findings have high external validity, as demographics of included patients is similar to what has previously been reported for patients undergoing meniscal surgery in Denmark\textsuperscript{39} and the United States\textsuperscript{40}.

In conclusion, we confirmed previous findings that preoperative mechanical symptoms are not associated with greater improvement after arthroscopic meniscal surgery among older patients ($>$40 years). However, for younger patients ($\leq$40 years) those with preoperative mechanical symptoms had greater improvement in
patient-reported outcomes after arthroscopic meniscal surgery than younger patients without such symptoms.

Randomized controlled trials are needed to confirm this potential subgroup benefit.

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Author contributions
Conception and design: KP, JBT, SL, ME and AT.

Acquisition of data: NN, UJ and JS.

Analysis and interpretation of data: KP and JBT.

Drafting manuscript: KP and JBT.

Revising manuscript and approving final version of manuscript: All authors.

Obtaining of funding: KP and JBT.

All authors take responsibility for the integrity of the data analysis.

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Conflict of interests
The authors have no competing interests to declare.
References


Figure legends

**Fig. 1.** Flowchart of inclusion. ‘Y’ denotes younger patients (≤40 years) and ‘O’ denotes older patients (>41 years).

**Fig. 2.** Mean KOOS, scores assessed before arthroscopic meniscal surgery, and at 12 and 52 week follow-up for younger (‘Y’ ≤40 years) and older patients (‘O’ >40 years), respectively, with and without mechanical symptoms (MS) prior to surgery (for complete data, see Supplementary Table II and III). Data from model adjusted for age, sex and body mass index. Bars indicate 95% confidence intervals. Between younger patients with and without mechanical symptoms the difference in KOOS, scores were significant at pre-surgery (p<0.001), but not at 52-weeks follow-up (p=0.293). Between older patients with and without mechanical symptoms, the difference was significant at all time points (p<0.001).

**Fig. 3.** Mean KOOS, scores assessed before arthroscopic meniscal surgery, and at 12 and 52 week follow-up for younger (‘Y’ ≤40 years) and older patients (‘O’ >40 years), respectively, having their preoperative mechanical symptoms (MS) alleviated or not at 52 weeks follow-up (for complete data, see Supplementary Table X and XI). Data from model adjusted for age, sex and body mass index. Bars indicate 95% confidence intervals. Between both younger and older patients alleviated or not from mechanical symptoms the differences in KOOS, scores were significant at pre-surgery (p=0.010 and p=0.029, respectively) and at 52-weeks follow-up (p<0.001 and p<0.001, respectively).
Table I. Baseline characteristics of patients with and without mechanical symptoms.

<table>
<thead>
<tr>
<th>Age, years (SD)</th>
<th>31.0 (7.3)</th>
<th>29.9 (7.1)</th>
<th>53.8 (8.3)</th>
<th>54.7 (9.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female, no. (%)</td>
<td>34 (38%)</td>
<td>26 (26%)</td>
<td>121 (48%)</td>
<td>109 (45%)</td>
</tr>
<tr>
<td>BMI kg/m² (SD)</td>
<td>26.8 (4.5)</td>
<td>25.9 (3.7)</td>
<td>27.7 (4.6)</td>
<td>27.3 (4.3)</td>
</tr>
<tr>
<td>Symptom onset, no. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slowly evolved over time</td>
<td>20 (22%)</td>
<td>9 (15%)</td>
<td>91 (36%)</td>
<td>88 (37%)</td>
</tr>
<tr>
<td>Semi-traumatic</td>
<td>31 (35%)</td>
<td>20 (33%)</td>
<td>110 (44%)</td>
<td>99 (41%)</td>
</tr>
<tr>
<td>Traumatic</td>
<td>38 (43%)</td>
<td>32 (52%)</td>
<td>50 (20%)</td>
<td>53 (22%)</td>
</tr>
<tr>
<td>Duration of symptoms, no. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-3 months</td>
<td>24 (27%)</td>
<td>17 (28%)</td>
<td>52 (21%)</td>
<td>36 (15%)</td>
</tr>
<tr>
<td>4-6 months</td>
<td>13 (14%)</td>
<td>11 (18%)</td>
<td>77 (31%)</td>
<td>80 (33%)</td>
</tr>
<tr>
<td>7-12 months</td>
<td>16 (18%)</td>
<td>15 (25%)</td>
<td>49 (19%)</td>
<td>55 (23%)</td>
</tr>
<tr>
<td>13-24 months</td>
<td>13 (14%)</td>
<td>7 (11%)</td>
<td>43 (17%)</td>
<td>31 (13%)</td>
</tr>
<tr>
<td>&gt;24 months</td>
<td>23 (26%)</td>
<td>11 (18%)</td>
<td>30 (12%)</td>
<td>38 (16%)</td>
</tr>
<tr>
<td>Type of surgery, no. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resection</td>
<td>72 (81)</td>
<td>46 (75)</td>
<td>249 (99)</td>
<td>233 (97)</td>
</tr>
<tr>
<td>Repair</td>
<td>15 (17)</td>
<td>9 (15)</td>
<td>2 (1)</td>
<td>7 (3)</td>
</tr>
<tr>
<td>Both</td>
<td>2 (2)</td>
<td>6 (10)</td>
<td>0 (0)</td>
<td>0 (0)</td>
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<tr>
<td>Compartment, no. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>57 (64%)</td>
<td>35 (57%)</td>
<td>193 (77%)</td>
<td>192 (80%)</td>
</tr>
<tr>
<td>Lateral</td>
<td>28 (31%)</td>
<td>19 (31%)</td>
<td>34 (13%)</td>
<td>28 (12%)</td>
</tr>
<tr>
<td>Both</td>
<td>4 (5%)</td>
<td>7 (12%)</td>
<td>24 (10%)</td>
<td>20 (8%)</td>
</tr>
<tr>
<td>Tear type, no (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longitudinal-vertical</td>
<td>34 (38%)</td>
<td>27 (44%)</td>
<td>30 (12%)</td>
<td>31 (13%)</td>
</tr>
<tr>
<td>Horizontal</td>
<td>4 (4%)</td>
<td>2 (3%)</td>
<td>17 (7%)</td>
<td>20 (8%)</td>
</tr>
<tr>
<td>Radial</td>
<td>4 (4%)</td>
<td>0 (0%)</td>
<td>20 (8%)</td>
<td>17 (7%)</td>
</tr>
<tr>
<td>Vertical flap</td>
<td>17 (19%)</td>
<td>9 (15%)</td>
<td>66 (26%)</td>
<td>56 (23%)</td>
</tr>
<tr>
<td>Horizontal flap</td>
<td>7 (8%)</td>
<td>3 (5%)</td>
<td>9 (4%)</td>
<td>13 (5%)</td>
</tr>
<tr>
<td>Complex</td>
<td>11 (12%)</td>
<td>10 (16%)</td>
<td>84 (34%)</td>
<td>76 (32%)</td>
</tr>
<tr>
<td>Root tear</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1 (0%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>More than one tear type</td>
<td>12 (13%)</td>
<td>10 (17%)</td>
<td>23 (9%)</td>
<td>26 (11%)</td>
</tr>
<tr>
<td>Radial location, no. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior</td>
<td>48 (54%)</td>
<td>33 (56%)</td>
<td>162 (65%)</td>
<td>176 (74%)</td>
</tr>
<tr>
<td>Posterior + mid body</td>
<td>13 (14%)</td>
<td>15 (25%)</td>
<td>45 (18%)</td>
<td>31 (13%)</td>
</tr>
<tr>
<td>Posterior + anterior</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>2 (1%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Mid body</td>
<td>12 (13%)</td>
<td>5 (9%)</td>
<td>21 (8%)</td>
<td>17 (7%)</td>
</tr>
<tr>
<td>Anterior + mid body</td>
<td>5 (6%)</td>
<td>1 (2%)</td>
<td>2 (1%)</td>
<td>2 (1%)</td>
</tr>
<tr>
<td>Anterior</td>
<td>5 (6%)</td>
<td>3 (5%)</td>
<td>7 (3%)</td>
<td>6 (2%)</td>
</tr>
<tr>
<td>All</td>
<td>6 (7%)</td>
<td>2 (3%)</td>
<td>10 (4%)</td>
<td>7 (3%)</td>
</tr>
<tr>
<td>Meniscal tissue quality, no (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-degenerative</td>
<td>70 (79%)</td>
<td>46 (75%)</td>
<td>68 (27%)</td>
<td>70 (29%)</td>
</tr>
<tr>
<td>Degenerative</td>
<td>17 (19%)</td>
<td>11 (18%)</td>
<td>176 (71%)</td>
<td>160 (67%)</td>
</tr>
<tr>
<td>Undetermined</td>
<td>2 (2%)</td>
<td>4 (7%)</td>
<td>4 (2%)</td>
<td>10 (4%)</td>
</tr>
<tr>
<td>ICRS cartilage grade, no. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial compartment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 0</td>
<td>59 (67%)</td>
<td>48 (80%)</td>
<td>38 (15%)</td>
<td>37 (15%)</td>
</tr>
<tr>
<td>Grade 1</td>
<td>18 (20%)</td>
<td>8 (13%)</td>
<td>59 (24%)</td>
<td>66 (28%)</td>
</tr>
<tr>
<td>Grade 2</td>
<td>4 (5%)</td>
<td>2 (3%)</td>
<td>62 (25%)</td>
<td>52 (22%)</td>
</tr>
<tr>
<td>Grade 3</td>
<td>6 (7%)</td>
<td>1 (2%)</td>
<td>63 (25%)</td>
<td>73 (30%)</td>
</tr>
<tr>
<td>Grade 4</td>
<td>1 (1%)</td>
<td>1 (2%)</td>
<td>28 (11%)</td>
<td>12 (5%)</td>
</tr>
<tr>
<td>Lateral compartment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 0</td>
<td>69 (78%)</td>
<td>45 (75%)</td>
<td>78 (31%)</td>
<td>77 (33%)</td>
</tr>
<tr>
<td>Grade 1</td>
<td>14 (16%)</td>
<td>9 (15%)</td>
<td>100 (40%)</td>
<td>86 (37%)</td>
</tr>
<tr>
<td>Grade 2</td>
<td>2 (2%)</td>
<td>4 (7%)</td>
<td>39 (16%)</td>
<td>50 (21%)</td>
</tr>
<tr>
<td>Grade 3</td>
<td>2 (3%)</td>
<td>2 (3%)</td>
<td>25 (10%)</td>
<td>16 (7%)</td>
</tr>
<tr>
<td>Grade 4</td>
<td>1 (1%)</td>
<td>0 (0%)</td>
<td>7 (3%)</td>
<td>6 (2%)</td>
</tr>
<tr>
<td>Patellofemoral compartment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 0</td>
<td>64 (73%)</td>
<td>51 (86%)</td>
<td>66 (26%)</td>
<td>50 (21%)</td>
</tr>
</tbody>
</table>
Grade 1  | 15 (17%) | 3 (5%) | 72 (29%) | 79 (33%)
Grade 2  | 3 (3%)  | 3 (5%) | 50 (20%) | 53 (22%)
Grade 3  | 5 (6%)  | 1 (2%) | 44 (18%) | 41 (17%)
Grade 4  | 1 (1%)  | 1 (2%) | 17 (7%)  | 13 (5%)

KOOS scores

KOOS\(_A\)  | 41.6 (15.2) | 56.6 (15.0) | 40.1 (14.0) | 50.2 (13.9)
Pain        | 53.4 (20.5) | 67.0 (17.0) | 49.4 (17.2) | 58.0 (17.3)
Symptoms   | 52.1 (16.3) | 72.9 (16.3) | 51.0 (16.8) | 69.0 (15.2)
ADL         | 64.4 (20.0) | 77.7 (16.1) | 57.5 (18.9) | 66.3 (18.2)
Sport/Rec   | 25.7 (20.6) | 38.9 (24.9) | 21.6 (19.8) | 28.3 (22.3)
QOL         | 35.2 (15.3) | 47.5 (14.4) | 38.6 (14.8) | 45.6 (14.7)

CI: Confidence interval, no.: Number, SD: Standard Deviation, BMI: Body Mass Index (kg/m\(^2\)). ADL: activities of daily living, Sport/rec: sport and recreational activities, QOL: knee-related quality of life.

\(^a\)Missing data on tear pattern, n=1.
\(^b\)Missing data on radial location, n=5.
\(^c\)Missing data on tissue quality, n=3.
\(^d\)Missing data on cartilage in medial compartment, n=3
\(^e\)Missing data on cartilage in lateral compartment, n=8
\(^f\)Missing data on cartilage in patellofemoral compartment, n=9
Table II. Knee Injury and Osteoarthritis Outcome change scores (KOOS) at 12 and 52 weeks follow-up for younger patients (≤40 years) with and without mechanical symptoms prior to surgery.

<table>
<thead>
<tr>
<th>KOOS scores, unadjusted</th>
<th>Mechanical symptoms (n=81)</th>
<th>No mechanical symptoms (n=54)</th>
<th>Difference (95% CI)</th>
<th>Mechanical symptoms (n=71)</th>
<th>No mechanical symptoms (n=50)</th>
<th>Difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KOOS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS Pain</td>
<td>16.1 (12.3, 19.8)</td>
<td>6.4 (1.8, 11.0)</td>
<td>9.6 (3.7, 15.6)</td>
<td>20.9 (17.0, 24.9)</td>
<td>10.5 (5.7, 15.2)</td>
<td>10.5 (4.3, 16.6)</td>
</tr>
<tr>
<td>KOOS Symptoms</td>
<td>17.1 (13.1, 21.1)</td>
<td>7.6 (2.7, 12.5)</td>
<td>9.5 (3.1, 15.8)</td>
<td>18.7 (14.5, 23.0)</td>
<td>11.1 (6.0, 16.1)</td>
<td>7.7 (1.1, 14.3)</td>
</tr>
<tr>
<td>KOOS ADL</td>
<td>14.0 (10.6, 18.6)</td>
<td>2.4 (-2.5, 7.2)</td>
<td>12.2 (5.9, 18.5)</td>
<td>19.4 (15.2, 23.5)</td>
<td>2.6 (-2.4, 7.6)</td>
<td>16.7 (10.2, 23.3)</td>
</tr>
<tr>
<td>KOOS Sport/Rec</td>
<td>19.4 (13.9, 24.9)</td>
<td>11.0 (4.2, 17.7)</td>
<td>8.5 (-0.2, 17.2)</td>
<td>27.1 (21.3, 32.9)</td>
<td>18.6 (11.7, 25.5)</td>
<td>8.5 (-0.5, 17.5)</td>
</tr>
<tr>
<td>KOOS QoL</td>
<td>13.3 (8.9, 17.6)</td>
<td>4.7 (-0.7, 10.0)</td>
<td>8.6 (1.7, 15.5)</td>
<td>18.8 (14.2, 23.3)</td>
<td>9.6 (4.1, 15.0)</td>
<td>9.2 (2.1, 16.3)</td>
</tr>
</tbody>
</table>

KOOS scores, adjusted*  
KOOS                   | 16.0 (12.3, 19.8)         | 6.4 (1.8, 11.0)              | 9.7 (3.7, 15.6)     | 20.9 (17.0, 24.8)         | 10.3 (5.7, 15.1)            | 10.5 (4.4, 16.6)    |
| KOOS Pain              | 17.0 (13.0, 21.1)         | 7.5 (2.6, 12.4)              | 9.5 (3.2, 15.8)     | 18.7 (14.5, 22.9)         | 11.0 (5.9, 16.0)            | 7.7 (1.2, 14.3)     |
| KOOS Symptoms          | 14.6 (10.6, 18.6)         | 2.4 (-2.4, 7.3)              | 12.2 (5.9, 18.5)    | 19.3 (15.2, 23.5)         | 2.6 (-2.4, 7.7)             | 16.7 (10.2, 23.2)   |
| KOOS ADL               | 14.5 (11.0, 17.9)         | 6.7 (2.5, 10.9)              | 7.8 (2.4, 13.2)     | 16.1 (12.5, 19.7)         | 8.3 (4.1, 12.6)             | 7.7 (2.2, 13.3)     |
| KOOS Sport/Rec         | 19.4 (13.9, 24.8)         | 10.9 (4.2, 17.6)             | 8.5 (-0.2, 17.1)    | 27.0 (21.3, 32.8)         | 18.5 (11.6, 25.4)           | 8.5 (-0.4, 17.5)    |
| KOOS QoL               | 13.2 (8.9, 17.6)          | 4.6 (-0.8, 9.9)              | 8.7 (1.8, 15.5)     | 18.7 (14.2, 23.3)         | 9.5 (4.0, 15.0)             | 9.2 (2.1, 16.3)     |

*Adjusted for age, sex and BMI.
ADL: activities of daily living, Sport/rec: sport and recreational activities, QOL: knee-related quality of life.
Numbers are mean values (95% CI)
### Table III. Knee Injury and Osteoarthritis Outcome change scores (KOOS) at 12 and 52 weeks follow-up for older patients (>40 years) with and without mechanical symptoms prior to surgery.

<table>
<thead>
<tr>
<th></th>
<th>12-weeks change</th>
<th>52-weeks change</th>
<th>Difference (95% CI)</th>
<th>Mechanical symptoms (n=246)</th>
<th>No mechanical symptoms (n=233)</th>
<th>Mechanical symptoms (n=221)</th>
<th>No mechanical symptoms (n=223)</th>
<th>Difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KOOS scores, unadjusted</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS</td>
<td>13.4 (11.2, 15.6)</td>
<td>11.5 (9.3, 13.8)</td>
<td>1.9 (-1.3, 5.0)</td>
<td>19.4 (17.1, 21.7)</td>
<td>18.9 (16.5, 21.2)</td>
<td>0.5 (-2.8, 3.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS Pain</td>
<td>16.6 (14.1, 19.0)</td>
<td>16.3 (13.8, 18.8)</td>
<td>0.3 (-3.2, 3.7)</td>
<td>20.8 (18.3, 23.2)</td>
<td>22.5 (20.0, 25.0)</td>
<td>-1.8 (-5.3, 1.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS Symptoms</td>
<td>14.4 (12.0, 16.7)</td>
<td>5.0 (2.6, 7.4)</td>
<td>9.4 (6.0, 12.7)</td>
<td>19.2 (16.8, 21.6)</td>
<td>10.6 (8.2, 13.1)</td>
<td>8.5 (5.1, 11.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS ADL</td>
<td>14.8 (12.7, 17.0)</td>
<td>13.5 (11.3, 15.7)</td>
<td>1.3 (-1.8, 4.4)</td>
<td>18.6 (16.4, 20.9)</td>
<td>18.7 (16.5, 21.0)</td>
<td>-0.1 (-3.3, 3.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS Sport/Rec</td>
<td>13.2 (10.0, 16.4)</td>
<td>16.1 (12.8, 19.4)</td>
<td>-2.9 (-7.6, 1.7)</td>
<td>21.2 (17.8, 24.5)</td>
<td>25.0 (21.7, 28.4)</td>
<td>-3.9 (-8.6, 0.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS QoL</td>
<td>9.4 (6.9, 12.0)</td>
<td>8.8 (6.1, 11.4)</td>
<td>0.7 (-3.0, 4.4)</td>
<td>16.4 (13.7, 19.0)</td>
<td>17.2 (14.6, 19.9)</td>
<td>-0.9 (-4.7, 2.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS scores, adjusted*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS</td>
<td>13.4 (11.2, 15.7)</td>
<td>11.6 (9.3, 13.8)</td>
<td>1.9 (-1.3, 5.1)</td>
<td>19.5 (17.2, 21.8)</td>
<td>18.8 (16.5, 21.1)</td>
<td>0.7 (-2.6, 3.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS Pain</td>
<td>16.6 (14.2, 19.0)</td>
<td>16.3 (13.8, 18.8)</td>
<td>0.3 (-3.2, 3.7)</td>
<td>20.9 (18.4, 23.4)</td>
<td>22.5 (20.0, 25.0)</td>
<td>-1.6 (-5.1, 1.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS Symptoms</td>
<td>14.4 (12.1, 16.7)</td>
<td>5.0 (2.6, 7.4)</td>
<td>9.4 (6.1, 12.7)</td>
<td>19.3 (16.9, 21.7)</td>
<td>10.6 (8.2, 13.0)</td>
<td>8.6 (5.2, 12.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS ADL</td>
<td>14.9 (12.7, 17.0)</td>
<td>13.5 (11.3, 15.8)</td>
<td>1.3 (-1.8, 4.4)</td>
<td>18.8 (16.5, 21.0)</td>
<td>18.7 (16.5, 21.0)</td>
<td>0.0 (-3.2, 3.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS Sport/Rec</td>
<td>13.3 (10.1, 16.5)</td>
<td>16.1 (12.8, 19.5)</td>
<td>-2.9 (-7.5, 1.7)</td>
<td>21.4 (18.0, 24.7)</td>
<td>25.0 (21.6, 28.4)</td>
<td>-3.6 (-8.4, 1.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS QoL</td>
<td>9.5 (6.9, 12.0)</td>
<td>8.8 (6.1, 11.4)</td>
<td>0.7 (-3.0, 4.4)</td>
<td>16.5 (13.8, 19.1)</td>
<td>17.2 (14.6, 19.9)</td>
<td>-0.8 (-4.5, 3.0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Adjusted for age, sex and BMI

ADL: activities of daily living, Sport/rec: sport and recreational activities, QOL: knee-related quality of life.

Numbers are mean values (95% CI)
Patients assigned for knee arthroscopy on clinical suspicion of a meniscal tear and assessed for eligibility for KACS (Y = 424, O = 835)

Excluded, did not fit inclusion criteria (Y = 62, O = 76)
- Previous ACL/PCL surgery (Y = 55, O = 57)
- Fracture on lower extremities (Y = 3, O = 2)
- No email address (Y = 2, O = 16)
- Did not understand Danish (Y = 1, O = 1)
- Not mentally able to reply (Y = 1, O = 0)

Excluded, other reasons (Y = 92, O = 121)
- No time to participate (Y = 2, O = 6)
- No reason/declined (Y = 36, O = 14)
- Consented, but no reply prior to surgery (Y = 54, O = 101)

Replied to questionnaire before surgery (Y = 270, O = 638)

Surgery (Y = 247, O = 591)

Excluded (Y = 23, O = 47)
- Surgery cancelled (Y = 16, O = 35)
- Re-scheduled to surgery at other hospital (Y = 7, O = 12)

Excluded, (Y = 97, O = 100)
- ACL/PCL reconstruction at surgery (Y = 13, O = 2)
- No meniscal tear (Y = 84, O = 98)

Patients replied to baseline questionnaire and having a meniscal tear at surgery (Y = 150, O = 491)

Mechanical symptoms before surgery (Y = 89, O = 251)

No reply to questionnaire (Y = 8, O = 5)

12 weeks assessment (Y = 81, O = 246)

No reply to questionnaire (Y = 10, O = 25)

52 weeks assessment (Y = 71, O = 221)

No mechanical symptoms before surgery (Y = 61, O = 240)

No reply to questionnaire (Y = 7, O = 7)

12 weeks assessment (Y = 54, O = 233)

No reply to questionnaire (Y = 4, O = 10)

52 weeks assessment (Y = 50, O = 223)