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Outcomes After Anterior Cruciate Ligament Reconstruction Using the Norwegian Knee Ligament Registry of 4691 Patients

How Does Meniscal Repair or Resection Affect Short-term Outcomes?

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Background: While the effects of concurrent meniscal resection and anterior cruciate ligament reconstruction (ACLR) are known to decrease patient outcomes and increase the rate of osteoarthritis over the long term, overall short-term patient functional outcomes in a large cohort of patients are not well known.

Purpose/Hypothesis: The purpose of this study was to compare the preoperative and 2-year postoperative Knee Injury and Osteoarthritis Outcome Score (KOOS) subscale scores after ACLR with and without meniscal injury. The hypothesis was that, in comparison with an isolated ACLR, patients with a medial meniscal (MM) or lateral meniscal (LM) resection with an ACLR would have significantly decreased 2-year postoperative KOOS outcomes, while those with an ACLR with an MM or LM repair would be indistinguishable from isolated ACLR.

Study Design: Cohort study; Level of evidence, 2.

Methods: The Norwegian Knee Ligament Registry (NKLR) was used to evaluate outcomes for a total of 4691 patients with primary ACLR. The KOOS scoring system was used to evaluate patients on 5 subscales (Pain, Other Symptoms, Activities of Daily Life [ADL], Sport and Recreation Function, and Quality of Life [QoL]) at time of surgery and at 2-year postoperative follow-up. Patients with isolated ACLR and ACLR with LM repair, LM resection, MM repair, or MM resection were compared using multiple linear regression modeling.

Results: Preoperatively, in comparison with isolated ACLR, patients who had an ACLR with either an MM repair or MM resection had significantly lower scores for all KOOS subscores, and LM repair had significantly decreased scores on the Other Symptoms, Pain, and ADL subscales. Postoperatively, in comparison with isolated ACLR, 2-year KOOS outcomes were not significantly different between patients with ACLR and LM repair, MM resection, or LM resection; however, those with MM repair had significantly lower scores on the Other Symptoms and QoL subscales.

Conclusion: Patients with ACLR with meniscal resections do not exhibit decreased clinical outcomes at 2 years postoperatively. It is recommended that clinicians follow patients with ACLR and concurrent meniscal treatment for longer than 2 years postoperatively.

Keywords: anterior cruciate ligament; meniscal resection; meniscal repair; patient outcomes; registry

A recent systematic review stated that studies with the highest methodological quality reported rates of osteoarthritis after isolated anterior cruciate ligament (ACL) injury (whether treated surgically or nonsurgically) ranging from 0% to 13%, while after combined ACL and meniscal injury, rates ranged between 21% and 48% at a minimum 10-year (long-term) follow-up.[12] Similarly, a meta-analysis of patients undergoing ACL reconstruction (ACLR) at a follow-up of at least 10 years demonstrated the occurrence of osteoarthritis for knees without meniscal resection at 16%, while those with a concomitant meniscal resection were 50%.[4] Shelbourne and Gray[18] also reported significantly lower subjective outcome scores after (partial or total) medial meniscal (MM) or lateral meniscal (LM) resection at a mean follow-up of 7.6 years. In this same study, 25% of patients with MM resections had abnormal or severely abnormal ratings, while only 3% of patients with intact menisci had abnormal radiographic ratings.[18] Thus, while the development of osteoarthritis has been

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described as higher in ACLR patients who have undergone a meniscal resection, it is unclear if these decreased patient clinical and objective outcomes initiate in the short-term (2-5 years) or mid-term (5-10 years) postoperative phase after ACLR.

Recent studies have attempted to further clarify the effects of concurrent meniscal repair or resection on postoperative outcomes after ACLR. Røtterud et al[17] reported that MM or LM injury (64% of which were treated with meniscal resection) did not result in an association with any of the Knee Injury and Osteoarthritis Outcome Score (KOOS) subscale scores at 2-year follow-up after ACLR, but they did not evaluate the effect of different treatments for these tears. Barenius et al[2] reported that MM and LM resections were significant risk factors for osteoarthritis at 14-year follow-up, while MM or LM repairs were not. In addition, Melton et al[11] reported that patients undergoing either meniscal repair or resection with ACLR had significantly lower International Knee Documentation Committee (IKDC) outcome scores than ACLRs with intact menisci at 10-year follow-up.[11]

As noted above, concurrent meniscal injury, especially when treated with resection, may negatively influence the long-term outcomes after ACLR. However, the prognosis for meniscal treatments on patient-reported outcomes is unknown at short-term follow-up, and this information would be important when educating patients on the expected short- versus long-term prognoses of treatment options. Knowledge of this information should also help to educate surgeons on their recommendations to their individual patients, especially if they do not routinely follow patients postoperatively after ACLR and concurrent meniscal resection for medium- to long-term follow-ups. Therefore, the purpose of our study was to use the Norwegian Knee Ligament Registry (NKLR) to compare patient preoperative and 2-year postoperative KOOS subscale scores after ACLR with and without meniscal injury. Patients with ACLR and no meniscal injury ("isolated ACLR") were compared with patients who underwent ACLR with concurrent MM or LM repair or resection. We hypothesized that patients with an MM or LM resection with ACLR would have significantly decreased 2-year postoperative clinical outcomes compared with isolated ACLR, while those with an ACLR with either an MM or LM meniscal repair would be indistinguishable from an isolated ACLR. In addition, it was hypothesized that patients who had an ACLR with MM or LM meniscal repair or resection would have decreased preoperative KOOS subscale scores compared with patients with isolated ACLRs.

METHODS

Norwegian Knee Ligament Registry

The NKLR was established in June 2004 for the purpose of prospectively collecting data for all cruciate ligament reconstructions in Norway.[7] A previous study has described the implementation of this registry in more detail.[7] Participation in the registry is voluntary for both surgeons and patients, with patients asked to sign an informed consent before surgery to allow their data to be entered into the registry.[7] The compliance rate for reporting these surgeries is approximately 86%, with higher rates in larger, public hospitals.[21,22] Patients are asked to complete the KOOS questionnaire preoperatively. Later 2-, 5-, and 10-year follow-ups using the KOOS questionnaire are collected by the NKLR.[7] The KOOS questionnaires are sent to patients at the follow-up times, with both Internet and mail options for patients to facilitate compliance.[7] The KOOS form is not returned to the patient if data are incomplete, with missing data treated according to the guidelines described by Roos et al.[16]

Knee Injury and Osteoarthritis Outcome Score

The KOOS questionnaire was chosen for the NKLR because it is considered to be user-friendly, self-explanatory, and patient based.[7] In addition, the KOOS questionnaire has been validated for use in ACLR, meniscal injury, and articular cartilage injury because it is highly reproducible and responsive for both individuals and groups.[6,15,17]

The KOOS questionnaire is divided into 5 subscales, totaling 42 questions. The 5 subscales are Pain (with 9 questions), Other Symptoms (7 questions), Activities of Daily Life (ADL) (17 questions), Sport and Recreation Function (Sport/Rec) (5 questions), and Quality of Life (QoL) (4 questions).[15] The Sport/Rec and QoL subscales have been reported by Roos et al[16] to be most responsive at a postoperative follow-up for ACLR. These authors also reported that in patients with meniscal injury, the Pain and ADL scores are also important for ensuring content validity for the KOOS questionnaire.[16] Each subscale

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is calculated using a scale of 0 to 100, with 100 being the maximum (best) score. The individual subscales are recommended to be evaluated independently.[16]

Patients

A total of 14,142 patients with primary ACLR from 2004 to 2012 were available in the NKLR database (Figure 1). For this study, patients with concomitant medial collateral ligament (MCL), posterior cruciate ligament (PCL), posterolateral corner injuries, or meniscal transplantations (n = 1198) were excluded. Patients who had surgeries performed in 2011 or 2012 and lacked a 2-year follow-up were also excluded (n = 3185). Patients with any concomitant meniscal procedures performed (n = 561), such as a resection of the contralateral compartment meniscus during a meniscal repair, were excluded in these groups, as well as patients with untreated meniscal injury (n = 594). Patients with untreated meniscal injury were excluded from further analysis because of a lack of standardization toward reporting which meniscus was injured and left untreated. In addition, patients for whom no preoperative KOOS data were collected were excluded (n = 1191). This patient group was not substantially different in terms of age, sex, year of surgery, time to surgery (in months), or meniscal injury/treatment than those who did complete the preoperative KOOS questionnaire (see analysis in Results section). Therefore, 7413 patients were eligible. Patients with a completed 2-year postoperative follow-up KOOS for at least 1 subscale were included in the final analysis group.[8] Among the eligible cohort, 4691 had valid follow-up, which was considerably larger than similar previous studies.[2,5] The percentage of 2-year KOOS outcome follow-up was 63.3% (4691/7413), which was higher than the follow-up rates reported by previous studies using the Swedish National Knee Ligament Register (41%)[1] and for both the NKLR and Swedish National Knee Ligament Register (54%).[16]

The final patient population of 4691 was then divided into a baseline group of ACLRs without meniscal injury ("Isolated ACL") (n = 2717) and 4 groups of ACLRs with meniscal injury: LM repair (n = 111), LM resection (n = 647), MM repair (n = 318), and MM resection (n = 898) (Figure 1). Knees in these groups were subject to only 1 meniscal treatment in either compartment. In addition, the meniscal repair groups involved menisci that were treated with either "synthetic fixation" or "suture" repair, which are commonly referred to as all-inside and inside-out techniques, respectively,[3] and were not further differentiated.

Statistical Analysis

Comparisons were made between the study cohort and the patients lost to follow-up with respect to baseline characteristics and preoperative KOOS subscale scores. Bivariate statistical tools, including the independent *t* test, Mann-Whitney *U* test, Fisher exact test, and chi-square test were used. Within the study group, raw summary statistics (median with first and third quartiles) were stratified by

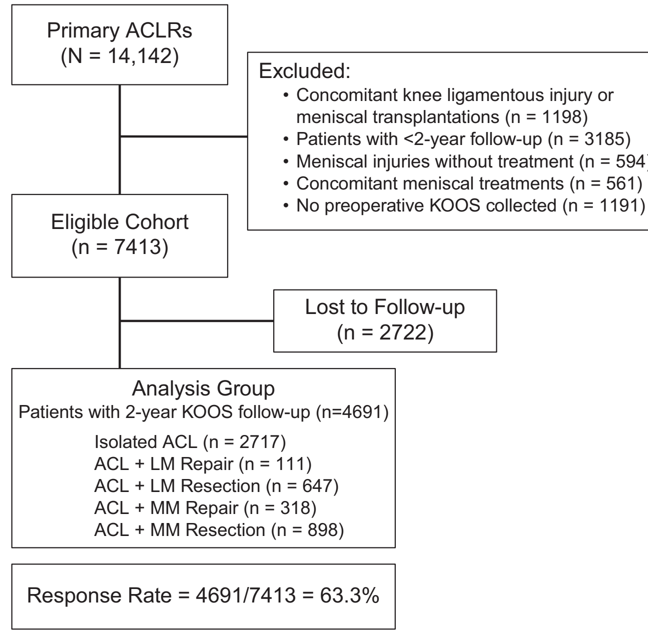

Figure 1. Flowchart of the Norwegian Knee Ligament Registry of 14,142 patients describing the exclusions and patients lost to follow-up that led to the final analysis group. ACL, anterior cruciate ligament; ACLR, anterior cruciate ligament reconstruction; KOOS, Knee Injury and Osteoarthritis Outcome Score; LM, lateral meniscus; MM, medial meniscus.

meniscal treatment group and calculated for both baseline and 2-year follow-up instances for each KOOS subscale score.

The primary goal of this study was to assess the effect of meniscal injury and treatment type on short-term patient-reported outcomes among those undergoing ACLR. To address this, multiple linear regression (MLR) models were built to estimate the effects of patients with ACLR and LM repair, LM resection, MM repair, or MM resection compared with patients with isolated ACL tears. The patient-specific variables of age, sex, year of surgery, and months from injury to surgery were considered potential confounders for the meniscal group effect and thus included as predictors in the models. The distribution of the time-to-surgery variable was skewed. To create a more normal distribution, we used the natural log of the variable instead of the raw value. This transformation improved the linear relationship of time to surgery with KOOS and enhanced the fit of the MLR models. In addition to modeling short-term outcomes, otherwise identical models were built separately for preoperative KOOS subscale scores to compare baseline condition among the meniscal injury groups. Coefficient estimates of the MLR models are reported with 95% confidence intervals. The statistical package R was used for all analyses (R Development Core Team).

Effect estimates (β) in the MLR models that pertain to categorical factors (sex and meniscal treatment group) may be interpreted as the expected marginal effect on KOOS score that can be attributed to that factor level

TABLE 1
Patient Characteristics and Baseline KOOS Subscale Scores at Time of ACL Reconstruction for Study Patients Included (N1) and Lost to Follow-up (N2)[a]

	Study Cohort	Lost to Follow-up	*P* Value
Age at surgery, mean ± SD, y (N1 = 4691; N2 = 2722)	28.7 ± 10.5	27.0 ± 9.5	<.001[w]
Time from injury to surgery, median [25th, 75th percentiles], mo (N1 = 4480; N2 = 2603)	8 [4, 17]	8 [4, 16]	.343[x]
Sex, No. (%)			<.001[y]
Male	2407 (51.3)	1762 (64.7)	
Female	2284 (48.7)	960 (35.3)	
Meniscal treatment, No. (%)			.068[z]
Isolated ACL	2717 (57.9)	1546 (56.8)	
LM repair	111 (2.4)	77 (2.8)	
LM resection	647 (13.8)	433 (15.9)	
MM repair	318 (6.8)	168 (6.2)	
MM resection	898 (19.1)	498 (18.3)	
KOOS, preoperative, mean ± SD			
Symptoms (N1 = 4685; N2 = 2715)	72.7 ± 17.8	71.1 ± 17.9	<.001[w]
Pain (N1 = 4621; N2 = 2697)	74.3 ± 17.8	72.7 ± 18.7	<.001[w]
ADL (N1 = 4612; N2 = 2688)	83.1 ± 17.6	80.8 ± 18.6	<.001[w]
Sport/Rec (N1 = 4599; N2 = 2673)	43.2 ± 26.7	41.5 ± 26.8	.009[w]
QoL (N1 = 4649; N2 = 2701)	34.8 ± 18.0	33.8 ± 17.9	.020[w]

[a]N1 and N2 are the nonmissing sample sizes for the study and lost to follow-up cohorts, respectively, for each variable. *P* values correspond to [w]independent *t* test, [x]Mann-Whitney *U* test, [y]Fisher exact test, or [z]chi-square test. ACL, anterior cruciate ligament; ADL, Activities of Daily Life; KOOS, Knee Injury and Osteoarthritis Outcome Score; LM, lateral meniscus; MM, medial meniscus; QoL, Quality of Life; Sport/Rec, Sport and Recreation Function.

compared with the baseline level (men and isolated ACLR group, respectively), all other factors held the same. Meanwhile, the effect estimates for age can be interpreted as the expected change in KOOS score given a 10-year increase in patient age, all other factors held constant. The time-to-surgery variable is the natural log of the raw value, so the effect estimates are the expected change in KOOS score given a 1-unit change on the logarithm scale of months from injury to surgery, all other factors equal.

RESULTS

Henceforth, meniscal treatment groups are referred to by their defining meniscal treatment (or lack thereof, in patients without a meniscal tear), with the understanding that all patients in the cohort underwent concurrent ACLR. Tables 1 to 3 and Appendices 1 and 2 (available online at http://ajsm.sagepub.com/supplemental) contain the comprehensive data analysis for each topic.

Lost to Follow-up Analysis

A comparison of the analysis group with the group lost to follow-up is detailed in Table 1. Men were significantly more likely than women to be lost to follow-up, accounting for 64.7% of the group lost to follow-up but only 51.3% of the study cohort ($P < .001$). In addition, patients in the group lost to follow-up were significantly younger ($P < .001$), although the difference in median age between groups was only 1.7 years. Meanwhile, no significant differences were found between the groups with regard to the prevalence of the different meniscal treatment groups ($P = .068$) or time to surgery ($P = .343$).

MLR Models: Effect of Meniscal Treatment Group

Median preoperative and 2-year postoperative KOOS raw subscale scores are presented with first and third quartiles for each meniscal treatment group in Table 2 and Table 3, respectively. Results of the MLR models are split into 2 tables, meniscal treatment group effects relative to isolated ACLR (Appendix 1, available online) and effect estimates for the patient-specific covariates (Appendix 2, available online).

Appendix 1 details the effects of meniscal treatment group on preoperative and 2-year postoperative follow-up KOOS subscale scores compared with the baseline isolated ACLR group. Both the MM repair and MM resection groups had significantly lower preoperative scores for all KOOS subscales. The LM repair group scores were significantly lower for the Other Symptoms, Pain, and ADL subscales. Conversely, the LM resection group exhibited preoperative KOOS scores that were not significantly different from the isolated ACLR group for all subscales.

Nearly every meniscal treatment group effect on the 2-year postoperative KOOS subscale scores was both clinically minimal (15 of 20 coefficient estimates were less than or equal to 2 points) and statistically nonsignificant. The 2 exceptions were both for the MM repair group, in which Other Symptoms and QoL subscale scores were significantly lower than the isolated ACLR group. In most cases, a substantial amount of the preoperative deficit in scores exhibited by the meniscal treatment groups with

TABLE 2
Summary Statistics for Preoperative KOOS Subscale Scores, Stratified by Meniscal Treatment Group[a]

	Isolated ACL	LM Repair	LM Resection	MM Repair	MM Resection
KOOS subscale					
Symptoms	75 [64, 89]	71 [54, 86]	75 [64, 89]	71 [57, 82]	71 [57, 86]
Pain	78 [64, 89]	78 [64, 89]	81 [67, 89]	75 [58, 86]	75 [61, 86]
ADL	90 [75, 97]	88 [74, 97]	91 [76, 97]	88 [71, 97]	85 [68, 96]
Sport/Rec	45 [25, 65]	45 [25, 70]	45 [25, 65]	35 [20, 65]	35 [15, 55]
QoL	31 [25, 50]	38 [25, 50]	38 [25, 50]	31 [22, 44]	31 [19, 44]

[a]Data are presented as median [first quartile, third quartile]. ACL, anterior cruciate ligament; ADL, Activities of Daily Life; KOOS, Knee Injury and Osteoarthritis Outcome Score; LM, lateral meniscus; MM, medial meniscus; QoL, Quality of Life; Sport/Rec, Sport and Recreation Function.

TABLE 3
Summary Statistics for 2-Year Postoperative Follow-up KOOS Subscale Scores, Stratified by Meniscal Treatment Group[a]

	Isolated ACL	LM Repair	LM Resection	MM Repair	MM Resection
KOOS subscale					
Symptoms	82 [64, 93]	79 [64, 89]	82 [64, 93]	75 [61, 89]	82 [64, 93]
Pain	89 [78, 97]	89 [78, 97]	92 [81, 97]	89 [75, 97]	89 [78, 97]
ADL	97 [90, 100]	97 [90, 100]	99 [91, 100]	97 [88, 100]	97 [88, 100]
Sport/Rec	75 [50, 90]	69 [45, 85]	75 [50, 90]	70 [45, 85]	70 [50, 90]
QoL	75 [50, 88]	69 [44, 81]	75 [50, 88]	62 [47, 81]	69 [50, 88]

[a]Data are presented as median [first quartile, third quartile]. ACL, anterior cruciate ligament; ADL, Activities of Daily Life; KOOS, Knee Injury and Osteoarthritis Outcome Score; LM, lateral meniscus; MM, medial meniscus; QoL, Quality of Life; Sport/Rec, Sport and Recreation Function.

respect to the isolated ACLR group was eliminated by 2 years. One notable exception was the MM repair group, for which the overall deficit in KOOS QoL relative to the subscore for the isolated ACLR group increased postoperatively.

MLR Models: Effect of Patient-Specific Variables

The effects of patient-specific covariates from the MLR models are detailed in Appendix 2. Higher patient age was significantly associated with lower preoperative KOOS scores for all subscales. These associations persisted at the 2-year postoperative follow-up for the KOOS Pain, ADL, and Sport/Rec subscales but were not significant for QoL. Patient age was positively associated with higher postoperative Other Symptom scores, with this relationship predicting a gain of 0.8 points per 10 years of patient age. Women exhibited significantly lower KOOS subscale scores than did men at baseline, and this generally persisted into the 2-year postoperative follow-up (Appendix 2).

For all subscales, longer time to surgery was associated with higher preoperative scores. Conversely, there was a significant negative association between the time-to-surgery and 2-year postoperative KOOS scores for all subscales except Other Symptoms. The magnitudes of these effects are detailed in Appendix 2. R^2 values ranged from 0.046 to 0.091 for preoperative models and 0.011 to 0.021 for postoperative models, indicating that less than 10% and 3% of variability in preoperative and postoperative KOOS subscale scores, respectively, can be explained by the predictors in our models. This suggests that even while accounting for meniscal treatment, age, sex, time to surgery, and year of surgery, much patient-to-patient variability exists for postoperative outcomes after ACLR with and without meniscal treatment.

DISCUSSION

In the current study, using the largest nationwide population cohort of any comparable study, our hypothesis that patients with MM and LM resection would have significantly worse 2-year clinical outcomes than isolated ACLR, while the MM or LM meniscal repair would have indistinguishable outcomes from an isolated ACLR, was not seen. Of most clinical interest was the finding that the 2-year postoperative outcomes in patients with an LM repair, MM resection, or LM resection were not significantly different from an isolated ACLR for any of the 5 KOOS subscales. Similar results were seen for patients in the MM repair group in comparison to an isolated ACLR on the Pain, ADL, and Sport/Rec subscales; however, the results after an MM repair were significantly decreased for the Other Symptoms and QoL KOOS subscale scores. Our findings indicate that at 2-year follow-up, the previously reported mid- and long-term negative effects of concurrent ACLR and meniscal resections in other cohorts[2,4,13,18,19] may not be prevalent, with patients continuing to be asymptomatic at a group level in the first few years after an ACLR and meniscal resection.

It is commonly accepted that most ACLR patients are discharged from clinical follow-up or are requested to return to clinic on an as-needed basis after demonstrating sufficient return of strength or passing a functional sports test within 1 year postoperatively. This study reveals that almost all patients do functionally well at up to 2 years postoperatively, disregarding the type of meniscal treatment. Thus, the surgeon's own experience with short-term clinical follow-up is likely to bias concurrent meniscal repair versus resection treatment decisions unless these patients are scrutinized with longer term follow-up. As of today, the literature reports that patients who undergo a meniscal resection rather than a meniscal repair have higher postoperative rates of osteoarthritis and decreased function over the long term (>10 years).[2,4,11,12,18] Despite no clinical difference being found in this cohort at 2 years postoperatively, we still advocate that meniscal tears be repaired whenever possible and that patients who have meniscal resections be advised to follow up with their physicians at either a routine time postoperatively (between 5 and 10 years postoperatively) or at the first signs of pain or swelling with activities to determine if they are developing osteoarthritis. The subjective and objective clinical findings at that further follow-up could direct whether activity modifications or other treatment may be indicated depending on whether signs or symptoms of osteoarthritis were present.

Furthermore, our hypothesis that patients who had a meniscal injury that progressed to MM or LM meniscal repair or resection would have significantly decreased preoperative KOOS subscale scores compared with isolated ACLRs was both partially confirmed and disproved. While patients who had either an MM repair or MM resection had significantly lower preoperative KOOS subscale scores than those patients with an isolated ACLR for all categories, those with a concurrent LM resection were not significantly different from the isolated ACLR group for any KOOS subscale score preoperatively. In addition, patients who had an LM repair had significantly lower preoperative scores on the Other Symptoms, Pain, and ADL subscales compared with those with an isolated ACLR. On the basis of our findings, MM injury that proceeded to repair or resection, as well as LM injury proceeding to LM repair, began worse off than isolated ACLR; however, it is encouraging that most groups (excluding the MM repair on the Other Symptoms and QoL KOOS subscale scores) were able to "catch up" to the isolated ACLR by the time of the postoperative follow-up.

A recent meta-analysis found that long-term rates of osteoarthritis were significantly increased after ACLR with meniscal resection.[4] Previous studies have also indicated that meniscal resections result in significantly decreased subjective outcomes scores and activity levels and increased numbers of total knee replacements and osteoarthritic progression at follow-ups ranging from 8 to 40 years.[2,4,13,18,19] However, for both the MM and LM resection groups in our current study, no significant differences were seen, indicating that perhaps the reported poor outcomes after meniscal resection are not immediately seen at 2-year follow-up.

Contrary to one of this study's stated hypotheses, there was a significant difference in KOOS outcomes between patients with an MM repair and an isolated ACLR at 2-year postoperative follow-up for the Other Symptoms and QoL KOOS subscale scores; however, patients with an LM repair were not significantly different from those with an isolated ACLR for any KOOS subscales at 2 years. Previous studies have described lower postoperative rates of osteoarthritis and higher subjective patient outcomes scores for meniscal repair in comparison to meniscal resection, with and without ACLR.[11,19] The relatively few differences between meniscal repair and meniscal resection seen in our study may be because the benefit of preserving meniscal tissue, which is the goal of meniscal repair, may not be appreciated until the repetitive loading of the knee is performed over the course of many years. In addition, the decreased mobility of the MM in comparison to the LM[20] and the differing insertion geometries of the medial and lateral meniscal roots[9,10] may potentially explain the better outcomes for LM repairs in comparison to MM repairs at short-term follow-up.

This study does have some inherent limitations and strengths. The short-term follow-up was not long enough to make any definitive conclusions about the effectiveness of meniscal repair or resection in combination with ACLR, but it is the first known study that has evaluated these treatments at short-term follow-up with a large nationwide population cohort. The authors encourage future investigations of the 5- and 10-year follow-up outcomes in these patients using the NKLR and believe the results of this current study would provide a direct comparison to any future studies using the same patient cohort. In addition, as described by Røtterud et al,[17] the loss of approximately 37% of patients either due to missing preoperative or 2-year KOOS follow-ups is not ideal but the follow-up is actually higher than in previous nationwide cohort studies.[1,16] This loss of patients has the potential for selection bias, but as demonstrated by Table 1, these differences seem to be of minimal, if any, clinical relevance. Previous nationwide cohort studies have focused on the effects of ACLRs with articular cartilage lesions[16] and of different ACL graft types[14] on postoperative outcomes after ACLR; therefore, the effect of these concomitant treatments was not analyzed in this study to focus on the meniscal treatments. Also, there were no objective data or radiographic analysis for these patients, so the potential of the development of asymptomatic osteoarthritis was both present and unknown. Patients were part of a large nationwide cohort encompassing numerous surgeons and hospitals; therefore, varying postoperative rehabilitation and surgical techniques were likely present among patients. However, the authors believe that this is also a strength of the study because it presents an accurate depiction of the real-world scenario of clinical outcomes for patients undergoing ACLR with and without meniscal treatment. Last, the relatively low R^2 values for the multiple linear regression models show that while the significant trends found in the current study are reliable within a cohort of patients, much patient-to-patient variability exists.

CONCLUSION

When using a large nationwide population cohort of 4691 patients, no significant difference between 2-year postoperative KOOS outcomes was seen between patients with isolated ACLR and ACLR with concomitant LM repair, LM resection, or MM resection. Patients who had an MM repair had significantly decreased postoperative Other Symptoms and QoL subscale scores in comparison to those with an isolated ACLR. In addition, results from this study indicate that patients with an ACLR with an MM repair, MM resection, or LM repair had significantly lower preoperative KOOS subscale scores than those with an isolated ACLR. However, for the most part, these patients are able to "catch up" with equivalent short-term postoperative outcomes to those with an isolated ACLR. Further studies are needed using a similar cohort to determine the effect of both meniscal repair and resections on the medium- and long-term subjective outcomes of patients after an ACLR with a meniscal injury.

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