Meniscal problems: to repair and to replace

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Time interval between trauma and arthroscopic meniscal repair has no influence on clinical survival.

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ABSTRACT

Introduction: Arthroscopic meniscal repair is the gold standard for longitudinal peripheral meniscal tears. The time interval between trauma and meniscal repair remains controversial. The aim of this study was to evaluate failure rates and clinical outcome of arthroscopic meniscal repair in relation to chronicity of injury.

Methods: Two hundred and thirty eight meniscal repairs were performed in 234 patients. Anterior cruciate ligament (ACL) was reconstructed in almost all ACL deficient knees (130 of 133). Time interval between injury and repair was divided into acute (<2 weeks), subacute (>2 weeks- <12 weeks) and chronic (>12 weeks). Patients completed postal questionnaires to evaluate clinical outcome and failure rates. Study instruments included Lysholm, Knee injury and Osteoarthritis Outcome Score (KOOS) and Tegner scoring systems.

Results: At a median follow-up of 41 months (interquartile range (IQR) 34 – 53 months) 55 medial and 10 lateral meniscal repairs failed (overall failure rate 27%). There was a significant higher failure rate for medial meniscal repair ($p < 0.05$) and ACL deficient knees without ACL reconstruction. Functional outcome scores showed only significant differences on the KOOS subscale 'Function in daily living' (95% CI 1.05 – 15.27, $p < 0.05$). No significant difference was found for any interval between trauma and repair.

Conclusion: The interval between trauma and arthroscopic meniscal repair has no influence on failure rate. Differences in survival rate of meniscal repair are more dependent on location of the lesion and ACL status, rather than chronicity of injury.

INTRODUCTION

Several determinants contribute to a successful meniscal repair. Firstly suture technique, of which inside-out suturing is still seen as the gold standard for meniscal repair, while all-inside suturing devices are gaining popularity since its introduction by Morgan.[1] Many studies reported their results on survival using different suturing techniques.[2,3,4] Traumatic anterior cruciate ligament (ACL) rupture is commonly found with meniscal tears. Meniscal repair in combination with a concomitant anterior cruciate ligament reconstruction (ACLR) in ACL injured knees show lower failure rates than isolated meniscal repair in a stable knee,[5] also at long-term follow-up.[6] Survival of meniscal repair further depends on type of meniscal lesion, patient's age and knee stability.[3]

Data describing the influence of time interval between the moment of injury and the moment of meniscal repair on meniscal repair survival is scarce.[7,8] The time interval in which it is still possible to perform a meniscal repair is controversial. With advancing age, meniscal tissue becomes degenerative which may lead to a decreased healing response. Chronic tears (existing more than 12 weeks) have a longer period of decreased vascularity and may lead to a lack of tissue viability over time.[9]

We performed a retrospective study to evaluate the reoperation and failure rates, patient-reported outcomes and complications of arthroscopic meniscal repair in relation to the chronicity of injury. We hypothesized that arthroscopic meniscal repair of chronic meniscal tears have higher failure rates (primary outcome) and lower functional outcome scores (secondary outcome).

MATERIALS AND METHODS

Patients

Between July 2006 and March 2013, 311 patients underwent an arthroscopic meniscal repair after a traumatic knee injury. All patients who had an arthroscopic meniscal repair in this period with or without ALCR were included. Only those patients with an arthroscopic meniscal repair in combination with a posterior cruciate ligament reconstruction or a multiligament reconstruction were excluded for evaluation. Operative treatment was performed by three different orthopedic surgeons according a standard procedure. All orthopedic surgeons have at least five years of experience in arthroscopic meniscal repair and ACLR. After getting an approval from the local Institutional Review Board multiple attempts were made, to contact all 311 patients by telephone during summer 2014. All medical records were checked for reoperations, postoperative radiology reports and images and complications. If patients could be reached, they were asked to complete

multiple questionnaires after they had given their informed consent. The questionnaires were sent by post or email.

Study instruments included the Knee injury and Osteoarthritis Outcome Score (KOOS),[10] Lysholm score,[11] which is categorized in four groups: excellent (94-100 points), good (84-94 points), fair (65-83 points) and poor (less than 65 points), Tegner score [12] and additional questions about patients' medical history, especially about any possible reoperation or radiological examinations elsewhere.

Lacking any consensus in literature on the definition of an acute or chronic meniscal tear, we divided our patients into three groups according to the interval between trauma and meniscal repair: ≤ 2 weeks (acute), >2 weeks – 12 weeks (subacute) and > 12 weeks (chronic). The definition of a chronic meniscal lesion varies in literature. A problem we see in defining the terms 'acute' and 'chronic' in other orthopaedic sports injuries as well.[13] Time intervals from 2 till 6 months post trauma are used defining a chronic meniscal tear.[7,14] In this study the threshold for chronic meniscal lesions was set at 12 weeks (3 months) and the threshold for acute lesions was set at two weeks. Making this distinction, a group with meniscal injury older than 2 weeks and younger than 12 weeks remains: subacute.

The criteria for failure were partial or (sub)total meniscectomy of the previous sutured meniscus or failure proven by radiological examination using magnetic resonance imaging (MRI) or Computed Tomography (CT) arthrography showing a tear or partial healing of a previous sutured meniscus.

Surgical technique and rehabilitation

All patients were evaluated preoperatively with MRI. Reparability of meniscal tears was first based on preoperative MRI findings described by Thoreux.[15] The definitive decision for meniscal repair was based on the intraoperative findings. Patients with a meniscal tear in the white-white zone, degenerative meniscal tissue at the site of the tear, a meniscal tear smaller than 1 centimeter or any other tear than a vertical meniscal tear, were excluded for meniscal repair. Time interval between injury and meniscal repair was not used as exclusion criterion. The standard procedure for isolated meniscal repair included rasping of the peripheral rim and meniscus, suturing the posterior horn with all-inside sutures and the middle section with inside-out sutures, and drilling holes in the intercondylar notch to provide blood and growth factors. For the inside-out technique we used 2.0 FiberWire sutures (Arthrex, Naples, Florida). The Meniscal Cinch (Arthrex, Naples, Florida) was used for the all-inside technique also with 2.0 FiberWire sutures. If an ACL insufficient knee was reconstructed, autologous semitendinosus and gracilis grafts were used for a single-bundle, transtibial reconstruction using the TransFix ACL reconstruction system (Arthrex, Naples, Florida) for all patients. ACLR was postponed in patients with a locked knee due to a displaced bucket handle tear, allowing range of knee motion to be recovered prior to undergoing ACLR six weeks later.

After meniscal repair, only partial weight bearing was permitted for all patients and all patients were instructed to restrict flexion of the knee to 90 degrees for six weeks. Patients treated with isolated meniscal repair, were allowed to practise sports, including sports involving pivoting, at three months based on clinical progress and similarity in the single leg hop test. In contrast, patients after a concomitant ACL reconstruction were allowed to run at three months postoperatively as tolerated, but sports involving pivoting were permitted at six months postoperatively also based on clinical progress and similarity in the single leg hop test. Compliance regarding rehabilitation was controlled by physiotherapists.

Statistics

Data were tested for normality. If data were not normally distributed median and interquartile range (IQR) was reported, in case of normality mean and standard deviation was presented. Students T-test, Chi-square test and one way analysis of variance (ANOVA) were used to calculate statistical significance. When possible, a post-hoc test (Bonferroni correction) was performed. Logistic regression analysis was used for predicting the outcome of categorical dependent variables. Two-sided 95% confidence intervals were reported, and a P value less than 0.05 was considered significant. Survival rates were calculated using the Kaplan-Meier survival function. Statistical analysis was performed using SPSS statistical software (version 20, SPSS Inc, Chicago, IL)

RESULTS

Median follow-up was 41 months (IQR, 34 – 53 months). Of 311 patients, data of 234 was available for evaluation (75%). Up to date personal data of 34 patients were not available, so they could not be reached by phone or mail, not even after contacting their general practitioner. Eight patients refused to participate. Four patients were excluded because they did not speak Dutch or English so they were unable to answer the Dutch or English questionnaires. Twenty-seven patients did not return their questionnaires after their informed consent. For four patients the exact trauma interval was not available. Altogether 77 patients (25%) were lost to follow-up, so 234 patients were evaluated subjectively. See Table 1 for demographic data.

In the remaining 234 patients 238 meniscal repairs were performed. The three groups divided according to the trauma interval (acute, subacute and chronic) consisted of 36, 91 and 107 patients respectively. The three groups showed no statistical differences for age, sex, and lesion location. Significant more bucket handle tears were sutured and significant more postponed ACLR were performed in the acute group ($p = 0.046$ and $p = 0.001$ respectively). The medial meniscus was sutured in more than two third (68%)

Table 1. Demographic data of included patients and patients lost to follow-up.

	Acute	Subacute	Chronic	Total
Included patients				
Number of patients	36	91	107	234
Median age (IQR)	29 (20 – 36)	24 (18 – 34)	23 (18 – 31)	24 (18 – 33)
Sex M/F	24/12	63/28	66/41	153/81
Patients lost to follow-up*				
Number of patients	11	30	30	73*
Median age (IQR)	25 (19 – 29)	26 (22 – 34)	24 (19 – 32)	25 (19 – 32)
Sex M/F	7/4	23/7	23/7	53/18

IQR = interquartile range; M = male; F = female; Age in years. * in 4 of the 77 patients lost to follow-up time interval between trauma and surgery was not known.

of the patients. In 106 of the 133 ACL (80%) deficient knees a concomitant ACLR was performed, in 24 patients an ACLR was performed six weeks after the meniscal repair. In three patients with a ruptured ACL, no reconstruction took place because they refused further ACL treatment. In four patients both medial and lateral meniscus tear was sutured. Almost half of the patients had a bucket handle tear (unstable, displaced, longitudinal tear extending more than 2 cm; 49%). A larger group of the patients had a peripheral vertical tear (a full-thickness, vertical tear extending less than 2 cm, but more than 1 cm; 41%). A small group of patients had a capsular tear (meniscocapsular separation; 10%). See Table 2 for patients' characteristics.

Primary outcome

Results of failure are described in Table 3. In a total of 238 meniscal repairs 65 meniscal repairs in 65 patients failed (27%). Fifty-six patients were known to have a failed meniscal repair according to our own data system, nine patients reported a reoperation by answering the questionnaires. None of the patients reported a failure based on radiological findings elsewhere. Twenty nine of 65 patients (45%) have had an evident new trauma causing a re-rupture of the previous sutured meniscus.

Table 2. Patients' characteristics. ACL = anterior cruciate ligament.

	Acute (n = 36)	**Subacute** (n = 91)	**Chronic** (n = 107)	**Total** (n = 234)
Isolated meniscal repair	21	45	38	104
ACL deficiency	15	46	69	130
Concomitant reconstruction	6	36	61	103
Postponed reconstruction	9	9	6	24
No reconstruction	0	1	2	3
	Acute (n = 36)	**Subacute** (n = 87)	**Chronic** (n = 107)	**Total** (n = 230)*
Medial meniscus	21	60	80	161
Peripheral vertical tear	1	28	38	67
Bucket handle tear	20	26	32	78
Capsular tear	0	6	10	16
Lateral meniscus	15	27	27	69
Peripheral vertical tear	2	10	15	27
Bucket handle tear	11	14	9	34
Capsular tear	2	3	3	8

* Data excluding four patients with bicompartmental meniscal repair.

Table 3. Failure rate of meniscal repairs. ACLR = anterior cruciate ligament reconstruction

	Failure (n = 65)		p-value
Acute	9/36	25.0%	0.923
Subacute	25/91	27.5%	
Chronic	31/107	28.9%	
Medial*	55/161	34.2%	0.001
Lateral	10/69	14.5%	
Capsular tear	8/24	33.3%	0.674
Bucket handle tear	33/112	29.5%	
Peripheral tear	24/94	25.5%	
Stable knee with intact ACL	33/104	31.7%	0.154 †
Stable knee after ACLR	29/127	22.8%	
Unstable knee without ACLR §	3/3	100%	
Concomitant ACLR	21/103	20.4%	0.167 ‡
Postponed ACLR	8/24	33.3%	
No ACLR §	3/3	100%	

* excluding 4 patients with bicompartmental meniscal repair (n = 230). † p-value of stable knee with intact ACL versus stable knee after intact ACL. ‡ p-value of concomitant ACLR versus postponed ACLR. § too small group for statistical analysis.

In the acute group nine meniscal repairs failed (25.0%), in the subacute group twenty-five (27.5%), in the chronic group 31 (28.4%) (Figure 1). These differences were not statistically significant. The medial meniscus failed significantly more than the lateral meniscus, 55 of 161 (34.1%) versus ten of 69 (14.5%) (p = 0.001). After logistic regression analysis, the odds ratio for the compartment coefficient is 2.99 with a 95% confidence interval of [1.42

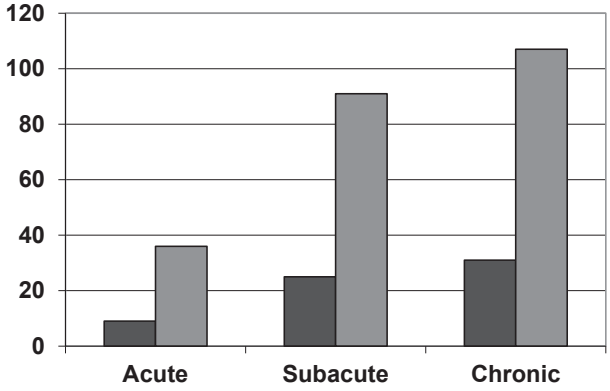

Figure 1. Bar chart showing number of failures and survivors in each group. Black = failure, grey = survivor.

- 6.31]. This suggests that those who have a meniscal repair in the medial compartment are three times more likely to fail than those with a lateral meniscal repair. The success rate of suturing capsular tears (66.7% survival), bucket handle tears (70.5% survival), and peripheral vertical tears (74.5% survival) did not significantly differ. No failure was seen in the four patients with a bicompartmental meniscal repair.

Of 234 patients, 130 patients (55.6%) had an insufficient ACL. All three patients having a meniscal repair in an ACL deficient refusing further ACL treatment failed. In the remaining 127 patients, 103 had a meniscal repair and an ACLR at once. Twenty-four patients had a postponed ACLR. A concomitant ACLR gave fewer failures than a postponed ACLR, but no significant differences in failure rate were found between these two groups. Twenty-one of 103 (20.4%) meniscal repairs with a concomitant ACLR failed, which not significantly differed from the meniscal repairs with a postponed ACLR, where eight out of 24 (33.3%) failed.

Secondary outcomes

Results of functional outcomes are described in Table 4. Functional outcome scores are shown for all 169 survivors. Functional outcome scores of patients with a failed meniscal repair were not evaluated, where we were only interested in the patient reported outcome measurements of patients with a successful meniscal repair to evaluate any differences between the different time intervals. Good Lysholm scores were seen for all subgroups. No significant differences in Lysholm score were found between the three groups. Tegner activity scale showed a higher activity level in the acute group, but the group differences were not significant. For KOOS score no significant difference was seen for all subscales, except for 'Function, daily living' (Activities in daily living; ADL). ADL scores were significantly higher for patients treated in the subacute and chronic group compared to the patients treated in the acute group (95% CI 1.05 – 15.27, p = 0.017). A survival point of

Table 4. Functional outcome scores of meniscal repair survivors (n = 169). All scores are the mean of each group (median, interquartile range).

	Acute (n = 27)	Subacute (n = 66)	Chronic (n = 76)	p-value (95%CI)
KOOS				
Symptoms	90 (96, 86 – 100)	91 (93, 87 – 100)	90 (96, 89 – 100)	0.846 (-8.07 – 5.63)
Pain	88 (97, 91 – 100)	91 (97, 89 – 100)	93 (97, 92 – 100)	0.228 (-12.66 – 2,47)
Function in daily living (ADL)	88 (100, 92 – 100)	95 (100, 97 – 100)	96 (100, 97 – 100)	0.017 (1.05 – 15.27) *

73% was found after 48 months (4 years) of follow-up (Figure 2). Mean time to failure was 13.6 months (median 9, IQR 5 – 19 months). Adverse events were found in only two cases. One patient had a suture granuloma after an all-inside repair. The second adverse event was observed in a patient after an inside-out meniscal repair where a septic arthritis of the knee developed. This was treated by arthroscopic lavage and antibiotics and the meniscal repair could be saved.

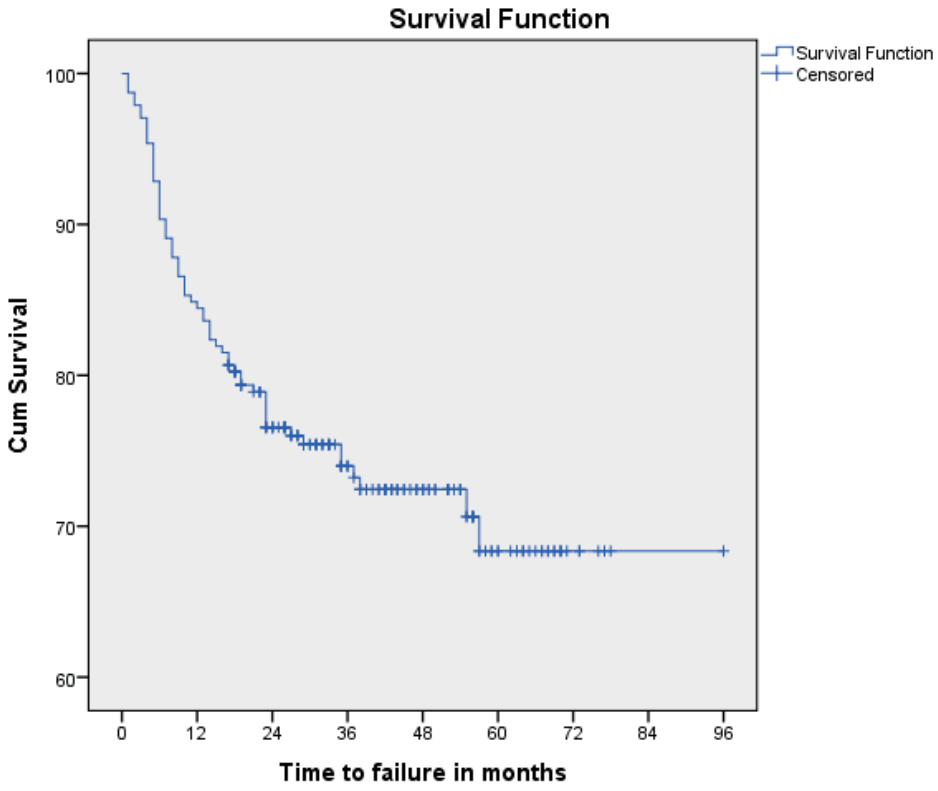

Figure 2. Survival curve of arthroscopic meniscal repair.

DISCUSSION

The goal of this retrospective study was to evaluate the reoperation and failure rates, subjective outcome score and complications of arthroscopic meniscal repair in relation to the time interval between injury and meniscal repair. We hypothesized that arthroscopic meniscal repair of chronic meniscal tears have higher failure rates and lower functional outcome scores. This study shows no significant difference in failure rate regarding the time interval between trauma and arthroscopic meniscal repair. This study also shows a similar clinical and radiological failure rate compared to the literature with a failure rate of 27%.[16]

We focused on chronicity of meniscal injury taking into account that defining acute and chronic meniscal tears is still controversial. In this study the threshold for chronic meniscal lesions was set at 12 weeks (3 months). We think that an acute tear may differ from other tears within the meaning of presence of mechanical problems (locked knee). We think more locked knees are seen in acute meniscal injury caused by displaced bucket handle tears. Making this distinction, a group with meniscal injury older than 2 weeks and younger than 12 weeks remains: subacute.

There is a well-known difficulty in assessing meniscal healing at follow-up. We believe that in an asymptomatic knee after meniscal repair the meniscus is healed, or at least partially healed. Second look arthroscopy is rarely possible because of costs and ethical considerations. Standard radiological follow-up using MRI also has a high additional cost and we did not use it to confirm meniscal healing. We did use it to confirm or exclude meniscal failure in the symptomatic patient. Because we did not perform a second-look arthroscopy, MRI arthrography or CT arthrography to confirm survival[17] at our minimum follow-up of one and a half year, we could have missed asymptomatic failures. So, we acknowledge that our functional outcome scores are an indirect evaluation of meniscal healing, also seen in the majority of similar studies.[18]

In our study, we have four patients with a bicompartmental meniscal repair. Because of the small number we used their data for survival analysis only. Repair of the lateral meniscus has a lower reoperation rate than repair of the medial meniscus in our study, a result also found in other studies.[16,18,19] The lower survival in medial meniscal repair is probably because of movement of the medial meniscus. The medial meniscus is anchored more tightly and has less flexibility and movement compared to the lateral meniscus.[20] Besides, the medial meniscus functions as a secondary stabilizer in the knee where it suffers from greater stress.[21]

Biomechanical laboratory testing has estimated that the lateral meniscus accounts for up to 70% of the load-bearing capacity of the lateral compartment, while the medial meniscus assumes up to 50% of the loads in its respective compartment.[22] After lateral meniscectomy compressive and shear stresses on the cartilage in the lateral compartment

are higher than after medial meniscectomy[23] contributing to cartilage degeneration[24] and joint space narrowing.[25] Taken together, the higher success rate of lateral meniscal repair and the bigger deteriorating effect on the cartilage after partial lateral meniscectomy, an attempt to lateral meniscal repair must always be considered facing a lateral meniscal tear.

We found a higher reoperation rate in meniscal repairs after postponed ACLR compared to meniscal repairs with concomitant ACLR. The advantage of a concomitant ACLR during meniscal repair is well described.[4,5,12] In our series, a postponed ACLR shows almost 70% more failure than a concomitant ACLR. Probably, cellular elements and biochemical mediators that are essential for the repair response provided by local bleeding have better influence on meniscal healing during concomitant ACLR than during postponed ACLR. Micro-fracturing may create lower levels of blood and growth factors than tunnel drilling. However, we did not find a significant difference in failure rate between postponed and concomitant ACLR or between isolated meniscal repairs in a stable knee compared to meniscal repair during a concomitant ACLR or postponed ACLR. Micro-fracturing in the notch during isolated meniscal repair, which provides blood and growth factors and can accomplish the same environment as during ACLR can be a possible explanation for that.

Despite our strict preoperative indications some patients may have had a clinically silent lesion of the meniscus which was identified and repaired during the concomitant ACLR where instability was their main indication to operate. We know some stable meniscal tears can heal without suturing,[26,27] giving false positive results for meniscal survival during concomitant ACLR. Meniscal repairs in all patients with an ACL deficient knee failed. This group was too small to yield a significant conclusion. It may be clear that an intact ACL is an important factor for success in meniscal repair. An ACLR must always be performed in an ACL deficient knee together with a meniscal repair.[18,28]

Significant more bucket handle tears were sutured and significant more postponed ACLR were performed in the acute group ($p = 0.046$ and $p = 0.001$ respectively). The majority of these patients had an acute trauma with a locked knee because of a displaced bucket handle lesion. Despite different tear patterns, requiring all inside suture, inside-out sutures or a combination of both, we did not find any significant differences in survival rate between different types of meniscal sutures. Rosso et al,[4] showed in a controlled laboratory study that FiberWire suture repair is significantly stronger in load-to-failure testing compared to Meniscal Cinch (both used is our study). Where other studies showed that some meniscal repair devices have similar biomechanical properties to suture repairs.[29] Both suture repairs and devices have a place in meniscal restoration and for that reason we did not consider suture type as a contributing variable for further evaluation here.

As mentioned before, we believe that in an asymptomatic knee after meniscal repair the meniscus is healed, or at least partially healed. Unfortunately, preoperative function scores are lacking, which is a limitation in this study. Unfortunately, we could not compare functional outcomes between patients with a meniscal repair and patients with a partial

meniscectomy after meniscal repair. Clinical survival of meniscal repair should show good patient reported outcome measurements. A good Lysholm score was seen in all groups.

Tegner activity scale showed a higher activity level in the acute group, but differences were not significant. Higher demands in sports and occupation in the acute group might compromise the outcome. As mentioned earlier, preoperative Tegner scores are lacking. An increase in Tegner activity scale in this young active population could tell us if patients had to modify their activity to reduce symptoms. ADL scores were significantly higher for patients treated in the subacute and chronic group compared to the patients treated in the acute group. Lower functional outcome in ADL, in a group with higher demands according to their Tegner score, can be the explanation for the lower 'Function, daily living' scores in the acute group.

The 75th percentile of the survival rate was 19 months which could suggest that the minimum follow-up period of 18 months in this study is too short to give a final conclusion about survival rates. A lengthening of the follow-up period is necessary.

There are several limitations for this study. First, this study is a retrospective case series, lacking a control group. A second limitation is the high rate of patients lost to follow-up. Seventy three patients (25%) were lost to follow-up. Nonetheless, because of the same patient characteristics in this group compared to the group with patients available at follow-up, we think the study population is suitable for evaluation and to draw conclusions. The lack of second look surgery or regular radiological evaluation at follow-up, mentioned earlier, is also a limitation. However, follow-up was performed by chart review and by asking patients if they were re-operated on their affected knee. Patients with recurrent symptoms (low questionnaire scores) without re-operation or radiographic evaluation could be failures, but this was not further evaluated. The difference in after treatment, especially the restriction in pivoting activities, could have had influence on the risk for re-injury. Final limitation of this retrospective cohort study is the heterogeneity of the study population. For that reason, we have chosen not to discuss the different types of repair techniques. Though, we analysed this and we found no significant differences in failure rate in number of sutures and repair technique. Some groups (patients with bicompartmental meniscal repair or an ACL deficient knee without ACLR) were too small to yield a significant conclusion.

In conclusion, there is no significant difference in failure rate regarding the time interval between trauma and arthroscopic meniscal repair. The consideration for meniscal repair should be based on preoperative MRI results and intraoperative findings, not on chronicity of injury. Survival of meniscal repair is more dependent on location of the lesion (medial versus lateral) and ACL status. When an ACLR is indicated together with a meniscal repair in an ACL deficient knee, a concomitant procedure is recommended above a postponed ACLR.

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