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Outcomes of Grade III MCL Injuries Treated Concurrently with ACL Reconstruction: A Multicenter Study

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Abstract

Purpose: To evaluate differences in repair and nonoperatively managed grade III MCL injuries during ACL reconstruction.

Methods: Patients enrolled in a multicenter prospective longitudinal group who underwent unilateral primary ACL reconstruction between 2002-2008 were evaluated. Patients with concomitant grade III MCL injuries treated either operatively or nonoperatively were identified. Concurrent injuries, subsequent surgeries, surgical chronicity, and MCL tear location were analyzed. Patient-reported outcomes were measured at time of ACL reconstruction and 2-year follow-up.

Results: Initially, 3028 patients were identified to have undergone primary ACL reconstruction during the time frame; 2586 patients completed 2-year follow-up (85%). Grade III MCL tears were documented in 1.1% (27/2586): 16 operatively managed patients and 11 nonoperatively treated MCLs during ACL reconstruction. Baseline KOOS and IKDC scores were lower in

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patients who underwent operative MCL treatment. Reoperation rates for arthrofibrosis were 19% after repair and 9% after conservative management, $p=0.48$. At 2 years, both groups significantly improved; however, the nonoperative MCL group maintained superior PROs in terms of MCID but these differences did not reach statistical significance (KOOS Sports Rec (88.2 versus 74.4, $p=0.10$), KOOS QOL (81.3 versus 68.4, $p=0.13$), and IKDC (87.6 versus 76.0, $p=0.14$)). Tibial-sided MCL injuries were associated with clinically inferior baseline scores compared with femoral-sided MCL (KOOS KRQOL 34.4 versus 18.5, $p=0.09$) but these differences resolved by 2 years. Surgical chronicity did not influence 2-year outcome.

Conclusions: Both operative and nonoperative management of MCL tears in our patient group demonstrated clinical improvements between study enrollment and 2-year follow-up. MCL surgery during ACL reconstruction was assigned to patient with worse symptoms at enrollment and was associated with worse outcomes at 2 years. A subset of patients with severe combined ACL and medial knee injuries may benefit from operative management; however, that population has yet to be defined.

Level of Evidence: Retrospective Cohort, Level 3

Introduction

The medial collateral ligament (MCL) and the anterior cruciate ligament (ACL) are the most commonly injured knee ligaments¹. While low grade sprains (defined as grades I and II) are common in athletic populations, complete tears of the MCL are rare events that are most commonly accompanied by ACL injury¹.

Low-grade MCL injuries are routinely treated nonoperatively.^{2, 3} Significant controversy exists in clinical practice and in the literature regarding the optimal treatment of high-grade (grade III) MCL injuries. The two most common treatment modalities in current practice are ACLR with nonoperative MCL management⁴⁻⁷ or surgical treatment of both ACL and MCL tears.⁸ Postoperative stiffness has been associated with operative repair of MCL injuries in conjunction with ACLR.⁹⁻¹² Decisions regarding acute or delayed surgery, choices between repair, reconstruction or nonoperative MCL management continue to be debated.¹³

Optimal treatment for complete ACL/MCL injuries is disagreed upon because of poor study quality in current literature, as assessed by Coleman methodology scoring,¹⁴ as well as injury infrequency. The purpose of the present study was to evaluate differences in repair and nonoperatively managed grade III MCL injuries during ACL reconstruction. We hypothesized that outcomes would be best with acute ACL reconstruction and operative management of MCL injuries would not influence outcome.

Methods

From an ongoing IRB-approved prospective longitudinal cohort study evaluating factors predictive of outcome after ACL injury, patients were identified who underwent unilateral primary ACLR between 2002 and 2008 at 7 centers by 17 surgeons with sports medicine fellowship training. Inclusion criteria for the study were an ACL tear and a grade III MCL tear. Patients were excluded if they also suffered bilateral knee injuries, a PCL tear, or a

posterolateral corner injury. All patients were indicated for ACL reconstruction, and the indication for MCL treatment was left to the treating surgeon. MCL repairs were performed with either suture anchors or staples, and MCL reconstructions were performed with soft tissue allografts. ACL reconstructions were performed at each enrolling surgeon's surgical preference.

After obtaining written informed consent, patients completed a 13-page questionnaire at time "zero" during enrollment (when surgery was indicated in the office), and then again at 2-year follow-up. This questionnaire allowed for collection of detailed demographic information, injury characteristics, previous and current therapy, comorbidities. This questionnaire also contained a series of validated outcome instruments, including the Knee Injury and Osteoarthritis Outcome Scores (KOOS),¹⁵ the International Knee Documentation Committee¹⁶ (IKDC) Subjective Knee Evaluation Form, and the Marx Activity Rating Scale¹⁷.

Also at the time of the index ACLR, surgeons completed a detailed questionnaire about the exam, observed pathology and treatment, and surgical technique utilized. Magnetic resonance imaging was used preoperatively to assess the MCL status. All examinations of the MCL were performed under anesthesia prior to ACLR. An MCL injury was assigned a complete "grade III" designation if the medial joint line exhibited laxity in full extension with valgus stress¹. No standardized radiography was used to assess for MCL injury grade.

Patients with operatively managed grade III MCL and ACL injuries were compared to patients who underwent ACLR and nonoperative grade III MCL management. The location of each patient's MCL injury was categorized by each surgeon upon operative findings. Categories included tibial, menisco-tibial, menisco-femoral, femoral, midsubstance/joint line and "not localized". For purposes of analysis, femoral-sided injuries were grouped together and tibial-sided injuries were grouped together. Injuries addressed within 30 days from the time of injury were considered acute, and after 30 days were considered delayed and the groups were compared. Concurrent injuries (to meniscus or articular cartilage) and subsequent surgeries were evaluated. Patient-reported outcomes were measured with KOOS, IKDC and Marx scores at time=0 and 2-year follow-up.

Statistical Analysis

Outcomes were compared between groups using univariate analysis including students t-test for continuous data elements and chi squared test for categorical data. Given the low incidence of grade III MCL injuries, we were not able to control for potential confounders with multiple comparisons or multivariate analysis. Significance was set to $p < 0.05$.

Results

3028 patients underwent primary ACLR in the group during the identified time frame, with 2586 patients completing 2-year follow-up (85%). In total, 221 (8.6%) patients were diagnosed with an MCL injury at the time of ACLR. There were 91 (3.5%) grade I MCL injuries, 103 (4.0%) grade II MCL injuries, and 27 (1.1%) grade III MCL injuries.

Of patients with complete (grade III) MCL and ACL tears, the median age was 24 years (mean 27.9, range 15-60). The mean body mass index (BMI) was 27.9 (range 19.2-39.0). No patient had undergone prior knee surgery. Medial meniscal tears were present in 11.1% (3/27) and lateral meniscal tears were found in 63% (17/27). Although all 27 patients who had grade III MCL tears underwent ACLR, 16 MCLs were managed operatively and 11 were managed nonoperatively. Of the 442 cases lost to follow-up, 0.9% (4/442) had grade III MCL injuries at the time of ACLR. Table 1 shows the demographics comparing those who had MCL repair and construction versus those who were not operatively managed at the time of ACL reconstruction.

Operatively Managed MCL Grade III Injuries with ACL Reconstruction

Of operatively addressed medial injuries there were 14 repairs, 1 autograft reconstruction and 1 allograft reconstruction. Concurrent cartilage pathology was common, as 75% (12/16) had meniscal tears and 50% (8/16) had chondral injuries (7 had lateral knee cartilage injury, 3 medial, 4 patellofemoral). The reoperation rate following combined ACL and MCL surgery was 25% (4/16), including 1 (1/16; 6.3%) that required reoperation for revision ACLR (at 2.5 years post-surgery) and 3 (3/16; 18.8%) that required reoperation for arthrofibrosis by their 2-year follow-up time point. The median time from injury to ACL surgery in this group was 33 days.

Nonoperatively Managed MCL Grade III Injuries with ACL Reconstruction

Concurrently, 11 patients underwent ACLR and nonoperative treatment of their grade III MCL tear. These patients were placed in a hinged knee brace for 6-8 weeks. Of these, 45.5% (5/11) had meniscal tears (all had lateral tears and 1 had bilateral tears). Chondral injuries were noted in 54.4% (6/11) patients (2 lateral knee cartilage injuries, 3 medial, 4 patellofemoral). Reoperation for arthrofibrosis occurred in one patient (1/11; 9.1%, $p=0.48$). The median time from injury to ACL surgery in the nonoperatively managed MCL group was 43 days. Concurrent meniscal or cartilage injuries did not differ between groups, and there was no difference in time from injury to surgery between the operative and nonoperatively managed MCL groups ($p=0.13$).

Patient-Reported Outcomes

Clinically important differences (8 points^{18, 19} on KOOS sub-scores) were noted in time zero (baseline) knee scores when operative and nonoperative MCL groups were compared. [Table 2] These scores were obtained from patients in the office at the time they were indicated for surgery. At time zero, the operatively managed MCL group had significantly lower scores than the conservatively managed group in terms of KOOS symptoms (46.4 versus 64.3), KOOS pain (65.8 versus 76.8), KOOS activities of daily living (ADL) (66.5 versus 77.1), KOOS sports/recreation (37.5 versus 50.0), and KOOS knee-related quality-of-life (KRQOL) (16.4 versus 44.3) subscales. At 2 years, patient-reported outcome scores were obtained on all 27 patients. At 2-year follow-up, KOOS symptoms, pain, and ADL scores were not clinically different between the operative and nonoperative MCL groups; however, KOOS sports/recreation (74.4 versus 88.2) and KRQOL (68.4 versus 81.3) subscales were found to be clinically superior in the conservatively managed MCL group at 2-year follow-up.

IKDC scores were clinically worse (>11.5 point difference) at the time of enrollment (32.7 versus 49.8) and at 2-year follow-up (76.0 versus 87.6) in the operatively managed group compared to the nonoperative group. Marx activity scores were equivalent at time zero (9.9 and 10.7); however, the operative group had lower activity level scores (mean 6.5) at 2 years compared to the nonoperative group (mean 10.7).

Location of MCL Injury

Classification of MCL injury location were available in 24/27 cases and grouped into proximal ($n=10$, femoral or menisco-femoral), distal ($n=11$, tibial or menisco-tibial) and midsubstance/joint line tears ($n=3$). Clinical outcomes were compared between femoral and tibial groups. [Table 3]

Patient-reported outcomes at time of study enrollment were lower for patients with tibial-sided MCL injuries in terms of KOOS ADL (61.9 versus 76.2), KOOS sports/recreation (37.5 versus 50.0), and KOOS KRQOL (15.9 versus 34.4). These differences did not reach clinical significance at 2-year follow-up. We found no difference in reoperation rates for knee stiffness when comparing the proximal and distal MCL groups. The rate MCL repair was not different between proximal and distal injuries, $p=0.8$. Tear location was not found to dictate surgical timing.

Acute versus delayed surgery

Surgical intervention for combined ACL and MCL injuries was assessed by injury chronicity. [Table 4] While enrollment scores were lower for acutely operated patients with regard to KOOS symptoms, pain, and ADL subscales, no differences in outcomes were observed according to surgical chronicity for combined ACL/MCL injuries at 2-year follow-up.

Discussion

Significant clinical improvements were seen following ACLR with nonoperative as well as operative management of MCL injuries at 2 years. Complete disruptions (grade III) of the MCL are rare in the setting of an ACL injury. This combined injury occurred in 1.1% of our patient group. We found that MCL repair or reconstruction was associated with (1) worse patient-reported outcomes and (2) lower activity levels compared to nonoperative MCL patients at 2-year follow-up. The MCL surgery group displayed worse functional scores at the time of study enrollment. Surgical chronicity was not associated with 2-year outcome. Distal MCL injuries were associated with worse patient-reported outcomes at the time of study enrollment but not at 2-year follow-up. Several of these findings warrant further discussion.

Operative versus Nonoperative MCL Treatment with ACL Reconstruction

Complete injuries to the MCL are rare during ACL injury and debate continues regarding optimal management. Prior to our report, there have been few comparative studies in the literature that have investigated outcomes following ACLR with and without MCL repair.^{10, 20, 21} The outcomes of patients in the present study may be more closely related to the

initial injury rather than the treatment effect. Noyes has previously reported worse outcomes with ACLR and MCL repair.¹⁰ Halinen et al randomized patients with acute combined ACL and grade III MCL tears to ACLR with or without MCL repair²⁰. They reported no difference between groups at 2-year follow-up and concluded that MCL repair may be unnecessary in this injury pattern. Surgical repair was performed between 4-23 days after injury; this is not common practice as most surgeons will allow time for MCL healing prior to intervention¹³. Further the results of this study may not be generalizable to younger athletic populations as Halinin's study was performed on patients with an average age of 39²⁰. This is a significantly older and less active group than the present study, and caution should be given to the generalizability of their data. Patients undergoing MCL repair for complete and incomplete injuries were compared to nonoperative MCL management and concurrent ACLR in a study performed by Hillard-Sembell. They determined that there was no difference in outcomes at final follow-up⁶. Shelbourne and Porter⁴ reported good to excellent outcomes after ACLR and nonoperative MCL management for combined injuries, and felt that complete MCL disruptions treated with ACLR alone have outcomes that approach isolated ACLRs.

Postoperative Stiffness after MCL Surgery

Operative management (repair or reconstruction) was associated with an 18.8% (3/16) rate of reoperation for stiffness compared to 9% (1/11) in the nonoperative group in our study, however this difference did not reach statistical significance. Similar findings have also been reported by Petersen et al⁹ who determined there was a 34% rate of motion loss following ACLR and MCL repair. Noyes et al in a prospective study determined that MCL repair during ACLR was a clinically significant risk factor for loss of knee motion following surgery.²² They determined that 22% of patients lost motion when ACLR was combined with MCL repair.²² Shelbourne and Porter⁴ reported a series of 16 patients with combined ACL and MCL injuries who underwent ACLR and MCL repair. They compared this consecutive patient group to a larger group of nonoperatively treated MCL tears who underwent ACLR alone. They concluded that 13 of the 16 patients treated with MCL repair had loss of motion when compared to the nonoperative MCL group where 9 of 68 underwent MUA and 5 of 68 underwent open scar excision to regain flexion. They also felt the outcomes of ACLR and nonoperatively managed MCLs approached that of isolated ACLRs.⁴ In Halinin's randomized study, the MCL repair group did take longer to regain motion, however no differences were appreciated at final follow-up.^{20, 23} Findings from the present study corroborate previous reports available in the literature, and patients should be counseled about postoperative stiffness and potential reoperation if MCL repair is indicated concurrently with ACLR.

Tear Location and Outcomes

The location of MCL tears has been correlated with a loss in post-operative range of motion and failure of nonoperative management in combined injury settings.^{21, 24} Robins et al²⁴ treated a series of 20 patients with ACLR and MCL repair. They concluded that proximal MCL repairs were associated with stiffness; of the 13 patients with MCL tears repaired proximal to the joint line, 5 patients required an additional 8 procedures to regain motion²⁴. Conversely, we found no difference between MCL tear location and loss of motion; instead,

we found that MCL surgery was associated with postoperative stiffness rather than tear location. Distal injuries had worse scores at the time of presentation in our series. These findings are corroborated by a study by Nakamura et al.²¹ who evaluated outcomes of complete MCL and ACL injuries; all patients (including grade II and III MCL injuries) were initially treated nonoperatively. All grade II injuries healed. Of the grade III injuries, all femoral MCL injuries treated nonoperatively went on to heal without complication. In contrast, all 5 complete tibial-sided injuries failed to heal and necessitated repair with advancement or reconstruction.²¹ These findings, coupled with our clinically relevant differences in patient-reported outcomes suggest that further exploration into the role of MCL repair should focus on tibial-sided injuries.

Interestingly, the operative MCL group started and finished the study with lower patient-reported outcomes and had similar improvements as the nonoperative group between injury and 2-year follow-up. Perhaps the “grade III” designation is not sensitive enough to detect differences in patients with complete ACL and MCL injuries, and the operative and nonoperative groups in our study may be different entities. This finding should be hypothesis generating and inquiry driving. Further studies defining the role of MCL repair or reconstruction during ACLR are warranted.

Limitations

Our study does have several limitations. First, our prospective observational patient group was subject to selection bias as surgeons across our multicenter group chose either to rehab the MCL or intervene operatively. We found that time from injury to study enrollment was similar between groups ($p=0.3$). The small numbers in our present study are a second limitation, however given that grade III MCL tears occur in about 1% of ACL injuries, the paucity of the injury is a limiting factor to study size. This does leave the data subject to type II error and it should be recognized that we may be underpowered to detect statistical differences between groups. Given the infrequency of this injury pattern, there were clinically significant differences in our analysis. Further, given the limited number of grade III MCL injuries available, we could not perform multivariate analysis. While several univariate analyses were utilized, we could not adjust for multiple comparisons.

However our data supports that operative intervention of the MCL should be considered with caution.

Conclusions

Both operative and nonoperative management of MCL tears in our patient group demonstrated clinical improvements between study enrollment and 2-year follow-up. MCL surgery during ACL reconstruction was assigned to patient with worse symptoms at enrollment and was associated with worse outcomes at 2-years. There may be a subset of patients with severe combined ACL and medial knee injuries that may benefit from operative management, however, that patient population has yet to be defined.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Demographics including age, sex, BMI, and current smoking status (at the time of surgery) comparing operatively treated MCL injuries and those treated nonoperatively at the time of ACL reconstruction. No significant differences were detected between groups.

MCL Repair/Recon		Nonoperative MCL	
Sex (% male)	53%	Sex	45%
Age	29.5	Age	26.6
BMI	28.4	BMI	26.8
Smoking	6%	Smoking	9%

Table 2:

A table comparing patient-reported outcomes at the time of enrollment and 2-year follow-up: a comparison is made between operative and nonoperative management of grade III MCL injuries. All patients had ACLRs. Patients with operatively managed MCL injuries had worse scores in terms of KOOS symptoms, pain, ADL, sports/recreation, KRQOL, and IKDC scores at the time of surgery. At 2 years, the operative group demonstrated clinically worse outcomes (KOOS = 8 points; IKDC = 11.5 points) in KOOS sports/recreation, KOOS KRQOL, and IKDC.

	Time 0 - Enrollment			2-Year Follow-up		
	Operative	Nonoperative	P	Operative	Nonoperative	P value
KOOS.Symptoms	46.4	64.3	0.07	79.0	86.7	0.18
KOOS.Pain	65.8	76.8	0.40	86.5	93.4	0.18
KOOS.ADL	66.5	77.1	0.53	91.9	96.8	0.30
KOOS.Sports Rec	37.5	50.0	0.44	74.4	88.2	0.10
KOOS.KRQOL	16.4	44.3	0.06	68.4	81.3	0.13
Marx	9.9	10.7	0.83	6.5	10.7	0.04
IKDC	32.7	49.8	0.14	76.0	87.6	0.14

Table 3:

A comparison of patient-reported outcomes as a function of MCL tear location: proximal (femoral sided) versus distal (tibial sided) injuries. KOOS ADL, sports/recreation and KRQOL subscales were significantly lower for distal MCL tears at the time of study enrollment. At 2-year follow-up, no clinically important differences in outcome were evident.

	<u>Time 0 - Enrollment</u>		<u>2-Year Follow-up</u>	
	Proximal	Distal	Proximal	Distal
KOOS.Symptoms	52.1	49.6	84.6	79.9
KOOS.Pain	69.7	67.2	91.9	87.6
KOOS.ADL	76.2	61.9	96.9	93.4
KOOS.Sports Rec	50.0	37.5	83.0	77.7
KOOS.KRQOL	34.4	15.9	75.6	69.3
Marx	11.2	11.1	11.1	8.1
IKDC	39.0	33.2	86.5	79.2

Table 4:

A comparison of enrollment and outcome scores comparing patients who had surgery within 30 days of injury (acute) versus after 30 days (delayed). While enrollment scores were lower for acutely operated patients with regard to KOOS symptoms, pain, and ADL subscales, no differences were detected at 2-year follow-up.

	<u>Time 0 - Enrollment</u>		<u>2-Year Follow-up</u>	
	acute	chronic	acute	chronic
KOOS.Symptoms	44.0	62.5	83.6	81.0
KOOS.Pain	60.0	78.5	89.4	89.3
KOOS.ADL	63.7	76.5	93.6	94.1
KOOS.Sports Rec	40.5	45.4	80.0	80.0
KOOS.KRQOL	27.1	28.3	73.4	73.8
Marx	9.7	10.6	9.5	7.4
IKDC	36.7	41.5	83.9	78.2