Surgical Outcomes of Medial Versus Lateral Multiligament-Injured, Dislocated Knees

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Purpose: To compare clinical and functional outcomes of surgically treated medial and lateral knee dislocations. **Methods:** A retrospective review of the medical records of patients who presented with knee dislocations was conducted. We identified patients who underwent surgical treatment of KDIII-M (anterior cruciate ligament/posterior cruciate ligament/medial collateral ligament) or KDIII-L (anterior cruciate ligament/posterior cruciate ligament/lateral collateral ligament) knee dislocation as documented by the Schenck classification. Minimum 2-year follow-up with Lysholm and International Knee Documentation Committee (IKDC) outcome scores was required for inclusion. Postoperative range of motion, ligamentous examination, and conversion to total knee arthroplasty were also collected. Data were analyzed using univariate and multivariate statistical models with $P < .05$ considered significant. **Results:** A total of 56 patients met the inclusion criteria, 24 with the KDIII-M injury pattern (43%) and 32 with the KDIII-L injury pattern (57%), with a mean age of 34 years (range, 16 to 62 years) and a mean follow-up of 6.5 years (range, 2 to 20 years). Patients undergoing medial repairs had worse outcomes for both the Lysholm score ($P = .008$) and IKDC score ($P = .003$). In addition, female sex was linked to worse outcomes (Lysholm score, 58.8 ± 21.5 *v* 77.8 ± 21.1, $P < .01$; IKDC score, 54.9 ± 23.7 *v* 75.2 ± 20.2, $P < .01$). No differences in outcome were found between patients with and patients without peroneal nerve injury (Lysholm score, $P = .81$; IKDC score, $P = .77$). No difference in laxity testing was found between the 2 groups. **Conclusions:** In patients undergoing multiligament knee reconstruction, our data suggest that those who undergo medial repair for knee dislocations are not as likely to achieve positive results as those who undergo reconstruction or lateral reconstruction/repair, regardless of the status of the peroneal nerve. In addition, medial reconstruction had comparable outcomes to those in patients treated with lateral reconstruction/repair. Lastly, female patients showed less favorable clinical outcomes than male patients. **Level of Evidence:** Level III, retrospective comparative study.

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The multiple ligament–injured knee is a complex problem in orthopaedic surgery, with ideal treatment remaining controversial.[1,2] Schenck[3] has published a classification system for multiple-ligament knee injuries including KDIII-M (anterior cruciate ligament [ACL]/posterior cruciate ligament [PCL]/medial collateral ligament [MCL]) and KDIII-L (ACL/PCL/lateral collateral ligament [LCL]). Both KDIII-M and KDIII-L injuries present an increased risk of vascular injury, and for KDIII-L injuries, the risk of neurologic injury is increased because of stretching of the peroneal nerve.[3-7] In addition to the heightened risk of concomitant neurovascular injury in either type of knee dislocation, articular cartilage and meniscus damage may lead to post-traumatic arthritis.[8-10]

Many isolated MCL injuries can be successfully managed nonoperatively, but those associated with a knee dislocation may require repair or reconstruction. Repair has shown promising results in the acute setting; however, reconstruction has recently been proved superior to repair in the literature.[11-14] The primary concerns in KDIII-M dislocations are the risk of vascular injury, including popliteal artery injury and knee

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The authors report the following potential conflict of interest or source of funding: A.J.K. receives support from Arthrex, Arthritis Foundation, and Histogenics. M.J.S. receives support from Arthrex, Stryker, and USA Hockey Foundation. B.A.L. receives support from Clinical Orthopaedics and Related Research, *Arthrex, National Institutes of Health, and VOT Solutions.*

Received June 16, 2015; accepted January 20, 2016.

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0749-8063/15555/$36.00

http://dx.doi.org/10.1016/j.arthro.2016.01.038

stiffness, especially in female patients because of an increased rate of heterotopic ossification.[11,12,15,16]

KDIII-L injuries are frequently a result of a high-energy trauma resulting in a combined hyperextension and varus force.[17] Peroneal nerve injury rates have been reported to range from 14% to 40%, with only modest recovery rates of 31% to 75%.[18-23] For lateral injuries, similar to injuries on the medial side, recent studies have favored reconstruction over repair, citing increased stability and lower failure rates.[24,25] Optimal surgical timing remains controversial. Outcomes have been improved with early surgical management for both repairs and reconstructions because identification of the anatomic structures is easier before scar formation occurs.[26] On the other hand, Owens et al.[27] found a higher rate of postoperative knee stiffness with early surgery.

Previous studies have reported the clinical results after knee dislocation; however, there is a paucity of data in the literature comparing the outcomes of medial- versus lateral-sided knee dislocations. Therefore, we designed a study to evaluate the outcomes of treatment for KDIII-M and KDIII-L knee dislocations. The purpose of this study was to compare clinical and functional outcomes of surgically treated medial and lateral knee dislocations. We hypothesized that KDIII-L dislocations would have worse outcomes because of the increased risk of associated peroneal nerve injury.

Methods

Study Design

A retrospective review of a prospectively gathered database of patients who presented with a multiligament-injured, dislocated knee was conducted. All patients gave written consent to participate in the study before inclusion in our database, and the study was approved by our institutional review board (IRB No. 07-004018). Patients were assessed by sports medicine fellowship–trained orthopaedic surgeons (A.J.K., M.J.S., B.A.L.). Classifications of injuries were based on ligamentous damage using the modified Schenck classification system.[3]

Inclusion and Exclusion Criteria

The study population of interest included only patients with KDIII-M (ACL/PCL/MCL) and KDIII-L (ACL/PCL/LCL) dislocations.[3] All patients underwent primary surgery between 1992 and 2012 for treatment of a knee dislocation by 2 experienced orthopedic surgeons (B.A.L. and M.J.S.). The diagnosis was confirmed with a physical examination, preoperative imaging, and intraoperative findings.

Patients were excluded if they had a history of major ipsilateral knee surgery and less than 2 years' follow-up. Peroneal nerve status was evaluated by previously reported methods.[28] Complete disruption consisted of tibialis anterior strength of 0 of 5 and extensor hallucis longus strength of 0 of 5. The patients also had complete sensation loss. Partial recovery was defined as improvement in at least 1 of the following measures: tibialis anterior strength, extensor hallucis longus strength, or sensation.

Surgical Technique

ACL Reconstruction. All patients underwent an arthroscopic-assisted single-bundle ACL reconstruction. Fixation was achieved using suspensory fixation on the femoral side and a bioabsorbable interference or metal screw on the tibial side. When necessary, secondary fixation was achieved with either a washer-post construct or a staple.

PCL Reconstruction. A transtibial-tunnel, single-bundle anterolateral PCL reconstruction with Achilles tendon allograft technique was used in all patients. An inside-out drilling technique was used for femoral tunnel placement. A metal interference screw was used for bone-to-bone fixation on the femoral side. Tibial-sided fixation was achieved with a bioabsorbable interference screw. Secondary fixation was achieved with a washer-post construct in all patients.

MCL/Posteromedial Capsule Repair. Either a distal or proximal attachment-site incision was used depending on the injury pattern. The superficial and deep portions of the ligament were identified at the tibial/femoral attachment site and reattached to their anatomic sites by suture anchors and/or a unicortical or bicortical screw with a washer-post construct.

MCL/Posteromedial Capsule Reconstruction. An open anatomic MCL reconstruction using an Achilles tendon allograft along with direct repair of all associated medial and posteromedial structures was used in all patients. An incision was made medial to the tibial tubercle to allow exposure of the superficial MCL insertion sites. The femoral site was then exposed by making a longitudinal incision over the medial epicondyle. The isometric point was found using both anatomic and radiographic landmarks, as described by Wijdicks et al.[29,30] A guidewire with suture wrapped around it was then inserted, and the knee was cycled through flexion and extension to verify isometry. The femoral socket was drilled to a depth of 20 mm, and the Achilles bone block was secured with interference screw fixation. On the tibial side, the Achilles tendon was secured with both suture anchors to secure the proximal tibial insertion of the superficial MCL and then a screw and washer-post

construct for the distal side. The posteromedial capsule was repaired by placing 2 to 3 suture anchors on the medial femoral condyle with mattress sutures tied in full extension. Alternatively, the capsule was imbricated in a "pants-over-vest" fashion with horizontal sutures.

Fibular Collateral Ligament/Posterolateral Capsule Repair. After incision, the peroneal nerve was dissected, identified, and protected. The fibular collateral ligament was reattached to the proximal or distal attachment sites with suture anchors. In addition, the popliteus tendon was attached to its anatomic location on the distal femur with suture anchors. The posterolateral capsule was then imbricated distally and anteriorly if indicated.

Fibular Collateral Ligament/Posterolateral Capsule Reconstruction. Patients underwent reconstruction with a single Achilles tendon with bone allograft. The bone plug was secured by a metal interference screw on the femoral side in line with the popliteal sulcus. The graft was then passed posterior to anterior through a fibular tunnel and looped back proximal and posterior to the lateral epicondyle on the femur. The isometric point was visualized through anatomic and radiographic landmarks as described by Pietrini et al.[31] A guidewire was inserted and suture was wrapped around it. After cycling of the knee through flexion and extension, the soft-tissue portion of the graft was secured with a bioabsorbable interference screw on the femur. Finally, the posterolateral capsule was shifted distally and anteriorly.

Postoperative Rehabilitation

A rehabilitation program reported by Edson[32] and Fanelli et al.[33] was used for all patients undergoing multiligament knee surgery. The knee remained in full extension for the first 3 weeks, and then progressive knee range of motion was begun. At 6 weeks postoperatively, patients were allowed to begin weight bearing. Patients who underwent staged reconstructions were kept in a hinged knee brace. Radiographs were taken to confirm the absence of posterior subluxation. Return to sport typically began at 8 to 12 months postoperatively. Use of a valgus unloader brace was encouraged for up to 1 year after surgery.

Functional and Clinical Assessment

All patients completed the Lysholm and International Knee Documentation Committee (IKDC) questionnaires at 12, 24, 60, and 120 months. Ligamentous examinations included the Lachman and posterior drawer tests, along with varus and valgus stress testing at 0° and 30°. Additional outcomes collected included conversion to total knee arthroplasty and range of motion at final follow-up. Any patient who did not return for follow-up was contacted directly by phone or mail for current outcome scores. All patients were contacted by phone to inquire if they underwent any further surgery on the affected knee.

Table 1. Summary of Data Collected

Factors for comparison
Knee dislocation type: KDIII-M *v* KDIII-L
Surgical technique: repair *v* reconstruction
Status of peroneal nerve: intact *v* disrupted
Time from injury to surgical intervention
Patient sex
Patient age
Outcomes studied
IKDC score
Lysholm score
Conversion to TKA
Postoperative range of motion

IKDC, International Knee Documentation Committee; KDIII-L, anterior cruciate ligament/posterior cruciate ligament/lateral collateral ligament; KDIII-M, anterior cruciate ligament/posterior cruciate ligament/medial collateral ligament; TKA, total knee arthroplasty.

Statistical Analysis

Comparisons of patient characteristics between the KDIII-M and KDIII-L groups were conducted using both univariate and multivariate statistical methods (Table 1). Independent sample *t* tests were used for continuous variables and the Fisher exact test for categorical variables. Outcome scores used for comparisons were those obtained at final follow-up for each patient. A Wilcoxon χ^2 analysis was used to compare outcome scores (IKDC and Lysholm) between groups. $P < .05$ was considered significant.

To determine independent predictors of outcome scores, multivariate analysis was performed. A linear regression model with backward selection was used. Furthermore, an analysis of variance was used to determine differences in surgical technique. All analyses were completed using JMP statistical software (version 7; SAS Institute, Cary, NC). An a priori power analysis determined a total sample size of 52 was necessary to detect a relevant difference of at least 9 points in IKDC scores with a power of 0.80 and significance level of .05.[34]

Results

Eighty-four patients initially met the inclusion criteria. Eleven patients were excluded because of prior surgery on the affected knee. Seventeen patients (23%) were lost to follow-up, resulting in a total of 56 patients (24 KDIII-M and 32 KDIII-L) at last follow-up. Twenty-four patients (15 male and 9 female patients) with an average age of 37.3 years (range, 16 to 57 years) presented with a KDIII-M dislocation. Thirty-two patients (23 male and 9 female patients) with an average age of 31.2 years (range, 16 to 62 years) presented with a

Table 2. Patient Demographic Data

Baseline Characteristic	KDIII-M	KDIII-L	*P* Value
Sex, n	23 M and 9 F	15 M and 9 F	.230
Age, yr	31.2 ± 10.8	37.3 ± 12.2	.063
Follow-up, mo	78.3 ± 60.4	76.1 ± 58.9	.892
Time from injury to surgery, mo	9.8 ± 23.3	7.2 ± 15.0	.635
Surgical technique, n	26 reconstruction and 6 repair	19 reconstruction and 5 repair	.423

NOTE. Data are presented as mean ± standard deviation unless otherwise indicated.

F, female; KDIII-L, anterior cruciate ligament/posterior cruciate ligament/lateral collateral ligament; KDIII-M, anterior cruciate ligament/posterior cruciate ligament/medial collateral ligament; M, male.

KDIII-L dislocation. Patients were followed up for a mean of 6.5 years (range, 2 to 20 years) after surgery.

For the Lachman test, the mean displacement was 0 mm in the KDIII-M group and 0.03 mm in the KDIII-L group ($P = .32$). For the posterior drawer test, the mean measurements were 0.55 mm for the KDIII-M group versus 0.62 mm for the KDIII-L group ($P = .80$). Of the patients in the lateral group, 5.4% had grade 1 varus laxity at full extension and grade 2 varus laxity at 30°. For the medial group, 0% of patients had valgus laxity at full extension, but at 30° of flexion, 13.3% had grade 1 laxity and 6.7% had grade 2 laxity. There was no significant difference in the proportion of patients who had laxity between the medial and lateral groups either at full extension ($P = .67$) or at 30° of flexion ($P = .20$).

An associated peroneal nerve injury occurred in 12 patients in the KDIII-L group (38%): 3 (25%) had a complete recovery, 6 (50%) had a partial recovery, and 3 (25%) showed no recovery from peroneal nerve injury. Lateral-sided repair was performed in 6 patients (19%) and reconstruction in 26 patients (81%). Medial-sided repair was performed in 6 patients (21%) and reconstruction in 19 patients (79%). No statistical differences were found between groups with respect to age, sex, or length of follow-up (Table 2).

Table 3. Univariate Analysis of KDIII-M *v* KDIII-L Outcomes

Outcome	KDIII-M	KDIII-L	*P* Value
IKDC score	62.1 ± 22.2	73.7 ± 23.1	.03
Lysholm score	64.7 ± 21.0	76.9 ± 23.1	.04
ROM, °	121 ± 15	128 ± 11	.04
Conversion to TKA, n	3 of 32 (13%)	1 of 24 (3%)	.21

NOTE. Data are presented as mean ± standard deviation unless otherwise indicated.

IKDC, International Knee Documentation Committee; KDIII-L, anterior cruciate ligament/posterior cruciate ligament/lateral collateral ligament; KDIII-M, anterior cruciate ligament/posterior cruciate ligament/medial collateral ligament; ROM, range of motion; TKA, total knee arthroplasty.

Table 4. Multivariate Analysis of Linear Regression Model With Backward Selection Using International Knee Documentation Committee Outcome Scores

Variable	Standardized Regression Coefficient (B)	*P* Value
Sex	−0.420	.002
Surgical technique	−0.394	.003

Univariate statistical analysis showed that patients in the KDIII-M group had decreased range of motion at final follow-up compared with the KDIII-L group (121° ± 15° *v* 128° ± 11°, $P = .04$). KDIII-M injuries were also associated with lower Lysholm scores (64.7 ± 21.0) compared with the KDIII-L group (76.9 ± 23.1, $P = .04$). In addition, IKDC scores were significantly lower in the medial group (62.1 ± 22.2 *v* 73.7 ± 23.1, $P = .04$). Medial-sided repair was inferior to all other surgical techniques ($P = .01$) (Table 3). The other techniques (medial reconstruction, lateral repair, lateral reconstruction) were all found to have similar results ($P = .89$). Female sex was linked to an inferior outcome for both outcome scores when the 2 groups were combined (Lysholm score, 58.8 ± 21.5 *v* 77.8 ± 21.1, $P < .01$; IKDC score, 54.9 ± 23.7 *v* 75.2 ± 20.2, $P < .01$). Peroneal nerve involvement in the KDIII-L group had no effect on outcome according to both the Lysholm score (77.0 ± 23.9 *v* 76.7 ± 22.6, $P = .81$) and IKDC score (74.0 ± 25.3 *v* 73.1 ± 19.9, $P = .77$).

Multivariate analysis showed only 2 independent predictors of decreased Lysholm and IKDC scores (Tables 4 and 5). Those factors were female sex and medial-sided surgical repair.

Additional Surgery

Lastly, 3 patients in the KDIII-M group (13%) and 1 patient in the KDIII-L group (3%) underwent conversion to total knee arthroplasty at a mean of 7 years (range, 3 to 10 years) postoperatively. No differences in conversion to total knee arthroplasty were observed between groups ($P = .21$). Outcome scores were obtained before any arthroplasty procedures and were therefore reflective of the multiligament reconstruction operation.

Discussion

In 56 patients undergoing multiligament knee reconstruction (24 KDIII-M and 32 KDIII-L), medial repairs were found to be a negative predictor of both IKDC score and Lysholm score. Medial reconstructions

Table 5. Multivariate Analysis of Linear Regression Model With Backward Selection Using Lysholm Outcome Scores

Variable	Standardized Regression Coefficient (B)	*P* Value
Sex	−0.391	.003
Surgical technique	−0.350	.008

were comparable to lateral repairs and lateral reconstructions. In addition, female patients showed inferior results compared with male patients.

Knee dislocations are devastating and potentially limb-threatening injuries with complications of popliteal artery disruption, peroneal nerve injury, and arthrofibrosis. Although recent data have compared reconstructed and/or repaired KDIII and KDIV injuries,[15] there is currently a paucity of data comparing medial versus lateral surgically treated knee dislocations. Therefore, we designed a study to evaluate the outcomes after operative treatment of KDIII-M and KDIII-L injuries. We found that some patients with KDIII-M dislocations have inferior results when compared with patients with KDIII-L dislocations. After multivariate analysis, it was clear that medial-sided repairs had significantly worse outcomes than medial reconstructions, lateral repairs, and lateral reconstructions, which were all similar in outcome.

In addition, female patients showed inferior outcomes to male patients. The inferior outcomes reported may be because of increased stiffness in the KDIII-M dislocations and the insignificance of peroneal nerve disruption in the KDIII-L group. Our finding that the status of the peroneal nerve does not affect outcome scores matches the conclusions of Krych et al.[19] In their matched, controlled series, similar functional outcome scores were found between 20 patients with peroneal nerve injury and 20 patients without nerve injury for both IKDC and Lysholm scores. This finding may be explained by the fact that current patient-reported outcome scores do not reflect peroneal nerve injury status.

Several recent studies have examined the effects of ligament repair versus reconstruction. Repairs were evenly distributed throughout our study. We found a significant decrease in outcomes for medial repair when compared with lateral repair, lateral reconstruction, and medial reconstruction. This finding agrees with the findings of Stannard et al.,[12] who reported a 20% failure rate in 25 knees undergoing medial repair but only a 4% failure rate in 48 reconstructed knees. These results were attributed to better stability after reconstruction procedures that restored the integrity of the MCL, posterior oblique ligament, and semitendinosus.

Our results showed that female patients have inferior outcomes when compared with male patients. Previous knee dislocation reports similarly showed a mean Lysholm score of 55 for female patients and 85 for male patients.[15]

Limitations

This study has a number of limitations including differences in surgical techniques and a small sample size. The study period of 20 years is a potential limitation because surgical techniques have evolved over time. To account for this, we stratified surgical techniques for repair versus reconstruction of medial and lateral structures. In addition, no differences were found in time from injury to surgery between the 2 groups. Our small sample size of 56 patients and the loss of 17 patients (23%) to follow-up limit conclusions. It is possible that the patients lost to follow-up could have inferior outcome scores compared with those who were available for follow-up. Finally, the lack of baseline scores makes it difficult to ascertain change from each patient's preoperative function and knee stability. However, this study provides important information for surgeon decision making and patient counseling on the expected surgical outcomes of knee dislocation.

Conclusions

In patients undergoing multiligament knee reconstruction, our data suggest that those who undergo medial repair for knee dislocations are not as likely to achieve positive results as those who undergo reconstruction or lateral reconstruction/repair, regardless of the status of the peroneal nerve. In addition, medial reconstruction had comparable outcomes to those in patients treated with lateral reconstruction/repair. Lastly, female patients showed less favorable clinical outcomes compared with male counterparts.

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