Repair of Medial Collateral Ligament Injury During Total Knee Arthroplasty

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abstract

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Intraoperative midsubstance lacerations of the medial collateral ligament (MCL) must be addressed during surgery, and failure to obtain coronal plane stability could affect patient outcomes and satisfaction. This article reports our results of a series of patients who sustained an intraoperative MCL injury during a primary total knee arthroplasty and were treated by direct primary repair and no change in implant constraint or post-operative protocol.

Over a 5-year period, 9 patients sustained this complication. We reviewed their subjective satisfaction and stability, as well as objective measures such as functional scores, physical examinations, and radiographs. Average patient age was 58 years, and mean patient body mass index was 43.3. All patients were satisfied with the procedure and demonstrated no instability on physical examination. Average Knee Society pain score was 91.5 and functional score was 73.3. No radiographic changes or signs of loosening were noted. This novel approach for intraoperative midsubstance lacerations of the MCL does not involve altering implants or postoperative protocols and has encouraging results.
The superficial medial collateral ligament (MCL) is essential to providing stability for valgus stress after a total knee arthroplasty (TKA).\(^1,2\) Although this complication has been reported to be rare, it is typically a surgeon-controlled factor that could significantly affect an implant’s overall longevity. Traditionally, authors have recommended increasing the level of constraint to offset the loss of soft tissue tension, but this could result in decreasing the life of the prosthesis without a consensus that it is necessary to ensure successful results.\(^3\) The MCL can be disrupted as a result of chronic attenuation found in valgus knees or iatrogenically by either excessive valgus force or being directly cut while making bony resections.\(^4,5\) Treatment involves making intraoperative decisions on whether to primarily repair or augment the ligament, and whether an implant with greater constraint is necessary to obtain stability. In addition, the surgeon must decide whether the postoperative protocol needs to be altered to allow healing of the medial soft tissue structures.

This article reports our results of 9 patients who sustained an intraoperative laceration of the superficial MCL that was noted during surgery and their subsequent outcomes. Objective knee function scores were compared with prospectively obtained results found in the literature and physical examination and radiographic results. Subjective patient results and level of satisfaction and activity were obtained.

**Materials and Methods**

Institutional Review Board approval was obtained prior to performing this study. We retrospectively reviewed all patients who underwent primary TKA between 2005 and 2010 to find those who had sustained an intraoperative iatrogenic midsubstance MCL laceration. Nine (0.8%) patients of 1105 experienced this complication. The patients included 7 women and 2 men with an average body mass index (BMI) of 43.3 kg/m\(^2\) (range, 29.1-55.7 kg/m\(^2\)). Five right and 4 left knees were involved. Minimum follow-up was 22 months. One patient was too ill to return for follow-up but was able to discuss his results via telephone. All patients had a diagnosis of osteoarthritis.

All surgeries were performed by 1 surgeon (J.P.). The knee was approached through a standard medial parapatellar approach, and a medial soft tissue release was performed with a curved osteotome, making sure to not disrupt the insertion of the MCL on the tibia. Bony cuts were made for a cruciate-retaining femoral component, typically using a measured resection technique. The injury was identified by direct visualization and palpation, as well as indirectly by valgus stress.

The ligament was repaired with a modified Becker stitch using a #5 Ethibond suture (Ethicon, Somerville, New Jersey) with a free needle (Figures 1, 2). The implant trials were removed, and 2 sutures were placed through the proximal portion of the MCL. The trial implants were reinserted to help determine appropriate medial tension and reapproximation (Figure 3). Once it was established that the repair could obtain good opposition with appropriate tension, the femoral, tibial, and final polyethylene components were implanted. The sutures were then passed through the distal portion. The knee was placed in 30° of flexion, and tension was held on 1 strand while the other was tied. The tension and repair could then be scrutinized by final testing prior to incision closure (Figure 4).

The same implant (PFC Sigma; DePuy, Warsaw, Indiana) was used for all patients without the use of additional constraint, including posterior stabilization. Postoperatively, patients were allowed to be fully weight bearing with full range of motion (ROM) of the operative knee. No bracing was used, and standard postoperative protocol was followed.

Patients were followed at regular intervals and seen at 2 and 6 weeks, 3 months, and 1 and 2 years. Eight patients were available for follow-up. Knee Society scores for pain and function were obtained. Two patients who underwent revisions for unrelated causes were excluded from the results of this study. A physical examination was performed to test ROM, as well as a ligamentous examination. Patients were asked to rate their satisfaction. Radiographs were reviewed by the senior author (J.P.) to determine if any loosening or radiographic changes were present.

**Results**

The 6 patients who were able to return for an office visit and did not undergo a revision procedure were well-functioning and subjectively satisfied with the outcomes of their procedures. Four patients were extremely satisfied with their results and 2 were very satisfied. No patient was unsatisfied. Three patients reported mild or occasional knee pain, and 3 reported none. The 6 patients would all recommend the procedure and consider undergoing it again.
Knee Society pain and function scores averaged 91.5 and 73.3, respectively. Physical examination of the affected knee demonstrated a ROM of 0° to 120.5° and stability to varus, valgus, and anteroposterior (AP) stress testing. Polyethylene thickness averaged 10.4 mm. Radiographs showed no signs of component position change, loosening, or malalignment.

Two of the original 9 patients underwent revision procedures. The first patient obtained a late infection 1 year after his index procedure and had a stable examination to varus and valgus stressing. The second revision was a result of patella avascular necrosis and was also unrelated to MCL disruption. This patient had a stable ligamentous examination on follow-up. One patient was too ill to follow-up but described his knee as asymptomatic via telephone interview and reported that he was satisfied with the procedure and would undergo it again.

**DISCUSSION**

Iatrogenic disruption of the MCL is a known complication of TKA that can affect patient outcome and satisfaction. The superficial MCL femoral attachment is approximately 1 cm anterior and distal to the adductor tubercle and consists of vertical and oblique fibers that coalesce with the anterior tibia approximately 4.5 cm distal to the medial joint line. The superficial MCL was reported to be the primary restraint to valgus forces by Wymenga et al, who transected the ligament and showed a medial joint line opening of 3 to 5 mm with valgus stress. The roles of 2 fiber orientations that work in concert with each other were illustrated by Whiteside, who systematically released the anterior fibers first, allowing greater laxity in increasing degrees of flexion, and then the posterior fibers, producing greater laxity in extension. The deep MCL consists of capsular extensions, is typically released during exposure of the posteromedial corner of a varus knee, and is considered a secondary restraint to valgus forces.

Release of the MCL in multiple cadaveric studies has shown an increase in the medial gap space, which is twice as much in flexion as it is in extension. In attempting to balance a TKA with a medial deficiency, it is difficult to catch up to the medial flexion gap laxity. This often leads to thick polyethylene components and lateral soft tissue releases in the unrecognized cases.

Nonoperative management of isolated MCL sprains has become the standard of care, and the typical injury pattern in a native knee results from avulsion of the femoral origin. Early rehabilitation is encouraged, and the patient is placed in a hinged knee brace to allow full ROM and weight bearing while protecting the medial soft tissue structures. This treatment has resulted in early return to preinjury activity with no long-term functional concerns. Thornton et al further supported this by reporting that early motion was safe and resulted in biomechanically stronger healing in a rabbit model.

Protecting the MCL is an essential aspect of TKA and involves careful placement of retractors and meticulous care in soft tissue handling and bony resections. Patient factors such as body habitus and preexisting deformity can play a role in disrupting the MCL. Winiarsky et al reported on the higher rate of perioperative complications seen in morbidly obese patients, and in addition to wound complications and infections, 8% of patients sustained avulsions of the MCL compared to none in the control group. They recommended early removal of medial osteophytes to relieve tension on the MCL. In addition to body habitus, overall alignment of the limb can result in attenuation of the medial structures in a valgus-oriented knee. Being aware of the soft tissue is also essential to protecting ligamentous structures during the bony resections. Dimitris et al reported that standard oscillating saw blade excursion exceeds the width of the medial and lateral femoral condyles, placing the collateral ligaments at risk, whereas a narrow blade would not exceed the width of either condyle.

Previous literature recommended the use of more constrained implants to restore coronal plane stability if the MCL was deemed incompetent or disrupted during the procedure. However, increasing the level of constraint can result in various concerns that a surgeon must take into consideration before selecting this type of implant. Condylar constrained prosthetic designs increase the stresses on implant fixation, which can play a role in aseptic loosening. This problem can be magnified by the additional bone loss.
incurred at the index procedure due to increasing the depth of bony cuts necessary to fit the more prominent intercondylar post, as well as the need for the use of a stem in most constrained prosthetic designs. In addition to needing larger bone cuts to accommodate its size, the taller tibial polyethylene can potentially fracture from the additional stresses placed on it, or can be an additional source of polyethylene wear. More recent studies involving the second-generation constrained condylar prosthesis have shown excellent results at 5 years, although additional concerns seen with increased constraint may still be problematic during longer-term follow-up. Furthermore, the addition of a posterior cruciate ligament (PCL)-substituting implant does not provide the same ability as the native PCL to provide a secondary stabilizer; Saeki et al reported that in the presence of a disrupted MCL, the PCL-substituting implant provided no valgus stability in any degree of flexion.

Recent research has attempted to apply the successful results of the nonoperative treatment of MCL tears in the native knee to TKA patients. Koo and Cho retrospectively studied the clinical and radiographic results of 15 primary TKAs complicated by avulsion of the tibial insertion of the MCL. These patients were not treated with any changes in level of constraint or postoperative bracing and were followed for 2 years. Eleven of the 15 complications occurred during bilateral procedures, and no difference in functional scores, subjective instability, or changes in valgus stress radiography were found between the 2 sides. Standing AP radiographs demonstrated increased valgus on the disrupted side, although patients were divided on which knee they subjectively preferred. The authors concluded that intraoperative avulsion of the MCL did not need conversion to a constrained prosthesis, primary repair or reconstruction of the ligament, or postoperative bracing.

Leopold et al retrospectively reported on 16 (2.7%) knees of 600 that had avulsions or midsubstance tears. Twelve of the injuries were midsubstance lacerations of the ligament. Patients with measurable valgus on preoperative radiographs were excluded to eliminate patients with incompetent medial soft tissue structures. The avulsions were treated with suture anchor reattachment, whereas the midsubstance tears were repaired with direct primary repair consisting of interrupted, nonabsorbable, heavy braided sutures. All patients were allowed to fully bear weight with unrestricted motion in a hinged knee brace for 6 weeks. Aside from the knee brace, no changes in postoperative protocol were noted. Twelve of the knees had unconstrained implants and 4 had posterior-stabilized implants. Mean body mass index was 32.5, with 3 patients being classified as morbidly obese. No patient required bracing for longer than 6 weeks or demonstrated any objective or subjective laxity. At 45 months, no patient required revision surgery, and 1 underwent manipulation. The authors concluded that primary repair or reattachment of the MCL could be obtained in a knee without preexisting valgus to restore stability and allow the use of an unconstrained total knee prosthesis.

Lee and Lotke retrospectively reviewed patients who underwent primary TKA over a 6-year period and found an iatrogenic intraoperative injury to the MCL in 2.2% of patients. They excluded all patients with prior MCL injuries or valgus deformity; 28 patients had transection of the ligament and 9 had intraoperative avulsion of the ligament. They attempted to repair the ligament in 14 patients and increased the level of constraint in 30 of 37 patients. Postoperatively, they allowed early motion and immediate weight bearing in patients treated with increased constraint but casted patients treated with repair and an unconstrained prosthesis. Average follow-up was 54 months. They found that patients who had the MCL disrupted had lower Knee Society scores compared with the uninjured controls but that the gap was decreased by looking at the subset of patients with increased constraint. Four of the 7 patients treated with repair alone were revised for instability, compared with none of the 30 patients treated with additional constraint. They concluded that recognition of the intraoperative MCL injury is crucial to prevent residual instability.

In addition to primary repair, Jung et al reported their technique and results of 5 patients whose transected MCL was augmented with a partial-thickness quadriceps tendon free graft. Patients were placed in a hinged knee brace with free ROM for the first few weeks, and weight bearing was restricted. Their patients demonstrated an average Knee Society clinical score of 87 and functional score of 85, no patients reported subjective instability, and no objective instability was seen at examination. No complications were noted with the extensor mechanism donor site. The authors felt that this could be used as an alternative for midsubstance tears with poor tissue quality, suspicion of stretching, or a small remaining gap.

Proper TKA balancing relies on appropriate soft tissue tension provided by intact collateral ligaments. Loss of the medial soft tissue structures such as the MCL can result in instability and accelerated wear, necessitating the need for a revision. Currently, no specific recommendations have been universally agreed on for this situation. Most studies are retrospective with various repair techniques, levels of constraints, and postoperative protocols, even in individual studies. This is further complicated by the spectrum of injuries that can affect the MCL, such as a preexisting valgus deformity resulting in incompetent medial soft tissue structures or an MCL avulsion or laceration. Each of these situations should be treated independently, and results cannot be grouped together since lacerations may not have the same healing capabilities as avulsions. Furthermore, most studies have obtained short- to mid-term follow-up, making long-term implications of increasing pros-
thetic constraint unclear for overall implant survival.

We focused our study on the retrospective results of an iatrogenic midsubstance MCL disruption and found that at 2-year follow-up, the patients had comparable functional scores to those found in the literature involving primary TKA. The average Knee Society scores we obtained for pain (91.5) and function (73.3) were higher than those found by Lee and Lotke, who noted average scores of 81 for pain and 74 for function for all MCL-injured TKAs. Patients were subjectively satisfied with their results and noted no instability. We demonstrated that objectively, patients’ physical examinations showed no signs of instability, and the patients obtained full ROM. Radiographs showed no signs of component loosening or malposition. No complications were directly related to this treatment, and no further surgeries for instability or stiffness were necessary in any patient.

The 2 revisions were not the result of the MCL disruption, but instead an infection and patella complication. The patient who was unable to follow up was reached via telephone and reported no complications or instability. Two of the 6 patients who followed up and did not have a revision had a BMI <40, which supported previous studies that demonstrated a higher complication rate in the morbidly obese. Also, by using an average polyethylene thickness of 10.4 mm, we were able to adequately retention the medial side without relying on an increased polyethylene size to fill the larger medial joint gaps seen in an MCL-deficient knee.

A limitation of our study was its retrospective nature. Although the patient population was small, taking into account the rarity of this complication and the fact that most studies include a full spectrum of MCL injuries, it is a large sample size for this specific injury. It would be beneficial to see longer-term follow-up because loosening of the bone cement or cement prosthesis interface is typically not demonstrated in the short term. However, this should not be a concern because all patients were stable to ligamentous stress on physical examination, and any issues with instability would be noted during short-term follow-up.

Another limitation of this study was the lack of a control group with which to directly compare our results, but because other studies have noted the results of large prospective data from primary TKAs, this could be extrapolated to compare the results of our functional scores. Also, our patient population was small and primarily obese, and these patients may not be as symptomatic as more active patients; however, obese patients put greater force through the repair while ambulating, and we would not expect more instability with patients with lower BMIs. Furthermore, all of our patients had cruciate-retaining implants, and although the PCL acts as a restraint to valgus forces, we feel that this technique can be applied to posterior-stabilized implants. Studies will be needed to determine if the results of our study can be extrapolated to posterior-stabilized implants.

**CONCLUSION**

Direct repair of a transected midsubstance superficial MCL, without the use of condylar constrained implants or postoperative protocol alterations such as protective weight bearing or bracing, can provide a stable reconstruction with good short-term results in certain selected patients. Although this should be taken into consideration for intra-substance lacerations, it cannot be extrapolated to avulsions. In our small series of 9 MCL lacerations during TKA, primary repair yielded good short-term results. Longer-term follow-up and larger, more generalizable studies will be needed to determine whether patients will continue to do well with this technique.

**REFERENCES**

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