INTRODUCTION

Anterior cruciate ligament (ACL) injuries affect a significant number of people annually. A focus of our recent research efforts has been the study of injuries associated with ACL tear, such as medial collateral ligament (MCL) injuries or meniscal tears, and how these associated injuries influence the management and outcome after an ACL injury. The purpose of this article is to provide an update on our approach and experience with these complex knee injuries.

COMBINED INJURIES TO THE ACL AND MCL

The optimal management of combined ACL-MCL injuries is controversial. Recent studies have shown good results with the operative management of ACL ruptures in conjunction with non-operative management of the MCL. Studies have shown that patients who underwent surgical ACL reconstruction and non-operative management of the MCL had superior range of motion and quicker strength gains in the short-term when compared to patients who underwent repair of both ligaments. Long-term results have also shown excellent stability and functional outcome in patients treated conservatively without surgery for the MCL.

Less clear is whether early or late ACL reconstruction offers superior long-term outcomes. Animal studies have revealed that MCL healing is adversely affected by ACL insufficiency. This finding has prompted some surgeons to perform early reconstruction of the ACL, restoring stability to the medial side of the knee and providing a favorable environment for MCL healing. This strategy would ideally obviate the need for subsequent surgery. These animal study results, however, have not been supported by clinical results from some authors who observed better outcomes with late ACL.

Recently, we have examined this relationship between timing of intervention in combined ACL-MCL injuries present our preliminary results with early ACL reconstruction and non-operative management of MCL tears here.

METHODS

We performed a retrospective study of patients with combined ACL-MCL injuries. Patients were managed with surgical ACL reconstruction and non-operative management of the MCL. Inclusion criteria were: (1) complete ACL tears with subsequent ligament reconstruction; (2) a minimum of a grade II MCL tear that was managed non-operatively; (3) surgical reconstruction within 3 weeks of the original injury; (4) no history of antecedent injury to the ipsilateral knee; and (5) 2 year follow-up data available. All data was gathered prospectively.

All patients had complete ACL tears, which were initially evaluated with routine clinical examinations. All ACL tears were also confirmed at the time of surgery. All patients had either grade II or grade III tears. Grade II tears were defined as those with medial joint line opening 5-10 mm greater than the contralateral knee upon application of a valgus stress with the knee flexed at 30°. Grade III collateral injuries had greater than 10 mm of medial joint line opening compared to the uninjured knee.

Unless there was some associated injury, such as a locked meniscus, that prevented full motion all surgical candidates had to meet the following preoperative prerequisites: (1) the ability to obtain full extension, (2) the ability to flex to at least 90 degrees, (3) good quadriceps control, as measured by the ability to perform a straight leg raise, and (4) near-normal appearance of the knee (minimal swelling). Patients who did not initially meet these prerequisites were placed in a supervised preoperative rehabilitation program until they reached these goals.

All patients underwent arthroscopically-assisted surgical reconstruction of the ACL with either a bone-patellar-tendon bone autograft or allograft using a two-incision technique with interference screws or an arthroscopically-assisted hamstring autograft.

Postoperative rehabilitation consisted of full passive and active range of motion for the first 6 weeks. Emphasis was placed on patellar and extensor mechanism mobility to prevent stiffness and scarring. Early quadriceps activity and weight bearing were encouraged. A knee brace was used to protect from valgus loading for 6 weeks. At 6 weeks, postoperative braces were exchanged for sport-type hinged braces. More intensive rehabilitation, including strengthening exercises and
proprioleptic training, was also introduced at 6 weeks and carried out until quadriceps strength normalized, at which point sport-specific activities were allowed.

Patients were followed with serial clinical examinations. Subjective outcomes measures consisted of Lysholm functional knee scores and Tegner activity scales. Subsequent procedures and complications were also recorded.

Results
Functional Outcomes
Subjective follow-up was obtained for all patients at minimum follow-up of 24 months. We found the knees to be functioning well with high functional scores by both the Lysholm and Tegner activity scales. There was no statistical difference between the Lysholm or Tegner scores in patients who had grade II MCL tears versus patients with grade III tears.

Associated Pathology
Of the patients with combined ACL-MCL injuries reviewed here, roughly 75% had associated injuries, including isolated lateral meniscal tears, isolated medial meniscal tears, combined meniscal tears, chondral injuries, and patellar fractures.

Complications and Subsequent Procedures
No patient required subsequent arthroscopy for secondary chondral or meniscal damage. No patients experienced ACL graft failure. One patient underwent re-arthroscopy for arthrofibrosis and subsequently did well.

Discussion
Two controversial issues regarding the management of combined ACL-MCL injuries have received recent attention in the literature. The first of these issues regards the various surgical options that are available for managing these injuries. Two principal surgical approaches exist with each approach having its proponents. Some authors recommend surgical repair of both ligaments, while others recommend ACL reconstruction and non-operative MCL management, and recently good results have been observed with operative MCL repair and non-operative ACL treatment. The most popular of these options is ACL reconstruction with non-operative MCL management. The rationale for this approach is that early stabilization of the knee facilitates MCL healing and prevents valgus instability.

The second controversial issue regarding combined ACL-MCL injuries is whether early ACL reconstruction or late ACL reconstruction provides optimal return of function and long-term results. Animal studies have revealed that MCL healing is adversely affected by ACL insufficiency. It has, therefore, been proposed that early reconstruction of the ACL will stabilize the medial compartment and foster MCL healing. The timing of ACL reconstruction in combined ACL-MCL injuries was studied by Petersen and Laprell. Their results, which were contrary to the animal studies, showed a lower rate of loss of motion, lower rate of re-arthroscopies, and better Lysholm scores with late reconstruction after a minimum of ten weeks from the time of initial injury when compared to early reconstruction within three weeks of initial injury.

The present study shows that early ACL reconstruction for the treatment of combined ACL-MCL injuries can lead to good results with excellent restoration of stability and function. Serial clinical exams performed post-operatively revealed excellent range of motion with minimal anterior displacement and valgus instability. Our results were superior to those observed by Petersen and Laprell in either their early reconstruction or their late reconstruction patient groups. In addition, the Lysholm scores observed in our population are comparable to those seen by Webb et al. with isolated ACL reconstructions. The MCL tear grade, whether type two or three, made no statistical difference with respect to long-term outcomes. This finding supports the notion that a crucial factor in MCL healing is stabilization of the medial compartment. This can be achieved by early reconstruction of the injured ACL or appropriate bracing preventing a valgus load on the healing ligament.

No patients in our series underwent subsequent arthroscopy secondary to meniscal or chondral injuries. These findings illustrate that ACL reconstruction can, at least in the short term, protect the knee from future injury as well as correct the underlying ligamentous defects. Furthermore, we had no failures of the ACL grafts. This was an important finding because early reconstruction could conceivably place more stress on the ACL graft while the injured MCL is healing consequently predisposing it to failure. Finally, no patients had subsequent valgus instability either subjectively or objectively confirming the ability of the MCL to heal and restore stability.

There are always concerns about whether early surgery might predispose to arthrofibrosis and motion problems. We believe that our preoperative protocol, which involves re-establishing motion, quadriceps control, and appearance, may exclude patients who are at risk for stiffness and motion problems. Surgery is delayed until the knee is in better condition to undergo the ACL reconstruction. Indeed, the rate of subsequent surgery in our series was lower than that noted by other authors. The functional outcomes of patients from this series who underwent early ACL reconstruction for combined ACL-MCL injury are also superior to those published by other authors.

We believe that managing patients with combined ACL-MCL injuries with early surgical ACL reconstruction and bracing of the medial collateral ligament offers many theoretical and practical advantages. Our findings support this approach to patients with combined ligament injuries, producing excellent clinical and functional outcomes.

Staged Management of Knees with Unstable Meniscal Tears and ACL Tears
The management of knees with unstable meniscal tears and ACL injuries is controversial. Some surgeons advocate an approach that addresses both injuries at the same surgical setting. At times, this approach requires a compromise on the rehabilitation of either the meniscus or the ACL. We have also made the clinical observation that many of the patients undergoing simultaneous surgical treatment subsequently
required additional procedures to release adhesions or to remove scar. Therefore, we have recently adopted a modified approach to the treatment of selected patients with these combined injuries in whom we were concerned about (1) the postoperative rehabilitation or (2) motion problems and arthrofibrosis. Patients who met these criteria and had ACL injuries with associated unstable meniscal tears were managed in a staged fashion. This approach permits a rehabilitation program that is tailored to the specific injury and its surgical treatment. By repairing the meniscus first, rehabilitating the knee, and then reconstructing the ACL, we hoped to avoid the motion problems and scar tissue that we had observed in our simultaneously treated cohort.

**Methods**

We performed a retrospective review of over 15 patients who had unstable meniscal tears and ACL tears and underwent early meniscal repair followed by staged ACL reconstruction. The criteria for inclusion in the study were: willingness to participate, no prior knee surgery, normal contralateral knee, no history of osteoarthritis, pain, or swelling in the affected knee, age less than 50 years, combined ACL and meniscal (medial and/or lateral) tears and absence of other significant ligamentous injury.

Arthroscopy was performed and all meniscal tears were repaired using an inside-out technique with non-absorbable suture. Meniscal repair was usually performed within two weeks of injury. ACL reconstruction was typically performed much later. Skiing soccer basketball football and motor vehicle accidents were the causes of the injuries.

**Meniscal Repair**

At the index surgery, patients underwent evaluation of the ACL tear and repair of the meniscus. This was performed using and inside-out technique with zone specific arthroscopic cannulae and nonabsorbable sutures. The preferred meniscal repair was a vertical mattress suture and this was used whenever feasible. The capsule was trephinated with a spinal needle to stimulate capsular bleeding and vascular infiltration at the repair site. The intercondylar notch was perforated repeatedly with a microfracture awl to allow the marrow elements with the stem cells to access the joint and the meniscal repair site.

The postoperative rehabilitation was then individualized among the patients according to the location and morphology of the meniscus tear and the quality of the repair. All patients used continuous passive motion. In all patients, passive motion and physical therapy were begun the day after surgery. The restrictions on motion and weight-bearing were determined at the time of the meniscal repair. Patients were limited to partial weight-bearing if the tear pattern was not compatible with full weight bearing (for example with radial tear). If the tear was a stable pattern (e.g., peripheral tear at the meniscocapsular junction), with a good quality repair, weight bearing was permitted. For tears of the posterior horns, flexion was limited to 90 degrees to prevent stressing the repair. Early passive motion and quadriceps isometrics were encouraged in all cases.

All were eventually advanced to full motion before undertaking the ACL reconstruction.

**ACL Reconstruction**

During the second procedure, a diagnostic arthroscopy was performed and the meniscal repair was inspected. The repair was contoured to a stable margin if needed. Adhesions were excised as necessary. The ACL was then reconstructed with bone-patellar tendon-bone autographs, utilizing a standard two-incision arthroscopically-assisted technique as has been described previously. The graft was fixed with interference screws on both the femoral and tibial sides.

Following the ACL reconstruction, our routine ACL rehabilitation protocol was used. This included full passive motion and early, full weight-bearing. Knee braces were again used for the first six weeks after ACL reconstruction. Patients completed a graduated rehabilitation program and were allowed to return to sport 4 to 6 months postoperatively.

**Outcomes**

The pre-operative evaluations included a physical examination, KT-1000 arthrometer ligament laxity testing, quadriceps and hamstring muscle strength testing, as well as AP, lateral, and standing roentgenograms. Objective outcome measures included clinical exam and KT-1000 evaluation while subjective outcomes included patient satisfaction, Lysholm, and Tegner activity scores. Survivorship included measures of clinical failure, such as excess laxity or recurrent tear, and the need for subsequent procedures, such as lysis of adhesions, revision meniscectomy, or ACL reconstruction.

**Results**

**Functional Outcomes**

Patients were followed up at a minimum of 24 months. Lysholm and Tegner scores were excellent. Patient satisfaction was similarly rated as excellent. Patients were also evaluated by measurements with the KT-1000 arthrometer. The mean side-to-side differences were all less than 5mm.

**Complications and Subsequent Procedures**

Subsequent procedures included revision ACL reconstruction, lateral partial meniscectomy, and partial medial meniscectomy, all for re-tears.

**Discussion**

Patients with combined injuries to the ACL and menisci have traditionally been managed with a single surgery to address both injuries. To avoid the complications of motion problems and scar tissue formation, we adopted an approach that allowed us to address each injury as a separate entity so that the rehabilitation program could be optimized for the specific injury and its repair. This preliminary study shows that this approach is safe and can provide results that are at least compatible with the simultaneous management of these injuries.

We found high satisfaction rates and good functional outcomes in this subset of patients with complex knee injuries.

Furthermore, we believed that this approach would decrease the need for subsequent procedures due to adhesions or motion loss. Indeed, when we compared this data with...
data from knees that were managed simultaneously we found a higher rate of motion problems and subsequent surgery in the single-stage group (unpublished data).

We conclude that the staged management of knees with unstable meniscal tears and ACL insufficiency leads to good clinical and functional outcomes without compromising the rehabilitation of either injury. A distinct advantage of the staged approach is that rehabilitation can be tailored to the specific injury and its repair. A study is currently underway to compare these outcomes with those from patients who underwent one-stage procedures that addressed both injuries.

**SUMMARY**

Complex knee injuries involving the ACL and other structures such as the menisci and the MCL pose a particular challenge to the surgeon. Various treatment modalities and surgical approaches have been recommended to optimize functional outcomes, minimize complications such as arthrofibrosis, and hasten recovery. Unfortunately, for many of these injuries, no consensus regarding the best treatment option exists. This article provides data that supports the two surgical approaches that we have used. The approach has yielded good short-term results for these two specific injury patterns, combined ACL-MCL tears and combined ACL-meniscal tears. Clearly, further studies are needed to address these complex situations and ideally, these studies would take the form of randomized controlled trials. Until such studies are carried out, we believe that retrospective reviews of cohorts such as ours will help us develop guidelines for the management of combined ACL injuries so that we can maximize functional outcomes and minimize complications.

**References**


