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ORIGINAL STUDY

Anatomic reconstruction of the medial collateral ligament in multi-ligaments knee injury using Achilles Allograft: a modification of Marx's Technique

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Medial Collateral Ligament (MCL) injury may require operative treatment. Marx et al. described the latest technique for reconstruction of MCL. While good results have been reported using the Marx technique, some issues have been observed. To address the mentioned issues, we have devised a modification to the Marx technique.

11 patients were enrolled and their ligaments were repaired according to this technique. At the last follow up the ROM, knee ligament laxity and functional outcome scores, subjective [IKDC] and Lysholm score were evaluated and recorded.

Knee motion was maintained in all cases. Two cases demonstrated 1+ valgus instability at 30 degree of knee flexion. Both were treated for combined MCL and PCL tear, the rest were stable. Average IKDC-subjective score was 93 ± 4 and average Lysholm score was 92 ± 3. All patients were satisfied and returned to their previous level of activity.

In this technique, the superficial MCL was reconstructed closer to its anatomical construct. Patients didn't have any complaints of hardware under skin and the need for second surgery for hardware removal was avoided. Also reconstructing the ligaments in 2 stages helped preserving the knee motion.

Level of Evidence : Level IV therapeutic.

Keywords : MCL repair ; Allograf t; Marx's technique ; Superficial MCL ; Anchor sutures ; Staged reconstruction.

INTRODUCTION

Ahe medial collateral ligament (MCL) of the knee is the primary stabilizer that resists valgus deforming forces. It provides 80% of the valgus stability in 30 degrees of knee flexion and 60% at full extension *(20,21)*. Other elements that play a role in valgus stability at full extension are the anterior cruciate ligament (ACL), the posteromedial capsule and the posterior oblique ligament *(11,20,21,27)*. Additionally, structures that are considered static stabilizers of the medial knee include the superficial and deep MCL as well as the posterior oblique ligament *(21)*.

Ligament injuries account for up to 40% of all injuries to the knee, and of these medial collateral ligament (MCL) injuries are the most common *(21,27,3,7,14,19)*. The popularity of sporting activities that involve valgus knee loading such as skiing, ice

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hockey and football has been a contributing factor to MCL injuries *(21)*.

Although most patients who sustain MCL injuries regain their activity level with nonoperative treatment *(21)*, severe cases with multiple ligament injuries and those with isolated symptomatic chronic MCL laxity may require operative treatment *(21,14,1,26)*.

Treatment of ACL and MCL injury, one of the most frequently combined ligamentous injuries of the knee, has been associated with a relatively high incidence of postoperative arthrofibrosis. Therefore it has been suggested by some authors to reconstruct combined ACL and MCL injury in two stages in order to avoid this complication *(3)*.

Several techniques for MCL reconstruction have been described. Some surgeons use semitendinosus autograft with preservation of the tibial insertion *(20,1,4,17)*, and some use allograft *(3,8)*. Double-bundle reconstruction, as compared to a single-bundle reconstruction, is another oft utilized technique, although it can be technically demanding. There are multiple attachment sites on the femur as well as on the tibia, more graft tissue is needed, and multiple fixation devices like staples, screws and washers are required *(20,3,13,26)*.

Marx et al. have described the latest technique for reconstruction of the MCL [20]. They used Achilles tendon allograft and reconstructed the MCL at the same time as the ACL. They secured the allograft by fixing the bone block attached to the allograft into the tibia using a metallic screw and washer *(20)*.

Although we have found Marx's technique for MCL reconstruction to be effective, there are some considerations and issues to contend with. For instance, after securing the distal part of the graft 5-7 cm below the joint line on the medial tibia, the graft may not lie in contact with the underlying bone and may remain tented over the bone. Additionally, some patients complain of hardware prominence. Furthermore, Marx reported loss of range of motion in several patients, especially those who had multiple ligament injuries. Marx mentioned finding the location for distal attachment of the allograft by checking isometry. However, this is rather subjective and possibly imprecise.

In order to resolve these issues we have developed a modification of Marx's technique. The aim of this study is to describe this new modification and evaluate the results of anatomic MCL reconstruction in multi-ligaments injury of the knee with the modified Marx technique.

PATIENTS & METHODS

Local institutional review board approval was obtained for the conduction of this study. From February 2013 to January 2015, eleven patient who had suffered MCL tears in addition to ACL, PCL or both ACL and PCL tears and were candidates for surgical reconstruction were recruited for this study.

Of these 11 patients one was female and the rest were male. The mean age was 32 years old (range 26 -38 years old). Mean follow up was 19 months (range 12-27 months).

All cases enrolled had multi-ligaments injury of the knee. Six patients with MCL+ACL, two with MCL+ PCL and three with MCL+ACL + PCL tears.

The criteria for MCL reconstruction was residual medial knee instability after failure of conservative treatment in patients with ACL and MCL injuries, and all patients with PCL or PCL and ACL injuries with MCL instability of 3+ or more. Infection, severe soft tissue trauma at the time of proposed surgery, and significant medical comorbidities were contraindications for surgery.

First stage:

During first 7 to 10 days post trauma after improvement of soft tissue and patient's general condition, MCL reconstruction was done at first stage. Progressive knee range of motion with functional knee brace was started within 2 weeks post-surgery. The patient was allowed to partial weight bear as tolerated with 2 crutches for 4-6 weeks and then full weight bear with a knee brace up to second stage. Muscles strengthening and proprioceptive exercises were advised.

Second stage:

Approximately 8 to 10 weeks after the first stage, when the patient regained full knee ROM and showed acceptable neuromuscular control, anatomic reconstruction of all other ligaments were done . The rehabilitation program under supervision of a physiotherapist was done early after surgery.

Patients were appropriately followed during their postoperative course. The following information was recorded at final follow up: follow up duration, range of motion, side-to-side ligament laxity differences and functional outcome scores. ACL laxity was assessed with the Lachman, anterior drawer and pivot shift test. The PCL was assessed with posterior drawer test. MCL laxity was assessed with valgus stress test at 0 and 30 degrees of knee flexion. All assessments were compared to the contralateral side and differences were recorded. Functional outcome scores utilized included the International Knee Documentation Committee (IKDC) subjective knee score and Lysholm knee score.

Achilles tendon allograft with a length of 12-14 cm was utilized. The 20 mm distal insertional Achilles tendon was trimmed to a width of 8 mm. The broad proximal portion of the allograft tendon was then sutured on both sides using a non-absorbable suture (Figure 1). The patient was positioned supine on a universal surgical bed. All surgeries were performed under general or spinal anesthesia A long medial longitudinal skin incision was made and skin, subcutaneous fascia and first layer of the medial side of the knee developed. The anatomical footprints of the MCL on the femoral and tibial sides were located, and then a guide pin was inserted 3 to 5 mm proximal and posterior to the medial femoral epicondyle and just at the center of femoral footprint. This pin was then guided parallel to the joint line under fluoroscopic guidance and in a 10-15 degree anterior direction to avoid the intercondylar notch. The femoral tunnel was made by reaming over the guide pin with an 8-mm diameter reamer up to a depth of 20 mm, and the prepared Achilles allograft was inserted into the femoral socket and fixed with an absorbable interference screw (Arthrex Bio-Interference screw, Naples, FL) (Figure 2). Two 5 mm anchor sutures (Depuy, Warsaw, IN) were inserted 1.5-2 cm apart on the tibial footprint of superficial MCL approximately 5-7 cm below the joint line. If localization of the anatomic footprint was difficult, we inserted the screws posterior and inferior to the pes anserinus on the posterior half of tibia. Another anchor suture was then inserted into the posterior half of the tibia 10 mm below the joint line at the proximal attachment site of the superficial MCL. The graft was passed under the pes anserinus tendons and over the anatomic foot print and fixed using two anchor sutures with optimal tension at

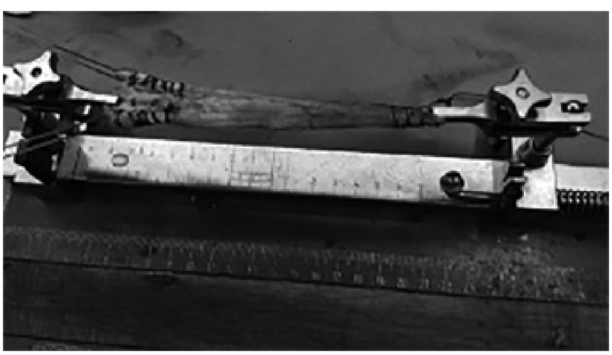

Figure 1. – Allograft preparation by applying appropriate tension and placement of nonabsorbable sutures.

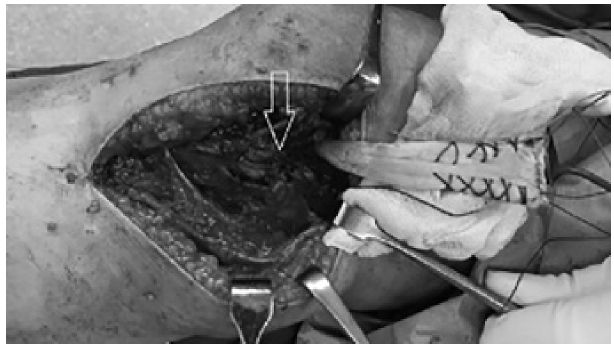

Figure 2. – The allograft is fixed into the femoral socket with an absorbable interference screw. The posteromedial capsule is reefed (white arrow).

Figure 3. – The allograft is fixed into the femoral socket with an absorbable interference screw. The posteromedial capsule is reefed (white arrow).

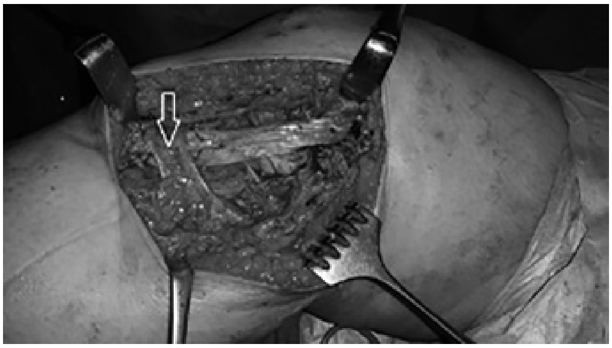

Figure 4. – Allograft is fixed and sutures are tied. The allograft is passed under the pes anserinus tendons (white arrow).

the 20-30 degrees of knee flexion under mild varus force (Figure 3). Finally, the proximal suture was fixed over the graft (Figure 4). In seven cases that showed posteromedial laxity, we reefed the capsule using nonabsorbable sutures prior to tibial graft fixation. Subcutaneous tissue and skin closure was performed in standard fashion and tunnel position and hardware placement were confirmed with postoperative radiographs (Figure 5).

Ethics approval and consent to participate

The study was approved by the institutional review board (IRB) of Firoozgar Hospital. Informed consents were obtained from each patient before admission.

RESULTS

At final follow up, no patients were found to have gross malalignment or gait abnormalities as assessed clinically and no complications were reported. All patients reported being satisfied and reported excellent results. The ROM was full in all cases. No complaints of hardware irritation were noted.

Side-to-side MCL integrity showed a firm end point on valgus stress test with no gross side-to-side differences at full extension in all the cases. Two cases demonstrated 1+ valgus instability at 30° of knee flexion. Both were treated for combined MCL and PCL tear.

Average IKDC-subjective scores demonstrated statistically significant improvements from 63 ± 2 to 93 ± 4 (P value<0.05).Lysholm scores demonstrated statistically significant improvements from 67 ± 4 to 92 ± 3 (P value<0.05) after surgery.

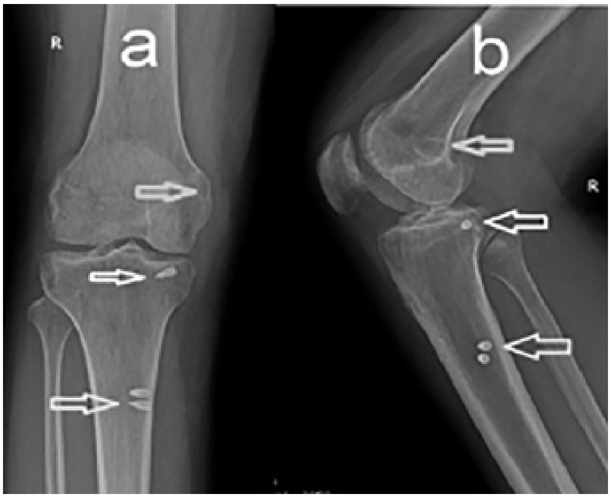

Figure 5. – Anterior-Posterior (a) and lateral (b) X-rays confirm tunnel position and hardware placement. One anchor suture is placed at the proximal attachment of superficial MCL (white arrow) and 2 suture anchors at the distal attachment of superficial MCL (yellow arrow). Note the position of the femoral tunnel (green arrow).

DISCUSSION

The superficial MCL is the largest structure of the medial part of the knee and originates from 3.2 mm proximal and 4.8 mm posterior to the medial epicondyle at the center of knee motion on the medial femoral epicondyle of the femur *(20,21,23)*. According to LaPrade et al. and Brantigan et al., the superficial MCL has 2 attachments on the tibia *(15,5,6)*. The proximal attachment of the superficial MCL inserts directly over the anterior arm of the semimembranosus approximately 1 cm below the knee *(15,5,6)*, and the distal attachment inserts on the proximal tibia just anterior to the posteromedial crest of the tibia and posterior to the pes anserine insertion, five to seven centimeters (cm) below the joint line, with an average length of 11 cm (10-12 cm) and an average width of 1.5 cm *(20,21,6,25)*. The superficial MCL consists of anterior and posterior portions which play different rolls anatomically *(21,3)*.The deep MCL is the thick part of the middle third of the medial capsule, also known as the middle capsular ligament which originates inferior to the medial epicondyle of the femur and inserts on the tibia 1 cm below the joint line *(20,21)*. MCL also provides a resistance to external rotational forces to the lower extremity *(3)*.

Ligament injuries account for up to 40 percent of all knee injuries, and of these, medial collateral ligament (MCL) injuries appear to be the most common *(21,3,19)*. I Bollen et al. demonstrated that the incidence of combined ACL and MCL tear is approximately 30% of incidence of ACL tears alone *(26)*. A portion of these patients need surgical reconstruction of the MCL. Also some MCL injuries may not respond well to conservative treatment and require surgical treatment *(16,22)*.

There have been several techniques described for MCL reconstruction. However, these procedures are not without possible concurrent morbidity and issues, including extensive surgical exposure, donor site morbidity, loss of motion, non-anatomic graft placement, and technical complexity with double-bundle constructs *(20,3,1,16,8,26).*

Marx et al introduced a new technique for MCL reconstruction that involved using an Achilles allograft. They reconstructed the MCL at the same time as ACL reconstruction *(20)*. The authors reported advantages such as no donor site morbidity, secure fixation with bone-to-bone healing on the femur, small skin incisions, and isometric reconstruction *(20)*.

Although we found this technique to have good results, we observed some issues and aimed to resolve them by introducing a modification to Marx's technique.

In this technique, we utilized an Achilles allograft without any bony attachment. We reconstruct the MCL in the first stage and other ligamentous injuries in the second stage when adequate knee ROM was achieved through rehabilitation. We feel there are several benefits to this modified technique. Knee range of motion may be improved by utilizing a two stage technique with a physical therapy protocol initiated between stages. Additionally, the use of allograft tendon eliminates potential donor site morbidity, and fixing the graft with anchor sutures may eliminate fixation site irritation and avoid the need for removal of hardware. Also, fixing the allograft in 2 places, the anatomical proximal and distal footprints of the superficial MCL, kept the allograft in contact with the bone along the entire surface of the tibia. This may enhance tendon-bone healing and may allow for more physiologic function due to achieving a more anatomic footprint.

Marx, et al. emphasized using tendoachilles allograft with a calcaneal bone block to promote bone-bone healing. He used a screw and a washer for fixing the bony part of the allograft into the tibia *(20)*. However, the medial proximal side of the leg has little subcutaneous coverage, and using screws and washer may cause hardware irritation necessitating future removal. In order to address this problem, we used anchor sutures to fix the allograft to the tibia. This technique minimizes potential irritation of metallic devices under the skin.

Marx, et al. looked for the most isometric point for attaching the allograft on tibia during surgery. Feeley, et al. performed a cadaveric study to determine the femoral and tibial fixation sites that would result in the most isometric MCL reconstruction technique *(10)*. They concluded that MCL reconstruction performed with the femoral attachment of the MCL within the femoral footprint and the tibial attachment within the footprint of the MCL would result in the least graft excursion when the knee was cycled between 0° and 90° *(10)*. In our technique, we used the anatomical footprint of the MCL for attachment rather than checking for the isometric site according to Feeley et al *(10)*.

In another study Bin et al. repaired or reconstructed medial or lateral ligament complexes in the first surgical stage within 2 weeks of injury. In the second stage, when full range of motion was obtained 3 to 6 months later, they reconstructed the ACL and/or the PCL. They evaluated their final outcomes based on stress radiographs, range of motion assessment, Lysholm score, Tegner activity stage, and International Knee Documentation Committee rating. All patients recovered full ROM, the mean Lysholm score was 87.6 points (range, 65 to 100 points), the mean Tegner stage was 3.9 (range 3 to 5) and the final overall IKDC rating was normal in 3 knees, nearly normal in 8, and abnormal in 4.They concluded that the 2-stage surgical approach resulted in good outcomes in terms of range of motion and stability *(26)*. In our series, we reconstructed the MCL in the first stage and the ACL and/or the PCL in the second stage. We didn't experience any loss of ROM in our patients.

Marx reported 2 cases of losses of 15° of flexion. Although this difference may not be statistically significant, two stage reconstruction may lead to better range of motion.

The most important limitation of our study was the low number of cases without a comparison group. Although the candidates for this type of reconstruction are few and other studies have reported similar numbers, a larger cohort is needed to conclusively demonstrate the benefits of this modification. Additionally, longer term follow-up is required to assess the long term efficacy of this technique.

In our patients with multi ligament-injured knees, valgus laxity and ROM were effectively restored through a 2-step surgical reconstruction. Patient-reported functional results were significantly improved postoperatively at the last follow-up. We feel that our modification of Marx's techniques may benefit patients by reducing metallic hardware irritation, and potentially restoring full return of knee ROM and stability.

List of abbreviations: ACL: Anterior Cruciate Ligament; PCL: Posterior Cruciate Ligament; MCL: Medial Collateral Ligament; IKDC: International Knee Documentation Committee; ROM: Range of Motion.

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