

## CASE SERIES

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# Outcomes of surgical management of combined ACL and posterior root tears of the lateral meniscus: A case series

Brian H Goldman, Chad A Edwards, Bradley Richey, Josh R Eskew, Richard F Pearce, Jeffery Turley, Daniel Kalbac

## ABSTRACT

**Introduction:** Tears of the posterior root of the lateral meniscus are often associated with anterior cruciate ligament (ACL) rupture. We present a series of patients treated with repair of the posterior root of the lateral meniscus (PLMR) concurrently with ACL reconstruction.

**Case Series:** From May 2016, 6 patients with PLMR tears with concurrent ACL rupture were evaluated and operated on. Patients were monitored and followed up at a mean of 16.5 months. Functional assessment and Lysholm scores were compared preoperatively and postoperatively. Patients demonstrated significant improvement postoperatively. All patients rated their outcome as excellent. Subjective scoring demonstrated a mean improvement between preoperative and postoperative Lysholm scores of 59 ( $p \leq 0.001$ ).

**Conclusion:** Based on previously defined metrics of clinical improvement for Lysholm scoring, patients have demonstrated not only a statistically significant improvement but also a clinically significant

improvement when compared to preoperative status. All patients reported satisfaction with the procedure and no patients in the group demonstrated residual mechanical symptoms or instability. More high-quality studies, including randomized controlled trials (RCTs), are needed to confirm the utility of this procedure.

**Keywords:** ACL reconstruction, Meniscal root tear, Meniscectomy, Posterior meniscal root tear

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## INTRODUCTION

Meniscal root tears are avulsions of the posterior or anterior horns of the menisci of the knee that have historically been underdiagnosed [1–3]. These tears make up 10–21% of all meniscal tears, representing over 100,000 cases per year in the United States [2]. The menisci function chiefly in shock absorption, weight distribution, and knee stabilization [4–6]. With advancements in magnetic resonance imaging (MRI) and arthroscopy, our ability to identify meniscal root tears has significantly improved; concomitantly, our awareness of the biomechanical consequences of such tears has increased. The menisci convert axial pressure into circumferential hoop stress, allowing the distributed transmission of 40–70% of the load

transmitted through the knee to the underlying tibia [7, 8]. Meniscal root tears, though technically radial tears, disrupt the normal circumferential fiber orientation, resulting in a loss of transverse load distribution and a functional meniscectomy [2, 3]. Such focal disruption in load bearing can result in increased tibiofemoral contact pressures, predisposing to premature arthritis [9]. Medial meniscus root tears are generally associated with degenerative conditions; conversely, lateral meniscus root tears are most commonly found in patients with a history of trauma [10]. In particular, tears of the posterior root of the lateral meniscus (PLMR) commonly occur in tandem with anterior cruciate ligament (ACL) tears [10–12]. Posterior root of the lateral meniscus tears have been reported as occurring in conjunction with 8% of ACL tears [13].

Though the exact mechanism of PLMR tear is as-of-yet unclear, it has been proposed that these injuries occur in combination with ACL tears because the increased mobility of the knee joint following ACL tear allows the subluxation of the tibia on the femur, causing impingement at the site of insertion of the posterior horn of the lateral meniscus [10]. Clinical diagnosis of such lesions is difficult, as ACL injury may mask PLMR tears. Magnetic resonance imaging remains the gold standard for diagnosis, and has been shown to reliably identify tears irrespective of ACL injury status [13]. Once the diagnosis of PLMR tear has been made, patient's options include non-surgical management, meniscectomy, and repair. In patients undergoing ACL reconstruction with acute PLMR tear and without underlying arthritis, surgical repair is indicated [1]. In this article, we present a series of 7 patients treated with repair of the posterior root of the lateral meniscus concurrent with ACL reconstruction.

## CASE SERIES

In this study we treated 6 patients with PLMR tears with concurrent ACL rupture. The patient evaluation and operations were from May 2016 to September 2017. Patient follow-up was conducted postoperatively at 1 week, 2 weeks, 2 months, 3 months, and then every 6 months thereafter for a mean of 16.5 months. Lysholm scores were taken preoperatively and postoperatively to evaluate the functionality and pain of the joint in each patient (Tables 1–3).

Inclusion criteria for this study were that patients had concomitant tears of the anterior cruciate ligament and posterior root of the lateral meniscus, and that they were not currently being treated with a revision repair. Exclusion criteria were the presence of any intraoperative or perioperative adverse events that could affect outcome, as well as the presence of any comorbid conditions requiring modification of standard surgical procedure.

## Surgical technique

Following clinical evaluation and MRI scans, it was determined that ACL reconstruction was indicated in these patients. All patients consented to this procedure, as well as any other indicated procedures upon arthroscopic examination. The patient was placed supine on the operating table with general anesthesia. A nonsterile tourniquet was placed to the proximal thigh and the extremity was prepped and draped in a typical arthroscopic fashion. Standard arthroscopic portals were made on either side of the patellar tendon and a blunt obturator, arthroscopic camera, and cannula were introduced with the knee in extension. During arthroscopic examination of the patients involved in this series, ACL tears and concomitant PLMR tears were appreciated. After diagnostic arthroscopy, the operative extremity was placed in a figure-of-four position to assess the lateral compartment. Upon visualization of the root tear, the integrity of the remaining meniscus was assessed to determine reparability. Utilizing a scorpion suture passer through the lateral portal, with the arthroscope through the medial portal, a #2 FiberWire suture was passed through the posterior meniscal root in a horizontal mattress fashion. A standard ACL type drill guide (Arthrex) set to 70° was utilized in this study; alternatively, a meniscal root tibial guide can be utilized. The tibial insertion of the posterior root was localized and a 6 mm FlipCutter (Arthrex) drill bit was drilled from the anterior aspect of the tibia directed toward the posterior root insertion. Once appropriate position was confirmed, the FlipCutter was flipped, and a full tunnel was drilled to approximately 10 mm from the articular surface. A FiberStick (Arthrex) was utilized at this time, passing through the tibial tunnel and retrieved through the lateral portal. The FiberStick suture was then utilized to shuttle the previously placed FiberWire suture through the tibial tunnel. It was properly tensioned and secured at the anterior aspect of the femur using a 4.75 mm SwiveLock anchor (Arthrex). Incisions were closed with and bandaged with Adaptic and 4 × 4 s.

## Patient 1

This patient was a 33-year-old male, who presented for right knee revision ACL reconstruction. Upon imaging and examination, the preoperative diagnosis was a complete anterior cruciate ligament tear of the right knee. The preoperative examination under anesthesia showed a 0 to 1+ Lachman, a 0 anterior drawer, and a negative pivot shift. During arthroscopy, complete ACL tear, posterior lateral meniscal root tear, partial posterior cruciate ligament tear, and chondromalacia anteromedial tibial plateau were identified. The following procedures were performed on the patient: revision ACL reconstruction using FlexiGraft GraftLink (Arthrex, Naples, FL) with internal bracing, lateral meniscus posterior meniscal root repair, foreign body excision in the tibial tunnel, and notchplasty.

**Patient 2**

This patient was a 40-year-old male who presented with a left knee injury that occurred stepping out of his truck. After imaging and examination the preoperative diagnosis was a complete anterior cruciate ligament tear of his left knee and a complex radial tear of the posterior lateral meniscal root tear. The preoperative examination under anesthesia showed a 2+ Lachman and 2+ drawer with a positive pivot shift. During arthroscopy a complete ACL tear of his left knee, complex radial tear of the posterior horn of the lateral meniscus, lateral meniscal root tear, medial meniscus body tear, overgrowth of the femoral notch, foreign body suture material tibial tunnel, and scar tissue formation were identified. The following procedures were performed on the patient: operative arthroscopy of the left knee with anterior cruciate ligament with revision ACL reconstruction with FlexiGraft GraftLink, lateral meniscus root repair, partial posterior horn body medial meniscectomy, foreign body suture material excision, femoral notchplasty, and StimuBlast bone graft (Arthrex, Naples, FL).

**Patient 3**

This patient was a 42-year-old male bodybuilder, who presented with a right knee injury. After imaging and examination the preoperative diagnosis was a complete ACL tear of his right knee with partial medial collateral ligament (MCL) tear, radial posterior lateral meniscal root tear medial and laterally. The preoperative examination under anesthesia showed a 1+ Lachman, 1+ drawer, and a positive pivot shift. During arthroscopy a complete ACL tear, right knee, meniscal root tear lateral meniscus, medial plica, loose body measuring 5 × 7 mm, and anterior horn and body tear lateral meniscus were identified. The following procedures were performed on the patient: operative arthroscopy of the right knee with ACL reconstruction with FlexiGraft GraftLink, lateral meniscal root repair, anterior horn and body partial lateral meniscectomy, loose body excision, plica excision, and StimuBlast with autologous conditioned plasma.

**Patient 4**

This patient was a 27-year-old male who injured his right knee while playing soccer. After imaging and examination the preoperative diagnosis was a high-grade tear of the ACL with posterior lateral meniscal root tear, which were confirmed during arthroscopy. Prior to surgery, the examination showed a 1+ Lachman, 1+ drawer, and a positive pivot shift. When the standard arthroscopic portals were made, the tourniquet failed and was removed for the remainder of the procedure. The following procedures were performed: operative arthroscopy of the right knee with ACL reconstruction with FlexiGraft GraftLink, lateral meniscus root repair, and StimuBlast autograft to right knee.

**Patient 5**

This patient was a 20-year-old female who presented with a right knee injury following a soccer injury. After imaging and examination the preoperative diagnosis was a complete ACL tear with posterior lateral meniscal root tear, hemarthrosis, and an MCL sprain. The examination under anesthesia showed a 1 to 2+ Lachman and 1 to 2+ drawer, and a positive pivot shift. During arthroscopy a complete anterior cruciate ligament tear, right knee, meniscal root tear posterior horn laterally, posterior body tear lateral meniscus, chondromalacia of the inferior pole patella, and hemarthrosis were identified. The following procedures were performed on the patient: operative arthroscopy of the right knee with anterior cruciate ligament reconstruction with patellar bone-tendon-bone autograft, bone graft to donor sites, patellar and tibial tubercle, abrasion arthroplasty of the undersurface of the inferior pole patella, posterior meniscal root repair, partial posterior horn lateral meniscectomy and body lateral meniscectomy, and platelet-rich plasma (PRP) infusion.

**Patient 6**

This patient was a 17-year-old high level female basketball player who injured her right knee jumping for a

Table 1: Preoperative Lysholm scores

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Limp	3	3	3	0	0	0
Cane or crutches use	5	5	5	5	0	0
Locking sensation in the knee	2	2	15	2	2	6
Giving way sensation from the knee	5	0	15	5	0	15
Pain	25	0	20	5	0	5
Swelling	10	2	10	0	0	0
Climbing stairs	10	2	10	2	0	2
Squatting	5	0	4	1	0	0
Total	65	14	82	20	2	28

Table 2: Postoperative Lysholm scores

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Limp	5	5	5	5	5	5
Cane or crutches use	5	5	5	5	5	5
Locking sensation in the knee	15	15	15	15	15	10
Giving way sensation from the knee	25	20	25	25	25	25
Pain	25	20	25	25	20	20
Swelling	10	10	10	10	6	6
Climbing stairs	10	10	10	10	10	10
Squatting	5	4	5	5	4	5
Total	100	89	100	100	90	86

Table 3: Total Lysholm scores

Patient	Preoperative Lysholm score	Postoperative Lysholm score
1	65	100
2	14	89
3	82	100
4	20	100
5	2	90
6	28	86
Average	35.17	94.17

Abbreviations: PLMR: posterior root of the lateral meniscus, ACL: anterior cruciate ligament, MCL: medial collateral ligament

shot in a basketball game. After imaging and examination the preoperative diagnosis was a complete ACL tear of her right knee, a complete MCL tear of the right knee, and a posterior lateral meniscal root tear. The examination under anesthesia showed a marked valgus laxity both at full extension and 30° of knee flexion and she also had a complete laxity with anterior drawer and Lachman test as well as a pivot shift test. During arthroscopy a complete anterior cruciate ligament tear, right knee, complete MCL tear right knee, posterior horn meniscal root tear, lateral aspect of the right knee, grade 2–3 chondromalacia at the lateral femoral condyle were identified. The following procedures were performed on this patient: ACL reconstruction with patellar bone-tendon-bone autograft, arthrotomy with MCL reconstruction, lateral meniscal root repair, bone graft to donor sites, notchplasty, and a thorough abrasion arthroplasty of the lateral femoral condyle.

## DISCUSSION

Arthroscopic ACL reconstruction is a commonly performed orthopedic procedure. With recent advances in arthroscopic technique and technology, our ability to identify previously missed tears of the menisci has improved. Among these previously missed meniscal

tears are meniscal root tears [1–3]. Historically, even when such tears were identified, the treatment of choice was meniscectomy. Today, while options for meniscal tears include both repair and resection, meniscectomy has been shown to result in inferior clinical outcomes compared to repair, including early development of osteoarthritis, failure to return to pre-injury activity level, and diminished return-to-play rates among athletes [14]. Multiple studies have now shown that meniscectomy almost inevitably results in the development of osteoarthritis, with rates approaching 90% at 30 years of follow-up [15]. Additionally, prior studies have shown that ACL reconstruction with meniscectomy to treat a radial meniscal tear have significantly worse clinical outcomes compared to meniscal repair [16]. However, consensus has yet to be reached on the necessity of concomitant repair of meniscal lesions while reconstructing the anterior cruciate ligament as opposed to conservative management. Shelbourne et al. reported that in the setting of concomitant PLMR and ACL tears, meniscal tears left unprepared in situ showed no difference in subjective or objective scores, though they noted some joint space narrowing at 10 years follow-up ( $1.0 \pm 1.6$  mm) [17]. Because the posterior lateral meniscal root has a complete blood supply, PLMR tears in particular have been hypothesized to have a great potential for healing upon repair [18]. However, few studies exist

today specifically assessing PLMR repair in the setting of ACL reconstruction. Ahn et al. assessed clinical outcomes following all-inside repair in this setting. This group demonstrated a significant decrease in sagittal extrusion ( $p = 0.007$ ), with mean Lysholm score improvement from 62 to 93 postoperatively [19]. Similarly, Anderson et al. reported a success rate of 91.67% of these repairs at 58 months follow-up on subjective analysis of knee function ( $n = 24$ ) [20]. Given the paucity of studies examining the outcomes of repair versus conservative treatment, it is difficult to say with certainty whether or not such results may prove significant at the population level. This study, therefore, aimed to further establish a firm baseline of expected clinical improvements following repair, to lay the groundwork for future work elucidating the clinical impact of PLMR repair versus conservative management or resection in the setting of ACL tears.

The present study examines clinical outcomes of 6 patients undergoing ACL reconstruction and concomitant repair of a posterior lateral meniscal root tear. The outcome of interest was improvement in Lysholm score following surgical intervention. Preoperatively, the mean Lysholm score was 35.17, which improved to 94.17 following surgery. All patients demonstrated increased Lysholm scores with a mean improvement between preoperative and postoperative Lysholm scores at 59 ( $p \leq 0.001$ ).

The Lysholm score system has been shown to be a reliable metric for use in both ACL and meniscal injuries, with considerable face validity and ability to detect change in chondral and ligament injuries. The minimum change detectable on the Lysholm score has been reported at 8.9–15.2 for knee injuries [21, 22]. Additionally, though psychometric analysis overall is lacking for Lysholm score reports, one study reported by the American Orthopaedic Society for Sports Medicine calculated minimum clinically important difference at 10.1 [22]. By both of these criteria, the patients in this case series demonstrated significant clinical improvement. Additionally, a mean postoperative Lysholm score of 94.17 falls into the range for excellent knee function [23]. Overall, the series of outcomes presented in this report provides evidence that combined ACL and posterior root of the lateral meniscus repair is a safe and effective means of surgical management for these injuries.

The present study has several limitations. Our patient population presented with a range of co-morbid knee injuries which required different management techniques. The small sample size of our patient pool limited the power of this study. Additional research employing randomized clinical trials would allow a more complete determination of the total biomechanical benefit of PLMR repair in parallel with ACL reconstruction. Finally, further studies should evaluate the functional kinematics of PLMR repair versus meniscectomy in patients receiving ACL reconstruction.

## CONCLUSION

In conclusion, combined ACL reconstruction with concomitant repair of a posterior lateral meniscal root tear is a safe and effective option for some patients. Based on previously defined metrics of clinical improvement for Lysholm scoring, patients treated with this procedure demonstrated not only a statistically significant improvement but also a clinically significant improvement when compared to preoperative status. All patients reported satisfaction with the procedure and no patients in the group demonstrated residual mechanical symptoms or instability. More high-powered studies, including RCTs, should evaluate the long-term functional consequences of such repairs versus conservative management.

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### Author Contributions

Brian H Goldman – Conception of the work, Design of the work, Analysis of data, Drafting the work, Revising

the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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**Conflict of Interest**

Authors declare no conflict of interest.

**Data Availability**

All relevant data are within the paper and its Supporting Information files.

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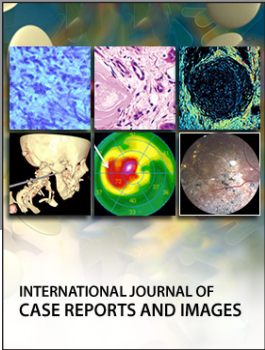
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