Technical Note

Anatomic Reconstruction of the Medial Collateral Ligament and the Posterior Oblique Ligament With Allograft for High-Grade Valgus Laxity

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Abstract: The medial collateral ligament (MCL) and the posterior oblique ligament (POL) are 2 of the main structures of the posteromedial corner of the knee. The MCL is important for valgus stability, whereas the POL is important for rotational stability. In cases of high-grade injury (grade 3) or when conservative treatment has failed, surgical intervention should be explored. Reconstruction is typically recommended over repair; however, there is still no consensus in the literature on the best reconstruction technique. This Technical Note describes an anatomic reconstruction of the posteromedial corner using a tibialis anterior allograft for the MCL and a semitendinosus allograft for the POL in the setting of a high-grade medial knee injury.

Two main structures of the posteromedial corner (PMC) of the knee include the medial collateral ligament (MCL) and the posterior oblique ligament (POL).[1] The MCL is the main restraint to valgus stress of the knee and the posterior oblique ligament (POL) is important for rotational stability of the knee.[2] The MCL is one of the most injured ligaments of the knee but often does not require surgery. In cases of grade 1-2 MCL injuries, conservative treatment is attempted first and is often successful.[3] In cases in which conservative treatment fails or in grade 3 injuries, especially with valgus gapping in extension, surgical reconstruction is recommended to restore the stability of the knee.[3]

Various reconstruction and repair techniques have been proposed in the literature[4-6]; however, repair has been reported to have greater rates of arthrofibrosis and failure at 2-year follow-up compared with reconstruction.[5] Reconstruction typically is recommended for high-grade injuries, but there is lack of consensus on the optimal technique with differences in graft selection and fixation. This technique describes an anatomic reconstruction of the MCL and POL with allograft in the setting of a high-grade PMC injury.

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Received May 3, 2025; accepted May 16, 2025.

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2212-6287/25886

https://doi.org/10.1016/j.eats.2025.103691

Surgical Technique

The technique of the MCL and POL reconstruction is shown in Video 1. The step-by-step guide and surgical pearls are in Table 1.

Anesthesia and Positioning

The patient is positioned in the supine position on the operating table and induced under general anesthesia. A knee examination, including valgus stress testing in extension and at 30° of flexion and anteromedial rotation via the anteromedial drawer test at 90°, is performed to validate the clinical examination findings. A well-padded high thigh tourniquet is placed on the surgical leg. The surgical leg is placed in a leg holder (Mizho OSI, Union City, CA) and the nonsurgical leg into an abduction stirrup (Birkova Product LLC, Gothenburg, NE). For infection prophylaxis, 2 g of perioperative cefazolin is administered.

Incision and Surgical Approach

An anteromedial incision is made from over the midpoint of the vastus medial obliquus muscle to just distal to the tibial tubercle, splitting the distance between the anterior tibial crest and the posteromedial

Table 1. Step-by-Step Guide and Surgical Pearls for an Anatomic Reconstruction of the MCL and POL Using Allografts

Step-by-Step Guide	Surgical Pearls
An anteromedial incision is made from over the midpoint of the vastus medial obliquus muscle to just distal to the tibial tubercle.	This incision should split the distance between the anterior tibial crest and the posteromedial aspect of the tibia.
Dissection is then carried over the medial aspect of the tibia.	The medial joint line should be identified.
The native distal tibial attachment of the MCL is located 6 cm distal to the joint line.	A spinal needle is placed at the joint line to help measure for the distal MCL attachment site.
A guide pin is drilled across the tibia using the collateral instrument tibial guide (Smith & Nephew, London, England) at the native distal attachment of the MCL.	A methylene blue marker can be used to mark the location before drilling the guide pin.
This guide pin is overreamed with a 7-mm reamer to a depth of 25-mm, a passing stitch is placed, and the distal aspect of the tibial tunnel is notched.	The opposite tibial cortex should remain intact while over reaming the guide pin.
The site for the POL tibial tunnel is approached and is marked.	The tunnel for the POL tibial attachment is just distal to the anterior arm of the semimembranosus tunnel.
A guide pin is drilled across the tibia using the collateral instrument tibial guide, exiting at the Gerdy tubercle.	The guide pin should aim towards the Gerdy tubercle.
The guide pin is overreamed with a 7-mm reamer to a depth of 25-mm and a passing stitch is placed.	Again, care should be taken to leave the opposite cortex intact.
On the femur, the adductor magnus tendon is identified first to identify the adductor tubercle.	The adductor tubercle serves at the "lighthouse" for anatomic identification on the femur.
The MCL femoral attachment located just posterior and proximal to the medial epicondyle is identified and a guide pin is drilled anteromedially across the femur.	From the adductor tubercle, measuring 12-mm distal and 8-mm anterior help to identify the medial epicondyle.
A small arthrotomy is created to separate and lift the posteromedial capsule at the attachment site of the POL on the femur and a guide is drilled anteromedially across the femur, parallel to the MCL guide pin.	The POL attachment is located about 7.7-mm distal and 6.4-mm posterior to the adductor tubercle.
Next, both guide pins are over reamed with a 7-mm reamer to a depth of 30-mm and passing stitches are placed.	It is important to pass both guide pins first to ensure they are at their anatomic locations and to ensure there is at least 9 mm between the pins to maintain a 2-mm bone bridge between the tunnels.
Both allografts are prepared on the back table and whipstitched at each end with a No. 2 nonabsorbable suture.	The MCL graft is prepared from a tibialis anterior allograft and is 16-cm in length. The POL graft is prepared from a semitendinosus allograft and is 11-cm in length.
The MCL and POL grafts are passed into their respective femoral tunnels and fixated with 7 × 20-mm bioabsorbable screws.	Both grafts should be passed into their femoral tunnels prior to fixation because the close proximity of the tunnels may result in the initial interference screw impinging on the second graft tunnel which would interfere with graft passage.
Soft tissue channels are made from the femoral MCL and POL tunnels to the tibial tunnels. Both grafts are passed through these channels and passed into their respective tibial tunnels.	For the MCL, a channel is made under the superficial sartorial fascial tissues along the native course of the MCL. For the POL, a channel is created under the posteromedial capsular layer.
The MCL graft is fixed first in the tibia with the knee at 30° of flexion, with a slight varus reduction force, and the knee in neutral rotation. A 7 × 20-mm bioabsorbable screw is used for fixation.	The fixation should occur at the distal aspect of the tunnel where it was previously notched.
The POL is fixated next with the knee in extension with a 7 × 20-mm bioabsorbable screw.	After POL fixation, the valgus gapping and anteromedial rotation should be eliminated.
To reconstitute the proximal soft tissue tibial attachment of the MCL, a the MCL allograft is fixated to a Q-FIX anchor placed 15-mm distal to the medial joint line.	The MCL allograft is sutured to the Q-FIX anchor with the knee in 30° of flexion.

MCL, medial collateral ligament; POL, posterior oblique ligament.

aspect of the tibia (Fig 1). Dissection is then carried over the medial aspect of the tibia. A spinal needle is placed at the joint line and the native distal tibial attachment of the MCL is located 6 cm distal to the joint line (Fig 2). This location is marked with a methylene blue marker, and a guide pin is drilled across the tibia using the collateral instrument tibial guide (Smith & Nephew, London, England) (Fig 3). This guide pin is overreamed with a 7-mm reamer to a depth of 25-mm, leaving the opposite tibial cortex intact, a passing stitch is placed, and the distal aspect of the tibial tunnel is notched.

Next, the site for the POL tibial tunnel is approached, just distal to the anterior arm of the semimembranosus tunnel. This location is marked, and a guide pin is drilled perpendicularly across the tibia using the collateral instrument tibial guide, exiting at the Gerdy tubercle (Fig 4). The guide pin is overreamed with a 7-mm reamer to a depth of 25-mm and a passing stitch is placed.

Fig 1. Incision for an anatomic medial collateral ligament (MCL) and posterior oblique ligament (POL) reconstruction for a right knee with the patient in the supine position. For an isolated MCL and POL reconstruction an anteromedial incision from the midpoint of the vastus medialis musculature to just distal to the tibial tubercle (purple arrow), splitting the distance between the anterior tibial crest and the posteromedial aspect of the tibia is performed. The incision can be adjusted depending on previous or concomitant procedures, as was the case in this patient whose previous incision was followed.

Attention is now brought to the femur. The adductor magnus tendon is identified first to identify the adductor tubercle (Fig 5). From the adductor tubercle, measuring 12-mm distal and 8-mm anterior helps to identify the medial epicondyle. The MCL femoral attachment is located just posterior and proximal to the medial epicondyle. A guide pin is drilled anterolaterally across the femur at this location (Fig 6).

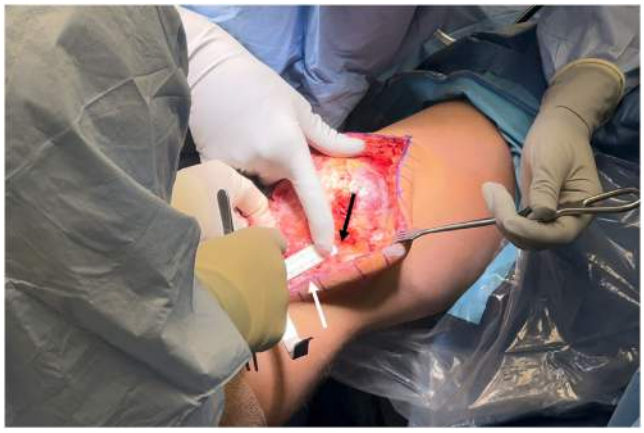

Fig 2. Medial collateral ligament (MCL) distal tibial attachment identification for an anatomic MCL and posterior oblique ligament reconstruction for a right knee with the patient in the supine position. A spinal needle (black arrow) should be placed at the medial joint line, from this spot, the distal tibial attachment of the MCL is located 6-cm distal to the joint line (white arrow). This point is marked with a methylene blue marker and is prepared for tunnel drilling.

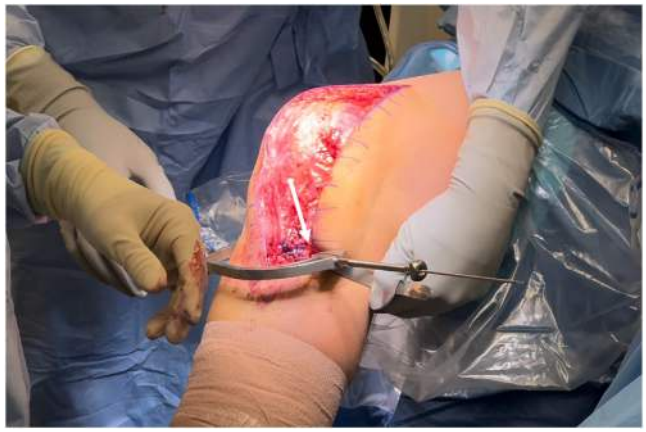

Fig 3. Medial collateral ligament (MCL) distal tibial tunnel drilling for an anatomic MCL and posterior oblique ligament reconstruction for a right knee with the patient in the supine position. A guide pin is drilled perpendicular across the tibia using the collateral guide set (Smith & Nephew, London, England) (white arrow). The guide pin is overreamed with a 7-mm reamer to a depth of 25-mm. A passing stitch is placed, and the distal aspect of the tunnel is notched.

Next, the femoral attachment of the POL is identified. A small arthrotomy is created to separate and lift the posteromedial capsule at the attachment site of the POL on the femur, located about 7.7-mm distal and 6.4-mm posterior to the adductor tubercle. A guide pin is drilled through the POL femoral attachment, parallel to the MCL guide pin (Fig 7). At least 9-mm between the pins is required to maintain a 2-mm bone bridge between the tunnels. It is very important to

Fig 4. Posterior oblique ligament (POL) tibial tunnel drilling for an anatomic medial collateral ligament (MCL) and POL reconstruction for a right knee with the patient in the supine position. The location for the POL tibial tunnel is identified, just distal to the anterior arm of the semimembranosus tendon. A guide pin is drilled across the tibia using the collateral guide set (Smith & Nephew, London, England), aimed toward the Gerdy tubercle (white arrow). The guide pin is overreamed with a 7-mm reamer to a depth of 25-mm. A passing stitch is placed.

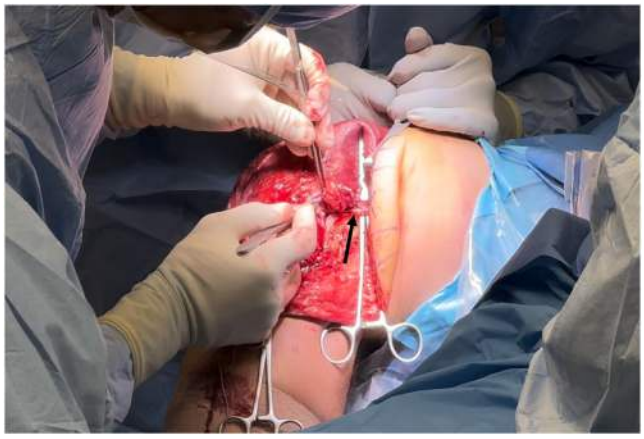

Fig 5. Adductor tendon and adductor tubercle identification for an anatomic medial collateral ligament (MCL) and posterior oblique ligament (POL) reconstruction for a right knee with the patient in the supine position. The adductor magnus tendon (black arrow) is commonly referred to as the "lighthouse" of the medial knee. From the adductor tubercle, which is identified by the adductor magnus tendon, other landmarks of the medial knee including the medial epicondyle, the MCL femoral attachment, and the POL femoral attachment can be located.

pass both guide pins and verify that they are both in the desired anatomic location because of their close proximity in case one or both pins need to be repositioned. Next, both guide pins are overreamed with a 7-mm reamer to a depth of 30-mm and passing stitches are placed.

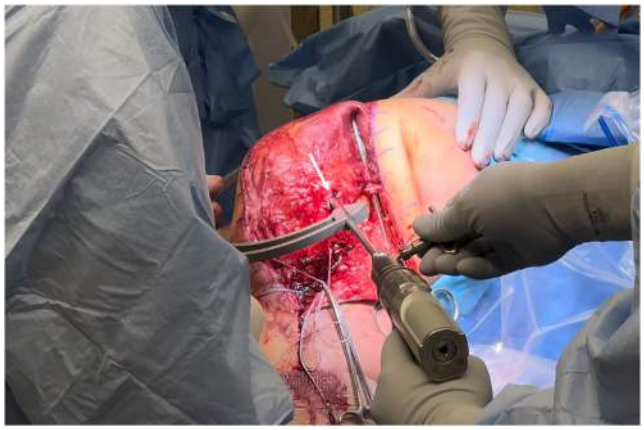

Fig 6. Medial collateral ligament (MCL) femoral tunnel drilling for an anatomic MCL and posterior oblique ligament (POL) reconstruction for a right knee with the patient in the supine position. The medial epicondyle is 12-mm distal and 8-mm anterior from the adductor tubercle. From the medial epicondyle, the MCL femoral attachment is just posterior and proximal. At this location, a guide pin is drilled anteromedially across the femur (white arrow). This is overreamed with a 7-mm reamer to a depth of 30-mm. A passing stitch is placed.

Fig 7. Posterior oblique ligament (POL) femoral tunnel drilling for an anatomic medial collateral ligament (MCL) and POL reconstruction for a right knee with the patient in the supine position. The MCL guide pin should be drilled first to establish a reference point (black arrow). The femoral attachment of the POL is on average 7.7-mm distal and 6.4-mm posterior to the adductor tubercle. A small arthrotomy is created through the posterior capsule to locate the anatomic attachment of the POL. A guide pin is drilled across the femur at this location (white arrow). This is overreamed with a 7-mm reamer to a depth of 30-mm. A passing stitch is placed.

Graft Preparation and Femoral Graft Fixation

The MCL graft is prepared from a tibialis anterior allograft and is 16-cm in length and whipstitched at each end with a No. 2 nonabsorbable suture (Smith &

Fig 8. Allograft preparation for an anatomic medial collateral ligament (MCL) and posterior oblique ligament (POL) reconstruction. The MCL graft is prepared from a tibialis anterior allograft and is 16-cm in length and whipstitched at each end with a No. 2 nonabsorbable suture (Smith & Nephew). The POL graft is prepared from a semitendinosus allograft and is 11-cm in length and whipstitched at each end with a #2 non-absorbable suture. In this case, the POL graft is marked with methylene blue marker.

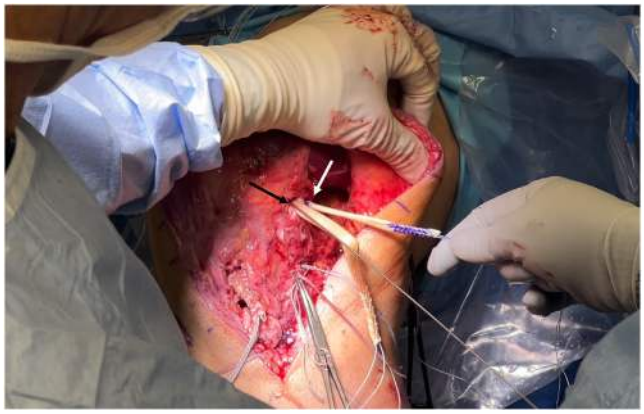

Fig 9. Femoral tunnel fixation for an anatomic medial collateral ligament (MCL) and posterior oblique ligament (POL) reconstruction for a right knee with the patient in the supine position. The MCL (black arrow) and POL (white arrow) grafts are first passed through their tunnels using a previously placed passing suture. The grafts are fixated with 7 × 20-mm bioabsorbable screws.

Nephew). The POL graft is prepared from a semitendinosus allograft and is 11-cm in length and whipstitched at each end with a No. 2 nonabsorbable suture (Fig 8).

First, the MCL and POL grafts are passed into their respective femoral tunnels and fixated with 7 × 20-mm bioabsorbable screws (Smith & Nephew) (Fig 9). It is important to pass both grafts into their femoral tunnels before fixation of either one because the close proximity of the tunnels may result in the initial interference screw impinging on the second graft tunnel, which would interfere with graft passage.

Final Graft Fixation

Soft-tissue channels are made from the femoral MCL and POL tunnels to the tibial tunnels. For the MCL, a channel is made under the superficial sartorial fascial tissues between the 2 reconstruction tunnels (Fig 10A). For the POL, a channel is created under the posteromedial capsular layer (Fig 10B). Both grafts are passed through these channels and passed into their respective tibial tunnels. The MCL graft is fixed first in the tibia with the knee at 30° of flexion, with a slight varus reduction force, and the knee in neutral rotation. A 7 × 20-mm bioabsorbable screw is used for fixation distal to the graft and at the previously notched position on the tibial tunnel (Fig 11A). The POL is fixated next with the knee in extension with a 7 × 20-mm bioabsorbable screw (Fig 11B). This final fixation eliminated the patient's valgus gapping and anteromedial rotation.

To reconstitute the proximal soft-tissue tibial attachment of the MCL, a Q-FIX anchor (Smith and Nephew) is placed 15 mm distal to the medial joint line. The MCL allograft is sutured to the Q-FIX anchor with the knee in 30° of flexion (Fig 12). Knee stability with the restoration of the valgus stress and anteromedial drawer tests is validated one last time. The tourniquet is let down and the deep and superficial tissues are closed with suture.

Postoperative Rehabilitation

The patient should be limited to 0-90° of knee flexion for the first 2 weeks and then may increase knee motion as tolerated. The patient should be non−weight-bearing for 6 weeks and then may weight bear as tolerated and wean from crutches. Progression to sport beings at 4 to 6 months and stress radiographs at 6 months should be performed to assess healing.

Discussion

In the setting of high-grade injuries to the PMC, especially with valgus gapping in extension and anteromedial rotatory instability, reconstruction of both the MCL and POL should be considered. Although reconstruction of both these structures together is less common, a systematic review by D'Ambrosi et al.[7] on outcomes after combined MCL and POL reconstruction reported satisfactory patient outcomes. Across the

Fig 10. Distal graft passage for an anatomic medial collateral ligament (MCL) and posterior oblique ligament (POL) reconstruction for a right knee with the patient in the supine position. A channel under the sartorial fascia to the MCL tibial tunnel is created and the MCL graft is passed through this channel (black arrow). A channel under the posteromedial capsule to the POL tibial tunnel is created and the POL graft is passed through this channel (white arrow).

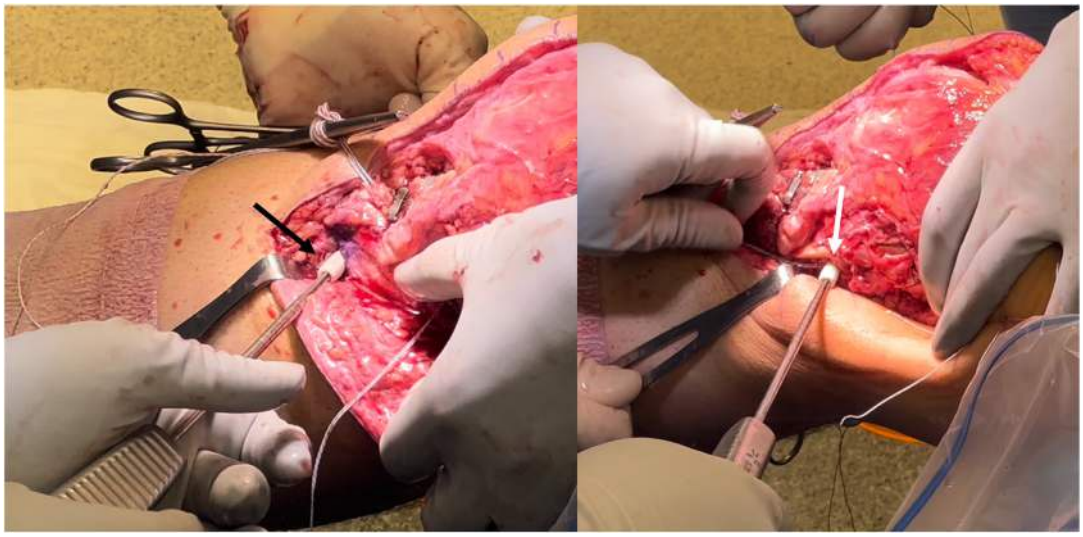

Fig 11. Tibial fixation for an anatomic medial collateral ligament (MCL) and posterior oblique ligament (POL) reconstruction for a right knee with the patient in the supine position. Both grafts are passed through their tibial tunnels using the passing suture that was previously placed. The MCL graft is fixated first with a 7 × 20-mm bioabsorbable screw at the previously placed distal notch in the tunnel with the knee in 30° of flexion and a slight varus force (black arrow). The POL is fixated next with a 7 × 20-mm bioabsorbable screw with the knee in extension (white arrow).

studies, they reported that 88% to 91.3% of patients were able to return to activities and only 10% of patients reported complications. A randomized controlled trial by LaPrade et al.[8] compared augmented MCL repair with autograft to MCL reconstruction with allograft and reported similar improvements in valgus stability between the 2 techniques but significantly greater Lysholm and Internation Knee Documentation Committee scores for the reconstruction technique.

Fig 12. Proximal tibial attachment of the medial collateral ligament (MCL) for an anatomic MCL and posterior oblique ligament (POL) reconstruction for a right knee with the patient in the supine position. A Q-FIX anchor (Smith & Nephew, London, England) is placed at the proximal tibial attachment of the MCL, located 15 mm distal to the joint line (white arrow). The double-loaded Q-FIX is fixated to the MCL using simple sutures with the knee is 30° of flexion.

The advantages of this technique include the use of allograft to avoid damaging and harvesting the hamstring tendons and the surrounding tissues, optimal reconstitution of the PMC by reconstruction of the MCL and POL, and anatomic reconstruction of the MCL by constituting its proximal and distal tibial attachments. The disadvantages of this technique include increased costs for using allografts, potential iatrogenic damage to the semimembranosus tendon during POL tibial tunnel drilling, and potential for tunnel convergence if this technique is used concomitantly with injuries to the anterior or posterior

Table 2. Advantages and Disadvantages of a Combined MCL and POL Reconstruction Using Allografts

Advantages	Disadvantages
No harvesting of the hamstring tendons for autografts	Increased costs for allografts
Anatomic repair of both the MCL and POL, including proximal and distal tibial attachments of the MCL	Potential iatrogenic damage to semimembranosus tendon during POL tibial tunnel drilling
Optimal reconstitution of the PMC by reconstructing the MCL and POL	Potential for tunnel converge with other ligament tunnels if performed concomitantly
Can be performed concomitantly with ACL, PCL, or PLC procedures	Large anteromedial incision
Robust fixation with tunnels	

ACL, anterior cruciate ligament; MCL, medial collateral ligament; PCL, posterior cruciate ligament; PLC, posterolateral corner; POL, posterior oblique ligament.

cruciate ligaments. All advantages and disadvantages are listed in Table 2.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: R.F.L. reports consulting or advisory and funding grants with Ossur; consulting or advisory, funding grants, and travel reimbursement from Smith & Nephew; consulting or advisory with Responsive Arthroscopy; funding grants from Arthroscopy Association of North America and American Orthopaedic Society for Sports Medicine; speaking and lecture fees from Foundation Medical; and patent with royalties paid to Ossur. All other authors (L.V.T., E.P.S., M.T.R., D.R.L.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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