Double-Row Suture Anchor Repair of Posterolateral Corner Avulsion Fractures

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Abstract: Posterolateral corner avulsion fractures are a rare variant of ligamentous knee injury primarily described in the skeletally immature population. Injury is often related to a direct varus moment placed on the knee during sporting activities. Various treatment strategies have been discussed ranging from nonoperative management, to excision of the bony fragment, to primary repair with screws or suture. The described technique is a means for achieving fixation of the bony avulsion using principles familiar to double-row transosseous equivalent rotator cuff repair. Proximal anchors are placed in the epiphysis, and sutures are passed in horizontal mattress fashion. Once tied, the limbs of these same sutures are then passed to more distal anchors. Remaining eyelet sutures can be used to manage peripheral tissue. The final repair provides anatomic reduction and compression of the fragment to its bony bed with minimal extracortical hardware prominence and no violation of the physis. Risks include potential for physeal injury or chondral damage to the lateral femoral condyle through aberrant anchor placement. Postoperative care includes toe-touch weight-bearing restrictions and range of motion restrictions of 0°-90° in a hinged brace for 6 weeks followed by gradual return to activity.

Reports of bony avulsion of the posterolateral corner (PLC) structures in the literature are sparse. The injury is most commonly reported in adolescent males engaged in sporting activities.[1] The bony fragment can include the femoral epiphyseal attachments of one or both of the popliteus and lateral collateral ligament (LCL) without involvement of the physis or metaphysis.[2-4] A purely ligamentous "peel-off" variant has been described in older patients.[5,6] Despite displacement of the origins of the major stabilizers of the lateral knee, clinical instability is not universally described. For this reason, conservative management with partial weight bearing and gradual return to activity has been successfully described.[7] Conversely, several techniques for operative management have been described in the setting of instability.[3,8-10]

With this in mind, we describe a technique for open primary repair of the PLC avulsion fracture. This technique has the advantages of using a suture anchor—only construct, minimizing the risk for hardware prominence or need for secondary surgery for hardware removal. Furthermore, it employs the concepts common to the arthroscopic sports medicine surgeon who performs double-row transosseous equivalent rotator cuff repair.

Tables 1 to 4 review the indications, key points, tips, pearls, pitfalls, risks, complications, and aftercare.

Surgical Technique

Diagnostic Arthroscopy and Approach

A thorough diagnostic arthroscopy is critical to proper diagnosis and management. A 30° scope can be used through a standard lateral viewing portal with a medial working portal. A probe introduced through the medial portal can be used to assess the medial and lateral compartment opening to a surgeon-applied valgus or varus stress, respectively. Because the degree of physiologic laxity may vary between compartments and between individuals, it can be helpful to assess the relationship of the meniscus to the tibia and femur as a key to the presence of pathologic instability (Fig 1). Any associated pathology should be treated. Careful examination of the anterior cruciate ligament (ACL) is paramount, as combined injury of the PLC and ACL is common.

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Table 1. Indications and Contraindications

Indications:
Bony avulsion fracture of the lateral distal femoral epiphysis
Clinical or radiographic signs of instability
Contraindications:
Fractures involving the physis or metaphysis

Once instability has been confirmed, a standard lateral approach centered over the lateral femoral epicondyle is planned extending distally towards Gerdy's tubercle and centered midway between the lateral border of the patella and the fibular head. The iliotibial (IT) band is split in line, exposing the fracture fragment, which is mobilized and debrided of callus. Care is taken to ensure that dissection proximally towards the physis is avoided.

Proximal Anchor Placement

By placing reduction sutures around the fragment edges, a provisional reduction can be performed that reveals the ideal positions for proximal row anchors. Once the fracture bed has been prepared, a punch for a 4.5- or 5.5-mm (dependent upon patient and fracture bed size) double-loaded Bio-Suture Tak anchor (Arthrex, Naples, FL) is inserted to the appropriate depth. The process is then repeated with a second anchor. Fluoroscopy is used to ensure the planned anchor placement is confined to the epiphysis and does not violate the distal femoral physis.

Sutures are then passed sequentially in a horizontal mattress fashion and tied, reducing the proximal end of the fragment, while the knee is flexed to 30° over a bump, and a slight valgus stress is applied to prevent gap formation or residual laxity (Figs 2 and 3).

Distal Row Anchor Placement

The suture tails from the tied proximal anchors are then divided, and one suture from each knot is selected and loaded through a 4.75-mm SwiveLok Anchor (Arthrex) consistent with a previously described suture bridge technique.[11-13] By tensioning the sutures through the anchor and assessing possible anchor positions, the ideal location can be identified, providing the best coverage of the fracture fragment.

Table 2. Key Points and Tips

Key Points:
Anatomic reduction with secure fixation and restoration of anatomy are the primary treatment goals.
A thorough understanding of anatomy and biomechanics of the lateral knee is paramount.
Tips:
Adequate debridement of the fragment improves visualization and facilitates complete reduction of the fracture.
Use free traction sutures to obtain provisional reduction prior to definitive anchor placement.
The eyelet sutures from the distal row suture anchors can be used for management of fracture edge dog ears.

Table 3. Pearls, Pitfalls, Risks, and Complications

Pearls
Placement of a spinal needle into the lateral gutter under arthroscopic visualization can help guide lateral incision placement and minimize the required skin incision.
Because the exposed bony bed is cancellous, a tap is not routinely required.
If extended arthroscopy is expected due to treatment of associated pathology, consider performing the open dissection and tagging structures for planned repair prior to arthroscopy to improve visualization.
Pitfalls and Risks:
Failure to position the knee at 30° and provide a reducing valgus stress prior to suture tying risks residual fracture gapping.
Dissection too distally risks damage to the peroneal nerve.
Dissection too proximally risks damage to the distal femoral physis.
Complications:
Physeal injury and subsequent growth disturbance
Symptomatic hardware
Failure of repair with recurrent laxity
Potential need for conversion to reconstruction

The appropriately sized tap is then inserted in the desired location near the articular border and is directed somewhat proximally away from the articular surface. Fluoroscopy and a brief arthroscopy are then used to confirm that the articular surface and femoral notch are not violated prior to anchor placement (Fig 4). The anchor is then placed, and sutures are individually tensioned to provide compression of the fracture fragment to its bony bed. The process is then repeated with a second anchor (Fig 5). Any relevant dog ears can be managed by passage of the distal row eyelet sutures placed in simple fashion to reduce tissue not captured by the remainder of the construct. All remaining sutures are cut.

Final Closure

A final arthroscopic examination is performed to demonstrate elimination of pathologic laxity and to ensure no violation of the articular cartilage with suture anchors. Final fluoroscopic images are obtained to demonstrate the final reduction. Physical examination is performed to confirm no range of motion (ROM) loss and restoration of varus stability and elimination of pathological rotatory instability. Stress radiographs can be obtained if desired. The wound is copiously irrigated, and then layered closure is performed of the IT band, subcutaneous layers, and skin (Fig 6).

Table 4. Aftercare

Aftercare
Toe-touch weight bearing for 6 weeks with crutches and brace
Limit range of motion to 0°-90° for 6 weeks
Closed kinetic chain exercises at 6 weeks
Open kinetic chain exercises at 8 weeks
Impact at 10 weeks
Return to sport at 3 months

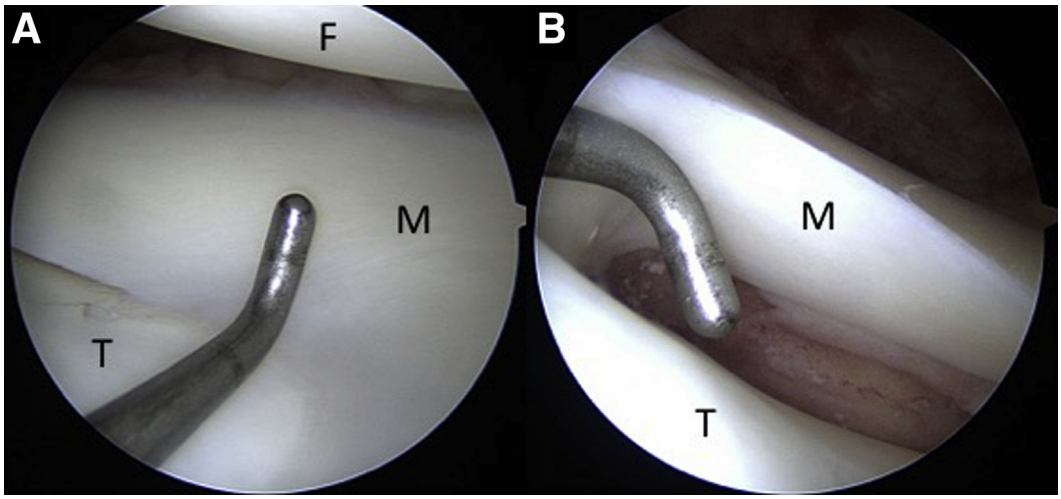

Fig 1. (A) Arthroscopic view of a right knee medial compartment with the 30° arthroscope in the lateral viewing portal using a 5-mm probe and physician-applied valgus. Notice the normal relationship of the femur (F), meniscus (M), and tibia (T), despite the relatively large physiologic gapping of the joint space. (B) Arthroscopic view of a right knee lateral compartment with the 30° arthroscope in the lateral viewing portal using a 5-mm probe and a physician-applied varus stress. Notice the abnormal separation of the meniscus from the tibia, "drive-through" sign, and inflamed synovium of the posterior capsule consistent with posterolateral corner insufficiency.

The entirety of the technique is described in Video 1.

Aftercare

The postoperative protocol should be determined by the treatment of concomitant pathology and repairs. In regards to the PLC repair alone, the patient will be toe touch weight bearing for 6 weeks, with the use of a hinged knee brace and crutches. ROM will be restricted to 0°-90 °s during this time. Six weeks postoperatively, the patient may begin to wean from the crutches and brace, bearing weight as tolerated. The physical therapist may also progress ROM to full as tolerated. Closed kinetic chain exercises may begin at the 6-week mark, followed by open kinetic chain at 8 weeks and impact activities at 10 weeks. Return to unrestricted sport can be anticipated at 3 months after surgery after confirmation of radiographic healing and restoration of normal stability on physical examination.

Discussion

Injury to the PLC in the skeletally immature is rare in the literature. Most reports have been of isolated injury to the popliteus tendon,[8] while others report avulsion of both the LCL and popliteus.[3] The characteristic findings are an adolescent athlete with a history of varus-directed force, hemarthrosis, and osteochondral fragment of the distal lateral extra-articular femoral epiphysis visible on radiographs with associated injury to the popliteus and/or LCL on magnetic resonance imaging.[3,4]

Both surgical and nonoperative management have been suggested in cases both with and without clinical exam findings consistent with PLC insufficiency.[7-9] A risk of nonoperative treatment is development of a bony bridge resulting in progressive valgus deformity requiring late osteotomy.[1] Methods of operative fixation vary from suture repair over a bony bridge, suture repair with suture anchors, and repair with screws and washers.[3,8-10]

The presence or absence of clinical instability should be determined by means of physical exam with testing at 0° and 30° to varus stress, as well as with posterolateral drawer and dial tests. Stress radiographs may be used adjunctively as described elsewhere for purely ligamentous injuries, but there is the potential for poor

Fig 2. Right knee supine position with the distal leg oriented to the right of the image. Proximal anchors have been placed, and suture limbs are being passed by free needle through the fracture fragment and retrieved superficially. Note that the proximal row is secured more posteriorly and superiorly.

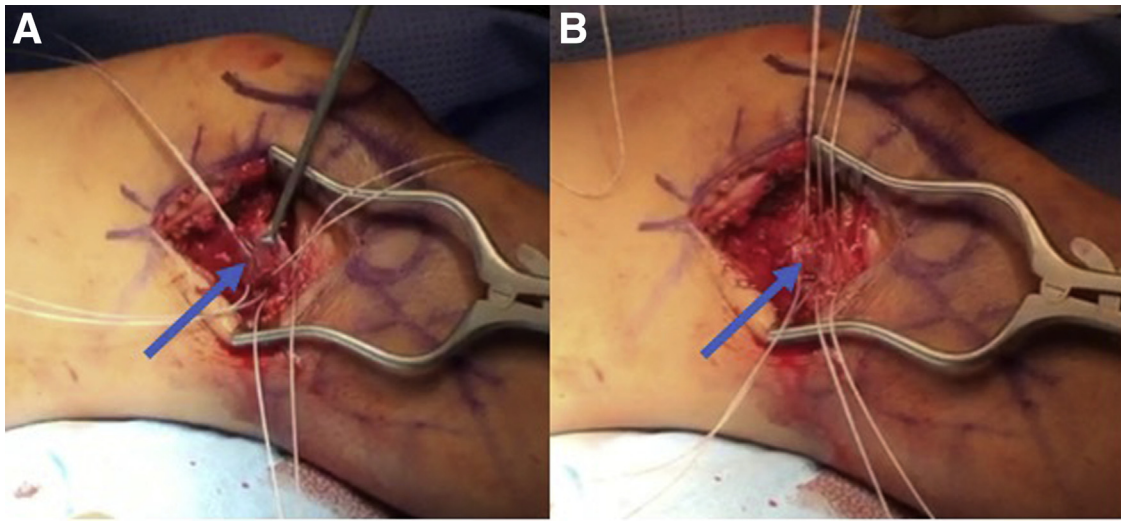

Fig 3. Right knee supine position with the distal leg oriented to the right of the image. (A) After placement of 2 suture anchors in the fracture bed, sutures have been passed in horizontal mattress fashion through the fracture fragment (blue arrow). (B) Provisional reduction is obtained by traction on the free suture ends.

tolerance in this population in the acute setting and theoretical risk of displacement of the fragment.[14] In discussion with patients and family members regarding treatment options, it should be considered that treatment of nonunion, malunion, or persistent instability may be more difficult in the chronic or subacute setting.

Primary repair of purely ligamentous femoral PLC avulsion injuries has been proven to be effective in the adult population[15,16]; however, given the relative rarity of this injury pattern, no outcome studies are available for review of pediatric bony avulsion injuries treated operatively.

Other options for treatment of these injuries could include screw fixation or screw and washer fixation. This has inherent limitations due to the short screw length, which can be achieved at the popliteus as screws in this location can risk penetration of the intercondylar notch. Primary reconstruction is also a treatment option; however, this requires additional tissue and morbidity (if autograft) or cost and disease transmission risk (if allograft). Additionally, this requires larger tunnels and larger fixation devices as well as a larger exposure.

Fig 4. Fluoroscopic image of a right knee demonstrating a punch (blue arrow) placed in the distal aspect of the lateral femoral epiphysis. Note that the punch is directed proximally away from the articular surface but still distal to the physis. A metallic self-retaining retractor is present in the lateral incision.

Fig 5. Right knee supine position with the distal leg oriented to the right of the image. Suture limbs from each proximal anchor knot are loaded to a distal anchor for placement anteriorly and inferiorly, nearer the articular margin in the position previously punched and tapped.

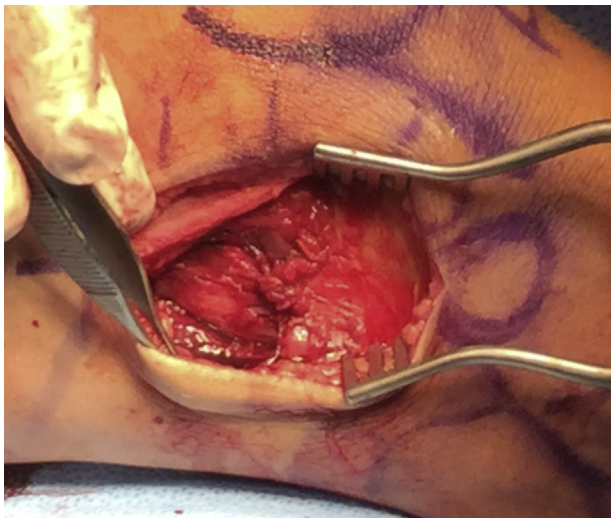

Fig 6. Right knee supine position with the distal leg oriented to the right of the image. Finalized repair is demonstrated.

The primary advantages of this technique are that it employs tools, implants, and techniques common to the arthroscopic surgeon and applies them to an uncommon pathology. The suture anchors are of a small diameter and are nonmetallic, decreasing the risk of hardware-associated complications. The repair construct is sufficient to allow early ROM for functional rehabilitation as has been illustrated in the case of rotator cuff repair.[13]

Risks of this technique include failure to capture the entire bony fragment, leaving a remnant that does not heal. Also there is the possibility of overtensioning the repair, resulting in constraint of the knee.

One primary limitation of this technique is that it may be difficult to capture or completely reduce the entire fragment. While appearing to be a single piece of bone on imaging, the femoral attachments are more often a highly comminuted shell of bone, which is held together by the avulsed soft tissues. Furthermore, use of certain sizes of suture anchors may be limited by the depth and surface area of the lateral femoral condyle in smaller patients.

In conclusion, primary suture anchor repair of a bony avulsion fracture of the lateral distal femoral epiphysis can be an effective technique for anatomic reduction and fixation using implants and techniques common to a technically skilled arthroscopic sports medicine surgeon familiar with the double-row transosseous equivalent technique of rotator cuff repair.

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