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Diagnosis and Treatment of Posterolateral Knee Injuries

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Posterolateral knee injuries can be very debilitating. It is important to understand the complex anatomy and pertinent diagnostic tests to properly treat posterolateral knee injuries. The fibular collateral ligament, popliteus tendon, and the popliteofibular ligament are the main static stabilizers against abnormal varus and posterolateral translational moments. Important radiographic imaging studies for the posterolateral knee include full length anteroposterior radiographs, taken with the patient standing, to assess for varus alignment in patients with chronic injuries and high field (1.5 tesla or higher) magnetic resonance imaging with specific posterolateral knee sectioning. A physical examination that includes the external rotation recurvation test, varus stress test at 30°, dial test at 30° and 90°, posterolateral drawer test, reverse pivot shift, and an assessment for a varus thrust gait are essential to properly diagnose a posterolateral knee injury. Patients with acute (< 3 weeks) anatomic repairs of Grade III posterolateral knee injuries have the best functional outcome. Although various surgical reconstruction techniques have been developed to treat chronic or irreparable acute posterolateral knee injuries, these techniques have not achieved outcomes comparable with the treatment of other ligament injuries of the knee. Techniques for anatomic reconstructions of these structures are just being developed. Improved education of clinicians as to the proper diagnosis of posterolateral knee injuries is necessary because a large number of these injuries still are missed on initial examinations. In addition, additional research into the most optimal posterolateral knee reconstruction techniques and outcome studies are needed to improve the treatment of this debilitating knee injury.

Injuries to the posterolateral corner of the knee increasingly have been recognized as a source of disability in patients. During the past several years, a concerted effort has been made to define more precisely the specific anatomic structures that comprise the posterolateral knee.[13,14,20,25–28] Through that work, more specific means to diagnose these injuries clinically, radiographically, and arthroscopically have been found.[11,13,17]

Posterolateral knee injuries have been found to be one of the most debilitating ligament injuries of the knee. Because of the convex opposing surfaces of the lateral femoral condyle and lateral tibial plateau, patients with posterolateral knee injuries may have instability even with normal gait. This is because the lack of the static posterolateral corner structures at foot strike, combined with the convex surfaces of the opposing lateral femoral condyle and lateral tibial plateau, results in lateral compartment

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opening. This varus-thrust gait pattern can be very disabling. In addition, if this injury is not recognized when there is a concurrent anterior cruciate ligament or posterior cruciate ligament tear, failure to repair or reconstruct the posterolateral corner structures at the time of cruciate ligament reconstruction places the cruciate ligament grafts at significant risk for failure.[7,16,18,19,23]

Applied Anatomy of the Posterolateral Corner of the Knee

It is important to understand the anatomy of the main static stabilizers of the posterolateral aspect of the knee to understand their biomechanical function, to observe them on magnetic resonance imaging (MRI) scans, or to repair or reconstruct these structures at the time of surgery. An overview of the main static stabilizers of the posterolateral aspect of the knee follows.

The fibular collateral ligament is the primary static stabilizer to varus opening of the knee.[4,5] It is thought to be most important in preventing varus instability of the knee in the initial 0° to 30° arc of knee flexion and has been observed to become slightly lax with additional degrees of knee flexion in the static testing condition.[4,5] However, these static tests discount the dynamic effect of the aponeurotic layers of the long and short heads of the biceps femoris on providing tension on the fibular collateral ligament dynamically.

The main attachment site of the fibular collateral ligament on the femur is at a point slightly proximal and posterior to the lateral epicondyle.[28] Its overall length is approximately 70 mm.[14] Its main attachment site distally is to the lateral aspect of the fibular head. At its more distal attachment site, the fibular collateral ligament's attachment on the fibular head is identified easily by making a horizontal incision through the anterior arm of the long head of the biceps femoris and entering the fibular collateral ligament-biceps bursa.[14] This has been found to be a common site of distal avulsion or midsubstance injuries to this ligament.[13,17]

The popliteus muscle and tendon complex on the posterolateral aspect of the knee has many components that provide a static and dynamic stabilizing effect to posterolateral rotation of the knee.[6,25,28] The popliteus tendon's main attachment is at the proximal fifth of the popliteus sulcus of the femur. From this point, the popliteus tendon courses distally and posteriorly, where it gives off three fascicles to the lateral meniscus (anteroinferior, posterosuperior, and posteroinferior fascicles).[25,28] These fascicles have been shown to have importance in providing stability to motion of the lateral meniscus.[12] After this point, the popliteus tendon continues more distally to the musculotendinous junction. At the musculotendinous junction, there are two divisions of the popliteofibular ligament that course laterally and distally from the musculotendinous junction to attach on the posteromedial aspect of the fibular styloid.[25,28] The popliteofibular ligament complex has been found to be an important stabilizer of external rotation of the knee.[20] In addition to the structures previously mentioned, the popliteus muscle also has an aponeurotic layer that courses from the popliteus muscle belly up to the posterior horn of the lateral meniscus.[28]

The midthird lateral capsular ligament is a thickening of the lateral capsule of the knee.[28] It is thought to be semiequivalent to the deep medial collateral ligament complex of the medial aspect of the knee.[12] This thickening of the lateral capsule extends from the capsular attachments from just anterior to the popliteus tendon attachment on the femur to the lateral gastrocnemius attachment. It then extends distally to its tibial attachment from slightly posterior to Gerdy's tubercle to the popliteal hiatus.

The midthird lateral capsular ligament can be divided into two components. The meniscofemoral component extends from the femur down to the meniscus. The meniscotibial component extends from the meniscus to the tibia. The meniscotibial component is found to be injured more frequently, most commonly with an avulsion off the tibia with or without a bony fragment (Segond fracture).[13,15] The midthird

lateral capsular ligament is thought to be an important secondary stabilizer to varus instability of the knee.[12]

The long head of the biceps femoris has five components at the knee[27,28] (Fig 1). The most important of these are the direct arm attachment to the posterolateral aspect of the fibular styloid, the anterior arm that courses lateral to the fibular collateral ligament, and the lateral aponeurotic attachment to the posterolateral aspect of the fibular collateral ligament.

The short head of the biceps femoris also has five major attachments at the knee.[27,28] The first major component of these is the capsular arm of the short head of the biceps femoris. The capsular arm extends from the main tendon of the short head of the biceps to the posterolateral aspect of the capsule and attaches just lateral to the tip of the fibular styloid. It provides a stout attachment to the posterolateral capsule, lateral gastrocnemius tendon, and the capsuloosseous layer of the iliotibial band. The more distal edge of the capsular arm is the fabellofibular ligament.[13,15,17,28] The fabellofibular ligament is found to be tight in extension and difficult to identify with increasing degrees of knee flexion as it becomes lax. Other important structures of the short head of the biceps femoris at the knee are a direct arm attachment to the posterolateral aspect of the fibular styloid and an anterior arm attachment that passes medial to the fibular collateral ligament and attaches with the meniscotibial portion of the midthird lateral capsular ligament on the tibia. The anterior arm of the short head of the biceps femoris frequently is found to be avulsed with a Segond fracture or a soft tissue Segond injury. This injury pattern frequently is recognized on coronal MRI scans through this area.[13]

Fig 1. A lateral view of a right knee shows the superficial layer of the iliotibial band, the tendinous portion of the long head of the biceps femoris, and the muscular portion of the short head of the biceps femoris. The fibular collateral ligament's outline is seen deep to the lateral aponeurotic layers of the biceps.

The iliotibial band[26,28] also is important in preventing increasing varus opening of the knee.[9] The superficial layer is a layer first encountered after dissecting through the subcutaneous tissues on the lateral aspect of the knee (Fig 1). It attaches to Gerdy's tubercle and extends proximally. In addition, a deep layer attaches this to the region of the lateral intermuscular septum. The capsuloosseous layer also extends from the region of the lateral intermuscular septum, blends with a confluence from the short head of the biceps femoris, and attaches to the anterolateral aspect of the tibia just posterior to Gerdy's tubercle. In this regard, it acts as an anterolateral sling to the knee. Because the superficial layer of the iliotibial band is infrequently injured with a posterolateral knee injury, it serves as an important reference for many of these other structures, and many of the surgical incisions for posterolateral corner repairs or reconstructions are based through it.[11,28]

Diagnosis of Posterolateral Knee Injuries

A history and physical examination that is done properly, with the knowledge of the patient's history and how to do examinations specific to the posterolateral knee, will allow the clinician to arrive at a diagnosis of posterolateral knee injuries in the majority of cases. In those instances where it is difficult to determine whether there is a posterolateral knee injury, such as in cruciate ligament or other ligament injury, the use of radiographs, MRI scans, or both may be a useful adjunct in the assessment of the location and severity of posterolateral knee injuries.

The majority of posterolateral knee injuries are caused by a blow to the anteromedial aspect of the knee, a contact or noncontact hyperextension injury, or a varus noncontact injury.[17] The majority of posterolateral knee injuries have been found to occur in combination with other ligamentous injuries. The most common combined injuries are anterior cruciate ligament and posterolateral corner and posterior cruciate ligament and posterolateral corner.[17] In this regard, it is important that the clinician not overlook a potential posterolateral corner injury in a patient with a cruciate ligament injury. In addition, 15% of patients with posterolateral knee injuries have been found to have a common peroneal nerve injury.[17] It is important to ask these patients at the time of their examination whether they had a history of any tingling or numbness in their lower extremity or any associated muscle weakness, especially for ankle dorsiflexion and great toe extension.

One of the first tests that is done as part of the posterolateral knee examination is the external rotation recurvatum test.[8,12,16] In doing this test, the clinician lifts up the great toe while stabilizing the patient's thigh as necessary, to determine whether there is any increase in recurvatum (hyperextension) of the effected knee. If there is, there is also commonly a component of relative varus alignment to the knee. A positive external rotation recurvatum test usually is indicative of a severe knee ligament injury. It has been found to be positive most commonly with a posterior cruciate ligament or bicruciate ligament injury. Measurement of the external rotation recurvatum test usually is expressed in negative degrees of knee motion or in increased heel height difference compared with the contralateral side.

The varus stress test at 0° and 30° knee flexion can be done next.[12,17] This test is done by stabilizing the thigh against the examining bed and applying a varus force across the knee by means of grasping the foot or ankle. The current authors do not recommend that this test be done solely by grabbing the distal leg because it does not allow for any rotation to occur at the joint, which may underestimate the amount of abnormal motion caused by injury.

A positive varus stress test at 0° knee flexion usually is indicative of a severe posterolateral knee injury. In addition, there is likely a component of a cruciate ligament injury because of the stabilizing effect of the anterior cruciate ligament and posterior cruciate ligament to varus stress in this position. When this test is positive, the posterolateral knee structures that are injured most commonly are the fibular collateral ligament, the meniscotibial portion of the midthird lateral capsular ligament, the popliteus tendon, and possibly the superficial layer of the iliotibial band.[17]

The varus stress test at 30° knee flexion is done next. This is done over the side of the examining table, while the distal thigh is stabilized. While doing this test, the examiner should place his or her fingers directly over the joint line to have an estimation of the amount of joint line opening in millimeters. Concurrent with this test, the contralateral healthy knee also needs to be examined. This is because some patients have a physiologic increase in varus joint line opening, especially in patients with an underlying amount of genu recurvatum.[3,17] The current authors classify the grade of joint line opening according to the guidelines of the American Medical Association.[1] Grade 1 injuries have 0 to 5 mm of opening, Grade 2 injuries have 5 to 10 mm of opening, and Grade 3 injuries have greater than 1 cm of joint line opening compared with the contralateral side. Smaller grades of joint line opening are indicative of a partial posterolateral corner injury, usually with a partial tear of the fibular collateral ligament or an isolated tear of the meniscotibial portion of the midthird lateral capsular ligament. Higher amounts of varus opening at 30° knee flexion usually are indicative of a complete tear of the fibular collateral ligament and injuries to other varus-stabilizing structures on the posterolateral aspect of the knee.[17]

The dial test, or posterolateral rotation test, is done at 30° and 90° knee flexion. It has been

found in the laboratory to provide a good assessment of the amount of posterolateral knee injury.[4,5,29] However, it is slightly more difficult to assess in the clinical situation. This test can be done with the patient either prone or supine. The current authors prefer to do the test with the patient supine, with the knee flexed over the side of the examining bed[12,15] (Fig 2). The thigh is stabilized and one foot is used to apply a rotation force through the foot and ankle. The examiner then looks for the amount of external rotation of the tibial tubercle, and compare it with the contralateral healthy knee.

An increase of 10° to 15° external rotation at 30° knee flexion, compared with the contralateral side, indicates a concurrent posterolateral knee injury.[2,4,5] Once the test has been done at 30° knee flexion, it is repeated at 90°. Normally, in an isolated posterolateral knee injury, there will be a decrease in external rotation at 90° compared with 30°.[5] If there is an increase of external rotation in the dial test at 30° knee flexion, it is indicative of a combined posterior cruciate ligament and posterolateral corner knee injury.[5]

Fig 2. A photograph shows the dial test at 30° in a left knee. The examiner looks for an increased amount of external rotation of the tibial tubercle, compared with the contralateral healthy knee.

The posterolateral drawer test first was described by Hughston and Norwood in 1980.[8] This test assesses the amount of posterolateral rotation of the knee at 90° knee flexion. An increase of posterolateral rotation in this test, compared with the contralateral knee, usually is indicative of a popliteus complex injury. It is important to differentiate this test from the posterior drawer test in neutral rotation (which tests the integrity of the posterior cruciate ligament). In the posterolateral drawer test, the knee is flexed to approximately 90°, similar to the starting position for a posterior drawer test, but the foot is rotated externally to 15°. The current authors prefer to sit on the foot to ensure that the foot is stabilized.[12,17] A gentle posterolateral rotation force then is applied to assess the amount of posterolateral rotation in the knee. It is important to compare increased amounts of posterolateral rotation with the healthy contralateral knee because there is some normal laxity seen in patients with physiologic genu recurvatum.[3]

The reverse pivot shift first was described by Jakob et al in 1981.[9] In this test, which is almost like the reverse of the normal pivot shift test of the knee, the knee is flexed to 45° to 60°, the foot is rotated externally, and a valgus stress is applied to the knee. The knee then is extended slowly. If the knee is subluxed (or dislocated) in flexion, it will be reduced by the iliotibial band as it changes function from a flexor to an extender of the knee at approximately 25° to 30° knee flexion. Basically, this test is a dynamic posterolateral drawer test. It is important to compare a positive reverse pivot shift test with the contralateral knee, because this test has been found to have the largest variability among all knee motion tests.[3] In 1991, Cooper[3] found it to be present in 35% of healthy knees examined with the patients under anesthesia.

In addition to the aforementioned clinical tests, it also is important to assess the patient's gait pattern, especially in a patient with a potential chronic posterolateral corner injury. Some

of these patients will have evidence of a varus thrust gait pattern, in which the lateral compartment of the knee opens up at foot strike and the joint is subluxed in varus and is readily visible by observing the patient from either anterior or posterior. Many of these patients have an underlying genu varus alignment. In some patients with a propensity toward this type of gait pattern, with time, they have learned to adapt with a flexed knee gait such that they do not thrust at foot strike. It also is important to recognize that not all patients who have a varus thrust gait have a posterolateral knee injury. Some patients who have this gait pattern have a component of medial compartment arthritis whereby they collapse on the medial compartment rather than truly open up the lateral compartment at foot strike. Plain radiographs of the knee and a clinical assessment will help to differentiate the difference between these two conditions.

Plain radiographs can be useful in the assessment of posterolateral knee injuries. A plain anteroposterior (AP) view will help to differentiate medial compartment arthritis from a normal medial compartment in patients who may have a varus thrust gait pattern. An AP radiograph with the knee in varus thrust also can be useful to assess the amount of lateral compartment joint line opening.[12] In addition, the AP view of the knee can be very helpful to observe Segond and arcuate avulsion fractures of the lateral capsule and fibular head, respectively.[13,17,24] In addition, it is important to obtain AP long leg (from hip to ankle) radiographs taken with the patient standing in patients who have chronic injuries to determine whether they have an underlying varus alignment of the injured extremity.

The use of high quality MRI scans has been found to be very useful in the assessment of injuries to individual structures of the posterolateral aspect of the knee.[13] In addition to the standard coronal, sagittal, and axial cuts, it has been found that the addition of thin-sliced (2 mm) proton density coronal oblique images, which include the entire fibular head and styloid, are very useful to obtain images of the fibular collateral ligament and popliteus tendon[13] (Fig 3). The current authors have found it to be very difficult to evaluate injuries to the posterolateral structures of the knee on low signal magnets. It is recommended that these MRI scans be obtained on 1.5 T magnets (or higher). Using these techniques, it was found that an MRI scan is very useful to assess injuries to the iliotibial band (superficial and deep layers), long head of the biceps femoris (direct and anterior arms), short head of the biceps femoris (direct arm and anterior arm), fibular collateral ligament, popliteus complex (femoral attachment, popliteomeniscal fascicles, and popliteofibular ligament), and the fabellofibular ligament.[13]

In addition to the history and physical examination and radiographic imaging techniques, arthroscopic evaluation of the lateral compartment of the knee also has been found to be very useful in the assessment of posterolateral knee injuries.[11] This can be useful in patients in whom it is still difficult to determine whether there is an underlying component of posterolateral knee injury. In a prospective series of 30 patients who had Grade 3 posterolateral knee injuries, all patients had a drive-through sign present, whereby there was greater than 1 cm of lateral joint line opening to a varus stress applied to the joint at the time

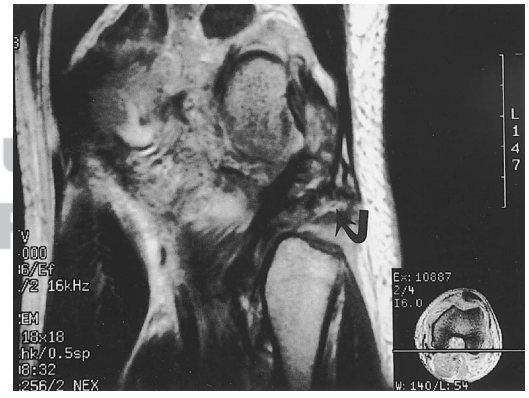

Fig 3. A coronal MRI scan of a left knee shows an arcuate fracture of the fibular head and styloid (arrow).

Fig 4. An arthroscopic drive-through sign of the lateral compartment of a right knee with a posterolateral knee injury is shown.

of arthroscopic evaluation[11] (Fig 4). The use of arthroscopy was found to be helpful in the surgical planning of incisions and the identification of injuries to individual structures of the posterolateral aspect of the knee. It was found to be especially helpful in determining injuries to the coronary ligament of the posterior horn of the lateral meniscus, avulsions of the popliteus tendon off the femur, tears of the popliteomeniscal fascicles, and in helping to assess whether the major component of the posterolateral knee injury was meniscofemoral or meniscotibial based. Injuries to individual structures of the posterolateral knee that are found to be readily identified include the popliteus tendon attachment on the femur, the popliteomeniscal fascicles, the meniscofemoral and meniscotibial portions of the midthird lateral capsular ligament, and the coronary ligament to the posterior aspect of the lateral meniscus.

Treatment of Injuries to the Posterolateral Corner of the Knee

Treatment of Isolated Posterolateral Knee Injuries

The recommended treatment for patients with Grade 1 to 2 posterolateral knee complex injuries (partial injuries) initially is nonoperative. The current authors generally tend to treat patients who have these injuries with a knee immobilizer in full extension for 3 to 4 weeks with no knee motion allowed. The patients may do quadriceps sets and straight leg raises in their immobilizer only. They also are nonweightbearing at this time. At the end of this period of immobilization, the patients are allowed to work on range of motion (ROM) of their knee and may initiate weightbearing at that point. They are allowed to increase their weightbearing as tolerated and may ambulate off crutches when they can walk without a limp. Closed chained quadriceps exercises, with the avoidance of active hamstring exercises for the first 6 to 10 weeks after injury, are allowed.

Patients who complain of pain or instability after this period of nonoperative treatment need to be reevaluated carefully to determine whether they have any instability present in their knee or whether they have any gait abnormalities. The specific tests used to determine abnormal knee motion for patients with posterolateral knee injuries should be repeated. In addition, a small percentage of these patients may have lateral knee pain with activities. In most instances, their MRI scans have been found to be normal. If the pain is accentuated by the examiner placing the knee in a figure-four position (the figure-of-four test), these patients may have a tear of their popliteomeniscal fascicles. Tearing of these fascicles results in increased lateral meniscal hypermobility and the meniscus is entrapped in the joint when the knee is put in the figure-four position. It is important to determine whether these patients have a reproduction of their symptoms with this maneuver. If they do, these patients have been found to benefit from repair of the lateral meniscus back to the popliteomeniscal fascicles of the popliteal hiatus.

In general, patients who have Grade 3 injuries to the posterolateral corner of the knee have been found to do poorly with nonoperative treatment.[10] It has been shown that the results of acute repairs are much better than the results of chronic repairs of posterolateral knee injuries.[15] In addition, it has been found that after approximately 3 weeks after injury, there is a significant development of scar tis-

sue planes along the posterolateral knee. Identification of the common peroneal nerve is complicated greatly by these scar tissue planes. For this reason, the current authors recommend that an attempted anatomic repair of individual structures of the posterolateral knee should be done within the first 1 to 2 weeks after injury.[12,15]

Repair of the injured posterolateral knee structures usually are treated with direct suture repair back to bone, suture anchors, a recess procedure, or supplemental fixation with local tissues (a portion of the iliotibial band or biceps femoris tendon). The current authors recommend that an avulsion of the popliteus tendon or the fibular collateral ligament off of their femoral attachment be repaired with a recess procedure. In the recess procedure, a small bone tunnel is drilled at the normal attachment site of the avulsed structure. Sutures then are placed in a whip stitch type pattern into the avulsed structure and then are passed over to the medial aspect of the knee with the use of a stylette pin. The sutures then are pulled medially and the avulsed structure then is pulled up into the bony tunnel. The sutures then are tied over a button on the anteromedial aspect of the femur. The recess procedure results in a secure repair that allows for early ROM.[12,15]

Tears of the meniscotibial portion of the midthird lateral capsular ligament usually are able to be repaired back directly to the tibia with sutures put directly through bone. The bone in this area of the anterolateral tibia usually is soft enough to be able to place a large needle through the bone and to obtain a secure fixation of a soft tissue Segond or a bony Segond avulsion injury of this area.[13,15] Direct suture repair back to bone also allows for early ROM without the fear of slippage of the tissues in the early postoperative period.

Avulsions of the direct arms of the biceps femoris, the fibular collateral ligament, or the popliteofibular ligament off the fibular head and styloid can be repaired directly back to bone with the use of suture anchors or direct suture repair through drill holes. The authors most commonly use suture anchors to achieve a more secure fixation. Avulsion fractures of the fibular head and the styloid (arcuate fractures)[24] usually include the popliteofibular ligament, direct arms of the long and short heads of the biceps femoris, and the fibular collateral ligament.[13] The avulsion fractures usually are repaired back to an anatomic position with a cerclage nonabsorbable suture or wire. Occasionally, large fractures may be able to be fixed by an open reduction and internal fixation. The most important factor is to attempt to obtain an anatomic reduction with secure fixation such that early ROM can be initiated.[12,15]

Other structures that may be injured on the posterolateral aspect of the knee usually are repaired by side to side suture repair. These include tears of the coronary ligament of the posterior horn of the lateral meniscus, the popliteomeniscal fascicles, portions of the iliotibial band, and other components of the long and short heads of the biceps femoris.

The main goal with an anatomic repair of injured posterolateral structures is to achieve a stable and secure repair such that early ROM can be initiated. In patients in whom there is tenuous fixation after suturing, especially in patients who may be 3 weeks or more from their acute injury, a period of cast immobilization may be necessary to allow healing.[15] In patients who do need some form of cast immobilization as part of their treatment regimen, the current authors recommend that a cast be applied at 60° knee flexion with the tibia internally rotated for 3 to 6 weeks. To prevent external rotation in the cast during this period of immobilization, the current authors commonly use a dowel rod placed at the base of the foot of the cast and positioned to prevent external rotation.

The postoperative treatment regimen for patients who have a primary repair of injured posterolateral structures includes a minimum of nonweightbearing on that affected extremity for 6 weeks after surgery. In addition, it is recommended that hamstring activity be minimized, which may be deleterious on the posterolateral corner repair, for the first 4 months

after surgery. Postoperative rehabilitation of patients with this surgical repair involves achieving ROM first, and then a program of progressive strengthening of the extremity generally is followed. As mentioned previously, hamstring strengthening exercises are avoided for the first 4 months after surgery. Closed chained quadriceps exercises, such as the use of an exercise bicycle usually are initiated at 6 to 8 weeks after surgery with progression to gentle leg presses and squats allowed at 3 months after surgery. Patients are allowed to jog and to participate in progressive strengthening exercises at 4 to 6 months after surgery (depending on the severity of the original injury).

Treatment of Isolated Chronic Posterolateral Knee Complex Injuries

In the assessment of chronic posterolateral knee injuries, it is important to recognize that the effect of bony alignment on a proposed surgical repair or reconstruction is important. It is well-recognized that a failure to correct a varus aligned limb before soft tissue reconstructions on the lateral and posterolateral aspect of the knee places these reconstructions at high risk for failure, because of the high risk of stretching out with time because of the extra stress placed on the limb because of this alignment. Therefore, it is recommended that a full length AP radiograph taken with the patient standing is obtained in all patients to assess the underlying extremity alignment on the effected side.

For patients who have normal or valgus alignment of their extremity, an anatomic repair or reconstruction (with allograft or autograft tissue) is recommended. An MRI scan has been found to be helpful to discern the location of injury of individual posterolateral structures and whether a surgical repair is feasible, because of the structures being avulsed, or whether a surgical reconstruction is recommended (for popliteus musculotendinous junction injuries or midsubstance avulsions of the fibular collateral ligament or popliteus tendon). The same principles for a primary repair in the acute situation would hold for a primary repair in the chronic situation. However, the majority of patients will need to have a reconstruction of these structures to restore stability to the effected knee over the long-term.

In patients who have a varus alignment concurrent with a Grade 3 posterolateral knee injury, it is recommended that they first have a proximal tibial osteotomy to correct the underlying varus alignment.[12,15,22] The current authors prefer the proximal tibial opening wedge osteotomy because it seems to tighten up some of the posterior structures of the knee and avoids surgery and scar tissue formation on the posterolateral aspect of the knee (Fig 5). The authors generally wait until at least 6 months after the osteotomy to ensure that the osteotomy has healed completely, the quadriceps mechanism is rehabilitated, and strength is regained before making a determination

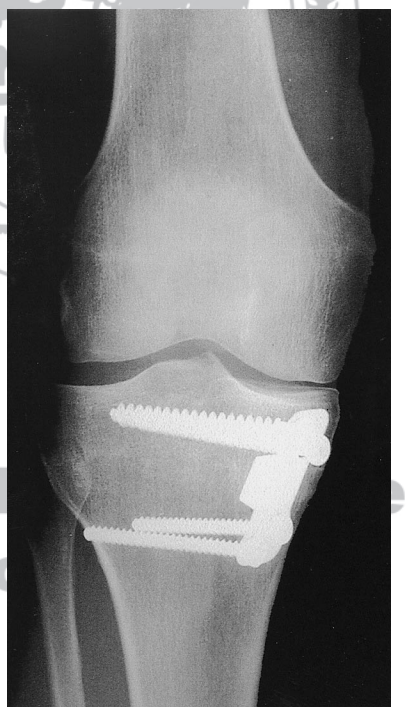

Fig 5. A radiograph taken 1 year postoperative shows a healed opening wedge proximal osteotomy in the right knee of a 28-year-old man with chronic Grade 3 posterolateral knee instability.

whether the patient would need a second stage posterolateral corner reconstruction.[12,21] This second stage surgery only is recommended if the patient still has problems with perceived instability with gait or during functional activities.

Treatment of Combined Grade 3 Posterolateral Knee Injuries and Other Grade 3 Ligament Injuries of the Knee

Acute Combination Grade 3 Posterolateral Knee and Other Ligament Injuries

The recommendations for patients who have Grade 3 posterolateral knee injuries in combination with other ligament injuries is the same as the treatment for patients with an acute isolated posterolateral knee injury.[12,15] The current authors recommend that a primary repair be done of the injured posterolateral knee structures within the first 2 to 3 weeks of injury and that a repair or reconstruction of the concurrent other ligament injuries of the knee be done concurrently with this. Ideally, stout and secure fixation is desired such that an early ROM program can be initiated so that arthrofibrosis does not develop in the knee. At a minimum, the surgeon needs to determine the safe zone for ROM on the table such that this minimum amount of motion can be done in the early postoperative period. A brief period of immobilization of 1 to 2 weeks may be indicated in some instances when there is a significant amount of tissue injury present in the knee.

Chronic Combined Grade 3 Posterolateral Knee and Other Ligament Injuries

Chronic Grade 3 posterolateral injuries usually are seen in combination with chronic cruciate ligament injuries. It has been shown clinically that unrecognized or untreated Grade 3 posterolateral corner injuries are a major cause of failure of cruciate ligament reconstructions.[15,22,23] In addition, it has been shown in several laboratory studies that a significant increase in force is seen on the anterior cruciate ligament and posterior cruciate ligament reconstruction grafts when there is a concurrent posterolateral corner injury present.[7,16,18,19] Therefore, it is recommended that Grade 3 posterolateral corner injuries be repaired or reconstructed when they are present at the same time that an anterior cruciate ligament or a posterior cruciate ligament reconstruction is done.[15,16]

There still is no clear consensus as to the type of repair or reconstruction that should be done when there is a chronic Grade 3 posterolateral knee injury. However, these same principles of treatment for an isolated chronic posterolateral knee injury need to be followed. First, the patient's alignment must be assessed to ensure that there is no varus alignment present that could cause a posterolateral knee repair or a reconstruction graft to stretch out with time.

If a proximal tibial osteotomy must be done because of the patient's underlying varus alignment with a concurrent posterolateral knee and other knee ligament injury, it is recommended that the patient wait until there is evidence of complete healing of the osteotomy, and have significant rehabilitation of that quadriceps mechanism, before proceeding with a second stage multiligament reconstruction. If the patients have continued instability with gait or with functional activities after the osteotomy is healed, the current authors then would recommend proceeding with multiligament knee reconstruction (including the posterolateral corner).

In patients with chronic knee instability, the authors recommend doing a reconstruction of all the injured ligaments at the same time. The same principles that would hold for an anterior cruciate ligament or posterior cruciate ligament reconstruction are true in a chronic posterolateral corner injury. Although rarely seen, the authors also would recommend doing the reconstruction of a chronic medial cruciate ligament complex instability concurrently with the posterolateral corner reconstruction to control rotational stability of the knee.

A primary repair of chronic posterolateral knee injuries in multiligament instability rarely is possible. It may be an option in a small number of patients. A careful analysis of the location of the injury should be based on the clini-

cal evaluation and the MRI scan to assess for the integrity and presence or absence of the key posterolateral structures.[12,15]

In patients in whom the posterolateral corner structures are deficient, the authors recommend an allograft reconstruction of the fibular collateral ligament and/or popliteus tendon and popliteofibular ligament complex. An anatomic reconstruction of these structures, with the allografts placed in the exact attachment sites of the normal structures, allows for early postoperative motion and restoration of the static function over the posterolateral corner of the knee.

The rehabilitation program that is followed in patients with combined posterolateral and other ligament repair needs to be individualized for each patient depending on the quality of the tissue repair at the time of surgery. It is desired that early ROM be achieved as soon as possible. It is recommended that the surgeon determine the safe zone that can be achieved without putting significant tension on the surgical repair or reconstruction just before closure to determine the minimum ROM that can be achieved. The patient's extremity then can be placed into a hinged knee brace within this limitation of motion, or placed into a knee immobilizer and allowed to work on passive motion through this range. In addition, a continuous passive motion machine may be used within this safe zone and then slowly advanced with time to achieve additional ROM. It is the usual goal with these complex knee reconstructions that full ROM is achieved between 6 to 8 weeks postoperatively.

Weightbearing is not allowed for patients with chronic posterolateral corner repairs or reconstructions until 6 to 8 weeks postoperatively.[12,15] This allows time for the posterolateral structures to heal in place. At that point, patients are allowed to slowly increase their weightbearing and may wean off the crutches when they can walk without a limp. Patients are allowed to do quadriceps setting exercises and straight leg raises, in their immobilizer only, four times daily. Patients are allowed to start on the exercise bicycle at 6 weeks postoperatively if they have at least 105° to 110° knee flexion. Light leg presses, to a maximum of 70° knee flexion, to between 20 and 30 kg, are initiated at 8 weeks after surgery. Hamstring exercises are not allowed for 4 months postoperatively because of their potential deleterious effects of the hamstrings pulling against the posterolateral repair or reconstruction. At this point, patients are allowed to progress on the rehabilitation program based on the other combined ligament reconstructions present.

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