Meniscal Tears: Diagnosis, Evaluation, and Treatment

Greg T. Hardin, MD, * Jack Farr, MD, * and Bernard R. Bach, Jr, MD†

ABSTRACT

Arthroscopic surgery for treatment of pathologic meniscal lesions has become the most commonly performed orthopaedic procedure in the United States. This article reviews the diagnosis, evaluation, and subsequent treatment of meniscal tears in the knee.

The histologic anatomy of the menisci consists of a structure made primarily of fibrocartilage with a proteoglycan matrix. The menisci consist of approximately 90% type I collagen. The fibers are oriented in a circumferential direction with connecting radial tie-rods to provide stability and strength. The medial meniscus is oval shaped and roughly 3.5 cm in length. The lateral meniscus is semicircular in shape and more uniform in thickness.

The vascular supply of the menisci is primarily through the geniculate arteries, especially the medial and lateral superior and inferior contributions. Both menisci demonstrate excellent circulation within the peripheral 10% to 30% of their substance. 1 Laterally, at the overlapping popliteal hiatus and lateral collateral ligament there is an avascular region. The inner two thirds of both menisci are poorly perfused and rely primarily on diffusion for nutrition.

The menisci perform numerous functions for the knee joint. They provide added stability and shock absorption, increased joint congruity, and lubrication for the adjacent articular surfaces. They also help prevent synovial impingement between the femur and tibia and limit the extremes of flexion and extension at the knee joint; also, they transmit load and reduce contact stresses, dispersing forces over a greater surface area. The posterior horns are noted to carry a greater proportion of the load than the anterior horns—up to 85% when the knee is flexed. 2

DIAGNOSIS

The patient history associated with a meniscal injury generally involves a twisting, squatting, or cutting maneuver. Sometimes the associated force can be as slight as that produced when a middle-aged person arises from a chair and turns to reach for an object. The associated compression and rotation at the knee joint can lead to abnormal sheer forces and can result in damage to the meniscus. The patient may complain of locking, with the knee held in 30° of flexion immediately after the injury. This may be associated with a displaced meniscal fragment. The injury can produce immediate swelling, especially if the tear is in the vascular peripheral one third of the meniscus. In general, knee locking that has its onset the day after injury is the result of “pseudolocking” secondary to hamstring

*Dr Hardin and Dr Farr are in private practice, Specialty Centers for Orthopaedic and Rehabilitative Excellence, Indianapolis, Indiana.
†Dr Bach is Director, Section of Sports Medicine, Rush Medical College, Chicago, Illinois.
spasm and is not caused by a displaced meniscal fragment.

The symptoms associated with a meniscal tear include effusion, locking, and joint-line pain. Nearly all symptomatic medial meniscus tears and approximately 50% of lateral meniscus tears have an associated knee effusion. There is often joint-line tenderness and incomplete knee motion at the extremes of flexion or extension. Many patients complain of “giving way,” which may be due to meniscal tissue continually being displaced during joint compression and rotation. The main symptoms associated with a lateral meniscus tear are pain during activity (usually cutting, pivoting) and morning stiffness. Patients who have a history of a remote injury with a resultant chronic meniscal tear will often have visible quadriceps atrophy.

Physical examination of the knee with a probable meniscal tear includes a thorough evaluation. Ligament testing including varus/valgus stability, anterior/posterior drawer, and Lachman and pivot shift test maneuvers are performed on the normal and abnormal knee. Observation for previous surgical scars, contusions, swelling, and gross joint and patellar alignment are also noted. Range of motion is assessed identifying the locked knee, usually between 30° and 60° of flexion. A spongy block to full knee extension may indicate a displaced bucket-handle meniscal tear located in the intercondylar notch. Specific joint-line tenderness is also helpful diagnostically, particularly in the posterior half of the menisci, because 81% of meniscal tears are located posteriorly. Quadriceps atrophy can be documented by measuring thigh circumference bilaterally, one hand-breadth above the patella, and comparing the measurement with the normal limb.

Fowler and Lubliner evaluated the predictive value of five clinical signs in diagnosing pathologic lesions of the meniscus. One hundred sixty-one patients (average age, 33 years) were prospectively evaluated. All were examined before surgery for joint-line tenderness, pain with forced flexion, response to the McMurray and Apley tests, and for blocks to full extension. Arthroscopy was used to verify the presence of meniscal tears. The authors concluded that no one specific test was predictive and that physical findings suggestive of meniscal lesions had decreased reliability in patients with associated anterior cruciate ligament (ACL) tears.

The differential diagnosis of a torn meniscus is extensive. It includes plica syndromes, popliteal tendinitis, osteochondritis lesions, loose bodies, patellofemoral pain/instability, fat pad impingement syndrome, inflammatory arthritis, physcal or tibial spine fractures, meniscofibial ligament sprains, synovial lesions or tumors, and discoid meniscus with or without a concurrent tear.

**EVALUATION**

Routine knee roentgenograms are obtained, including anteroposterior, lateral, tunnel, and Merchant’s views. These primarily rule out other abnormalities, including fractures, osteoarthritis, loose bodies, osteochondritis, and intrameniscal calcification as seen with pseudogout. One must remember that there is a high association of degenerative meniscal tears with osteoarthritis of the knee in the middle-aged adult. It is sometimes very difficult to determine which is the primary cause of the pain. Noble performed autopsies on 70 asymptomatic patients older than 55 years of age and noted that 18.5% of these individuals had at least one horizontal cleavage tear and 11% had discoid menisci. Seventy-six percent of the cadavers had microscopic evidence of medial meniscus degeneration despite a normal gross appearance. Measurements demonstrated that the medial meniscus had a larger surface area, was broader, and was thicker posteriorly than the lateral meniscus. This may explain the higher incidence of degenerative tears in this region.

Historically, arthrography of the knee was commonly performed using double-contrast technique. Accuracies varied from 50% to 97% depending on the study. This proce-
procedure is invasive, can result in reactions to the contrast media, and has been associated with knee synovitis secondary to the contrast media. Bone scans are sometimes indicated when attempting to rule out early degenerative joint disease and/or avascular necrosis as the primary cause of the patient's symptoms.\(^8\)

Magnetic resonance imaging (MRI) is a noninvasive procedure that results in no radiation exposure to the patient. It takes approximately 20 minutes to perform and has a reported 70% to 95% accuracy in the diagnosis of meniscal tears.\(^3\) The normal meniscus and fibrocartilage demonstrate a dark signal with meniscal tears, showing a bright, white (high-intensity) signal. Sagittal views of the knee demonstrate the anterior and posterior horns of the meniscus and the cruciate ligaments. Coronal knee views show the meniscal body, morphology, discoid menisci, cysts, bucket-handle tears, parrot-beak tears, bony injuries, and collateral ligament injuries. Magnetic resonance imaging meniscal tear signals have three grades: grade 1 is an irregular signal that is intrameniscal in location; grade 2 is a linear signal that does not extend to the meniscal surface; and grade 3 is a linear signal that extends to a meniscal surface and is considered diagnostic of a meniscal tear.\(^10\)

Numerous pitfalls are associated with MRI with regard to meniscal-ear diagnosis.\(^3\) These include the transverse ligament that can mimic a meniscal tear in the anterior horn, which is a rare place for a meniscal lesion to be present. The popliteal bursa on the lateral side can mimic a posterior-horn lateral meniscus tear secondary to its high-intensity signal. The lateral inferior geniculate artery can be confused with an anterior-horn lateral meniscus tear. The normal peripheral meniscal concavity can simulate a tear secondary to volume averaging. On rare occasions, the meniscofemoral ligaments of Humphry and Wrisberg, as well as loose bodies, can mimic tears.\(^3\)

A double-blind study of 50 patients by Raucest et al\(^11\) showed an overall MRI sensitivity of 88% and specificity of 57% with regard to meniscal abnormalities. The sensitivity with regard to a medial meniscus tear was 94%, and 78% for a lateral meniscus tear. These researchers were able to identify meniscal tears in 78% of their patients using MRI. Additionally, they had performed an earlier clinical study of 3,500 patients, using arthroscopy to verify lesions, and had found that their physical examination was able to identify meniscal tears 75% of the time, a sensitivity only slightly below that of their MRI study.

Magnetic resonance imaging is helpful as a presurgical screening tool in the evaluation of adolescents with acute knee trauma in an attempt to avoid arthroscopy. It is also useful in ruling out meniscal lesions in patients who have acute ACL tears and who desire nonoperative treatment. Additionally, in the older patient who has visible degenerative joint disease on plain roentgenograms, the MRI is useful in evaluating degenerative tears to rule out underlying abnormalities such as avascular necrosis and neoplasms. However, MRI is not useful in verifying the healing of meniscal repairs postoperatively.\(^9\)

Arthroscopy is the procedure by which all clinical studies are compared. It is an invasive procedure requiring an anesthetic, but it allows direct visualization of pathologic meniscal lesions. It is operator dependent and allows concomitant therapeutic intervention.

**TYPES OF MENISCAL TEARS**

Medial meniscus tears outnumber lateral meniscus tears from 2:1 to 5:1 in their incidence.\(^5\) Bilateral tears are noted in up to 7% of patients. Fifty to seventy percent of patients with ACL injuries have associated meniscal pathology, especially radial and parrot-beak tears. Those with acute ACL tears have twice as many lateral as medial meniscus tears. Medial meniscus bucket-handle tears are often associated with chronic ACL insufficiency, and an afflicted patient may present with the knee locked at 30° of flexion. Knees with both chronic ACL insufficiency and recurrent instability have an increased incidence of posterior medial meniscus vertical cleft tears. Most cleft
tears are stable and are noted only incidentally at the time of arthroscopy.

Lateral bucket-handle tears may cause patients to present with their knees locked in 60° of flexion. However, bucket-handle tears are found three times more often in the medial meniscus than in the lateral meniscus. Posterior cruciate ligament tears are infrequently associated with meniscal pathology; in such instances, lesions occurring on the medial meniscus outnumber those occurring on the lateral meniscus. Isolated medial collateral ligament injuries are rarely associated with medial meniscus tears. Radial tears are usually located in the middle one third of the lateral meniscus, and degenerative tears are located in the posterior half of both menisci.

Tear classifications are based on descriptions of their appearance and orientation. Vertical and horizontal tears as well as longitudinal and oblique (parrot-beak) tears are noted. Complex tears have multiple different cleavage planes and may be of either complete or incomplete thickness. Degenerative and radial (transverse) tears are also seen. Vertical or oblique tears make up approximately 80% of all tears. The four major types of meniscal tears are listed in Table I. Mulhollan has classified meniscal tears based on their location and peripheral and central surface appearances (personal communication). Red-red tears are peripheral detachments, have a functional blood supply on the capsular and meniscal sides of the lesion, and have the best prognosis for healing.1,2 Red-white tears have an active peripheral blood supply with a central surface devoid of functioning vessels. These generally have sufficient vascularity to heal if repaired appropriately. The last category is the white-white tear, which is totally within the inner two thirds of the meniscus and is associated with no true vascularity and theoretically cannot heal.

**TREATMENT**

The management of a meniscal tear can vary anywhere from a conservative, possibly nonoperative approach to the historical treatment of total meniscectomy. With the advent of arthroscopy and improved instrumentation, the partial meniscectomy of appropriate lesions can now be easily performed as an alternative to complete resection. The management of meniscal lesions in the ACL-insufficient patient is generally influenced by the subsequent treatment of the ligament injury.

**Nonoperative Treatment**

During an arthroscopic evaluation, it may be determined that some meniscal tears may remain untreated. These include partial-thickness split tears that involve less than half the width of the meniscus or full-thickness short tears (≤ 5 mm in size) that are vertical or oblique in their orientation. Tears that are stable to arthroscopic probe palpation (ie, translate ≤ 3 mm upon probe stressing) and short radial tears (< 5 mm in length) may not require resection.3

Nonoperative treatment of meniscal tears was assessed by Weiss et al13 in 1989. These investigators evaluated 80 stable tears defined as vertical-longitudinal tears with < 3 mm of displacement and radial tears that involved less than one third of the meniscus width. Repeat arthroscopy on 32 of these tears at an average of 26 months after initial arthroscopy showed that 17 of 26 longitudinal tears and 1 of 6 radial tears had healed. They concluded that stable vertical-longitudinal tears, especially in the peripheral one third, could be left alone. Radial tears, however, have a low potential to heal.
Meniscal symptoms and sports participation in patients awaiting arthroscopic surgery for meniscal lesions were outlined by Hede et al in 1990. They evaluated 36 patients (average age, 38 years) who waited 6 to 24 months after diagnosis before undergoing arthroscopic evaluation. Only 2 of 27 patients were able to continue participating in sports at the same intensity level while awaiting surgery. Twenty-three patients had partial symptom relief, 4 had no change in their symptoms throughout their waiting period, and 9 became symptom-free.

**Total Meniscectomy**

Historically, the initial treatment of a meniscal tear was an open total meniscectomy. Patients who underwent this treatment were found to have an accelerated rate of osteoarthritis roentgenographically and arthroscopically. In 1948, Fairbanks reported four roentgenographic findings indicative of previous meniscectomy (Table II). He concluded that meniscectomy reduced the energy of absorption at the knee joint and increased point contact stresses. This led to joint-space narrowing, osteophyte formation, fracture of the subcondylar trabeculae, and increased bone density with accelerated osteoarthritis formation.

Mechanical changes in the knee after meniscectomy were studied in canine and human cadavers. Compression testing with increasing loads and variable stress demonstrated that meniscal functions include load transmission, energy absorption, and deforming capabilities. Stress was noted to markedly increase across the joint after subsequent meniscectomy.

In a cadaver study, Levy et al noted that with isolated lateral meniscectomy, no change occurred in the anteroposterior translation of the knee. Additionally, there was no change in anteroposterior translation when lateral meniscectomy was associated with an ACL injury over what would be seen with an ACL injury alone. However, when resecting the medial meniscus, they noted a marked increase in the anterior translation of the tibia on the femur. These researchers concluded that the medial meniscus restrains the anterior translation of the tibia by acting as a posterior wedge and that the lateral meniscus does not.

McCarty et al compared partial versus total meniscectomy and found that for the total meniscectomy patients, the hospital stay averaged 1 day longer, crutch use was 1 week longer, and complication rates including infections and deep venous thrombosis were markedly increased over those of the partial meniscectomy patients. Roentgenographic documentation of osteoarthritis was noted in twice as many total meniscectomy patients. Additionally, the knee scoring system used showed that the partial meniscectomy patients performed better clinically than the total meniscectomy patients.

**Partial Meniscectomy**

Meniscal tears that are treated by partial meniscectomy include tears that are complex, tears associated with multiple cleavage planes, multilevel longitudinal tears, degenerative tears, and large radial and flap tears. Patients who are older than 40 years of age or who have unstable ACL-deficient knees are generally treated by partial meniscectomy. Avascular tears (those > 5 mm from the periphery [white-white tears]) and tears in obviously noncompliant patients are also probably best treated by partial meniscectomy.

The goals of partial meniscectomy include resecting only the catching or sliding portion

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<tr>
<th>Table II. Roentgenographic Findings Indicative of Previous Meniscectomy</th>
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<tbody>
<tr>
<td>1. Posterior ridging of the femoral condyles</td>
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<td>2. Flattening of the femoral surface</td>
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<td>3. Joint-space narrowing</td>
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<td>4. Tibial-margin squaring and sclerosis</td>
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(unstable pieces), preserving a capsular rim, and removing as little meniscus as possible. It is unnecessary to obtain a perfectly smooth rim, but sudden changes in the contour of the meniscus should be avoided. Whenever unsure, the surgeon should leave more rather than less meniscus, because degenerative roentgenographic changes are also seen postoperatively with partial meniscectomy.16

Meniscus Repair

Acceptable tear configurations for surgical repair include unstable, longitudinal-vertical tears located in the peripheral one third that are >1 cm in length.22–27 Additionally, vascular tears (located 3 mm from the periphery in adults, 6 mm in teenagers) and bucket-handle tears (>1 cm in length involving more than half the thickness of the meniscus) are candidates for repair. Some authors believe that repeat tears (re-tears) meeting these conditions are also candidates.22,23

Another consideration with regard to performing a meniscus repair is whether the patient is a competitive athlete. Both athletes and their coaches are well aware that a meniscus repair may result in greater loss of competitive time, including the current season. One must carefully consider the options, especially with regard to the age of the patient and the risk of subsequent development of arthritis in young meniscectomy patients.24

The ability of peripheral meniscal lesions to heal in patients older than 40 years of age is debatable. The character of the meniscal tissue is probably not optimal for repair even though little is changed in the vascular anatomy.23

Currently, 80% to 90% of acute meniscal repairs are performed in knees associated with an ACL injury. It is recommended that the meniscus, if it is of an acceptable configuration, be repaired at the same time or before the ACL reconstruction is performed.24 In the past, patients electing not to have reconstruction of their torn ACL who also had repairable meniscal tears were encouraged to have partial meniscectomies. Nonreconstructed patients had increased rates of re-tear of their meniscus repairs. Re-tear rates as high as 38% have been reported in nonreconstructed patients compared with 5% in reconstructed ACL patients at 5 years postoperatively.24 However, one must be cautious in drawing conclusions from this commonly quoted study because it involved a total of only 14 patients.24 Recently, Hanks et al25 reported on 22 patients with ACL-deficient knees who underwent 23 subsequent meniscus repairs. Eleven operations were performed as open arthrotomies and 11 were performed using arthroscopic techniques. The average age of the patients was 25 years and the average follow-up was 4.5 years. Three repairs (13%) subsequently failed. The investigators concluded that meniscus repair is not contraindicated in ACL-deficient knees.

Postoperative care has generally been associated with a long rehabilitation period including prolonged non-weight-bearing status and restrictions in range of motion. With the advent of improved techniques and suture material, rehabilitation has been accelerated. Current techniques have progressed to the point of immediate weight bearing associated with early range of motion and return to participation in sports as early as 4 to 6 weeks postrepair.24,27,28

CONCLUSION

The meniscus is a dynamic structure with important local functions. Its anatomy and vascularity help to determine optimal treatment options. Improvements in arthroscopic techniques and postoperative rehabilitation have made meniscal surgery a safe and successful procedure.

REFERENCES