Meniscal Injury: I. Basic Science and Evaluation

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Abstract

The patient with meniscal injury may present with pain, swelling, or mechanical symptoms and often requires surgical intervention for symptom resolution. Treatment of such injuries relies on understanding the gross and microanatomic features of the meniscus that are important in maintaining meniscal function. The ability of the meniscus to participate in load bearing, shock absorption, joint lubrication, and joint stability depends on the maintenance of its structural integrity. The diagnosis of meniscal injury often can be made by clinical evaluation utilizing the history, physical examination, and plain radiographs. Magnetic resonance imaging can be useful in confirming the diagnosis when clinical findings are inconclusive. Treatment depends on tear pattern, vascularity, and an assessment of tissue quality. Surgical decision making for the treatment of meniscal injury is based on patient factors and understanding of the meniscal structure, function, and pathology.

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Injury to the meniscus from both athletic events and activities of daily living is common. Occurring in isolation or in association with ligamentous injury, meniscal tears can result in marked physical impairment. The presence of clinical symptoms of pain, swelling, locking, catching, and loss of motion often require surgical intervention. Arthroscopic treatment of meniscal injuries has become one of the most common orthopaedic surgical procedures in the United States; in many centers, it constitutes 10% to 20% of all surgeries.[1] To adequately evaluate and treat such injuries, understanding of meniscal anatomy and function is necessary. In addition, appreciation of the types of tears and their significance in regard to treatment options is needed. Finally, accurate preoperative diagnosis of these injuries allows more effective patient counseling regarding proper management. Understanding of the anatomy and function of the meniscus has greatly increased in the last 20 years. The history and physical examination, along with the use of magnetic resonance imaging (MRI), remain the primary methods of diagnosing meniscal pathology. Decision making in the treatment of meniscal injury is influenced by patient factors as well as the nature of the meniscal pathology.

Anatomy

Gross Features

Meniscal anatomy has been extensively studied since Bland-Sutton[2] first described the meniscus as "the functionless remnants of intra-articular leg muscles." The anatomy is important both in the types of meniscal tears and their subsequent treatment. From a gross anatomic perspective, the menisci are C-shaped or semicircular fibrocartilaginous structures with bony attachments at the anterior and posterior aspects of the tibial plateau (Fig. 1). The medial meniscus is C-shaped, with the posterior horn larger than the anterior horn in the anteroposterior dimension. Variation in meniscal morphology and attachments can be observed. Recent studies have examined anatomic variation in attachments of the anterior horn of the medial meniscus and the role the transverse intermeniscal ligament plays in medial meniscus stability. Berlet and Fowler[3] described four types of anterior horn medial meniscus attachments. The type IV variant has no firm bony attachment and

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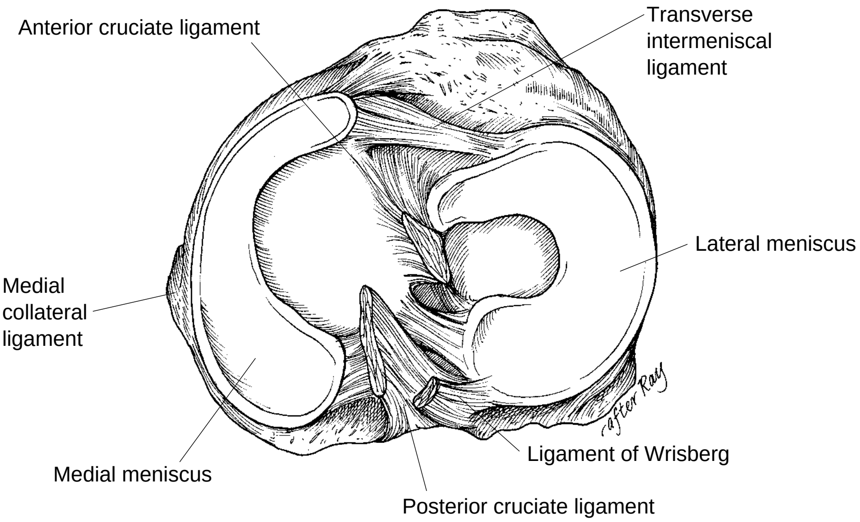

Figure 1 Anatomy of the menisci viewed from above. Note the differences in position and shape of the medial and lateral menisci. (Adapted with permission from Pagnani MJ, Warren RF, Arnoczky SP, Wickiewicz TL: Anatomy of the knee, in Nicholas JA, Hershman EB [eds]: *The Lower Extremity and Spine in Sports Medicine*, ed 2. St Louis, MO: Mosby, 1995, pp 581-614.)

was seen in only 3% (1 of 34) of their specimens. Nelson and LaPrade[4] found a similar type of attachment in 14% of 47 specimens. In the majority of specimens, however, a firm anterior bony attachment was observed. The remainder of the medial meniscus is firmly attached to the joint capsule. The posterior bony attachment lies anterior to the insertion of the posterior cruciate ligament.

Johnson et al[5] mapped the bony insertion sites of the meniscus in an effort to identify appropriate landmarks for meniscus transplantation. They noted the location of each insertion site (Fig. 2) and the insertion site surface area. The anterior horn of the medial meniscus has the largest insertion site surface area (61.4 mm^2) and the posterior horn of the lateral meniscus, the smallest (28.5 mm^2). The capsular attachment of the medial meniscus on the tibial side is referred to as the coronary ligament. A thickening of the capsular attachment in the midportion spans from the tibia to the femur and is referred to as the deep medial collateral ligament.

The lateral meniscus is also anchored anteriorly and posteriorly through bony attachments and has an almost semicircular configuration. It covers a larger portion of the tibial articular surface than does the medial meniscus (Fig. 1). Discoid variants have been reported with an incidence of 3.5% to 5%, most being the incomplete type.[6] The anterior and posterior horns attach much closer to each other than do those of the medial meniscus, with the anterior horn inserting adjacent to the anterior cruciate ligament (ACL) and the posterior horn inserting behind the intracondylar eminence anterior to the posterior horn of the medial meniscus. A variation in the posterior horn attachment includes the Wrisberg variation of discoid lateral meniscus, in which the posterior horn bony attachment is absent and the posterior meniscofemoral ligament of Wrisberg is the only stabilizing structure. This variation can allow excessive motion and result in posterior horn instability. The anterior meniscofemoral ligament of Humphry runs from the posterior horn of the lateral meniscus anterior to the posterior cruciate ligament and inserts on the femur.

Posterior and lateral to the posterior bony insertion of the lateral meniscus lies the popliteus tendon. The area surrounding this tendon is known as the popliteal hiatus. Simonian et al[7] have investigated the role that the popliteomeniscal fasciculi play in lateral meniscus stability. Disruption of both the anteroinferior and posterosuperior fasciculi can result in increased meniscal motion at the hiatus and may be important in causing hypermobility of the posterior horn of the lateral meniscus. The remaining attachments of the lateral meniscus to the tibia are through the capsule but are not as well developed as the attachments on the medial side. This lack of development allows for increased translation of the lateral meniscus throughout a range of motion. Using three-dimensional

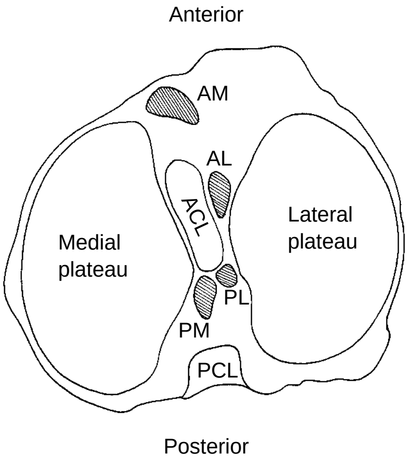

Figure 2 Meniscus horn insertion sites viewed from above. Note the proximity to the anterior cruciate ligament (ACL). AL = anterior horn lateral meniscus, AM = anterior horn medial meniscus, PCL = posterior cruciate ligament, PL = posterior horn lateral meniscus, PM = posterior horn medial meniscus. (Adapted with permission.[5])

MRI, Thompson at al[8] demonstrated 11.2 mm of posterior excursion of the lateral meniscus and 5.2 mm of the medial meniscus during knee flexion.

Microstructure and Biochemistry

The fibrocartilaginous structure of the meniscus has a varied architecture of coarse collagen bundles. Scanning electron microscopy has revealed the orientation of collagen fibers to be mainly circumferential, with some radial fibers at the surface and within the midsubstance.[9] This orientation allows compressive loads to be dispersed by the circumferential fibers, while the radial fibers act as tie fibers to resist longitudinal tearing (Fig. 3). At the surface of the meniscus, fiber orientation is more of a mesh network or random configuration, thought to be important in the distribution of shear stress. Collagen is 60% to 70% of the dry weight of the meniscus. The majority of collagen (90%) is type I, with types II, III, V, and VI present in much smaller amounts. Elastin accounts for approximately 0.6% of the dry weight of the meniscus and noncollagenous proteins, for 8% to 13%.[10]

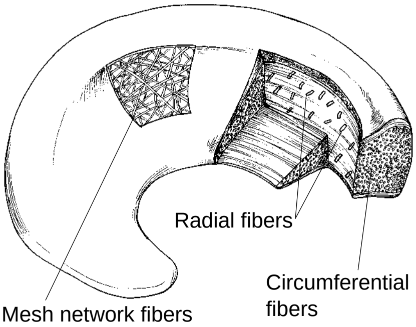

Figure 3 Schematic of collagen bundles and their orientation within the meniscus. (Adapted with permission from Bullough PG, Munuera L, Murphy J, Weinstein AM: The strength of the menisci of the knee as it relates to their fine structure. *J Bone Joint Surg Br* 1970;52:564-567.)

The cells of the meniscus have been called fibrochondrocytes because of their appearance and the fact that they synthesize a fibrocartilaginous matrix. The fibrochondrocytes appear to be of two types, with the more superficial cells being oval or fusiform and the deeper cells more rounded. Both types contain abundant endoplasmic reticula and Golgi complexes and few mitochondria.

Blood Supply and Neuroanatomic Findings

At birth, the entire meniscus is vascular; by age 9 months, the inner one third has become avascular. This decrease in vascularity continues to age 10 years, when the meniscus closely resembles the adult meniscus. Arnoczky and Warren[11] studied the adult blood supply and demonstrated that only the outer 10% to 25% of the lateral meniscus and 10% to 30% of the medial meniscus is vascular (Fig. 4). This vascularity arises from the superior and inferior branches of the medial and lateral genicular arteries, which form a perimeniscal capillary plexus. A synovial fringe extends a short distance over both the femoral and tibial surfaces of the menisci but does not contribute to the meniscal blood supply. At the popliteal hiatus, the meniscus is relatively avascular secondary to a lack of penetrating vessels and synovial fringe. Because of the avascular nature of the inner two thirds of the meniscus, cell nutrition is believed to occur mainly through diffusion or mechanical pumping.[12] Neural elements are most abundant in the outer portion of the meniscus, particularly myelinated and unmyelinated nerve fibers. These nerve fibers likely explain the findings of Dye et al,[13] who did neurosensory mapping of the internal structures of the knee. On probing, centrally located meniscal tissue gave little or no pain awareness, whereas more peripheral tissue and the meniscal capsular tissue resulted in slight to moderate discomfort.

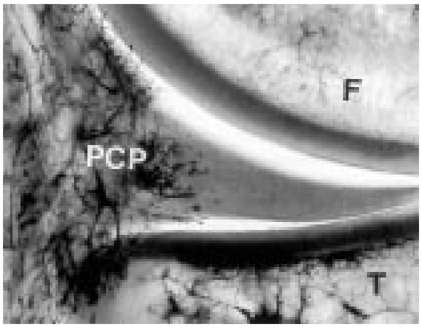

Figure 4 The microvasculature of the meniscus. F = femur, T = tibia, PCP = perimeniscal capillary plexus. (Reproduced with permission.[11])

The anterior and posterior horns of the meniscus are innervated with mechanoreceptors that may play a role in proprioceptive feedback during extremes of motion. Their exact role in joint function, however, remains unclear.

Functions of the Meniscus

The menisci are important in many aspects of knee function, including load sharing, shock absorption, reduction in joint contact stresses, passive stabilization, increasing congruity and contact area, limitation of extremes of flexion and extension, and proprioception. Many of these functions are achieved through the ability of the menisci to transmit and distribute load over the tibial plateau. The findings of joint space narrowing, osteophyte formation, and squaring of the femoral condyles after total meniscectomy suggested that the meniscus is important in joint protection and led to investigations of the role of the meniscus in joint function.

The medial and lateral menisci transmit at least 50% to 70% or at times more of the load when the knee is in extension; this increases to 85% with 90° of knee flexion.[14] Radin et al[15] demonstrated that these loads were well distributed when the menisci were intact. Removal of the medial meniscus results in a 50% to 70% reduction in femoral condyle contact area and in a 100% increase in contact stress.[16,17] Total lateral meniscectomy causes a 40% to 50% decrease in contact area and increases contact stress in the lateral compartment to 200% to 300% of normal.

With the decrease in contact area within the joint, stresses are increased and are unevenly distributed. This results in increased compression and shear across the joint. Along with the biomechanical changes that can occur with meniscectomy, the results of some studies[12] suggest that biochemical activity of cartilage is also affected. The improved joint congruity, which occurs through meniscus contact, is thought to play a role in joint lubrication and cell nutrition.

The meniscus also plays a role in shock absorption. Compression studies using bovine menisci have demonstrated that meniscal tissue is approximately one half as stiff as articular cartilage. In one study,[18] the shock absorption capacity of the normal knee was reduced by 20% after meniscectomy.

The menisci also play a key role in enhancing joint stability.[19] Medial meniscectomy in the ACL-intact knee has little effect on anteroposterior motion, but in the ACL-deficient knee, it results in an increase in anterior tibial translation of up to 58% at 90° of flexion. Shoemaker and Markolf[20] demonstrated that the posterior horn of the medial meniscus is the most important structure resisting an applied anterior tibial force in an ACL-deficient knee. Allen et al[21] showed that the resultant force in the medial meniscus of the ACL-deficient knee increased by 52% in full extension and by 197% at 60° of flexion under a 134-N load. Although the inner two thirds of the meniscus is important in maximizing joint contact area and increasing shock absorption, the integrity of the peripheral one third is essential for both load transmission and stability.

Epidemiology

The mean annual incidence of meniscal tears is 60 to 70 per 100,000.[22,23] Meniscal tears are more common in males; the male:female ratio ranges from 2.5:1 to 4:1. In a study by Poehling et al,[24] slightly more than one third of all tears were associated with an ACL injury. The peak incidence for this group was in men 21 to 30 years old and in girls and women 11 to 20 years old. Degenerative types of meniscal tears commonly occur in men in their fourth, fifth, and sixth decades. Meniscal pathology in women is rather constant after the second decade of life. Younger patients are more likely to have an acute traumatic event as the cause of their meniscal pathology.

In patients with acute ACL injury, lateral meniscus tears occur more frequently than do medial meniscus tears.[25] In patients with chronic ACL-deficient knees, however, medial meniscus tears are more prevalent. Because of its high rate of tearing in chronic ACL-deficient knees, the role of the medial meniscus as a secondary restraint to anteroposterior translation is thought to be important.

Meniscal injury is also frequent in the setting of tibial plateau fracture, with 17 of 36 patients (47%) in one study having a meniscal tear associated with the fracture.[26] The meniscal injuries were diagnosed by arthroscopy at the time of fracture fixation; almost all required surgical repair. Femoral shaft fractures also have been associated with concurrent meniscal injury, and the presence of hemarthrosis should increase the index of suspicion for ligamentous or meniscal injury in this setting.[27]

Diagnosis

History

The diagnosis of meniscal tear can frequently be made from a careful history, physical examination, and appropriate diagnostic tests. The onset of symptoms and mechanism of injury are often clues to the diagnosis. Patient age may be a factor with regard to the likelihood of surgical repair as well as the presence of associated chondrosis or other joint damage. In isolation, meniscal tears often occur during a twisting injury or hyperflexion event, and they may present with acute pain and swelling. Complaints of locking or catching may be present but also may be secondary to other pathology, such as chondral injury or patellofemoral chondrosis. Loss of motion with a mechanical block to extension is commonly the result of a displaced bucket handle meniscal tear and usually requires acute surgical treatment. Degenerative tears of the menisci tend to occur in older patients (>40 years), frequently with an atraumatic chronic history of mild joint swelling, joint line pain, and mechanical symptoms. These tears are often associated with some degree of chondral damage.

Physical Examination

A complete examination of the lower extremity is required for any patient suspected of having meniscal pathology. An inspection should be done to assess for joint effusion, quadriceps muscle atrophy, and any joint line swelling that may occur with a perimeniscal cyst. Range of motion must be assessed to determine whether a mechanical block to extension or loss of flexion is present. Palpation of the femur, tibial plateaus, and patellofemoral region to assess tenderness are routine, followed by ligament stability testing. Numerous specialized tests have been described that may aid in making the diagnosis of meniscal tear. These include joint line palpation, the flexion McMurray test, the Apley grind test, and others. Clinical studies to evaluate these tests have documented mixed results with regard to their usefulness. Weinstabl et al[28] found that joint line tenderness was the best clinical sign of a meniscal tear, with a 74% sensitivity and 50% positive predictive value. Evans et al[29] evaluated the flexion McMurray test to determine intraobserver reliability as well as accuracy. The findings of a medially based "thud" with rotation and flexion was the only McMurray sign to correlate well with meniscal pathology. This finding had a specificity of 98% but a sensitivity of only 15%. Other authors[30] have reported lower specificity for this test and sensitivities ranging from 30% to 50%. Many of the other clinical tests, taken in isolation, also have had poor sensitivity and positive predictive values.

In the setting of ACL injury, Shelbourne et al[31] demonstrated that joint line tenderness was not useful in defining meniscal injury preoperatively. Accuracy in this study was 54.9% for medial meniscus tears and 53.2% for lateral meniscus tears, which may reflect the confounding variables that occur with ACL injury, such as bone bruising and collateral ligament injury.

In spite of the poor reliability of these tests done in isolation, clinical evaluation remains a very useful tool in the diagnosis of meniscal pathology. In a study by Terry et al,[32] a thorough history, physical examination, and plain radiographs were used to determine the accuracy of preoperative clinical diagnosis for meniscal tear. Using arthroscopic confirmation as a means of definitive diagnosis, their overall clinical evaluation had a sensitivity of 95%, specificity of 72%, and positive predictive value of 85% for medial meniscus tears, and a sensitivity of 88%, specificity of 92%, and positive predictive value of 58% for lateral meniscus tears. Common misdiagnoses included fibrotic plica, fat pad impingement, chondral lesions, and synovitis.

Diagnostic Studies

Imaging studies such as plain radiographs, arthrography, MRI, and arthroscopy have all been proposed as adjuncts to the history and physical examination in defining meniscal pathology.

Radiography

Before any further diagnostic studies are undertaken, plain radiographs should be obtained. A standard series will include a 30° or 45° posteroanterior flexion weight-bearing view of both knees, a true lateral radiograph, and a Merchant or skyline view. Although these radiographic views cannot confirm the diagnosis of meniscal tear, they are extremely important in defining bony pathology and evaluating the knee for joint space narrowing. Because articular cartilage wear often is more advanced in the posterior aspects of the femoral condyles, the 30° or 45° posteroanterior flexion weight-bearing view is more sensitive than standard standing views for detecting early joint space narrowing.[33] Unweighted radiographs are of little value in this regard. Patients with joint space narrowing need to be counseled regarding chondrosis and degenerative joint disease as likely causes of knee pain when meniscal tear is being considered as the diagnosis. The Merchant view is helpful in evaluating the patellofemoral joint because this joint is often a source of medial knee pain.

Arthrography

With the advent of MRI, arthrography has become infrequently used in the evaluation of patients with suspected meniscal pathology. Historically, arthrography has been shown to have an accuracy of approximately 75% to 85% in selected studies. However, a lower accuracy has been documented in other studies.

Magnetic Resonance Imaging

The advantages of MRI in evaluating the patient with a suspected meniscal tear include its noninvasive nature, the ability to assess the knee in multiple planes, the absence of ionizing radiation, and the capacity to evaluate other structures within the joint. The limitations are its relatively high cost and the potential for misinterpretation or error because of technical inadequacies of the study or variability in interpretation. Early studies evaluating MRI technology often were conducted with magnets of low field strength. Accuracy for detecting meniscal tears was commonly reported at 80% to 90%. With improved technology and increased experience in reading these scans, the accuracy of detection is now considered to be approximately 95% or better.[34]

The normal appearance of the meniscus on MRI is that of a uniformly low-signal structure. Areas of increased signal within the meniscus occur in children and increase with age in adults. These intrasubstance changes are seen frequently and are a common cause of overreading meniscal tears on MRI scans. The meniscus grading system delineates grades 0, I, II, and III (Fig. 5). Only grade III changes (low signal intensity that abuts the free edge of the meniscus) are consistent with meniscal tearing (Fig. 6). Other anatomic structures adjacent to the meniscus, such as the intermeniscal

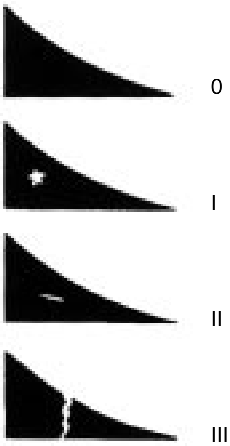

Figure 5 Grading scale for meniscal tears on MRI. Grade 0 is a normal meniscus. Grades I and II have an intrameniscal signal that does not abut the free edge. Grade III has a signal change that abuts the free edge of the meniscus, indicating a meniscal tear. (Reproduced with permission from Thaete FL, Britton CA: Magnetic resonance imaging, in Fu FH, Harner CD, Vince KG, Miller MD [eds]: *Knee Surgery*, vol 1. Philadelphia, PA: Williams & Wilkins, 1994, pp 325-352.)

ligament and the hiatus of the popliteus tendon, can be a cause of confusion in reading MRI scans.

Although MRI is a powerful tool in the detection of meniscal pathology, the entire clinical picture must be evaluated in deciding on treatment. In a study of MRI findings in asymptomatic patients between the ages of 18 and 39 years with a normal physical examination, LaPrade et al[35] found MRI scans to be consistent with a meniscal tear in 5.6% of knees. In a study by Boden et al[36] of asymptomatic subjects, 13% (8/63) of those less than 45 years old had MRI scans that were read as positive, and 36% (4/11) of those more than 45 years old had positive scans.

In a study comparing clinical evaluation with MRI of athletes with suspected meniscal pathology, Muellner et al[34] demonstrated similar effectiveness. They showed essentially equivalent accuracy (94.5% versus 95.5%), positive predictive values (91.5% versus 96.5%), negative predictive values (99.0% versus 91.5%), sensitivities (96.6% versus 98.0%), and specificities (87.0% versus 85.5%). In this study, MRI added little to the clinical examination in making the diagnosis of meniscal tear.

Arthroscopy

The gold standard for confirming the diagnosis of meniscal tear is an arthroscopic examination. During arthroscopy, the meniscocapsular junction can be probed and the superior and inferior surfaces examined. Placement of the arthroscope in the posteromedial or posterolateral compartment may be necessary to assure that peripheral posterior horn tears are not missed. At the popliteal hiatus, direct probing will help assess hypermobility, which can occur after popliteomeniscal fasciculi disruption. With a careful, systematic approach, arthroscopic evaluation should be the definitive means of detecting meniscal tears.

Classification of Meniscal Tears

Meniscal tear classification can be based on the pattern of the tear seen at arthroscopy or on the etiology of the meniscal injury. The two etiologic categories are tears from excessive application of force to a normal meniscus and tears occurring from normal forces acting on a degenerative structure.

Commonly described patterns of meniscal tear include vertical longitudinal, oblique, complex (including degenerative), transverse (radial), and horizontal[37] (Fig. 7). The incidence of these tear patterns has been evaluated by Metcalf et al,[37] who found that 81% of tears were oblique or vertical longitudinal. With increasing age, degenerative complex tears are more frequently seen, with most meniscal pathology found in the posterior horns.

Figure 6 Sagittal MRI scan of a grade III change within the medial meniscus, consistent with a meniscal tear.

Vertical longitudinal tears can be complete (ie, bucket handle tears) or incomplete and most often occur in younger individuals. These tears are most commonly associated with ACL injury. Bucket handle tears usually begin in the posterior horn and can vary in length from <1 cm to greater than two thirds of the meniscus. They are often unstable and can cause mechanical symptoms or true locking of the knee. The medial meniscus is more commonly affected, likely because its more secure attachments to the tibial plateau make it susceptible to shear injury. Incomplete tears also affect the posterior horn of the meniscus and can be found on both the superior and inferior surfaces of the meniscus. These tears may or may not be symptomatic. They can be found at the time of arthroscopy during probing of the meniscus.

Oblique tears, often called flap or parrot beak tears, can occur at any location but are most often found at the junction of the posterior and middle thirds of the meniscus. Symptoms may result from the free torn edge of the flap catching in the joint and producing traction on the meniscocapsular junction. Propagation of the tear also may occur in this manner.

Complex or degenerative tears occur in multiple planes and are more common in older age groups (>40 years). Occurring in the posterior horn and midbody, they are often associated with degenerative changes of articular cartilage in the knee and represent part of the pathology of degenerative arthritis.

Transverse or radial tears occur in isolation or in conjunction with other tears. They are typically located at the junction of the posterior and middle thirds of the medial meniscus or near the posterior attachment of the lateral meniscus. They may be asymptomatic but can propagate across the entire meniscus if the edges catch within the joint. Complete radial tears disrupt the circumferential fibers of the meniscus and result in a loss of load-bearing function.

Horizontal tears are believed to begin near the inner margin of the meniscus and extend toward the capsule. They tend to occur in the plane of the horizontally oriented middle perforating collagen fiber bundles and are thought to be the result of shear forces generated by axial compression. They may occur in all age groups but increase in frequency with age. They are also commonly seen in the lateral menisci of runners. Meniscal cysts are often associated with horizontal tears and can be symptomatic because of localized swelling.

Meniscal cysts represent 1% to 10% of meniscal pathology.[38] They are highly correlated with meniscal tears and most often occur in the lateral meniscus. Pathologically, these cysts appear directly connected to the meniscus and are filled with a gel-like material biochemically similar to synovial fluid. Symptoms include joint line pain, and the cysts are often palpable on physical examination at or below the joint line.

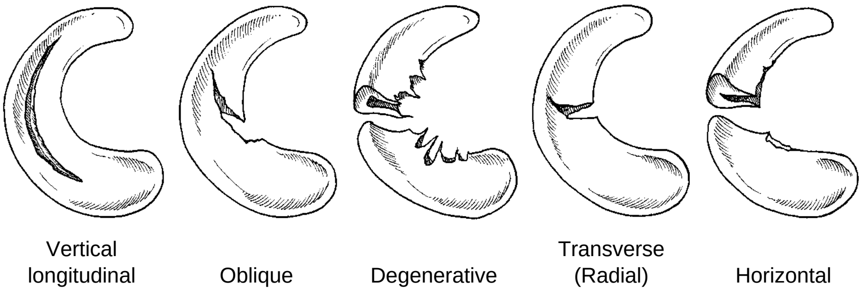

Figure 7 Classification of meniscal tears. (Adapted with permission.[40])

Surgical Decision Making

Indications for Arthroscopic Treatment

The surgical indications for arthroscopic treatment of meniscal pathology include (1) symptoms of meniscal injury that affect activities of daily living, work, and/or sports; (2) positive physical findings of joint line tenderness, joint effusion, limitation of motion, and provocative signs, such as pain with squatting or a positive flexion McMurray or Apley grind test; (3) failure to respond to nonsurgical treatment, including activity modification, medication, and a rehabilitation program; and (4) absence of other causes of knee pain identified on plain radiographs or other imaging studies.[37] In some clinical situations, one or more of these indications may be absent; however, these criteria should be considered before surgical treatment is undertaken.

In the setting of ACL injury, the surgical treatment of meniscal pathology is most often done concurrently with ACL reconstruction. Surgical timing is most often dictated by issues related to ACL surgery, such as range of motion, swelling, quadriceps muscle function, and associated ligament injuries. Loss of motion because of a displaced meniscal tear may necessitate urgent treatment.

Surgical Setup

Most arthroscopic meniscal surgery can be done on an outpatient basis. General, regional, or local anesthesia can be used, although general and regional anesthesia provide better limb-muscle relaxation. Tourniquet use is not necessary in the majority of patients and has been shown to have potential adverse effects, including electromyographic evidence of quadriceps muscle damage and a potential increased risk of thrombophlebitis.[39]

Gravity flow into the knee for arthroscopy is safe, efficient, and inexpensive. However, it may result in suboptimal flow during more complex procedures. Pump systems maintain a constant pressure and flow; however, fluid extravasation can occur with these systems, and a degree of vigilance must be maintained, especially in acute knee injuries where capsular disruption may have occurred.

A leg holder or post is used to provide a fulcrum around which valgus and varus stress can be applied to the knee for better visualization.[40] A leg holder provides excellent access to the entire limb and facilitates meniscal repair and ligamentous reconstructions. The leg post provides less rotational control but may be used with the patient fully supported on the operating room bed, making surgical setup and patient positioning somewhat easier. However, during a meniscal repair, the bed may limit access to the medial and lateral aspects of the knee and make needle retrieval somewhat more difficult.

Care must be exercised with either device to prevent inadvertent injury to the collateral ligaments during stressing of the joint when attempting to visualize the medial and lateral compartments.

Surgical instrumentation should include a 30° and 70° arthroscope, manual instruments, and a motorized arthroscopic shaver.[40] In addition, instrumentation for a possible meniscal repair should be available. Surgeon preference dictates the instrumentation, which nevertheless should allow for repair in all zones of the meniscus.

It is important for the surgeon to develop a standardized, systematic approach to conducting an arthroscopic knee examination. Knowledge of a wide variety of portals and surgical techniques is necessary, as is the ability to modify these to adapt to various knee structures and pathology.

Surgical Treatment

The most commonly accepted criteria for meniscal repair include (1) a complete vertical longitudinal tear >10 mm long; (2) a tear within the peripheral 10% to 30% of the meniscus or within 3 or 4 mm of the meniscocapsular junction; (3) a tear that can be displaced by probing, thus demonstrating instability; (4) a tear without secondary degeneration or deformity; (5) a tear in an active patient; and (6) a tear associated with concurrent ligament stabilization or in a ligamentously stable knee.[41] When these criteria are present, formal repair using a variety of methods should be conducted. In a situation in which these criteria are not present, treatment must be individualized.

Not all meniscal tears cause symptoms or problems. Henning et al[42] suggested that certain tears do not require treatment because they heal spontaneously or remain asymptomatic. These include short (<10 mm), stable vertical longitudinal tears; stable partial-thickness tears (<50% of the meniscal depth) on the superior or inferior surface; and small (<3 mm) radial tears. In a stable knee or in a knee with a reconstructed ACL, these tears may heal spontaneously or remain asymptomatic. The technique of simple rasping and/or trephination may enhance the healing potential of these tears and should be considered. Weiss et al[43] reported complete healing in 65% of stable vertical longitudinal meniscal tears examined during a repeat arthroscopic examination. Six of 52 patients with stable tears required additional treatment over a 2- to 10-year follow-up; however, 4 of these patients had a new traumatic event. Stable in this study was defined as <3 mm of displacement with probing.

Many meniscal tears encountered during surgery do not fall into the repairable or spontaneously healing categories. These types of tears usually require partial meniscectomy to remove unstable fragments, eliminate any locking and catching, and decrease the pain associated with unstable meniscal fragments. When treating tears that are not suitable for repair, resection techniques that strive to remove nonfunctional tissue should be used, preserving as much viable tissue as possible to minimize the effect on joint mechanics.

Summary

The medial and lateral menisci are fibrocartilaginous structures that play a vital role in load bearing and the reduction of contact stresses on the articular cartilage of the knee. Injury to the meniscus is common, with tears most frequently located in the midportion and posterior horn. The injuries may occur as acute traumatic tears or as part of a degenerative process and may present as a painful knee with swelling, joint line tenderness, and the mechanical symptoms of catching or locking. Although specific clinical tests used in isolation have a poor predictive value in diagnosing meniscal tears, the overall clinical evaluation, including a careful history, a thorough physical examination, and plain radiographs, is comparable to MRI in diagnosing meniscal tears. MRI remains useful in clinical situations when the diagnosis is unclear, although positive results also can be seen in asymptomatic patients (greater in older patients). In deciding whether to proceed with surgery, the overall clinical situation must be evaluated. Repairability of the meniscus is based on tear pattern, vascularity, and the quality of the meniscal tissue, along with other factors, such as concurrent ligamentous injury.

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