

MENISCAL TEARS IN THE ATHLETE

Operative and Nonoperative Management

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The active individual frequently presents to the physician with typical signs and symptoms of a meniscal tear, but occasionally they present with a number of factors which cause the decision making of the treatment to be somewhat difficult. It is important for the physician treating an athlete with a known or suspected meniscal tear to understand the structure and function of the meniscus and the factors involved in managing an athlete with nonoperative versus operative treatment.

MENISCUS STRUCTURE

The menisci are semilunar shaped cartilages on the medial and lateral sides of the knee joint. The medial meniscus is semicircular in shape, whereas the lateral meniscus is almost a complete circle. They were once thought of as vestigial structures, but are now known to be integral components of optimal knee function.

The menisci are dynamic structures in that they move with knee motion. The medial meniscus is relatively less mobile than the lateral, translating 2 to 5

Dr Marx is supported by an American Academy of Orthopaedic Surgeons Health Services Research Fellowship and a Royal College of Physicians and Surgeons of Canada Detweiler Traveling Fellowship.

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mm in the anteroposterior plane, whereas the lateral meniscus translates up to 9 to 11 mm.³¹ The decreased motion of the medial meniscus compared with the lateral is caused by its attachments to the deep medial collateral ligament. This relative lack of motion has important clinical implications with respect to the increased incidence of meniscal tearing on the medial side.

The menisci are made of fibrocartilage, consisting of approximately 75% type one collagen. The collagen fibers lie mostly along the longitudinal axis, with oblique and radial fibers as well to enhance the structural integrity. The viscoelastic properties of the menisci allow compressive loads to be dissipated along its circumferential fibers, thereby reducing the direct forces on the articular cartilage.

The most peripheral 20% to 30% of the medial meniscus and the peripheral 10% to 25% of the lateral meniscus are vascular (Fig. 1).^{3,4} Branches from the superior, inferior, and lateral geniculate arteries supply this vascular zone. The avascular zone of the menisci, which includes at least the inner third of each meniscus, is nourished by synovial fluid diffusion. The middle third zone is not completely avascular as it receives some blood supply, but it derives most nourishment from the synovial fluid. The vascular distribution has important clinical implications for meniscal repair surgery as healing is greatly enhanced in the vascular regions.

MENISCUS FUNCTION

The main function of the menisci is to distribute load across the knee joint. Forces across the knee joint may be as high as two to four times body weight during walking, and up to six to eight times body weight during running. Fairbank's observations of loss of articular cartilage, flattening of the femoral condyles, and osteophytes in meniscectomized knees alerted clinicians to the importance of the menisci.²¹



Figure 1. Frontal section, 5-mm thick, of medial knee compartment (using Spalteholz x 3 technique to show vasculature). Vessels from the perimeniscal capillary plexus (PCP) can be seen penetrating the periphery of the medial meniscus. F=Femur; T=tibia. (From Arnoczky SP, Warren RF: Microvasculature of the human meniscus. *Am J Sports Med* 10:91, 1982; with permission.)

Hoop stress refers to the tension generated circumferentially in the meniscus under applied loads. When the meniscus is loaded in weight bearing, the meniscal fibers elongate as they are pushed to the periphery. Hoop stress is generated as the axial load is converted to tensile strain. The menisci transmit approximately 50% of the load, and close to 90% of the load at 90° of knee flexion.³¹ Most of the force is transmitted through the posterior horns with flexion past 90°.

The lateral meniscus has been shown to transmit a greater percentage of the load in the lateral compartment (approximately 70%), compared with the medial meniscus on the medial side (approximately 50%).^{1, 51} This suggests that patients who undergo lateral meniscectomy may be at higher risk for early subsequent joint degeneration. Medial meniscectomy has been demonstrated to decrease the contact surface area of the femoral condyle by 50% to 70% while doubling the stresses on the tibial plateau.⁶ When meniscal integrity is compromised, abnormal articular contact stresses result, leading to increased wear of the articular cartilage and early degenerative changes. The more meniscal tissue that is excised, the greater the loss of contact surface area and the greater the increase in peak local contact stresses.

The meniscus also has a role in knee stability. It deepens the socket of the tibia to better conform to the ovoid shape of the femoral condyles. As well, its triangular shape permits it to act as a wedge to potentially limit femoral translation on the tibial plateau. During flexion the femoral condyles and the menisci translate posteriorly, whereas the reverse is true in extension. Isolated medial or lateral meniscectomy does not result in significant increases in anteroposterior translation. The menisci act, however, as secondary stabilizers in the anterior cruciate ligament (ACL) deficient knee.^{30, 32} The posterior horn of the medial meniscus is particularly important for this function because it acts as a wedge to resist anterior translation.^{9, 29}

Lastly, the meniscus has a role in joint lubrication. During loading of the knee, when the meniscus is compressed, synovial fluid is driven into the articular cartilage. This form of lubrication reduces the coefficient of friction in the knee significantly.⁴⁷ Synovial fluid also serves the chondrocytes as a vehicle for nutrition.

MENISCUS EVALUATION

The history often can be the most important part of patient evaluation in the assessment of individuals with meniscal tears. The mechanism of injury, presence of catching or locking, pain, and swelling are critical aspects of the history. The patient often describes a twisting injury to the knee, or full flexion of the knee (as in kneeling) that leads to pain or locking. The twisting can lead to meniscal tearing through shear forces, whereas loading the knee in full flexion can overload the posterior horn leading to a meniscal tear. Displaced fragments of meniscus can act as a mechanical block, causing the knee to catch, give way, or lock. A few patients describe an unlocking maneuver that they perform to allow their knee to resume a full range of motion. The latter scenario is most common in patients who suffer a displaced bucket-handle tear. Chronic tears can present with recurrent pain and swelling, which may intermittently trouble the patient.

Physical examination specific to meniscal tears includes inspection, palpation, range of motion, and tests for meniscal integrity. A comprehensive examination of the knee also should be performed to rule out associated pathology;

however, a review of the complete knee examination is beyond the scope of this review. As well, the spine and hip should be routinely examined in all patients with knee complaints.

Diminished thigh girth and a decrease in the apparent size of the quadriceps muscle is usually seen in tears that are not acute because of reflex inhibition of this muscle group. Effusion is common with meniscal tears, but may be activity dependent. Joint line tenderness usually is present in patients with meniscal tears and is the most reliable clinical sign in a patient with an intact ACL. This can be a nonspecific sign, however, in the setting of an ACL or medial collateral ligament injury, or in the presence of osteoarthritis. If the tear is in the posterior horn, as it often is, the pain is at the posterolateral or posteromedial edge of the tibia. Lack of full range of motion may be caused by a displaced flap of meniscal tissue. McMurray's test involves extending the knee from a fully flexed position with either external rotation and a valgus stress or internal rotation and a varus stress, to load the lateral and medial menisci, respectively. A finger is positioned along the joint line in question, and clicking with this maneuver is suggestive of meniscal tear.

Radiographic evaluation should include standing anteroposterior, lateral, tunnel, and axial views. For an accurate assessment of degenerative changes, the 45° posteroanterior flexion weight-bearing view is useful.⁴⁴ MR imaging has largely replaced arthrography as the imaging modality of choice for the menisci as the accuracy has been shown to be greater than 90%.^{20, 34, 41} MR imaging is not routinely required for the diagnosis of meniscal tears before proceeding with arthroscopic surgery; however, this investigation confirms the diagnosis and provides additional information concerning the status of the ligaments and articular cartilage.³⁹ Diagnostic arthroscopy is the gold standard for the diagnosis of a meniscal tear.

FACTORS OF OPERATIVE VERSUS NONOPERATIVE MANAGEMENT

Multiple factors are involved in decisions regarding the management of an athlete with a known or suspected meniscal tear. Factors, such as the severity of the symptoms, the ability to perform one's activity, and the timing of possible surgery, must be taken into account. The need for surgical management is quite evident in an individual with significant symptoms, such as a locked knee, or debilitating pain with clinical or MR imaging evidence of a meniscal tear. It can be much more difficult to make a treatment decision on an individual with relatively mild symptoms of a meniscal tear that is in a middle to late season of competition.

The severity of the symptoms can vary for different types of meniscal tears. A bucket-handle tear may cause the knee to lock and be quite painful, whereas a small vertical or radial tear that displaces may cause occasional symptoms of giving way and only mild pain. If the symptoms are infrequent and there is no locking, then an initial period of conservative management may be indicated depending on the activity level and demands of the athlete.¹⁸ Diagnostic studies may not be necessary if there are minimal symptoms and good response to conservative treatment (Fig. 2).

If, however, there are recurrent mild symptoms of swelling and pain, then the decision of nonoperative treatment is more difficult. If the athletes' ability to compete is impaired because of the symptoms, then nonoperative management is unlikely to be satisfactory and arthroscopic surgery should be helpful, al-

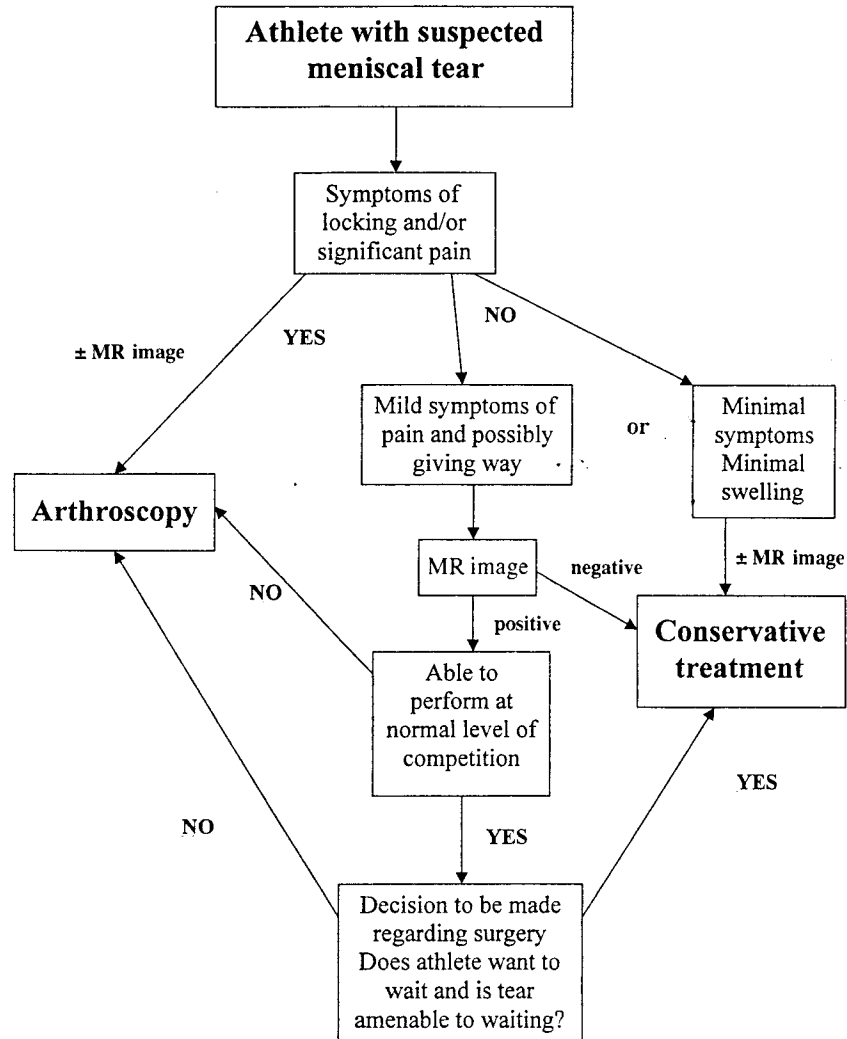


Figure 2. Algorithm for decision making in treatment of athlete with known or suspected meniscal tear.

though it may mean a delay in returning to competition of 1 to 4 weeks. An athlete with recurrent mild symptoms but without impairment in the ability to compete may be a suitable candidate for delayed operative management.

In either scenario, a diagnostic study, such as an MR imaging, may be helpful in assessing the presence as well as size and location of a meniscal tear. The symptoms, the ability to compete effectively, and findings on examination and MR imaging are useful in the determination of the timing of surgery. Thorough consultation between the athlete, the physician, and the athletic trainer must be undertaken before any decision is made. The athlete must be given a clear explanation of what a meniscus tear is and the potential ramifications of delaying surgery, which include a possibility of the propagation of the tear or significant symptoms during a competition, which may preclude further participation at a particular event.

Few published studies have examined the results of nonoperative treatment of meniscal tears,^{22, 53} and to the authors' knowledge none have been performed in a prospective randomized fashion. They are not aware of any studies that followed meniscal tears that were not documented arthroscopically. Weiss et al⁵³ retrospectively reviewed 3612 arthroscopic meniscal procedures that were

performed with or without an associated ligamentous lesion. The authors identified 80 meniscal tears (in 75 patients) that were assumed to be stable and were not operated on. Seventy of the tears were vertical (longitudinal), and 10 were vertical radial tears. All of the radial tears and most (74%) of the vertical tears that were deemed stable involved the lateral meniscus. At the time of follow-up 2 to 10 years later, only 6 of 52 patients had needed additional intervention because of symptoms that were related to the meniscal tear. Four of them had the intervention after a sports-related traumatic extension of a stable tear, and two of them because persistent symptoms were caused by the original meniscal lesion. Repeat arthroscopy performed on 32 patients (average 26 months) revealed 17 of the 26 longitudinal tears had completely healed. Five of the six radial tears had no evidence of healing, and one had extended. The authors concluded that stable (displacement < 3 mm) vertical tears, which tend to occur in the peripheral vascular portions of the menisci, have great potential for healing. They concluded that tears such as these should be left alone unless it is the only abnormality that is found and it is causing the patient's symptoms. The authors were inconclusive and did not propose any guidelines for radial tears.

Fitzgibbons and Shelbourne²² reviewed meniscus tears in light of a concurrent ACL reconstruction and found favorable results in the nontreatment of a number of types of lateral meniscal tears. One hundred eighty-nine lateral meniscal tears that were left in situ at the time of anterior cruciate ligament reconstruction were followed an average of 2.6 years. The authors found that: (1) posterior horn avulsion tears that were left alone did not cause clinical symptoms after ACL reconstruction; (2) vertical tears posterior to the popliteus tendon were asymptomatic before and after reconstruction; and (3) other complete and incomplete lateral meniscal tears (vertical longitudinal, radial, or anterior vertical), if stable at the time of anterior cruciate ligament reconstruction, could be left in situ without becoming clinically symptomatic.

Case Discussion

To illustrate the point regarding nonoperative management the case of a 22-year-old college senior and starting linebacker for a NCAA division I football team is presented. He presented after a game in mid-October with an effusion and with pain in the lateral aspect of his knee. He could not remember any episode where he injured it. Examination revealed a ligamentously stable knee with lateral joint line tenderness. The effusion and symptoms persisted despite treatment with a nonsteroidal anti-inflammatory drug (NSAID), ice, and electrical stimulation. A lateral meniscus tear was suspected and confirmed with MR imaging (Fig. 3). At that time, the option of surgery was discussed with the player. With a chance to qualify for a bowl game by winning two of the four games remaining in the season, it was the player's sentiment to delay surgery until after the season if possible. Two days before the next game, the player had the knee aspirated. The patient had relief and was placed on indomethacin (Indocin) 50 mg two times per day. The player played well in the following game and only had mild symptoms throughout the remainder of the season. The knee had intermittent swelling which was controlled with ice and the Indocin. No further aspirations were necessary. With persistent lateral joint pain and discomfort at the end of the season, the player opted to have arthroscopic surgery. At the time of surgery a radial split was evident in the lateral meniscus extending almost 6 mm in the midportion of the meniscus (Fig. 4). No other

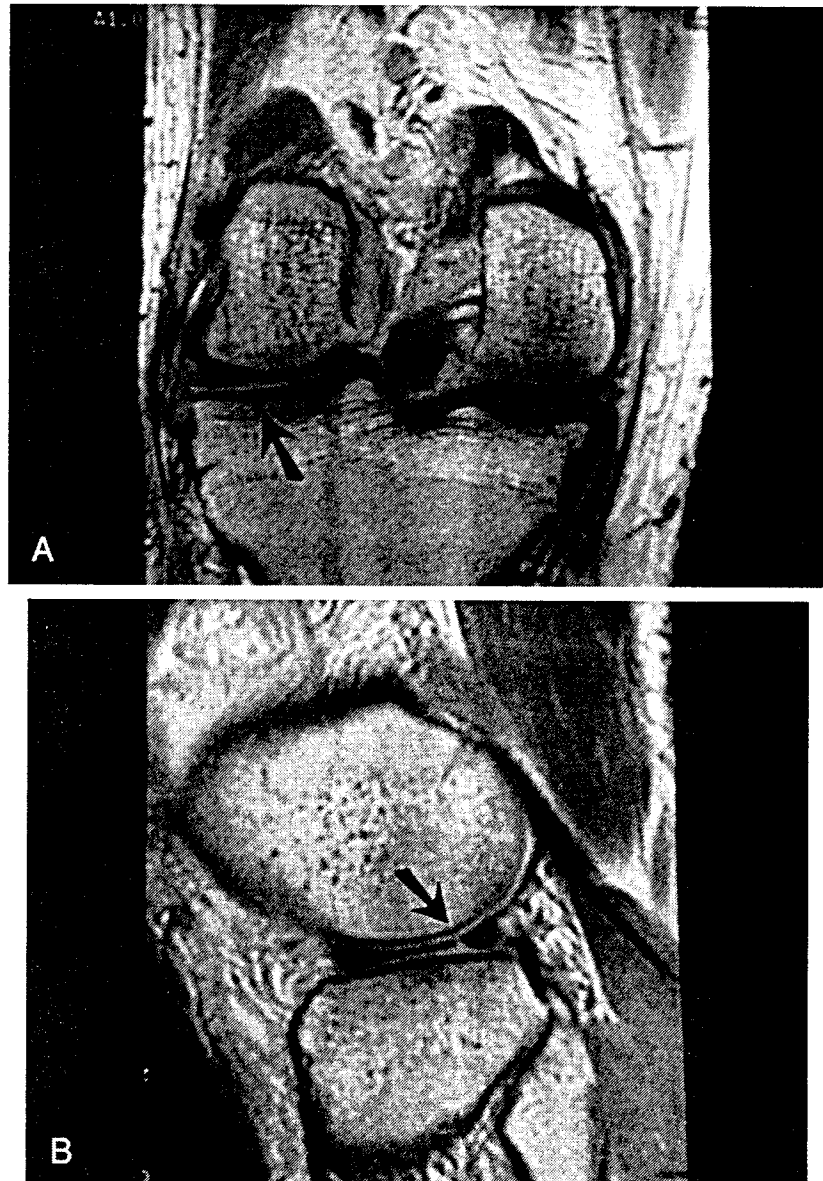


Figure 3. A, Coronal fast spin-echo (FSE) proton density MR image of right knee demonstrates tear in posterior horn of lateral meniscus (*arrow*). B, Sagittal proton density MR image demonstrates tear in lateral meniscus (*arrow*).

pathology was evident. The player was started on an aggressive rehabilitation program and 3 weeks later successfully played in a postseason bowl game.

Nonoperative Rehabilitation

The nonoperative rehabilitation of an athlete with a known or suspected meniscal tear needs to include a number of items. Cryotherapy and NSAIDs play a very important role in the management. These help control the amount of swelling and give some relief from the pain. Sometimes an aspiration is useful to decrease the effusion and rarely, if necessary, an athlete may need to undergo a judicious one-time injection of a corticosteroid. Although not routinely advocated, an injection may provide an athlete with a way to control the irritation

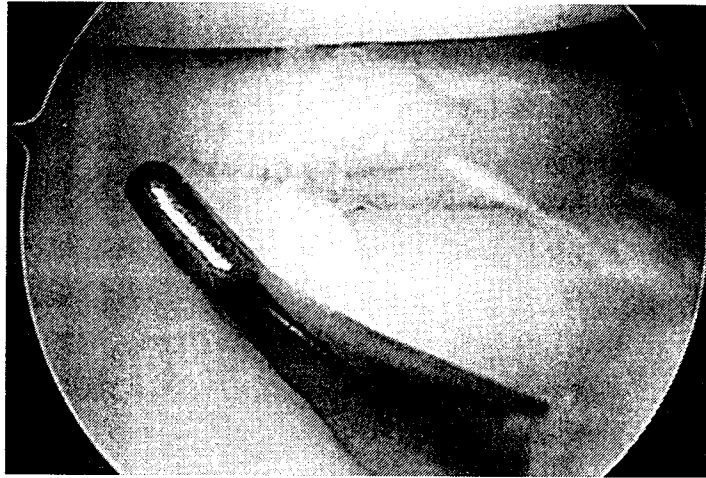


Figure 4. Arthroscopic surgery shows radial splint in lateral meniscus extending almost 6 mm in the midportion of the meniscus (*arrow*).

within the knee so that performance may not falter. Maintenance of range of motion of the knee is important, as is muscular strength and endurance. A progression of resistance exercises is instituted as tolerated by the athlete. This is followed by a gradual return to running. Nonimpact conditioning consisting of bicycle or pool therapy is helpful during this postoperative recovery period. A goal before return to athletic activity is strength of the injured lower extremity within 20% to 30% of the contralateral side.¹⁸ These factors in rehabilitation can be achieved and facilitated with the help of a physical therapist or athletic trainer. Initially, activity modification is useful, particularly in the weekend warrior athlete.

The time frame for return to activity depends on a number of factors as discussed earlier. A lot of this depends on the demands and motivation of the athlete as well as the severity of the meniscal tear. If the athlete does not tolerate the nonoperative treatment with the rehabilitation then the next step is surgical management.

OPERATIVE MANAGEMENT

Once a decision has been made to proceed with operative management then further decisions need to be made at the time of surgery regarding the treatment of the meniscus tear. Intraoperatively, a decision has to be made whether to repair, excise, or leave the tear in the meniscus alone. The concept of repairing the meniscus is not new. The first report of meniscus repair was in 1885 by Annandale.² Since then there have been numerous studies and articles published on the treatment of meniscal tears, particularly since the advent of arthroscopy in the past 30 years.^{10, 11, 15, 18, 36, 43, 45, 50, 53}

Numerous factors are involved in the determination of treatment of a meniscal tear. In assessing these factors one has to be cognizant of meniscal biomechanics, including the role in load transmission and congruity of the knee joint, as discussed previously. Because of the importance of intact functional meniscus tissue, the first goal is to preserve as much of the viable tissue as is possible. Decisions on the type of treatment should reflect this. Factors of the meniscal tear that need to be taken into consideration during the thought process

include the location, the length, the tear pattern, and the stability of the tear, and any damage to the integrity of the meniscus body.¹⁵ These characteristics can be assessed arthroscopically using traditional anterior lateral and medial portals. Occasionally a posterior portal is necessary to visualize the posterior horn of the medial meniscus. A probe is used to assess the tear. Other factors to consider are the athlete's age, presence of a degenerative tear, concurrent intra-articular injuries, chronicity of the tear, and desired timing of return to competition.

REPAIR OR LEAVE ALONE

The location of the tear is critical in the determination of those tears that lie in the vascular zone of the meniscus and are suitable for repair. Typically, this involves a tear in the peripheral one third of the meniscus. Questionable reparability are those menisci with tears in the middle one third. If vascularity of the meniscus is visualized with observable bleeding in the tear area, a repair is considered. DeHaven considers those tears in the peripheral 3 mm as vascular, those 5 mm or more from the periphery as being avascular, and those between 3 and 5 mm as being variable in vascularity.¹⁵ The area in the posterolateral aspect of the lateral meniscus around the popliteus tendon is an area of watershed and relative hypovascularity even in the peripheral one third.^{3, 37} In those areas with marginal vascularization, abrasion of the meniscal tissue or a fibrin clot may be used to enhance healing of a repair.^{5, 43, 45, 50} One of the authors (TLW) has documented successful healing in five patients with radial tears in the hypovascular zone of the lateral meniscus using a fibrin clot.⁵⁰

The pattern, the length, and the stability of the tear play important roles in the decision making. If the circumferential hoop fibers remain intact there is a greater chance for healing than when they are disrupted, such as in a complete radial tear.³⁶ Radial tears in general are less amenable to repair, although some complete tears do warrant attempts at repair, especially when the alternative is a subtotal meniscectomy. Short inner radial tears (<5 mm) usually do not heal, but often can be left alone as they may be asymptomatic.^{18, 53} Bucket-handle tears that are complex with radial components, often seen in chronic cases, have more difficulty healing with repair than simple acute bucket-handle tears.¹¹ Radial tears at the posterior horn heal better than those in the middle part of the meniscus secondary to the improved vascularity in this region.¹¹ Fitzgibbons and Shelbourne²² have demonstrated that posterior horn avulsions of the lateral meniscus can result in no clinical symptoms when left alone in conjunction with an ACL reconstruction. Longitudinal (vertical) tears in the periphery are most amenable to repair.^{10, 11, 36} Some authors believe that stable tears less than 1 cm in length can be left alone.^{11, 54} Stable tears have been defined as those in which the central portion cannot be displaced more than 3 mm.⁵³ Those longitudinal tears that are stable and in the peripheral two thirds often can be left alone, particularly if they are less than 5 mm in length.¹⁸ Partial thickness tears of various types, particularly longitudinal tears, usually can be left alone if less than 5 mm in length.¹⁸ Oblique tears have difficulty healing as do horizontal tears.

Repair of the meniscus has been demonstrated to be more successful when done in conjunction with an ACL reconstruction (62% to 96% healing rate), versus no ACL reconstruction (17% to 62%).^{15, 45, 52} The reasons for this are likely because of the stability provided by the ACL reconstruction as well as the favorable healing environment from the hemarthrosis incurred during ACL reconstruction.^{14, 33, 35, 49, 54} As mentioned earlier, Fitzgibbons and Shelbourne²²

have demonstrated that a number of lateral meniscal tears remain asymptomatic when left alone at the time of ACL reconstruction. In a smaller series, Orfaly et al³⁸ had similar results.

Any significant injury to the meniscus body, such as a complex tear, numerous cleavage tears, change in the meniscal body contour, or degenerative tearing may render any repair effort as futile. The problem with such injuries to the menisci body is that the structural integrity of the meniscus is damaged and the vascularity may be impaired.¹⁵ Additionally, degenerative tears are difficult to hold with meniscal repair material.²⁷ The older athletes often have a degenerative component to their tears. The degenerative portion should be debrided and repair attempted depending on the type of tear and age of the individual. Often the older athlete has articular cartilage degeneration in addition to a meniscal tear. In this type of patient, a meniscal repair is ill-advised.¹¹ The chronicity of the tear also plays a role in the amount of degenerative changes found as well as complexity of the tear. Some authors have demonstrated better healing in acute tears than chronic tears.^{14, 24} Although this may be true, there has not been conclusive evidence that a tear more than 2 or 3 months old demonstrates impaired healing.

Timing of return to play is important. An athlete undergoing arthroscopic management of a meniscal tear during the season may not want to undergo meniscal repair, particularly if that would limit his or her ability to partake in an upcoming important competition. A partial meniscectomy may be more desirable for that athlete. Again, as previously mentioned, preoperative discussions and thorough counseling with the athlete are necessary before surgery.

It is beyond the scope of this article to discuss the details of the techniques involved in the meniscal repair; however, they briefly are mentioned here. The types of repair include the time honored open repair¹⁷ and arthroscopic techniques of the inside-out and outside-in suture repairs, and the all-inside techniques. The inside-out and outside-in repairs involve a mini-incision and securing the meniscus to capsule with suture. The all inside technique entails many options, including arthroscopic suture tying, and numerous absorbable fixation devices with such names as arrow, fastener, dart, and staple. Suffice it to say there are a number of options for meniscal repair and the surgeon needs to choose that with which he or she is most comfortable.

Rehabilitation After Repair

There are many differing views on rehabilitation after repair of the meniscus. Traditionally, an individual with a meniscal tear has been treated with immobilization or no weight bearing.^{17, 19, 35, 42, 45} DeHaven has published good results^{17, 19} with this type of aftercare and currently recommends 2-weeks of immobilization with the knee in extension for isolated repairs.¹⁶ This is followed by limited motion (10° to 80°) for another 2 weeks, followed by unrestricted motion. A meniscal repair done in conjunction with an ACL reconstruction is allowed immediate motion. Weight bearing is significantly limited until 6 weeks for isolated repairs and repairs done in conjunction with an ACL reconstruction. DeHaven believes that the repair needs to be further protected from heavy stresses for at least 6 months after surgery. This includes refraining from agility drills, full-speed running, and full squats.

Other authors advocate a more accelerated rehabilitation program.^{7, 8, 46} Shelbourne⁴⁶ and Barber^{7, 8} have demonstrated good results with immediate range of motion and weight bearing as tolerated after meniscal repair. Both

authors believe that activity restrictions are unnecessary after repair of the meniscus. The return to full activity was seen at an average of 10 weeks in Shelbourne's group.⁴⁶

Concepts are continuing to evolve regarding the rehabilitation following meniscal repair. Currently, there is not adequate prospective data supporting either the traditional conservative method of postoperative care following meniscal repair, nor is there any supporting accelerated rehabilitation. Accelerated rehabilitation, however, is certainly attractive, particularly to the athlete who would like to return to their sport early. This type of program warrants further investigation.

EXCISION

The decision to remove a torn meniscus fragment is made only after considering the factors discussed in the previous section. If excision of meniscal tissue is performed, the concept of preserving as much viable meniscus tissue as possible remains applicable. The general idea is to remove only a torn, degenerated, or abnormally shaped meniscus fragment and perform a partial meniscectomy and not a total meniscectomy. The adverse effects on the knee joint after a total meniscectomy have been well documented.^{21, 23, 25, 28, 30, 48} The excision of a tear or degenerative tissue allows for functional meniscus to remain and perform its normal role. A rim of tissue must be preserved. If it is not, the meniscus becomes destabilized and normal function lost. Particular tear patterns that are good candidates for partial meniscectomy include: most tears involving the inner one third (avascular zone) of the meniscus, horizontal cleavage tears, oblique tears, radial tears, and tears with degenerative tissue. The results from partial meniscectomy of those with acute traumatic tears are better than those that have degenerative tears.^{12, 13, 40} Those patients with concomitant articular cartilage lesions have been shown to have worse postoperative function than those without.²⁶

The decision to excise a meniscal lesion involves many factors, as discussed previously. Again, the ability to return to play early may be an important factor for the professional athlete or even the weekend athlete.

Rehabilitation After Excision

The rehabilitation of the individual after arthroscopic excision (partial meniscectomy) involves full active and passive range of motion on postoperative day one. Crutches are given and used until there is no limp evident upon walking. The patient is allowed to weight bear as tolerated immediately, although many patients prefer partial weight bearing secondary to the pain from the surgery. Quadriceps sets, straight leg raising, and standing theraband exercises are initiated on postoperative day one. At the second visit, use of the stationary bike is begun and progressive resistance exercises are started depending on the amount of swelling and pain present. Functional activities are typically started at day seven or eight and progress as tolerated. Running could begin at this time if the patient is doing exceptionally well; however, it typically may not be until 10 to 14 days after surgery. A return to competition may be within 2 weeks on occasion, depending on the athlete and the sport. More likely it will take 3 to 4 weeks to return. As in the rehabilitation for nonoperative

management of meniscal tears, ice, and NSAIDs assist in controlling the swelling and allow for an easier transition back to activity.

SUMMARY

There are many factors to consider when treating an active individual with a known or suspected meniscal tear. The athlete with a meniscal tear sometimes can return to competition, temporarily delaying surgery until after the season. If an athlete remains symptomatic and is unable to return, however, then arthroscopic surgery generally is effective to allow the athlete to resume participation. The decision of meniscal repair versus excision must be carefully thought out and discussed with the athlete before surgery. Either treatment can allow the athlete to return to their sport. It is controversial whether or not an athlete should be allowed early return to play after meniscal repair. Further prospective randomized studies would provide useful information in deciding which type of treatment and which type of rehabilitation is best suited for the active individual.

ACKNOWLEDGMENT

We would like to acknowledge Kurt P. Spindler, MD, for providing editorial assistance in the preparation of the manuscript.

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