

# Meniscal Injury

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One of the most common knee problems in athletes and physically active individuals is related to the meniscus. In the past, some surgeons thought of the meniscus as an appendage similar to vermiform appendix. They suggested that the meniscus was a functionless remnant of leg muscle origin.<sup>1</sup> Most of them excised the meniscus if it was diseased. At that time, the biomechanical importance of the meniscus for knee function was not yet established, and it was also believed that total excision of torn meniscus provided the satisfied clinical results. When the knowledge regarding its anatomy and function and the long-term clinical outcome have greatly increased over the years, the clinical approach to the meniscal problem has undergone dramatic change and led to a recent trend to preserve meniscus tissue if at all possible. Currently, the physician treating an athlete or a patient with a known or suspected meniscal tear needs to understand the structure and function of the meniscus and the factors involved in treating those kinds of patients. This article will present in the anatomy and role of the meniscus, clinical presentation of meniscal injury and the various treatment methods.

## Anatomy and Functions

The menisci are semicircular fibrocartilaginous structures that cover one half to two thirds of the articular surface of the corresponding tibial plateau. The peripheral border of each meniscus is thick and attached to the inside capsule of the knee joint whereas the central border tapers to a thin free edge.

The medial meniscus is semilunar in shape and the anterior and posterior horns are separated approximately the length of the meniscus. The anterior horn is quite small when compared to the posterior horn that is large with a broad base. The anterior horn of the medial meniscus is close proximity to the infrapatellar fat pad and inserts at the intercondylar fossa in front of the anterior cruciate ligament. The entire medial meniscus is attached firmly to the joint capsule.

The lateral meniscus is almost circular in shape and the anterior and posterior horns are in close proximity. The anterior horn, midportion and posterior horn are uniform in size and cover a large portion of the articular surface of the tibia than the medial side. The lateral meniscus is attached firmly to the capsule except

for the area posterior to midportion where the popliteus tendon crosses the joint through the popliteus hiatus.

Histologically, the meniscus is an interlaced network of collagen bundles. The majorities of these bundles of fibrocartilage are circumferentially oriented in the longitudinal axis. The remaining fibers are obliquely oriented to the longitudinal axis. The circumferential fibers provide tensile strength and the interlaced fibers provide resistance to compressive forces and splitting.

The menisci are relatively avascular structures. The only limited peripheral blood supply originates predominately from the medial and lateral geniculate arteries. These vessels anastomose into a parameniscal capillary plexus supplying the synovial and capsular tissues of the knee joint. The peripheral plexus supplies the peripheral border of the meniscus including joint capsule and then gives the radial branches directed toward the center of the joint. Anatomic studies have shown that the area of vascular penetration is approximately 10% to 30% of the medial and 10% to 25% of the width of the lateral meniscus. This vascular penetration area is considered the red-on-red zone (red-red) and has the highest healing potential. The avascular inner two thirds of the meniscus, known as the white-on-white zone (white-white), receives the nutrition supply from the diffusion mechanism or mechanical pumping of synovial fluid. This area has worst healing potential. Between these two zones is a variable vascular area called the red-on-white zone (red-white) that is considered intermediate healing potential. The menisci contain both free nerve endings and corpuscular mechanoreceptors and may act as a source of proprioceptive feedback for the knee joint.

The function of the menisci has been clinically established by the degenerative changes following the meniscectomy. The study has shown that the radiographic changes following meniscectomy include narrowing of the joint space, flattening of the femoral condyle and the formation of osteophytes.<sup>2</sup> Menisci play the necessary functional roles in the knee joint including load transmission, shock absorption, joint stabilizer, joint lubrication and proprioception.

## Classification

Various classifications of tears of the menisci have been proposed according to the anatomical location, the

location in relation to vascular supply, tear patterns, etiology of tears and other factors. Most of the commonly used classifications are based on the tear pattern found at surgery including vertical longitudinal, oblique or flap, degenerative or complex, radial, and horizontal cleavage.<sup>3,4</sup>

The vertical longitudinal or bucket handle tear are most common findings after traumatic events of young athletes. The tear can be located along the entire length or width of the meniscus. This results in an unstable fragment that can cause mechanical locking within the joint. This type of tear has a high association with an ACL injury.

The oblique, flap, or parrot beak tear occurs with the incidence between 30 to 60 years of age and can be presented anywhere along the meniscus. The leading unstable edge of this tear may protrude and catch between the joint during weight bearing. According to the geometric complexity, the treatment of this tear pattern is usually meniscectomy.

The degenerative or complex pattern generally occurs in several planes and is probably the most common of all meniscal lesions. It is usually found in patients over 40 to 50 years of age with an insidious onset of the symptoms. This tear pattern is commonly found in association with a degenerative osteoarthritis of the knee. Most surgeons do not recommend for surgical repair.

The radial tear is usually found at the posterior horn of the lateral meniscus, particularly in young athletes. These small radial tears are not initially symptomatic, but as the leading fragment protrude and catch between the joint during weight bearing, the tear may progress. This results in increased instability and the symptoms.

The horizontal cleavage tear occurs in all age groups and locates most commonly at the posterior horn of medial meniscus. The tear begins at the inner border and extends toward the joint capsule in a horizontal plane. This results in upper and lower flaps which can protrude and catch between the joint during weight bearing.

### Clinical diagnosis

The definite diagnosis of meniscal tear may be difficult from the history taking and physical examination especially in the older athletes with osteoarthritis or athletes with chondral injuries. Athletes with isolated meniscal tears usually complain of pain and local tenderness over the joint line or referred to the popliteal region worse with knee flexion and weight-bearing. Swelling may be sudden or occur over 24 hours. Rapid effusion of the knee suggests bleeding from a peripheral tear (in the highly vascular portion of the meniscus). Slower appearance of effusion suggests that the effusion is synovial fluid rather than blood. If the meniscal tear is associated with any unstable fragment, the patients may have mechanical symptoms such as popping, locking, or catching. On the physical examination, there is often a positive compression and distraction test (Apley's test). This test is meant to differentiate meniscal and collateral ligament pathology. With the patient in prone position, the affected leg is flexed to 90 degrees at the level of knee joint, then axial compression and distraction forces are applied through the heel when the tibia is placed in external and internal rotation. If

the meniscal injury is present, this maneuver will cause pain during axial compression and rotation portion because of compression and shear force are placed on the menisci. If ligamentous injury is present, pain will be presented with the distraction phase as the result of tension occurred on the collateral ligament. There are several additional specific tests for meniscal tear. These include extending the fully flexed knee while internally and externally rotating the tibia and applying a valgus force on the knee joint (McMurray's test). Placement of the opposite hand's fingers over the joint line allows the palpation of a "click" created by movement of the meniscal tear fragment. Another clinical test is the squat test. This test can be performed by several repetitive motions of the knee from standing to fully squatting position with the alternately internal and external rotation of the tibia. Pain on the medial or lateral side of the knee implies the location of the meniscal tear. If the pain occurs in internally rotated position of the leg, the lateral meniscal injury should be diagnosed. Medial meniscal tear generally produce pain in the external rotation position. A bucket handle torn meniscus commonly locks the knee in a flexed position causing painful extension and flexion.

### Imaging studies

Roentgenograms: Plain roentgenograms of the knee cannot diagnose the meniscal tear but are a reasonable indicator of other internal derangement, such as osteochondral lesions that might occur during the injury, or the degenerative changes in the involved compartment of the knee. Four views are usually obtained: a 30 to 45 degree posteroanterior flexion weight-bearing view, a lateral weight-bearing view, an intercondylar notch view, and a patella skyline view.

Arthrography: The usefulness of arthrography in documentation of meniscal tears is related to the injection technique and the interpretation skill of the radiologist. Several studies have shown that arthrography demonstrated accuracies of 83 to 93% when optimal technique is used.<sup>5-8</sup> These studies accentuate the low cost, availability and low morbidity of this diagnostic test.

Magnetic resonance imaging (MRI): Magnetic resonance imaging (MRI) of the knee generally has replaced arthrography. The diagnostic accuracy of the MRI has been demonstrated to be greater than 90%.<sup>9-11</sup> The major advantage over arthrography is that MRI is a noninvasive procedure and provides additional information concerning the status of the ligaments and articular cartilage structure.

### Nonoperative Treatment

Stable peripheral longitudinal tears and incomplete meniscal tears without other pathological condition such as a torn anterior cruciate ligament have been shown to heal with nonoperative treatment.<sup>12</sup> Most of them will not progress and can heal if the knee is stable. Chronic meniscal tears with the mechanical symptoms including catching or locking of the knee tend to respond best to surgical treatment. The important aspects of nonoperative treatment are 1) prevention of pain and swelling, 2) obtaining full range of motion as soon as possible after the injury, and 3) beginning the strengthening exercise after symmetric range of motion has been obtained. If the symptoms such as pain, tenderness, or swelling

persist after 4-6 weeks of conservative treatment period, operative treatment is advised.

### Operative Treatment

**Meniscectomy:** The general goals of the meniscectomy include removal of only the torn or unstable portion of meniscus, with subsequent contouring of the remaining part and preservation of the capsular rim. Because the evidence of degenerative osteoarthritis risk is increased after total meniscectomy, it is no longer considered the treatment of choice in active patient. All effort should be made to maintain as much normal meniscus tissue as possible. Hypermobile torn meniscal fragment has to be removed, leaving a smooth contour in the meniscus with no incongruous edges. The medium to long-term follow-up studies have shown that, after the arthroscopic partial meniscectomy, the patients had good to excellent results and were able to recover to their sports activities.<sup>13,14</sup>

**Meniscal repair:** Unstable meniscal tears or tears in the avascular inner two thirds area are generally unable to heal unless brought the torn part into contact with a vascular supply from the periphery. The absolute indication for meniscal repair is an acute, longitudinal, peripheral tear that is 1 to 2 cm in length in young athlete. However, the recent study has found that, even in the large bucket-handle tears, repair in conjunction with concomitant anterior cruciate ligament reconstruction achieves high satisfactory results.<sup>15</sup> Several different methods have been advocated to augment healing of the repaired meniscus in the avascular portion such as fibrin sealant, sown blood clot, free synovial autografts, bone marrow cell, and trephination.<sup>16-18</sup>

**Meniscal allograft transplantation:** The indications for meniscal transplantation usually related to articular cartilage preservation.<sup>19</sup> These include 1) total meniscectomy in young and active patients, 2) low-grade medial degenerative arthritis of the knee in middle-aged and elderly patients, and 3) advance medial knee joint arthritis in elderly patients. The contraindications to this procedure are those patients whose symptoms are not localized in the meniscal-deficient compartment, malalignment knee joint or ligament instability that is uncorrected, excessive weight, skeletal immaturity, and history of previous infection. Despite several studies showing the good clinical results and significant pain relief,<sup>20-22</sup> allograft risk including immunologic reaction and disease transmission have to be concerned. Long-term follow-up is needed to define the survivorship of these procedures especially in a young patient.

### Summary

Meniscal injuries are very common in sports activities. Understanding of the structure and functional roles of the meniscus definitely improves the clinical outcome in those kinds of patients. There are several methods of treatment ranging from simple conservative

means to complicated surgical procedures. Selecting the best method of treatment for individual patients depends on various factors including patient's age, activity level and compliance, tears pattern and location, and finally the concomitant abnormalities or injuries.

### REFERENCES

1. Sutton JB. Ligament, their nature and morphology. 2nd ed. London: H.K. Lewis; 1987. p. 28-32.
2. Fairbank TJ. Knee joint changes after meniscectomy. *J Bone Joint Surg.* 1948 Nov;30B(4):664-70.
3. Poehling GG, Ruch DS, Chabon SJ. The landscape of meniscal injuries. *Clin Sports Med.* 1990 Jul;9(3):539-49.
4. DeHaven KE, Sebastianelli WJ. Open meniscus repair, indications, technique, and results [review]. *Clin Sports Med.* 1990 Jul;9(3):577-87.
5. Gillies H, Seligson D. Precision in the diagnosis of meniscal lesions: a comparison of clinical evaluation, arthrography, and arthroscopy. *J Bone Joint Surg.* 1979 Apr;61(3):343-6.
6. Dumas JM, Edde DJ. Meniscal abnormalities: prospective correlation of double contrast arthrography and arthroscopy. *Radiology.* 1986 Aug; 160(2):453-6.
7. Norwood LA Jr, Shields CL Jr, Russo J, Kerlan RK, Jobe FW, Carter VS, et al. Arthroscopy of the lateral meniscus in knees with normal arthrograms. *Am J Sports Med.* 1977 Nov-Dec;5(6):271-4.
8. Daniel D, Daniels E, Aronson D. The diagnosis of meniscal pathology. *Clin Orthop Relat Res.* 1982 Mar;(163):218-24.
9. Ekstrom JE. Arthrography. Where does it fit in? [review]. *Clin Sports Med.* 1990 Jul; 9(3):561-6.
10. Mink JH, Levy T, Crues JV 3rd. Tears of the anterior cruciate ligament and menisci of the knee: MR imaging evaluation. *Radiology.* 1988 Jun; 167(3):769-74.
11. Reicher MA, Hartzman S, Duckwiler G, Bassett LW, Anderson LJ, Gold RH. Meniscal injuries: detection using MR imaging. *Radiology.* 1986 Jun;159(3):753-7.
12. Weiss CB, Lundberg M, Hamberg P, DeHaven KE, Gillquist J. Non-operative treatment of meniscal tears. *J Bone Joint Surg.* 1989 Jul;71 (6):811-22.
13. Schimmer RC, Brulhart KB, Duff C, Glinz W. Arthroscopic partial meniscectomy: A 12-year follow-up and two-step evaluation of the long term course. *Arthroscopy.* 1998 Mar;14(2):136-142.
14. Scheller G, Sobau C, Bulow JU. Arthroscopic partial lateral meniscectomy in an otherwise normal knee: clinical, functional, and radiographic results of a long-term follow-up study. *Arthroscopy.* 2001 Nov-Dec;17(9):946-52.
15. Feng H, Hong L, Geng XS, Zhang H, Wang XS, Jiang XY. Second-look arthroscopic evaluation of bucket-handle meniscus tear repairs with anterior cruciate ligament reconstruction: 67 consecutive cases. *Arthroscopy.* 2008 Dec;24(12):1358-66.
16. Hashimoto J, Kurosaka M, Yoshiya S, Hirohata K. Meniscal repair using fibrin sealant and endothelial cell growth factor. *Am J Sports Med.* 1992 Sep-Oct;20(5):537-41.
17. Jitsuike J, Ochi M, Ikuta Y. Meniscal repair enhanced by an interpositional free synovial autograft: an experimental study in rabbits. *Arthroscopy.* 1994 Dec;10(6):659-66.
18. Port J, Jackson DW, Lee TQ, Simon TM. Meniscal repair supplemented with exogenous fibrin clot and autogenous cultured marrow cells in the goat model. *Am J Sports Med.* 1996 Jul-Aug;24(4):547-55.
19. Lubowitz JH, Verdonk PC, Reid JB 3rd, Verdonk R. Meniscus allograft transplantation: a current concepts review. *Knee Surg Sports Traumatol Arthrosc.* 2007 May;15(5):476-92.
20. Farr J, Rawal A, Marberry KM. Concomitant meniscal allograft transplantation and autologous chondrocyte implantation: minimum 2-year follow-up. *Am J Sports Med.* 2007 Sep;35(9):1459-66.
21. Rue JP, Yanke AB, Busam ML, McNickle AG, Cole BJ. Prospective evaluation of concurrent meniscus transplantation and articular cartilage repair: minimum 2-year follow-up. *Am J Sports Med.* 2008;36(9): 1770-8.
22. Chang HC, Teh KL, Leong KL, Mak SL, Karim SA. Clinical evaluation of arthroscopic-assisted allograft meniscal transplantation. *Ann Acad Med Singapore.* 2008;37(4):266-72.