Meniscal injuries: evaluation and management - current review

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Abstract
Introduction
The menisci play important roles in the function of the knee. Meniscal injuries are common; the traditional treatment had been excision of the torn meniscus. Nonetheless, recently, there has been an increase in the awareness of the biomechanical and functional importance of the meniscus. This has resulted in the evolution of the treatment modalities. The purpose of this article is to review the literature on meniscal injuries providing background information on this topic including pathogenesis, diagnosis and the most recent management modalities.

Conclusion
When feasible, it is preferable that meniscal repair can be done in an attempt to maintain the meniscal integrity. If meniscal repair cannot be done, partial meniscectomy could be considered aiming to retain as much viable meniscal tissue as possible. If total meniscectomy is required, meniscal transplantation can be contemplated if it is not contraindicated.

Introduction
The importance of the menisci for the normal function the human knee is well understood, especially in younger patients who are athletically active or involved in strenuous occupations1. Injury to the meniscus from both athletic events and activities of daily living is common. Whether injuries occur in isolation or are associated with ligamentous injury, meniscal tears can result in marked physical impairment2. The history and physical examination, along with the use of magnetic resonance imaging (MRI), remain the primary methods of diagnosing meniscal pathology. Deciding on the treatment of meniscal injury is influenced by patient factors as well as the nature of the meniscal pathology2. The aim of this review was to evaluate and discuss the management of meniscal injuries.

Discussion
Anatomy
The menisci are fibrocartilaginous structures3, which consist of approximately 75% Type I collagen. The collagen fibres lie mostly along the longitudinal axis, with oblique and radial fibres that enhance structural integrity. The viscoelastic properties of the menisci allow compressive loads to be dissipated along circumferential fibres, thereby reducing the impact forces on the articular cartilage4,5.

Arnoczky and Warren3,6 first described the blood supply of each meniscus: the peripheral 20%–30% of the medial meniscus and the peripheral 10%–25% of the lateral meniscus are vascular. 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 one-third of each meniscus, is nourished by synovial fluid diffusion. The middle one-third zone may have some blood supply, yet most of its nourishment is likely to be from the synovial fluid. The vascular distribution has important clinical implications for meniscal repair surgery because healing is enhanced greatly in the vascular regions.

The menisci are C-shaped or semicircular fibrocartilaginous structures with bony attachments at the anterior and posterior aspects of the tibial plateau. The medial meniscus is C-shaped, with the posterior horn larger than the anterior horn in the anteroposterior dimension. 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 the medial meniscus7,8.

The lateral meniscus translates as much as 9–11 mm in the anteroposterior (AP) plane, whereas the medial meniscus is less mobile translating only 2–5 mm. This relative lack of motion may be clinically important as a contributing factor to the increased incidence of meniscal tears on the medial side7,8.

Function of the meniscus
The primary function of the menisci is load sharing, which is accomplished through improving knee congruity and increasing the joint contact area. Forces across the knee could be as high as two- to four times body weight during walking and as high as six- to eight times body weight during running. When the meniscus is loaded in weight bearing, the meniscus fibres elongate as they are pushed to the periphery4. The medial and lateral menisci transmit 50% and 70% of their compartmental loads, respectively; this suggests that patients who have lateral meniscectomy may be at higher risk for early subsequent joint degeneration7,9.
The menisci also play a role in knee stability. Isolated medial or lateral meniscectomy does not result in significant increases in AP translation. However, the menisci act as secondary stabilisers in the knee that is anterior cruciate ligament deficient. The posterior horn of the medial meniscus is particularly important for this function because it acts as a wedge to resist anterior translation.

Lastly, the menisci have a role in shock absorption; meniscectomy has been reported to decrease the shock absorption capabilities of the knee by as much as 20%.

**Examination**

**History**
The mechanism of injury and the onset of symptoms are often clues to the diagnosis. The patient often describes a twisting injury of the knee or full flexion of the knee (as in kneeling).

Pain localised to the joint line swelling may be present, and patients often complain of this. Displaced fragments of meniscus can act as a mechanical block causing the knee to catch, give way or lock.

**Physical examination**
A complete examination of the lower extremity is required for any patient. An inspection could assess joint effusion or quadriceps muscle atrophy. To determine the presence of a mechanical block to extension or loss of flexion, range of motion should be assessed. While palpation for joint line tenderness is recommended, clinical studies have documented mixed results with regard to the usefulness of the joint line tenderness in obtaining a diagnosis. Weinstaff et al. found that joint line tenderness was the best clinical sign of a meniscal tear, with 74% sensitivity and 50% positive predictive value. Nevertheless, Shelbourne et al. demonstrated that joint line tenderness was not useful in defining meniscal injury preoperatively, which is associated with ACL injury. Accuracy in this study was 54.9% for medial meniscus tears and 53.2% for lateral meniscus tears. This could be explained by the confounding variables that occur with anterior cruciate ligament (ACL) injury, such as bone bruising and collateral ligament injury.

In the McMurray test, the patient lies supine and the knee is flexed to 90°. Then, the examiner applies a varus or valgus stress to the knee while internally or externally rotating the leg. The test is considered positive when a pop or click is palpated at the joint line while the knee is slowly extended.

Evans et al. studied the accuracy and interexaminer reliability of the McMurray test for the diagnosis of meniscal tears. The only significant McMurray sign found to correlate with meniscal injury was a “thud” elicited on the medial joint line with a meniscal meniscal tear. This finding had a specificity of 98% but a sensitivity of only 15%.

For the Apley grind test, the patient lies prone with the knee flexed to 90°. The examiner assesses for the pain by performing an internal and external rotation of the leg while applying axial load. The sensitivity of this test is 41% for both medial and lateral tears, and the specificity is 93% and 86% for medial and lateral meniscal tears, respectively.

The Thessaly test was described by Karachalios et al. The patient stands on the affected knee and flexes it to 90° then internally and externally rotates the knee and body. A positive test produces either pain at the joint line or a locking or catching sensation. The Thessaly test was found to have sensitivity of 89% and 92% and specificity of 97% and 96% for the medial and lateral menisci, respectively.

**Diagnostic studies**

**Radiography**
A standard series include a 30° or 45° posteroanterior flexion weight-bearing view of both the knees, a true lateral radiograph and a Merchant or skyline view. These radiographic views cannot confirm the diagnosis of meniscal tear; nonetheless, they are extremely important in defining bony pathology and evaluating the knee for joint space narrowing.

**Magnetic resonance imaging**
MRI has many advantages in evaluating patients with suspected meniscal tears, such as its non-invasive nature, the ability to access the knee in multiple planes, the absence of ionising radiation and the capacity to evaluate other structures within the joint. MRI has become the imaging procedure of choice. However, there has been some controversy about its added value in the diagnosis.

In a study conducted by a Miller, the overall accuracy for the clinical diagnosis of meniscal tear was 80.7% and the corresponding accuracy for MRI was 73.7%. He concluded that relying on MRI alone without using clinical judgement might lead to inappropriate treatment in a high percentage of cases. In a study comparing clinical evaluation with MRI of athletes with suspected meniscal pathology, Mueller et al. demonstrated similar effectiveness. They showed essentially equivalent accuracy (94.5% vs 95.5%), sensitivities (96.6% vs 98.0%) and specificities (87.0% vs 85.5%). In this study, MRI added little to the clinical examination in making the diagnosis of meniscal tear.

**Arthroscopy**
Arthroscopy is the most direct method of establishing a diagnosis of meniscal injury. The diagnosis must include adequate and careful probing of the meniscus. Sometimes it can be difficult to detect tears of the posterior horn, and especially of the medial meniscus. In these cases, the use of an accessory portal may be required.

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Classification of meniscal tears
Meniscal tears are described by location and shape. Based on the location of vascularity, tears could be located in the peripheral vascular zone (red-red), middle zone (red-white) and central zone (white-white). Cooper et al.\textsuperscript{23} categorised 12 zones with each meniscus divided into thirds both longitudinally and radially. Tears of meniscus can be classified as acute or degenerative tears. The latter could occur in elderly patients with chronic knee instability or malalignment\textsuperscript{2}.

Different types of meniscal tears are revealed in various patterns, including vertical longitudinal, oblique, complex, transverse (radial) and horizontal. Metcalf et al.\textsuperscript{24} found that 81\% of tears were oblique or vertical longitudinal.

Vertical longitudinal tears can be complete, such as the bucket-handle tear, or incomplete tear, and usually it occurs in younger patients. Bucket-handle tears usually begin in the posterior horn. They are often unstable and can cause mechanical symptoms or locking\textsuperscript{24}.

Oblique tears usually occur at the junction of the posterior and middle thirds of the meniscus. Symptoms may result from the torn free edge of the flap catching in the joint\textsuperscript{2}. Complex tears occur in multiple planes and are more common in older age groups. They are often associated with degenerative changes of the articular cartilage of the knee\textsuperscript{2}.

Transverse or radial tears could occur in conjunction with other tears. They are typically at the junction of posterior and medial thirds of the medial meniscus or near the posterior attachment of the lateral meniscus. A complete radial tear will result in the loss of load-bearing function\textsuperscript{2}.

Horizontal cleavage tears are frequent and may exist without clinical symptoms. They are generally considered to begin near the inner margin of the meniscus. There is little information on the significance of this type of tear. They can give rise to flap tears but are otherwise mechanically stable\textsuperscript{23}.

Decision making in the treatment of meniscus tear
Numerous factors are involved in deciding upon the correct line of treatment for a meniscus tear. However, due to the importance of the intact functional meniscus tissue, the first goal is to preserve as much of the viable tissue as possible, and the treatment decision should reflect that\textsuperscript{2}.

Non-surgical treatment
Non-surgical treatment for a meniscus tear may be suitable for asymptomatic tears, for older patients who are willing to change their life styles, and for those who are at the high risk of surgery.

Patients initially should be managed with rest, ice compression and elevation of the knee. Rehabilitation with painless full range of motion and strengthening is performed\textsuperscript{14}.

Surgical management
Total meniscectomy was previously a common procedure. However, as the long-term results have become available, the procedure has fallen out of favour. In 7 years follow-up in stable knees, Yocum et al.\textsuperscript{26} only found satisfactory results in 54\% of the cases. Additionally, 20 patients had lost motion.

Partial resection of the meniscus is advocated when repair is not feasible. General guidelines have been provided by Metcalf et al.\textsuperscript{24} for arthroscopic resection.

- All mobile fragments that can be pulled past the inner margin of the meniscus into the centre of the joint should be removed.
- The remaining meniscus rim should be smoothed to avoid any further tear. Nonetheless, a perfectly smooth rim is not mandatory, as repeated arthroscopy has shown that rim remodeling and smoothing happen at 6–9 months.
- The probe should be used repeatedly to get more information about the mobility and texture of the remaining rim.
- All efforts should be made to protect the meniscocapsular junction, as this maintains meniscal stability.
- Both manual and motorised resection instruments should be used simultaneously. This will optimise efficiency, as manual instruments allow a more controlled resection while motorised instruments remove loose debris.

Short-term results of a partial meniscectomy are excellent. Jaureguito et al.\textsuperscript{27} reported 90\% good or excellent outcomes at 2-year follow-up, with 85\% of patients returning to their desired activity level. However, some long-term results have led to questions on the efficacy of partial meniscectomy. Fauno and Nielsen\textsuperscript{28} found that osteoarthritic radiographic changes occurred in 53\% of knees that have undergone meniscectomy at 8 years follow-up.

Meniscal repair
Although meniscal preservation is important, only certain types of tear are amenable to repair. The indications of meniscal repair include:

- Tears more than 1 cm and less than 4 cm in length: tears measuring less than 1 cm are considered stable and repair is usually unnecessary, while tears measuring more than 4 cm are unstable to the degree that attempted repairs usually fail\textsuperscript{17}.
- Red-red zone tear: the vascular supply of a meniscal tear is the most important intrinsic factor in healing. Scott et al.\textsuperscript{29} have found that tears within 2 mm of the meniscal vascular rim have higher rates of healing after repair compared with other types of tears.
• Vertical tears: these are commonly repaired because they are amenable to suture fixation.

• Patients aged less than 40 years: it has been presumed that the menisci of younger patients have more healing responses. Moreover, some studies have shown better success in younger patients. However, other studies have shown no difference based on age.

• Acute tear: Tegrootenhuysen et al. found a significantly higher success rate in tears repaired less than 6 weeks from the injury. In contrast, Scott et al. indicated no difference in the healing rate no matter when the injury occurred.

• Concurrent ACL reconstruction: outcome studies have demonstrated that repairs of the meniscus performed concurrently with ACL reconstruction are more successful than repairs done in ACL-intact knees. Therefore, it is generally recommended that ACL reconstruction and meniscal repair should be done concurrently.

Repair techniques

Generally, meniscal repair begins with a complete arthroscopic assessment of the knee and full evaluation of the tear. The margins are debrided with or without rasping.

Inside-out technique

Sutures are inserted into the meniscus using a needle cannula under arthroscopic visualization. A medial or lateral incision is required to retrieve suture needles as they exit the joint capsule. Proper positioning of the incision and appropriate dissection down to the capsule are required to minimise the risk of neurovascular bundle. This technique can treat all types of tears and provides excellent fixation. However, some disadvantages are that there are potential risks to neurovascular structures; it is a technically demanding procedure; and there is a need for accessory incisions.

Van der Reis and Cannon followed up 172 patients with inside-out meniscal repairs. Healing was evaluated by either second-look arthroscopy (131 repairs) or by arthrograms (41 repairs). Satisfactory anatomic healing was evident in 70% of the cases. Nevertheless, on clinical assessment, 88% of the repairs had no symptoms and were deemed clinically healed.

Outside-in technique

The sutures are passed through the meniscus from the outside. This procedure was developed to decrease the risks associated with the inside-out technique. However, outside-in repairs are mainly limited to the anterior portions of the medial and lateral menisci. Studies have indicated success with this technique. In a study conducted by Morgan and Cascells, 70 patients who had outside-in meniscal repair were followed from 12 to 28 months. There were excellent results in 98.6% of patients.

All-inside technique

All-inside repair techniques have become popular because they avoid many of the potential complications of other repair techniques and decrease the operative time. Tears that are anterior to the posterior one-third of the meniscus are usually not amenable to this technique. The first generation all-inside technique involved the insertion of rigid arrow or screw implant devices made of absorbable polymers; however, the devices were prone to breaking. The second generation of the headless screws and arrows showed less protrusion and better rigid fixation. The third generation all-inside suturing system remains a viable option for meniscal repair. It involves insertion of the sutures and suture fixators. Fourth generation repair devices allow the placement of sutures in the meniscus without using an incision or a fixator system.

Enhancement of the healing process

Biological factors could be of greater importance than previously thought to the success of meniscal repair. Exogenous fibrin clots seem to improve healing in humans. It is postulated that the clots act as a chemotactic mitogenetic stimulus. It has been shown that trephination or rasping alone without suturing the meniscus could be a viable option in stable tears.

Fox et al. reported good to excellent results in 90% of cases that were treated by rasping or trephination.

Allograft transplantation

The indications for allograft meniscal transplantation continue to change as the clinical experience increases. Currently, the ideal patient is one who has previously had total or near total meniscectomy with joint line pain, early chondral changes, normal anatomic alignment and a stable knee. Any ligamentous injuries or malalignment must be addressed at the same time. Allograft meniscal transplantation success rates are difficult to quantify because of the varied criteria of success that has been used. Moreover, in the literature, the results of meniscus transplants have ranged from promising to disappointing.

Van Arkel and de Boer evaluated the clinical results of 23 patients with a cryopreserved non-tissue-antigen-matched meniscal transplant at a 2- to 5-year follow-up. Twenty patients had satisfactory results while only three transplants failed and the allografts were removed after 12, 20 and 24 months.

However, Hommen et al. reported that 25% of medial allografts and 50% of lateral allografts had failed at a mean of 141 months of follow-up. The investigators reported that when they added second-look surgery, MRI
and improvement survey results to their analysis, the overall failure rate was 55%. Moreover, 85% of the patients had undergone subsequent procedures on the transplanted knee.

Conclusion
The menisci have an essential function in force transmission across the knee. Injury to the meniscus is common; the tears are most frequently located in the midportion and posterior horn. In making a decision on whether surgery is viable, the overall clinical situation must be evaluated.

Generally, when feasible, it is preferable that meniscal repair be done in an attempt to maintain the meniscal integrity. If meniscal repair cannot be done, partial meniscectomy should be considered aiming to retain as much viable meniscal tissue as possible. If total meniscectomy is required, meniscal transplantation can be contemplated if it is not contraindicated.

References
33. Gunes T, Bostan B, Erdem M, Asci M, Sen C, Kelestemur MH. Biomechani-
cal evaluation of arthroscopic all-inside meniscus repairs. Knee Surg Sports
34. Henning CE, Lynch MA, Yearout KM, Vequist SW, Stallbaumer RJ, Decker KA. Arthroscopic meniscal repair using an
35. Fox JM, Rintz KG, Ferkel RD. Trephino-
tation of incomplete meniscal tears. Ar-
36. Greis PE, Holmstrom MC, Bardana DD, Burks RT. Meniscal injury: II. Man-
37. Van Arkel ER, de Boer HH. Human
meniscal transplantation: prelimi-
nary results at 2- to 5-year follow-up.
589–95.
38. Hommen JP, Applegate GR, Del Pizzo W. Meniscal allograft transplantation:
Ten-year results of cryopreserved al-
lografts. Arthroscopy. 2007 Apr;23(4):
388–93.

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