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Meniscus Tears: Risk Factors, Physical Examination, and Preventive Approaches

Ruipeng Li

Archbishop Riordan High School, San Francisco, USA

rli2025@riordanhs.org

Abstract. Abstract. Meniscus injuries are among the most frequent knee issues, affecting individuals across a wide age range and often resulting from acute trauma or age-related degeneration. The meniscus, essential for knee stability, shock absorption, and joint lubrication, is particularly vulnerable to injury in sports involving twisting and pivoting motions. This review discusses the anatomy of the meniscus, various types of tears—such as radial, horizontal, complex, and bucket-handle tears—and the primary risk factors, including sports activities and occupational stress. Diagnostic tools like the McMurray and Apley compression tests, along with MRI, are crucial in assessing the severity of the injury. Effective prevention strategies include strengthening exercises for the quadriceps and hamstrings, flexibility routines, proper movement techniques, and the use of protective gear like knee braces. Early detection and consistent preventive measures are critical in preserving knee function, minimizing the risk of re-injury, and preventing long-term complications such as osteoarthritis.

Keywords: Meniscus injuries, Knee stability, Meniscus tear diagnosis, Injury prevention, Rehabilitation strategies.

1. Introduction

Meniscus tears are among the most common knee injuries, affecting nearly a million individuals in the United States annually. The menisci, two C-shaped cartilage structures located in each knee, serve as vital cushions between the tibia (shinbone) and femur (thighbone), reducing friction and protecting the joint. A meniscus tear, often caused by a sudden twist or rotation of the knee, can manifest in various forms, including radial, horizontal, longitudinal, and complex tears, with radial tears being the most severe according to Verywell Health [1, 2].

Due to the limited blood supply in certain regions of the meniscus, these injuries have a low capacity for self-healing without medical intervention. Meniscus tears are most commonly observed in two age groups: 15 to 30 years and 45 to 70 years. Their primary function as shock absorbers helps prevent direct contact between bones in the knee joint, thus minimizing damage. Magnetic resonance imaging (MRI) is the preferred diagnostic tool for detecting acute meniscus tears, given its high accuracy. Treatments range from nonsurgical options and rehabilitation to surgical repair, depending on the severity of the injury [3].

Prevention plays a key role in reducing the risk of meniscal injuries, particularly for individuals at higher risk, such as athletes and older adults. Factors like previous surgery, age, and involvement in contact sports can increase the likelihood of re-injury. Strengthening the muscles around the knee,

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particularly the quadriceps and hamstrings, is essential for preventing tears. Given the critical role of the knee in movement, meniscus injuries are especially detrimental to athletes. Therefore, this review will focus on the prevention, mechanisms of injury, and recovery strategies for meniscus tears.

2. Anatomy of the meniscus

The meniscus consists of two distinct parts: the medial and lateral meniscus. The medial meniscus, a crescent-shaped cartilage, is positioned between the medial tibial and femoral condyles, while the lateral meniscus is located on the outer side of the knee. Both menisci are vital for shock absorption, joint stability, and proper distribution of synovial fluid within the knee joint. The medial meniscus is on the inner side of the knee, and the lateral meniscus is on the outer side. During standing, the menisci bear approximately 80% of body weight, and this can increase to 150% or more during dynamic activities such as walking. The meniscus's ability to withstand and distribute such forces is vital to knee function [4, 5].

Synovial fluid acts as a natural lubricant and cushion within the joint, reducing friction and promoting smooth movement. Approximately 65% to 75% of the meniscus receives nourishment from the synovial fluid, which is essential for maintaining its health and integrity [5].

3. Types of meniscus tears

Meniscus tears can be categorized into several distinct types, each with unique characteristics and treatment approaches [6]:

Radial Tears: These are the most frequent meniscal tears, occurring in the avascular zone, where there is limited blood supply. Since this region lacks vascularization, self-healing is not possible. The typical treatment involves arthroscopic removal of the damaged meniscus portion.

Horizontal Tears: Running along the meniscus fibers, these tears can develop in both vascular and avascular areas. When located near the outer, vascularized region, repair through suturing is possible. However, tears in the avascular center are unlikely to heal, even after surgery [7].

Complex Tears: A combination of tear patterns, often involving both radial and horizontal components, characterizes complex tears. Due to their nature, repairs are rarely done, though some torn sections may be removed while addressing other knee issues.

Bucket-Handle Tears: These centrally located tears can cause the knee to lock, severely restricting movement. Immediate surgery is usually needed to restore function.

Flap Tears: This type of tear occurs when a section of cartilage folds back, potentially causing the knee to catch or lock. If the tear impedes movement, surgeons can remove the flap while preserving as much healthy tissue as possible.

4. Factors causing meniscus tear

Meniscus tears are often associated with sports and activities that involve sudden, twisting movements. As noted by the Cleveland Clinic, "People who play sports such as tennis, soccer, basketball, or football, which involve quick, rotational movements, are at higher risk for meniscus tears." Contact sports further elevate this risk. For example, in basketball, players frequently switch between offense and defense, sprinting at full speed before abruptly changing direction. Such rapid and forceful movements can place excessive stress on the knee, leading to a meniscal tear [8].

When a meniscus tear occurs, individuals often experience a popping sensation, followed by difficulty walking. Swelling and stiffness in the knee typically develop soon after, accompanied by significant pain, especially during rotational or twisting movements. Additionally, fully straightening the knee may become difficult due to the injury.

Meniscus injuries commonly affect two age groups: those between 15-30 years and individuals over 40 years of age. In younger populations, particularly those engaged in sports like basketball, soccer, football, or skiing, meniscus tears are often the result of acute trauma from sudden stops, twists, or high-impact activities. These injuries typically result from overloading the knee or overtraining. In contrast, individuals over 40 years old face a higher risk of meniscal degeneration due to age-related changes.

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Over time, the meniscal cartilage weakens, making it more susceptible to tears even during 1minor movements or routine stress [9].

Occupational factors also play a significant role in the development of meniscus injuries. Jobs that require heavy lifting, squatting, or kneeling, such as those in construction, carpentry, plumbing, or warehouse work, can increase the likelihood of a meniscus tear. Athletes who engage in repetitive knee strain are also particularly vulnerable.

5. Physical examination

Several physical examination techniques are commonly used to assess meniscus injuries, each targeting different aspects of the knee's structure and function [10, 11]:

McMurray Test: This test checks for tears in the medial or lateral meniscus. The patient lies on their back with the knee fully bent. The examiner rotates the tibia inward and outward while applying valgus stress, then slowly extends the knee. A clicking sound or pain along the joint line suggests a positive result, indicating a meniscal tear.

Apley Compression Test: Used to assess meniscal injury, this test has the patient lie face down with the knee bent at 90 degrees. The examiner presses down on the foot while rotating the tibia. If the patient experiences discomfort, locking, or catching, a meniscus injury may be present.

Duck Walk Test: To evaluate meniscus damage, the patient squats and walks in a flexed position. Pain or discomfort along the joint line while doing so suggests a possible tear.

Ege's Test: This weight-bearing test involves squatting with feet apart and toes turned outward (for medial meniscus) or inward (for lateral meniscus). Pain or clicking during the movements may indicate meniscal damage.

6. Prevention

There are various methods to prevent meniscus injuries, particularly through targeted exercises and proper preparation. Healthline suggests eight exercises that can strengthen the muscles around the knee, particularly the quadriceps and hamstrings, which play a crucial role in knee stability [12-15].

Quadriceps Setting: This is an isometric exercise focused on strengthening the front thigh muscles. The patient either sits with legs extended or lies flat, and the quadriceps are activated by pressing the back of the knee toward the ground. The goal is to contract the muscles without moving the leg.

Mini Squats: To target the quadriceps, stand with your back against a wall, feet shoulder-width apart and a foot away from the wall. Slightly bend your knees, lowering the buttocks just a bit. It’s important to avoid deep squats to prevent putting excess pressure on the knee.

Straight Leg Raise: While lying on the floor with one foot flat and the other leg extended, lift the extended leg off the floor in a controlled manner. Ensure the back and pelvis remain neutral while engaging the thigh muscles, helping strengthen the quadriceps and stretch the hamstrings.

Hamstring Heel Digs: This exercise works the hamstrings and core. Lying on your back with knees bent and feet flat, flex the feet so only the heels are on the ground. Press the heels down, slide them a few inches away, then return to the original position.

Leg Extensions: While seated with feet flat, lift one foot off the floor, fully straightening the leg. This exercise activates the muscles at the front of the thigh.

Standing Heel Raises: Strengthening the calf muscles, this exercise involves standing with feet hip-width apart, using a surface for support. Slowly lift the heels off the ground, rising onto the balls of your feet, pause, and then lower them back down.

Clamshell Exercise: Targeting the hip abductors, this exercise requires lying on one side with knees bent. Engage the core, and raise the top knee while keeping the feet together and maintaining hip and pelvis stability.

Hamstring Curls: While lying on your stomach with legs straight, slowly bend one knee, bringing the foot toward the buttocks, then lower it back. This exercise strengthens the muscles along the back of the thigh.

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In addition to strengthening exercises, certain movements should be avoided to prevent meniscus tears, particularly pivoting, deep squatting, and twisting motions. Warming up and cooling down are essential components of injury prevention, including dynamic stretches and light exercises before and after workouts. Warming up increases blood flow to the muscles, preparing the body for physical activity.

Strength training that focuses on the muscles around the knee, including the quadriceps, hamstrings, and calves, is particularly beneficial. Additionally, using knee braces can reduce stress on the joint and provide stability during physical activity. Unlike knee sleeves, which offer minimal support, braces are specifically designed to protect against further injury and are commonly used in sports settings [16].

7. Conclusion

Meniscus injuries are common and can significantly impair a person's mobility and comfort. These injuries can arise from a variety of factors, including acute trauma and age-related degeneration. The meniscus plays a critical role in maintaining knee stability, absorbing shock, and lubricating the joint. Proper diagnosis through physical examination and imaging techniques, such as MRI, is crucial for determining the appropriate course of treatment and rehabilitation.

Preventive strategies, including strengthening exercises, flexibility routines, proper sports techniques, and the use of protective gear, are essential in reducing the risk of meniscus injuries. Early prevention and consistent adherence to preventive practices are key to maintaining knee function and reducing the risk of long-term complications, such as osteoarthritis. By focusing on prevention and rehabilitation, individuals can improve long-term outcomes and minimize the likelihood of future meniscal damage.

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