

Advanced Treatment for Meniscus Injury

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Abstract:

Meniscus injuries are recognized as critical to knee joint function and mobility. This paper examines different diagnostic and treatment strategies for meniscal injuries. Technological advancements such as MRI and arthroscopies, alongside physical diagnostic tests like the Apley test, have significantly improved the accuracy of diagnosis. Treatment depends on severity and individual needs, ranging from conservative management to surgery like meniscectomies or meniscus repairs. Research shows that accelerated rehabilitation may be effective in certain conditions, but standard protocols are being developed. This study uses recent findings and patient outcome data to emphasize the importance of diagnostic and treatment methods in managing meniscus injuries.

Keywords: Meniscus Injury, Diagnosis, Rehabilitation, Meniscal Repair, Knee Joint Biomechanics

1 Introduction

The meniscus injury was accumulated and first discovered in 1884, with the advancements of Dr. JB Sutton, who sought to eagerly understand the nature and formation of ligaments. Technological advancements in understanding meniscus injuries have contributed to broader research in knee joint science. What was at first discovered to be “pointless,” the evolution of the meniscus understanding has fundamentally shaped the future for research and evolution. Significant research on the meniscus began in 2021, leading to a global shift in understanding. The meniscus injury is a forceful and protracted twist of tissue in the knee, so it makes sense that most who have this injury are individuals who engage in extra amounts of physical movement. An assessment to test this theory had finally been tested, and out of 421 patients, all patients were engaged in wrestling, baseball, soccer, rugby or handball. 77% of those patients

did receive meniscectomy, which is surgical removal of the meniscus. After the surgery, over 87% of these patients went to continue on their sports of choice (D'Ambrosi et al., 2022). These results provide strong evidence of not only the improvement and evolution of our understanding of the meniscus, but also the rate at which those are able to continue their pastimes. This highlights the value of effective rehabilitation. As participation in sports continues to rise, especially among youth and young adults, optimizing recovery protocols becomes essential not only for individual well-being but also to prevent long-term joint complications. Improved treatment may reduce the likelihood of chronic conditions such as osteoarthritis, which creates better outcomes and quality of life.

2 Mechanism and Anatomy

The meniscus is cartilage sitting within a knee joint,

which provides stability to the joint.. Without it, the knee joints would not hold and would rub together, eventually causing tears. It consists of two crescent-shaped structures, the medial and lateral menisci, positioned between the femur (thigh bone) and tibia (shin bone). The meniscus is located between the tibia and cartilage, its purpose almost like a cushion. It absorbs shock, helps distribute body weight across the joint, and plays a key role in joint lubrication and proprioception, which is the body's ability to sense movement and position. Most times when acquired, the meniscus derives from quick movements and a high number of stresses. Oftentimes, this is a result of physical movement in sports, and as you get older, the chance of tearing the meniscus gradually increases. Movements involving sudden twisting, pivoting, or deep squatting are common reasons of acute injury, especially in athletes. In older adults, degenerative tears may occur gradually with age-related wear. A torn meniscus causes the outside of the knee to swell, and movement of the knee will become more difficult and warmer to the touch. Pain is often felt along the joint line, and patients may notice catching, locking, or clicking during movement. Healing the meniscus on its own is more common, yet in more severe cases requiring surgery, the process is more expensive and results are often mixed. Tears on the outer (vascular) portion of the meniscus have better healing potential due to blood supply, whereas inner tears often require surgical intervention due to poor vascularity. When left untreated, an unhealed meniscus joint can lead to degenerative knee arthritis. The patient's age and activity level also play a large role in consideration of surgery. Younger patients with acute traumatic tears are more likely to undergo repair, while older individuals with degenerative damage may be managed conservatively or with partial meniscectomy. Additionally, differences in meniscal structure can affect injury patterns. The medial meniscus is less mobile because of its stronger attachment to its surrounding tissues, which makes it more susceptible to injury. In contrast, the lateral meniscus has greater mobility and is typically injured under high-stress, rapid motion. These anatomical characteristics inform clinical evaluation and can influence the choice of treatment.

3 DIAGNOSES

Meniscus injury diagnosis combines specific clinical methods and various imaging techniques to obtain a precise assessment and an appropriate therapeutic approach. Research suggests that physical examination demonstrates high diagnostic accuracy, particularly for lateral meniscus tears. The Apley test, for example, has shown strong diag-

nostic performance, with an area under the curve (AUC) of 0.842 (Krakowski et al., 2021). Other commonly used clinical tests include the McMurray test and joint line tenderness palpation, which can help localize the tear and assess mechanical symptoms such as clicking or locking. Magnetic Resonance Imaging (MRI) is commonly utilized to visualize soft tissue structures for medial meniscus injuries, which indicates high diagnostic reliability. However, MRI has been less accurate in detecting meniscus lesions. Some suggest that physical exams are better in certain situations (Krakowski et al., 2021). Thus, MRI should not replace physical exams; it should instead be used as a tool when physical examinations are unclear.

Arthroscopy is currently the standard for meniscus injury diagnosis. It provides direct visualization as well as the ability to perform simultaneous treatment. It is most useful in cases where imaging results are inconsistent or in cases of suspected intra-articular pathology. Because diagnostic methods vary, it is wise to use assessments that include physical exams and imaging techniques. This would improve diagnostic accuracy and help guide management strategies for meniscal injuries. This approach would provide a clearer picture of the injury, allowing clinicians to customize treatment based on the type, location, and severity of the tear. Diagnostic technology such as three-dimensional MRI and advanced ultrasound imaging are being explored to enhance the detection of injuries. Though not yet standard in health care facilities, these devices can deliver more precise diagnostics as well as allow for more precise monitoring of healing with time.

4 Treatment, Rehabilitation, and Management

Rehabilitation is a step-by-step process that aims to restore knee function, strength, and stability while reducing the risk of re-injury. Recovery depends on whether the treatment is non-surgical or surgical. For meniscal repair specifically, a longer rehabilitation period is preferred to a meniscectomy, which could put more strain on the knee. However, meniscectomies can still be favorable because of their high healing potential and low revision rate. Meniscal repair is often preferred for younger and more active patients because it lowers the risk of osteoarthritis. Research confirms that limiting flexion to 90 degrees not cause significant gapping in most tear patterns, an early safe range of motion (Calanna et. al, 2022).

The rehabilitation process is divided into multiple phases. It starts with the initial phase, which focuses on protecting the repair site, reducing swelling, and preventing muscle atrophy on the meniscus. This period usually lasts for two

weeks after surgery, and patients are commonly given a knee brace that limits active motion and crutches for partial weight-bearing. Gentle range of motion exercises are introduced carefully, usually limited to 0-90 degrees of flexion, to avoid re-injury. Isometric quadriceps contractions, straight leg raises, and ankle pumps help activate the muscles and maintain muscle function (Fried et al., 2021). Cold therapy, elevation, and anti-inflammatory treatments are also used to address discomfort. The healing process and strength development lasts usually two to six weeks, focusing on controlled motion and progressing weight-bearing.

The transition from healing into initial strength-building is typically around two to six weeks, and focuses on controlled motion and progressive weight-bearing. By week six, patients should achieve full range of motion while accommodating weight-bearing, as long as healing remains stable. To reactivate muscle function, there are strength-building exercises such as mini-squats, limited angle leg presses, and resistance band movements. The one-leg stance can improve balance, as well as knee and joint stability. Cardiovascular exercises like cycling and hydrotherapy can also put less stress on the knee and help improve endurance.

Resistive training consists of step-ups, lunges, and hamstring exercises, but balance exercises require more dynamic activities. The last stage of rehabilitation can last up to six months after surgery to prepare an athlete to return. Strength and conditioning continue to focus on agility, sport-specific drills, and proper biomechanics to reduce the chance of re-injury. In the later weeks, athletes typically start to return to cutting maneuvers, jump landings, and pivot drills based on their sport's requirement. Timelines vary, with the majority of athletes returning between three to ten months, depending on factors like injury severity and rehabilitation success. The overall rehabilitation strategy increasingly prioritizes individualized protocols.

Bio-mechanical studies show that accelerated rehabilitation, which involves early weight-bearing and range of motion, can be used safely in stable, longitudinal tears with a low re-injury risk. But few protocols apply to more complex or unstable tears. A randomized trial by Lind et al. found no difference in function and healing between accelerated and restricted protocols in vertical tears. This supports the emphasis on safety of early motion under the proper conditions. However, caution is still advised when dealing with root tears, radial tears, or poor tissue quality, as early loading can affect repair. Because rehabilitation procedures for these injuries are still not standard, more research should be done to improve recovery methods and long-term knee function. Additionally, patient education

plays an important part in the rehabilitation process. When patients understand weight-bearing limitations, exercise progression, and signs of re-injury they can play an active part in their recovery.

5 CONCLUSIONS

Understanding of the meniscus has drastically evolved since its discovery in the 19th century, transforming it from an unknown tissue to a focus in orthopedic research. Accurate diagnosis both by physical exam and imaging, especially MRI's, has helped clinicians to better personalize treatment plans to individual cases. Rehabilitation after meniscus injury now focuses on progressive recovery as well as early, safe movement. While traditional methods like meniscectomies are still common, newer evidence supports the effectiveness of meniscal repair and individualized rehabilitation strategies. The evidence strongly supports a patient-centered approach to care that maximizes recovery and minimizes re-injury. As our understanding of meniscal biomechanics grows, customizing rehab plans to fit the specific type of tear has become more common, particularly when deciding how soon to allow weight-bearing or range of motion. Factors like tear type, location, tissue quality, and patient goals now guide individualized recovery strategies. Ongoing teamwork among orthopedic specialists, physical therapists, and researchers is vital for improving care. Continued study of both surgical methods and rehab protocols will be key in refining best practices and enhancing patient outcomes. Further research is necessary to continue to improve diagnostic accuracy and set clear but flexible rehab plans for the best long-term joint health.

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