Indications for Meniscus Repair

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KEYWORDS

- Meniscal tear • Knee injury • Meniscectomy
- Osteoarthritis • Meniscal repair

One of the earliest descriptions of the menisci was recorded by Bland-Sutton in 1897.[1] At that time, the menisci were thought to be vestigial tissue and were depicted as "the functionless remnants of intra-articular leg muscles."[1] Further advances in our understanding of the menisci have demonstrated that the menisci provide mechanical support and secondary stabilization, localized pressure distribution and load sharing, and lubrication and proprioception to the knee joint.[2,3]

When the menisci are injured, treatment is centered on both symptomatic relief (eg, pain and mechanical symptoms) as well as prevention of future sequelae (eg, osteoarthritis and cartilage degeneration). Many variables are considered in developing an operative treatment strategy after conservative management has failed. Patient-centered factors such as age, activity level, and physical fitness are important, as are characteristics of the meniscal tear itself such as size, location, and chronicity.

This review describes the function, anatomy, and biology of the menisci, discusses common mechanisms of injury and diagnostic strategies for localizing meniscal symptomatology, and highlights variables that are associated with improved prognosis for meniscal repair. Surgical indications for both meniscal tissue excision and salvage will be discussed, and an in-depth review of meniscal repair options will be presented.

FUNCTION AND ANATOMY OF THE MENISCUS

Both the macro- and microscopic anatomy of the menisci determines its function. The medial and lateral menisci are 2 C-shaped fibrocartilaginous structures attached anteriorly and posteriorly to the tibial plateau. The medial meniscus is longer in the anterior-posterior direction than the lateral meniscus and is continuous with the deep fibers of the medial collateral ligament and medial joint capsule, rendering it less

The authors have nothing to disclose.
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Clin Sports Med 31 (2012) 1–14
doi:10.1016/j.csm.2011.08.012 sportsmed.theclinics.com

mobile. They function to provide mechanical support and secondary stabilization, localized pressure distribution and load sharing, and lubrication and proprioception to the knee joint.[2,3] The role of the meniscus as a secondary stabilizer of the knee is significant and has been quantified by Bedi and colleagues.[4] This study noted that transection of the anterior cruciate ligament (ACL) and meniscectomy resulted in nearly double the anterior tibial translation in both Lachman and pivot shift testing compared with that of the ACL alone, as measured with knee-specific computer navigation software. Mechanically, the menisci also transmit at least 50% to 75% of the axial load in knee extension and up to 85% with the knee in 90° of flexion.[5] When meniscal tissue is removed, as is the case with partial or total meniscectomy, the contact area of the knee joint (in both the same and opposite compartments) decreases, thereby increasing localized pressure on the surface of the articular cartilage. Increased pressure on the articular surface causes local cartilage damage, which leads to accelerated subchondral sclerosis and osteoarthritis.[6]

By dry weight, the menisci are comprised of mostly type I collagen (60%–70%), with a small amount of elastin (<1%) and other proteins (8%–13%).[7] Histologically, dense fibrocartilage is comprised of collagen fibers that are arranged circumferentially (to disperse compressive loads) with some radial fibers as well (to resist longitudinal tearing). At the surface, collagen fibers are arranged randomly to disperse shear stress associated with flexion and extension of the knee joint.[2] Proteoglycan macromolecules serve to hold and retain water, which is paramount to the compressive, shock-absorbing properties of the menisci and augments its ability to aid in lubrication of the knee joint. Finally, fibrochondrocytes exist sparsely dispersed throughout the meniscal tissue and act to synthesize extracellular matrix and support the acellular components of the menisci.

The blood supply of the menisci originates at the periphery in the perimeniscal capillary plexus, which are tributaries of the medial and lateral geniculate arteries. Importantly, only the peripheral 25% to 30% of meniscus is vascularized[8] (**Fig. 1**). The gradient attenuation in vascularity from the periphery to the central portion of the menisci is gradual but for ease of clinical classification led to the designation of 3 vascular “zones.” The outer third is known as the *red-red zone* because of its relatively high concentration of vascular channels. In this zone, bleeding at the site if injury promotes fibrovascular scar formation and migration of anabolic cells in response to cytokines released during the inflammatory response. Because of this, tears in this zone have the highest healing potential. The middle vascular zone is termed the *red-white zone*. In this zone, there is intermediate vascularity, which leads to a less predictable result with regard to healing meniscal tears. If a repair is attempted in this zone, synovial abrasion, vascular access channels, and fibrin clot may be used to increase local blood flow and maximize healing potential. The red-red and red-white zones combine to form the outer 4 mm of the meniscus.[9] The remainder of the meniscus is avascular in adults and is therefore called the *white-white zone*. Nutrition of this tissue is achieved solely from the synovial fluid via passive diffusion, which is aided by motion of the knee joint. Consequently, injury in white-white zone of the meniscus does not stimulate a healing response, and there is a poor prognosis for healing after attempted repair.

MECHANISM OF INJURY AND DIAGNOSIS

Meniscal tears can be either traumatic or degenerative. Degenerative tears have been closely associated with osteoarthritis. Acute tears are often related to trauma, most frequently as a result of a twisting motion. Patients may or may not be able to recall a single traumatic event. Pain is often localized to the joint line and is usually