

Anatomic, Vascular, and Mechanical Overview of the Achilles Tendon

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KEYWORDS

• Achilles • Anatomy • Tendon • Biomechanics

KEY POINTS

- The anatomic and histologic properties of the Achilles tendon are directly related to resistance to mechanical damage and subsequent pathologic processes as well as tendon healing.
- Gastrocnemius and soleus anatomy have a direct effect on many pathologic processes in the foot and ankle.
- Experimental data indicating uniform hemodynamic flow throughout the Achilles tendon has challenged the widespread notion that ischemia is a primary etiology of pathology and rupture in the central portion of the tendon, which is based on a circumstantial association with an anatomic watershed.

GROSS ANATOMY

The Achilles is composed of the conjoined tendons of the gastrocnemius, soleus, and occasionally plantaris muscles.^{1,2} These associated muscles and the Achilles tendon make up the superficial posterior compartment of the leg. The gastrocnemius muscle is the most superficial component of the triceps surae. The medial and lateral heads of the gastrocnemius arise from the femoral condyles. The medial head originates from behind the medial supracondylar line and adductor tubercle, superior to the medial femoral condyle. The lateral head originates from the posterior aspect of the lateral femoral condyle superior and posterior to the lateral epicondyle, as well as from a portion of the lateral lip of the linea aspera superior to the lateral condyle. The medial head is larger, longer, and extends farther distally than the lateral head. Both heads share an additional origin from the posterior aspect of the knee capsule termed the popliteal ligament. The deep surface of the muscle is tendinous and intimately approximated to the soleus muscle. Deep to both heads may lie bursae. The gastrocnemius

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heads are large, fusiform bodies that join in the midcalf to form a wide aponeurosis at the muscle's distal aspect. The heads form a tendinous raphe where they meet midline and communicate with the deep, anterior aspect of the aponeurosis. This aponeurosis continues distally as a component of the Achilles tendon.

The soleus muscle is a broad, flat, pennate muscle that arises entirely from below the knee. The muscle lies deep to the gastrocnemius muscle within the superficial posterior compartment of the leg and is housed between 2 aponeurotic lamellae with the posterior aponeurosis beginning more proximally than that of the gastrocnemius. Muscle origins include the head and proximal fourth of the posterior fibula, the oblique line and middle third of the medial tibial border, and the fibrous arch between the 2. The gross muscle is wider and extends more distally than the gastrocnemius with fibers joining centrally in a posterior aponeurosis or intramuscular tendon, which promotes a bipennate arrangement of muscle fibers. This central intramuscular tendon merges distally to form a component of the Achilles tendon. Between gastrocnemius and soleus muscles lies a layer of dense fibrous connective tissue with a film of loose connective tissue between the each of the layers. The posterior aponeurosis of the soleus is the largest contributory component of the Achilles tendon.

The plantaris muscle is variable in size and absent in 6% to 8% of individuals.² The plantaris originates from the superior aspect of the lateral femoral condyle. The muscle belly runs medially and continues as a long tendon that extends distally between the gastrocnemius and soleus to insert on the medial border of the Achilles tendon.

The nerve supply to the gastrosoleus is derived from tibial branches proximally. The Achilles tendon has sparse innervation from several sources arising from the paratenon soft tissues. The sural nerve is a main contributor to tendon and peritendon structures and is at risk for injury during surgical procedures because of its proximity to the tendon and aponeurosis posteriorly.

The Achilles tendon begins at the musculotendinous junction of the gastrocnemius and soleus muscles with typical full incorporation occurring approximately 8 to 10 cm above the calcaneal insertion site.¹ In total, the Achilles tendon is approximately 15 cm in length and begins flattened at the musculotendinous junction and becomes rounded approximately 4 cm from the calcaneus. The anterior and medial aspects of the tendon receive fibers from the soleus, and the posterior aspect is derived from gastrocnemius fibers. The contributions and proportions from both the gastrocnemius and soleus are variable. As fibers travel distally, they rotate 90° such that gastrocnemius fibers attach laterally and posteriorly, whereas the fibers of the soleus attach medially and anteriorly. This spiraling has been shown to result in less fiber buckling when the tendon is lax and less deformation when tension is applied to the tendon.³ At its insertion site, the tendon flattens and broadens into a deltoid-type of attachment and develops an anterior concavity before inserting along the middle third of the posterior aspect of the calcaneus. The surface of the distal tendon that overlies the calcaneus is composed of fibrocartilage. Underneath the tendon lies the retrocalcaneal bursa, which is interpositioned between the tendon and the posterior calcaneal tuberosity. At the distal-most insertion of the tendon, some collagen fibers form Sharpey fibers and become continuous with fibrous tissue overlying the calcaneus.

There is no true synovial sheath surrounding the Achilles tendon. Instead, a paratenon forms an elastic sleeve around the tendon to permit gliding. It is composed of sheets of dense connective tissue that separate the tendon from the deep fascia of the leg. Within this tendon lie numerous blood vessels and nerves. The peritendinous structure and the abundance of mucopolysaccharides within the sheath permits sliding of the tendon along the adjacent tissues. Proximally, the paratenon is continuous with the muscle fascia and distally it blends with the periosteum of the calcaneus.

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