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Pes Anserinus: Anatomy and Pathology of Native and Harvested Tendons

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OBJECTIVE. The purpose of this article is to review the anatomy and pathology of the pes anserinus to increase the accuracy of imaging interpretation of findings affecting these medial knee structures.

CONCLUSION. The pes anserinus, consisting of the conjoined tendons of the sartorius, gracilis, and semitendinosus muscles and their insertions at the medial aspect of the knee, is often neglected during imaging assessment. Common pathologic conditions affecting the pes anserinus include overuse, acute trauma, iatrogenic disorders, and tumors and tumorlike lesions.

Pes Anserinus Muscles

The sartorius, Latin for “tailor” in reference to the cross-legged sitting position of garment makers, is a strap muscle innervated by the femoral nerve. It originates from the anterior-superior iliac spine, traverses the anterior compartment of the thigh from the lateral to medial direction as it courses inferiorty, and inserts into the proximomedial tibia. It is the longest muscle in the human body, but is fairly weak, acting only as a synergistic muscle.

Gracilis, Latin for “slender,” describes the long, thin appearance of this strap muscle, which is innervated by the obturator nerve. It originates from the ischiopubic ramus and courses inferiorly within the medial compartment of the thigh to the knee, where it runs and inserts just posterior to the sartorius muscle and tendon.

The semitendinosus, named after its long insertional tendon that forms in the midthigh, is a fusiform pennate muscle innervated by
the sciatic nerve. It originates from the ischi- 
al tuberosity as a conjoined tendon in com- mon with the long head of the biceps femoris muscle and courses inferiorly in the posterior- 
or compartment of the thigh behind the semi- membranous muscle toward the knee, where it inserts posterior to the gracilis tendon.

**Pes Anserinus Tendons**

The anatomy of the pes anserinus is in- tricate. The sartorius tendon remains inti- mate with the crural fascia (layer 1), and the gracilis and semitendinosus tendons are loc- ated on the deep surface of this superfi- cial layer over the medial tibia. Importantly, 
lys, the pes anserinus lies superficial to and 
inserts proximal and anterior to the superfi- cial MCL (layer 2) [1–3]. The pes anserinus 
tendon complex consistently inserts into the 
proximomedial tibia 42 ± 7 mm below the 
level of the tibial plateau, distal and medial to the tibial tuberosity [9, 10]. Each tendon 
attaches in a nearly linear arrangement— 
the sartorius proximally, followed by the gracilis 
and semitendinosus tendons (average tendon 
widths of 8.0, 8.4, and 11.3 mm, respective- ly)—at the lateral edge of the pes anserinus 
bursa [3]. These tendons can have individ- 
ual insertions; however, accessory tendons 
and fascial bands are often present that 
have independent osseous and soft-tissue attach- ments. The semitendinosus tendon, the most 
morphologically variable tendon of the pes 
anserinus, can have as many as three tendi- 
nous insertions and various soft-tissue exten- 
sions, including a constant band that attaches 
to the gastrocnemius fascia [4–10] (Fig. 1B).

**Pes Anserinus Bursa**

The synovium-lined pes anserinus bursa is a 
consistently present anatomic bursa situated etweenthe pes anserinus and the distal 
superficial MCL. Unlike the popliteal bursa 
at the posterior aspect of the knee, the pes 
anserinus bursa does not communicate with the 
articular cavity of the knee. It is irregu- 
larly circular and follows the course of the 
sartorius muscle and tendon. In cadaveric 
dissections, the pes anserinus bursa typical- ly extends proximally to the joint line (i.e., 
proximal articular surfaces of the medial and 
lateral tibial condyles), though it can extend 
as far as 20 mm above this line, as seen in ap- 
proximately 24% of specimens [7]. Addi- 
tional bursa situated along the medial aspect of 
the knee include the semimembranosus and 
MCL bursae. The semimembranosus bursa is posterior and superior to the pes anserinus 
bursa, whereas the MCL bursa is between 
deep and superficial fibers of the MCL at the 
central third of the knee. Although bursi- 
tis of these bursae can coexist with pes anse- inus bursal fluid, the bursae are not known 
to communicate with each other [11–15].

**Saphenous Nerve and Its Branches**

The saphenous nerve arises from the femor- al nerve at the femoral triangle and then 
courses distally through the adductor canal, 
crosses medially to the femoral vessels, ex- tends toward the knee between the sartorius 
and gracilis tendons (Fig. 1C), and continues 
inferiorly within the medial subcutaneous fat 
of the leg along with the greater saphenous 
vein. Just above the knee joint, the saphenous 
nerve bifurcates into infrapatellar and sarto- 
rial branches. The infrapatellar branch can 
pierce the sartorius muscle or course anterior 
or posterior to it. It provides sensory innerva- 
tion to the medial infrapatellar region (Fig. 
1D). Its subcutaneous location and horizontal 
course along the medial knee place it at risk of 
injury during surgical procedures involving 
the pes anserinus, such as graft harvest- 
ing for ACL reconstruction. Some authors 
[10, 16, 17] have suggested that an oblique 
incision paralleling this branch, rather than 
a perpendicular vertical incision, may lower 
the risk of nerve injury. The sartorial branch is 
intimate with the gracilis tendon for ap- 
proximately 5 cm before crossing it at an 
average of 12 cm above the pes anserinus inser- 
tion to pierce the crural fascia and become 
subcutaneous [18, 19]. It provides sensory 
nervation to the medial aspect of the leg (Fig. 
1D). The proximity of the sartorial branch to 
the gracilis tendon also places it at risk of 
injury during tendon harvest.

**Disorders of the Pes Anserinus**

Disorders of the pes anserinus can be di- 
vided into four broad categories: overuse, 
acute trauma, iatrogenic causes, and tumors 
and tumorlike lesions (Table 1).

**Overuse**

*Pes anserinus bursitis*—*Pes anserinus* 
bursitis is mostly related to overuse by ac- 
tive persons, typically runners. It has also 
been associated with inflammatory arthri- 
tides, diabetes mellitus, obesity, injury, and 
friction from nearby osteophytes or exosto- 
ses. The diagnosis of pes anserinus bursi- 
tis is usually established by the characteris-
tic clinical finding of pain localized to the 
proximomedial tibia, but in some instances 
the clinical picture is unclear, and advanced 
imaging is requested.

With ultrasound, the pes anserinus bur- 
sa can be identified in its usual position 
(i.e., between the pes tendons and the tibia) 
in approximately 67% of volunteers with- 
out symptoms, between the pes tendons and 
MCL in 21%, and between the constituents of 
the pes anserinus in 8% [20]. At MRI, fluid is 
seen within the bursa deep to the pes anseri- 
inus tendons and superficial to the superfi- 
cial MCL [21]. Classically, distention of the bursa 
occurs near the pes anserinus insertion, dis- 
tal and medial to the tibial tuberosity (Fig. 2), 
and fluid may invaginate deep to the superfi- 
cial MCL. The pes anserinus bursa can also 
extend above the joint line [7].

Pes anserinus bursitis is typically man- 
aged conservatively with rest and oral an- 
tiinflammatory agents. In refractory cases, 
aspiration of the bursal contents and local 
injection of anesthetics or corticosteroids may 
be required. Importantly, the infrapatellar 
branch of the saphenous nerve often lies ad- 
jacent to the proximal surface of the bursa, 
and the sartorial branch often courses along 
the bursa posteriorly. Therefore, the distal 
and anterior aspects of the bursa, located ap- 
proximately 2 cm medial and 1.2 cm superior 
to the inferomedial point of the tibial tuber- 
osity, has been suggested as a safe access site 
for such procedures [7].

### TABLE 1: Pathologic Conditions of the Pes Anserinus

<table>
<thead>
<tr>
<th>Condition</th>
<th>Overuse</th>
<th>Acute Trauma</th>
<th>Iatrogenic Causes</th>
<th>Tumors and Tumorlike Lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pes anserinus bursitis</td>
<td>Musculotendinous injury</td>
<td>Complete pes anserinus tear</td>
<td>Neotendon injury</td>
<td>Tenosynovial giant cell tumor</td>
</tr>
<tr>
<td>Posteromedial knee friction syn-</td>
<td>Complete pes anserinus</td>
<td>Superficial medial collateral</td>
<td>Failed regeneration</td>
<td>Periosteal ganglion cyst of</td>
</tr>
<tr>
<td>drome</td>
<td>tear</td>
<td>ligament tear with Stener-</td>
<td>Adjacent nerve injury</td>
<td>the tibia</td>
</tr>
<tr>
<td>Pes anserinus snapping syndrome</td>
<td></td>
<td>like lesion</td>
<td></td>
<td>Gout</td>
</tr>
</tbody>
</table>

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Posteromedial knee friction and pes anserinus snapping syndromes—Posteromedial knee friction syndrome has been described as a cause of posteromedial knee pain in active patients. It occurs in the narrow space between the medial femoral condyle and the overlying sartorius or gracilis tendon and is caused by friction between bone and tendon [22]. MRI shows poorly marginated edema between the medial femoral condyle and the sartorius or gracilis tendon. More common causes of posteromedial edema—including medial meniscal tear, ligament injury, and leaking popliteal cyst—should be excluded before this diagnosis is suggested.

Pes anserinus snapping syndrome occurs when the semitendinosus or gracilis tendon snaps over the tibial condyle or semimembranosus tendon at the posteromedial aspect of the knee during knee flexion and extension [23–27]. Diminutive pes anserinus accessory fascial bands may contribute to pes anserinus snapping syndrome by allowing forward subluxation of the gracilis and semitendinosus tendons over the posteromedial corner of the tibia [25]. Although the imaging findings associated with this syndrome have received little attention, sonography has been suggested as the imaging method of choice owing to its dynamic capability [26, 27]. In a small series of patients [26], tenotomy has been reported to be a successful treatment method.

Trauma

Pes anserinus musculotendinous injuries—Isolated musculotendinous injuries to the pes anserinus are uncommon. When such injuries do occur, the sartorius is most commonly affected [28]. The sartorius muscle is predisposed to strain injury because it is the longest muscle in the human body, spans two joints, and is superficially located. Its superficial location also puts it at risk of blunt concussive injury that can result in intramuscular hematoma or interstitial hemorrhage and injury to nearby osseous and soft tissues [29]. Isolated myotendinous strains and distal tendinous avulsions of the semitendinosus are rare but have been reported in high-level athletes [30–33] (Fig. 3). These injuries can be difficult to treat. Cooper and Conway [31] reported that conservative treatment failed in 42% of patients with partial semitendinosus tendon tears. In some cases, however, tenotomy has been performed with good outcomes [32].

Complete pes anserinus tendon tears—Complete tears of the pes anserinus tendons are uncommon, typically resulting from forceful trauma, such as a knee dislocation, in which multiple ligaments are torn. The torn pes anserinus tendons typically retract proximally and can be displaced into a proximal tibial fracture or the medial femorotibial compartment if the underlying MCL complex is also disrupted (Fig. 4).

Superficial medial collateral ligament tear with Stener-like lesion—The MCL complex (i.e., superficial and deep MCLs) and posterior oblique ligament are the primary valgus stabilizers of the knee and are commonly injured. The superficial MCL, deep MCL, and posterior oblique ligament fail at forces of 557, 101, and 256 N, respectively [34]. The pes anserinus is a secondary valgus stabilizer and is not commonly injured in isolation. Instead, it is occasionally injured when one or more of the primary valgus stabilizers of the knee fails.

The superficial MCL originates near the medial femoral epicondyle. Most MCL tears occur proximally in this region and are treated nonoperatively [35]. The main distal attachment of the superficial MCL is at the tibia, approximately 60 mm below the joint line, distal to the pes anserinus insertion. Although injuries to the distal superficial MCL are uncommon, complete tears have the potential to retract and become displaced superficial to the pes anserinus tendons, resulting in a Stener-like lesion. MRI plays a key role in the diagnosis of a distal superficial MCL tear with a Stener-like lesion, because valgus instability testing of the knee can be inconclusive. Normally, the superficial MCL lies deep to the pes anserinus tendons. When the superficial MCL is proximally retracted and its distal end is superficial to the pes anserinus tendons, a Stener-like lesion should be described, because anatomic healing of the injured superficial MCL at its tibial attachment is prevented by the interposed pes anserinus tendons [36] (Fig. 5).

Iatrogenic Causes

The most commonly used autografts for ACL reconstruction are either bone-patellar tendon-bone, or pes anserinus tendon preparations, specifically the gracilis and semitendinosus. Use of an autograft derived from the pes tendons results in less morbidity than a bone-patellar tendon-bone autograft and appears to be just as strong or stronger once fully matured. The double-bundle hamstring autograft has been reported to have more than twice the tensile strength of native ACL, and patellar tendon has been reported to have 160% of such tensile strength [37, 38]. After harvesting for ACL reconstruction, the pes anserinus tendons regenerate, albeit with altered anatomic and histologic characteristics that are not typically clinically evident [39–43]. Although regenerated neotendon appears normalized on ultrasound and MR images within 2 or 3 years after surgery [40, 41] (Fig. 6), histologic analysis shows focal calcification, irregular collagen, increased capillary formation, and fibroblastic proliferation [44, 45]. These histologic characteristics of the pes anserinus neotendons may explain their higher risk of injury [7], although this is not entirely clear. The consensus is that regenerated neotendons should not be reharvested if revision surgery is needed. Moreover, regeneration of the medial hamstring tendons after harvesting does not always occur. In such cases, the muscle bellies lack distal attachments and can retract into the thigh, creating a palpable lump similar to the “Popeye” deformity that occurs in the upper arm after disruption of the distal biceps brachii tendon [46] (Fig. 8).

Other complications of pes anserinus tendon harvesting include intraoperative premature graft rupture and damage to surrounding structures, such as the MCL and saphenous nerve (Fig. 9). Accessory tendons and fascial bands are often associated with the pes anserinus. These extensions must be released before tendon harvesting because they can divert a tendon stripper, causing premature amputation of the ACL graft tissue, resulting in an inadequate, short graft [9, 10].

Tumors or Tumorlike Lesions

A variety of tumors and tumorlike lesions occur in the vicinity of the pes anserinus. Tenosynovial giant cell tumor, previously called giant cell tumor of the tendon sheath, is a fairly common benign soft-tissue tumor that originates from synovium. It is histologically identical to pigmented villonodular synovitis. Tenosynovial giant cell tumor often arises in the wrist and hand but can occur adjacent to any tendon, including the pes anserinus. It is typically slow growing. MRI shows characteristic low signal intensity on T1- and T2-weighted images (Fig. 10A).

Osteochondromas and tibial spurs, which lack a true cartilage cap, can occur near the pes anserinus and result in frictional pes anserinus bursitis. These bone outgrowths can be successfully treated with surgical removal [47].

The peristeum at a tubular bone is com-
posed of an outer fibrous layer containing fibroblasts and an inner cambium layer containing progenitor cells. Periosteal ganglion cysts are thought to arise by mucoid degeneration of the fibrous peristeum. The proximal tibia, near the pes anserinus insertion, is the most common site of such cysts [48–50] (Fig. 10B), although the cysts also occur at the medial malleolus and the distal shafts of the radius, ulna, and femur. Imaging shows a periosteal cystic mass with subjacent cortical scalloping, a margin of bone sclerosis, and, occasionally, speculated periosteal bone formation that may raise suspicion of malignancy. The typical location and appearance of this lesion, however, generally lead to the correct diagnosis.

Gout, although a well-recognized cause of bursitis at locations such as the anterior knee and olecranon, is an infrequent cause of symptomatic pes anserinus bursitis [51] (Fig. 10C). Calcium pyrophosphate dihydrate (CPPD) crystal deposits are common in both hyaline cartilage and fibrocartilage, where it is called chondrocalcinosis. Less commonly, CPPD crystal deposition occurs in capsular, tendinous, ligamentous, and synovial tissues. With bursal involvement, an inflammatory response to CPPD deposition can also result in bursitis.

**Conclusion**

The pes anserinus consists of the conjoined tendons of the sartorius, gracilis, and semitendinosus muscles. It inserts into the proximomedial tibia and acts as a secondary valgus restraint augmenting the medial supracondylar restraint. Gout, although a well-recognized cause of bursitis, can also result in bursitis. The typical location and appearance of this lesion, however, generally lead to the correct diagnosis.

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(Figures start on next page)
Fig. 1—Medial knee.

A. Photograph of cadaveric knee dissection in medial view shows pes anserinus components.

B. Axial T1-weighted MR image shows three anatomic layers of knee as developed by Warren and Marshall [1]. Sartorius muscle and tendon (thick arrow) are enveloped by crural fascia (layer 1), and deeper gracilis (curved arrow) and semitendinosus (arrowhead) tendons are situated between layers 1 and 2. Wavy arrow denotes saphenous nerve as it pierces deep fascia between sartorius and gracilis tendons to become subcutaneous. Thin arrows denote accessory bands connecting gracilis and semitendinosus tendons to crural fascia.

C and D. Schematics show anatomy of saphenous nerve and its infrapatellar and sartorial branches relative to pes anserinus (C) and sensory innervation to medial leg (D).
Fig. 2—Adult with medial knee pain and swelling due to pes anserinus bursitis. Axial T2-weighted fat-suppressed MR image shows fluid-filled pes anserinus bursa (asterisks), consistent with bursitis. Fluid is deep to pes anserinus tendons. Straight arrow denotes sartorius tendon; curved arrow, gracilis tendon; arrowhead, semitendinosus tendon.

Fig. 3—18-year-old male baseball player with semitendinosus rupture who heard pop with instant pain on sliding into second base. A and B, Sagittal T1-weighted MR image (A) and similarly oriented long-axis ultrasound image (B) show complete tear of semitendinosus tendon (arrowhead) with bony avulsion (asterisk).

Fig. 4—39-year-old man with complete avulsion of pes anserinus. Coronal STIR MR image shows uncommon complete avulsion of pes anserinus, which can occur with substantial injury, such as knee dislocation as in this case. Torn tendons (chevron) can displace into joint.

Fig. 5—22-year-old man with complete tear of distal superficial medial collateral ligament (MCL) with Stener-like lesion. A and B, Schematic (A) and coronal T2-weighted fat-suppressed MR image (B) show complete tear of distal superficial MCL (thin arrows, B) displaced superficial to sartorius (thick arrow, B) and gracilis (curved arrow, B), preventing anatomic healing of superficial MCL.
Fig. 6—Gracilis and semitendinosus neotendon formation at different times after medial hamstring harvesting for anterior cruciate ligament (ACL) reconstruction.

A, Axial T2-weighted fat-saturated MR image of 43-year-old man 7 weeks after tendon harvest shows early gracilis (curved arrow) and semitendinosus (arrowhead) neotendon formation with signal intensity higher than expected of normal tendon. Straight arrow indicates sartorius tendon.

B, Axial T1-weighted MR image of 42-year-old man 14 years after tendon harvest shows thickened gracilis (curved arrow) and semitendinosus (arrowhead) neotendons with normal low signal intensity. Tibial tunnel (asterisk) is related to ACL reconstruction. Straight arrow indicates sartorius tendon.

Fig. 7—35-year-old male runner with complete tear of pes anserinus, recent history of right posteromedial knee pain after 83-mile (134 km) run, and remote history of reconstruction of anterior cruciate ligament by hamstring autograft.

A and B, Photograph of injured right knee (A) shows loss of muscle and tendon definition (arrows, A) in comparison with normal left knee (B).

C and D, Coronal proton density–weighted (C) and axial T1-weighted (D) MR images show complete tears of pes anserinus tendons (chevron). Arrow (C) denotes intact superficial medial collateral ligament.

(Fig. 7 continues on next page)
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Fig. 7 (continued)—35-year-old male runner with complete tear of pes anserinus, recent history of right posteromedial knee pain after 83-mile (134 km) run, and remote history of reconstruction of anterior cruciate ligament by hamstring autograft. E and F, Transverse (E) and longitudinal (F) gray-scale ultrasound images obtained 1 month after D and C and oriented to them show indistinct sartorius (straight arrow, E), gracilis (curved arrow, E), and semitendinosus (arrowheads, F) tendons, confirming tears. Asterisk (F) denotes scar tissue.

Fig. 8—31-year-old man with failed semitendinosus neotendon regeneration presenting as posterior thigh mass after hamstring autograft anterior cruciate ligament (ACL) reconstruction. A and B, Axial T1-weighted MR images show absence of semitendinosus tendon (arrowhead) at level of knee (A) and distal femur (B). Straight arrow denotes sartorius muscle; curved arrow, gracilis neotendon; asterisk (A), femoral tunnel for ACL graft. C, Axial T1-weighted MR image shows muscle is atrophied and retracted to level of mid thigh underlying marker indicating palpable abnormality. Arrowhead denotes semitendinosus tendon.
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Fig. 9—22-year-old woman with saphenous neuroma after anterior cruciate ligament (ACL) reconstruction 3 years earlier. Coronal T1-weighted fat-suppressed contrast-enhanced MR image shows saphenous neuroma (asterisk) with nearby scarring (arrow) from prior hamstring autograft harvest for ACL reconstruction. Neuroma was resected, and symptoms resolved.

Fig. 10—Tumors and tumorlike lesions.
A, 40-year-old man with pathologically proven tenosynovial giant cell tumor involving pes anserinus bursa. Axial T1-weighted fat-suppressed contrast-enhanced MR image shows heterogeneously enhancing soft-tissue mass (asterisk) deep to sartorius (thick arrow) and gracilis (curved arrow) tendons and overlying superficial medial collateral ligament (thin arrow).
B, 42-year-old man with anterior tibial mass for several years characteristic of periosteal ganglion cyst. Axial T2-weighted fat-suppressed MR image shows cystic lesion (asterisk) at anteromedial tibia near pes anserinus insertion, which is classic location of periosteal ganglion cyst, with subtle scalloping of underlying tibial cortex.
C, 44-year-old man with gouty involvement of knee. Coronal CT arthrogram shows gouty deposits (asterisks) at pes anserinus bursa and popliteal sulcus.