

The Semimembranosus-Tibial Collateral Ligament Bursa

ANATOMICAL STUDY AND MAGNETIC RESONANCE IMAGING*

BY SHAWN P. HENNIGAN, M.D.†, CARSON D. SCHNECK, M.D., PH.D.†, MAMED MESGARZADEH, M.D.†,
AND MICHAEL CLANCY, M.D.†, PHILADELPHIA, PENNSYLVANIA

*Investigation performed at the Departments of Anatomy and Cell Biology, Diagnostic Imaging, and Orthopedic Surgery,
Temple University School of Medicine and Hospital, Philadelphia*

ABSTRACT: A bursa that was deep to the tibial collateral ligament and adjacent to the semimembranosus tendon was studied in fifty cadaveric knees; a vinyl solution was injected into four of the specimens in order to facilitate a study of the relationship between the bursa and its surrounding structures. The bursa had the shape of an inverted U: the superficial arm was an elliptical pocket that was located between the semimembranosus tendon and the tibial collateral ligament, and the deep arm was a triangular pocket that was located between the semimembranosus tendon and the medial tibial condyle. The bursa measured, on the average, twenty-one millimeters in its greatest anteroposterior dimension and ten millimeters in its greatest superoinferior dimension.

Magnetic resonance images were made of two patients, and they showed fluid in the bursa.

In the course of dissecting the five slips of insertion of the semimembranosus⁹, we identified a bursa about the anterior expansion of the semimembranosus tendon; the bursa extended deep and anterior to the posterior edge of the tibial collateral ligament. The bursa formed an inverted U about the semimembranosus tendon, with a superficial and a deep pocket that were joined superiorly. The relationship between the bursa and both the semimembranosus and the tibial collateral ligament suggested the name semimembranosus-tibial collateral ligament bursa.

Despite an extensive review of the English-language literature, we did not find a description of a bursa that had this shape and location. The description by Warren and Marshall of the five bands of insertion of the semimembranosus did not include any mention of a related bursa. In their classic study, Brantigan and Voshell described a number of bursae that were present in five different locations about the tibial collateral ligament, with variations between the specimens,

but they did not mention any bursae that were related to the semimembranosus tendon⁷. Stuttle described a "no-name and no-fame bursa," which was located in the region of the anterior edge of the tibial collateral ligament, but he did not describe any bursae in association with the thick anterior extension of the semimembranosus tendon.

We therefore studied a large series of knees in order to define the frequency with which the semimembranosus-tibial collateral ligament bursa is present, as well as to define its size, shape, and relationship to adjacent ligaments and bone and to nearby bursae.

Materials and Methods

Fifty embalmed knees were dissected, and photographs were made at each stage of the dissection. Three separate anteroposterior and superoinferior measurements were made of each pocket of the bursa; the anteroposterior measurements were made parallel to the semimembranosus tendon, and the superoinferior measurements were made perpendicular to that tendon (Fig. 1, *A* and *B*). The extent of the bursa anterior and posterior to the posterior border of the tibial collateral ligament was measured (Fig. 1, *C*). Next, the relationship of the bursa to the medial tibial condyle was examined so that the location of the bursa could be found on physical and radiographic examinations (Fig. 1, *D*). The relationships of the bursa to the nearby semimembranosus-gastrocnemius and to the anserine bursae also were determined (Fig. 1, *E*).

A colored vinyl solution (Carolina Biological Supply Company, Burlington, North Carolina) was injected into the intact semimembranosus-tibial collateral ligament bursa, the semimembranosus-gastrocnemius bursa, and the anserine bursa of four of the specimens. After the solution had hardened, the semimembranosus tendon was removed *in toto* from its insertion, with the cast of the bursa still attached, in order to facilitate a study of the relationship between the bursa and its surrounding structures.

In two specimens, the semimembranosus-tibial collateral ligament bursa was analyzed histologically in order to confirm that this structure was a true bursa and not a potential space created by the dissection. A large

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†Temple University School of Medicine, 3400 North Broad Street, Philadelphia, Pennsylvania 19140. Please address requests for reprints to Dr. Schneck, Department of Anatomy and Cell Biology.

TABLE I
DIMENSIONS OF THE SEMIMEMBRANOSUS-TIBIAL
COLLATERAL LIGAMENT BURSA*

	Superficial Pocket	Deep Pocket
Anteroposterior dimension (mm)		
At superior border	21 ± 6.2 (7-36)	18 ± 4.6 (8-30)
At middle of pocket	21 ± 7.3 (6-39)	15 ± 4.7 (7-29)
At inferior border	15 ± 7.0 (4-37)	9 ± 3.5 (3-20)
Superoinferior dimension (mm)		
At anterior border	7 ± 3.7 (4-20)	7 ± 2.7 (2-21)
At middle of pocket	10 ± 2.5 (5-15)	10 ± 3.1 (4-19)
At inferior border	8 ± 3.6 (3-18)	7 ± 2.8 (3-15)

*Mean and standard deviation, with the range in parentheses.

block of tissue — including the undisturbed bursa, the semimembranosus tendon, the inferior portion of the tibial collateral ligament, and the periosteum of the medial tibial condyle — was removed *in toto*. Serial histological sections of this block were prepared and stained with hematoxylin and eosin.

As the anatomical studies proceeded, we asked the Department of Orthopedic Surgery of Temple University Hospital to identify patients who might have an abnormality of the semimembranosus-tibial collateral ligament bursa. Two such patients were identified, and magnetic resonance images were made.

Results

A semimembranosus-tibial collateral ligament bursa of substantial size was present in all fifty specimens. Every bursa had the shape of an inverted U, with a superficial pocket and a deep pocket that were broadly continuous over the anterosuperior edge of the semimembranosus tendon. The superficial pocket was located between the deep aspect of the tibial collateral ligament and the superficial surface of the semimembranosus tendon; the deep pocket was located between the deep aspect of the semimembranosus tendon and the medial tibial condyle. The greatest anteroposterior and superoinferior dimensions of both pockets varied considerably between the specimens, ranging from seven to thirty-nine millimeters and from four to twenty-one millimeters, respectively.

The general orientation of the two pockets of the bursa and their relationship to each other were largely

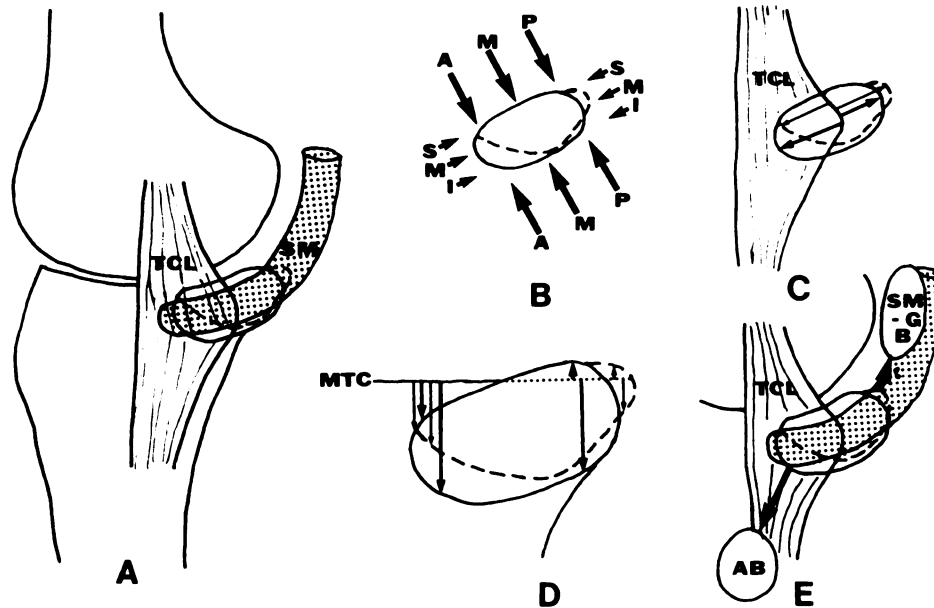


FIG. 1

Drawings demonstrating the orientation and measurements of the superficial pocket (solid line) and deep pocket (interrupted line) of the semimembranosus-tibial collateral ligament bursa.

A: The relationship of the elliptical superficial and triangular deep pockets of the bursa to the semimembranosus tendon (SM) and the tibial collateral ligament (TCL).

B: The anteroposterior measurements (small arrows) were made at the superior border (S), the inferior border (I), and midway between these borders (M). The superoinferior measurements (large arrows) were made at the anterior border (A), the posterior border (P), and midway between these borders (M).

C: The distances that the superficial pocket (thick arrows) and deep pocket (thin arrows) extended posterior to and deeply anterior to the posterior edge of the tibial collateral ligament (TCL).

D: The distances that the anterior and posterior ends of the superior and inferior borders of the superficial pocket (thick arrows) and deep pocket (thin arrows) extended inferior or superior to the superior edge of the medial tibial condyle (MTC).

E: The distances (arrows) between the semimembranosus-tibial collateral ligament bursa and the semimembranosus-gastrocnemius bursa (SM-GB) and the anserine bursa (AB). TCL = tibial collateral ligament.

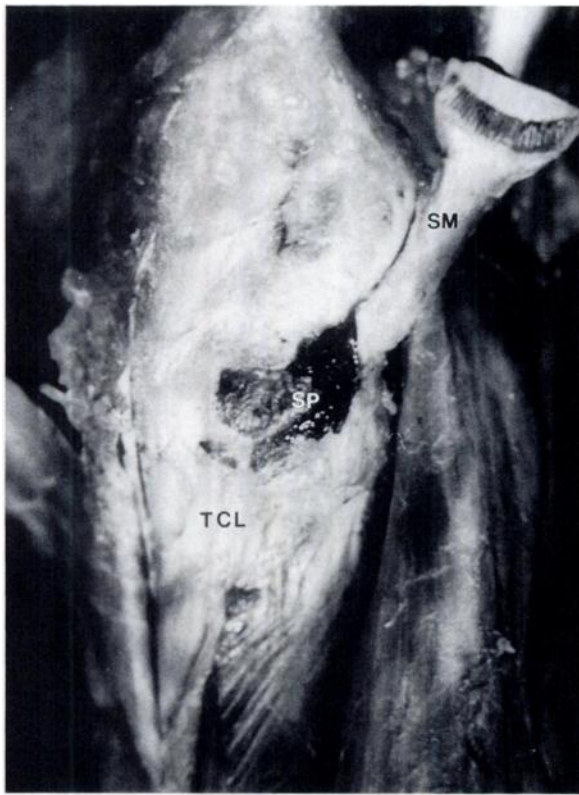


FIG. 2-A

Figs. 2-A and 2-B: Photographs made after the injection of the semimembranosus-tibial collateral ligament bursa with blue vinyl solution.

Fig. 2-A: Medial view of the semimembranosus tendon (SM) coursing behind the medial femoral condyle. The tendons of the pes anserinus have been reflected anteriorly. The superficial pocket (SP) of the bursa extends deep to the tibial collateral ligament (TCL).

a function of the obliquity of the semimembranosus tendon and its attachment. The anterior slip of the tendon passed inferiorly obliquely as it coursed anteriorly (Fig. 1). Therefore, the anterior end of each pocket of the bursa projected to a level that was inferior to the posterior end. Also, the deep fibers of the anterior part of the tendon inserted into the medial aspect of the tibia more posteriorly or proximally than did the superficial fibers. Hence, the deep pocket of the bursa was more posterior and superior than the superficial pocket. In a

TABLE II

DISTANCE THAT THE SEMIMEMBRANOSUS-TIBIAL COLLATERAL LIGAMENT BURSA EXTENDED ANTERIOR AND DEEP TO THE POSTERIOR EDGE OF THE TIBIAL COLLATERAL LIGAMENT AND POSTERIOR TO THE POSTERIOR EDGE OF THE TIBIAL COLLATERAL LIGAMENT*

	Superficial Pocket	Deep Pocket
Distance anterior and deep to posterior edge of tibial collateral ligament (mm)	10 ± 5.3 (2-28)	10 ± 4.0 (2-22)
Distance posterior to posterior edge of tibial collateral ligament (mm)	9 ± 6.0 (5-18)	8 ± 4.4 (1-25)

*Mean and standard deviation, with the range in parentheses.

medial view in which the outlines of the pockets of the bursa are superimposed, the deep pocket is slightly posterior to the superficial pocket (Fig. 1). The over-all three-dimensional geometry of the bursa was best displayed by the casts that were formed in four of the specimens after the injection of acrylic solution (Figs. 2-A and 2-B).

Superficial Pocket

The superficial pocket was elliptical in shape (Figs. 1 and 2-A). The greatest anteroposterior dimension was 21 ± 7.3 millimeters (mean and standard deviation), across the middle of the bursa (Table I). The greatest superoinferior dimension averaged 10 ± 2.5 millimeters, also across the middle of the bursa.

The superficial pocket had a consistent relationship with the tibial collateral ligament: slightly more than

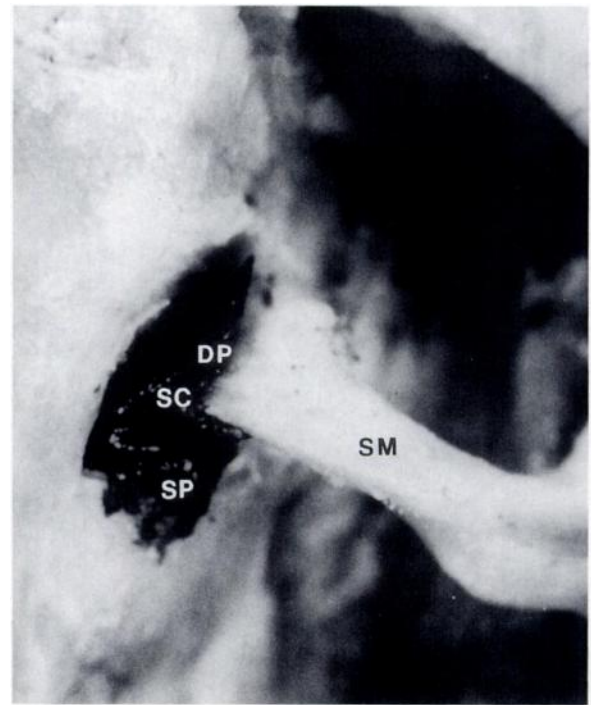


FIG. 2-B

The semimembranosus tendon (SM) has been rotated inferiorly. The deep pocket (DP) and its superior communication (SC) with the superficial pocket (SP) can be seen.

half of the pocket (10 ± 5.3 millimeters) extended anterior and deep to the posterior edge of the ligament, and slightly less than half of the pocket (9 ± 6.0 millimeters) extended posterior to the ligament (Table II).

The anterior end of the superior border of the superficial pocket was an average of 8 ± 5.3 millimeters distal to the superior edge of the medial tibial condyle (Table III), and the anterior end of the inferior border extended an average of 19 ± 5.2 millimeters distal to that location. The posterior end of the superior border of the superficial pocket extended an average of 2 ± 6.1 millimeters

TABLE III
DISTANCE THAT THE SEMIMEMBRANOSUS-TIBIAL
COLLATERAL LIGAMENT BURSA EXTENDED INFERIOR
TO THE SUPERIOR EDGE OF THE MEDIAL TIBIAL CONDYLE*

	Superficial Pocket	Deep Pocket
Distance from superior edge of medial tibial condyle (mm)		
To anterior end of superior border of bursa	8 ± 5.3 (-4-18)	9 ± 3.8 (1-21)
To anterior end of inferior border of bursa	19 ± 5.2 (8-33)	15 ± 4.8 (5-30)
To posterior end of superior border of bursa	-2 ± 6.1 (-19-10)	-1 ± 5.1 (-11-11)
To posterior end of inferior border of bursa	16 ± 6.5 (1-28)	12 ± 3.4 (3-20)

*Mean and standard deviation, with the range in parentheses. Negative values indicate that the distance is proximal to the superior edge of the tibial condyle.

proximal to the superior edge of the medial tibial condyle (Table III), and the posterior end of the inferior border extended an average of 16 ± 6.5 millimeters distal to it.

Deep Pocket

The deep pocket was located more proximally and posteriorly than the superficial pocket (Fig. 1). The size of the deep pocket generally was similar to that of the superficial pocket, but since its greatest average antero-posterior dimension (18 ± 4.6 millimeters) was along its superior border (Table I), this pocket was more triangular in shape (Fig. 1). As in the superficial pocket, the greatest average superoinferior dimension of the deep

pocket (10 ± 3.1 millimeters) was at the middle of the bursa.

The relationship of the deep pocket to the tibial collateral ligament was similar to that of the superficial pocket, in that slightly more than half of the deep pocket (10 ± 4.0 millimeters) extended anterior and deep to the posterior edge of the ligament and slightly less than half of the pocket (8 ± 4.4 millimeters) extended posterior to the ligament (Table II).

In all fifty specimens, the anterior end of the superior margin of the deep pocket remained distal to the superior edge of the medial tibial condyle, by an average of 9 ± 3.8 millimeters (Table III); the anterior end of the inferior margin was an average of 15 ± 4.8 millimeters distal to the superior edge of the medial tibial condyle. Posteriorly, the superior margin of the deep pocket was slightly proximal to the superior edge of the medial tibial condyle, by an average of 1 ± 5.1 millimeters (Table III), but it was proximal in only twenty-eight (56 per cent) of the specimens. The posterior end of the inferior border of the deep pocket was distal to the medial tibial condyle in all fifty specimens, by an average of 12 ± 3.4 millimeters.

Relationship to Other Bursae

The semimembranosus-tibial collateral ligament bursa was located between the semimembranosus-gastrocnemius bursa and the anserine bursa (Fig. 1, E). It was an average of 9 ± 4.4 millimeters from the semimembranosus-gastrocnemius bursa and 22 ± 7.8 millimeters from the anserine bursa. The semimem-

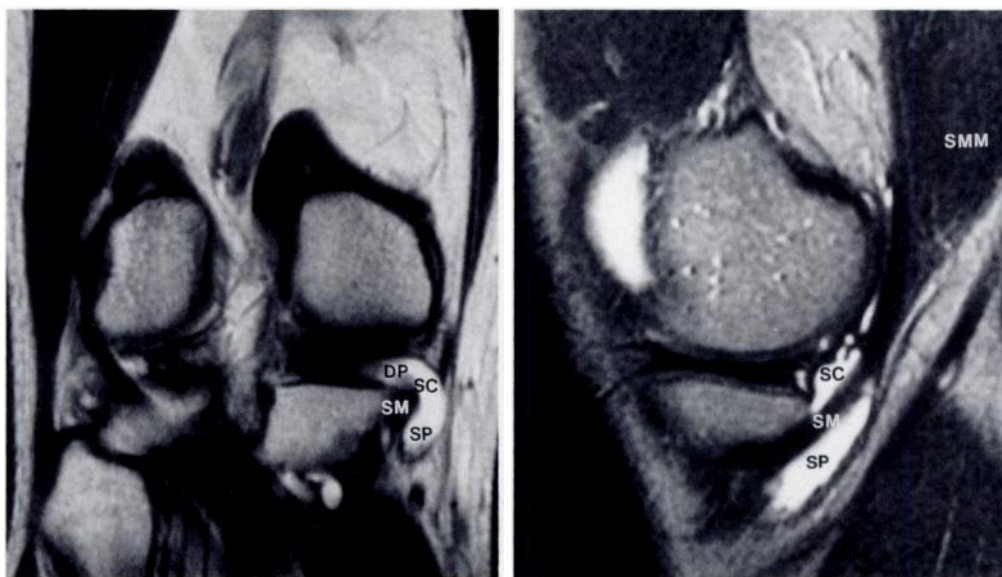


FIG. 3-A

FIG. 3-B

Figs. 3-A and 3-B: Magnetic resonance images demonstrating fluid in the semimembranosus-tibial collateral ligament bursa of a forty-one-year-old man who had sustained a twisting injury of the medial side of the knee.

Fig. 3-A: Coronal T2-weighted image demonstrating the semimembranosus-tibial collateral ligament bursa as it drapes over the semimembranosus tendon (SM). There is increased signal intensity, characteristic of an effusion, within the semimembranosus-tibial collateral ligament bursa. DP = deep pocket, SC = superior communication, and SP = superficial pocket.

Fig. 3-B: Sagittal T2-weighted image demonstrating the effusion both in the superficial pocket (SP) and in the superior communication (SC) of the semimembranosus-tibial collateral ligament bursa. SMM = semimembranosus muscle and SM = semimembranosus tendon.

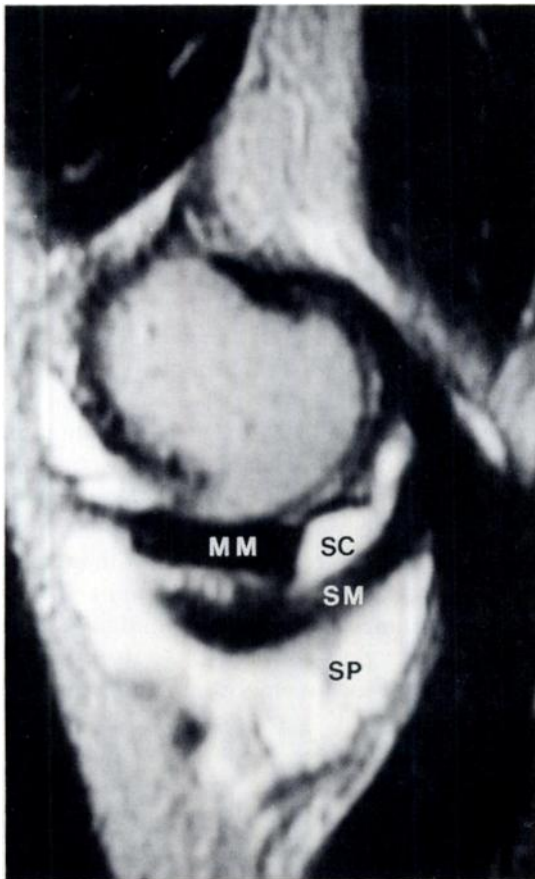


FIG. 4

Sagittal T2-weighted magnetic resonance image of a thirty-seven-year-old woman who had multiple traumatic effusions about the knee, with involvement of the semimembranosus-tibial collateral ligament bursa. An effusion is present within both the superficial pocket (SP) and the superior communication (SC) of the bursa on either side of the semimembranosus tendon (SM). There is high signal intensity that is characteristic of an effusion. MM = medial meniscus.

branosus-tibial collateral ligament bursa was not continuous with either bursa or with the knee joint in any specimen.

Histological Studies

Histological studies revealed the semimembranosus-tibial collateral ligament bursa to be fully enclosed by a discrete wall. Under high-power magnification, it was found to be lined by synovial-type cells lying on loose connective and adipose tissues.

Magnetic Resonance-Imaging Studies in Patients

During the last two months of the anatomical studies, magnetic resonance images were made of one patient who had had acute trauma and of another who had had long-term repetitive trauma involving the knee; these images showed fluid in the semimembranosus-tibial collateral ligament bursa of both patients.

Case Reports

CASE 1. A forty-one-year-old man who had sustained a twisting injury of the lower limb while at work was seen because of pain in the

knee. Physical examination revealed a small effusion in the knee. The patient improved steadily during five weeks of non-operative management, but the pain and effusion subsequently returned. A magnetic resonance image revealed a discrete effusion about the semimembranosus tendon that was consistent with the presence of fluid distending the semimembranosus-tibial collateral ligament bursa (Figs. 3-A and 3-B).

CASE 2. A thirty-seven-year-old woman who had worked full-time as an aerobics instructor for many years was seen because of pain in both knees; the pain had been present for two years and recently had worsened. Physical examination revealed a mild effusion in the left knee. The pain resolved after non-operative treatment, but it recurred after the patient resumed her normal activities. Magnetic resonance images of the knee revealed an effusion in the joint and a large effusion surrounding the semimembranosus tendon that was consistent with the presence of fluid in an enlarged semimembranosus-tibial collateral ligament bursa (Fig. 4).

Discussion

A number of authors have described bursae related to the tibial collateral ligament or to the semimembranosus tendon; the present study clarifies the exact size, shape, location, and anatomical relationships of a bursa that was consistently present in fifty specimens. Brantigan and Voshell described five different bursae deep to the tibial collateral ligament and their rates of occurrence in fifty-seven specimens². However, 7 per cent of the specimens in that study had no bursa deep to the tibial collateral ligament, and 11 per cent had as many as three bursae there. None of the bursae in that study were described as being related to the semimembranosus tendon, and the highest prevalence of a bursa in any single location was 51 per cent.

A year after their original paper², Voshell and Brantigan reported a study of ten limbs with bursitis in the region of the tibial collateral ligament⁸. They described the relatively consistent clinical finding of a palpable, tender enlargement beneath the tibial collateral ligament that usually became more painful with extension, hyperextension, or abduction (valgus stress) of the knee, or with external rotation of the leg. These clinical findings were consistent with those of Kerlan and Glouzman, who reported on a series of ninety-one limbs with bursitis of the tibial collateral ligament. Halperin et al. reported the results of operative treatment of semimembranosus tenosynovitis in a study that involved sixteen patients and the dissection of forty knees; they described a bursa that was deep to the reflected head of the semimembranosus tendon, but they did not describe the larger superficial pocket of the bursa. In a more recent study, on magnetic resonance imaging of the bursa of the tibial collateral ligament, Lee and Yao found bursitis in seven limbs, but they did not state that the bursa had any relationship to the semimembranosus tendon.

The functional importance of the semimembranosus-tibial collateral ligament bursa requires some consideration. Warren and Marshall observed that the direct insertion of the semimembranosus tendon into

the posterior aspect of the medial tibial condyle, and the anterior reflection of the tendon under the tibial collateral ligament, were the strongest heads of insertion of the semimembranosus. It is likely that the anterior reflection of the semimembranosus has substantial load-bearing functions. Slocum et al. described the semimembranosus as "the muscular pillar of the posteromedial corner of the knee," an important support of the posteromedial corner of the knee against both valgus thrust and anteromedial tibial displacement. The anterior reflection of the semimembranosus tendon has a unique relationship, both with the tibial collateral ligament and with the medial tibial condyle, that could subject the tendon to repeated trauma. In their earliest paper, Brantigan and Voshell observed that although the anterior fibers of the tibial collateral ligament are taut throughout the full range of flexion and extension, the oblique posterior fibers of the ligament are taut in extension but relaxed in flexion¹. Halperin et al. observed that, during extension, the anterior reflection of the semimembranosus tendon forms an obtuse angle with the more proximal portion of the tendon and is firmly compressed against the medial tibial condyle as the tendon is tensed by extension of the knee. Hence, during extension of the knee, the anterior reflection of the semimembranosus tendon tends to be compressed between the overlying tibial collateral ligament and the underlying medial tibial condyle. Similarly, valgus or external rotation stress on the knee places tension both on the tibial collateral ligament and on the semi-

membranous tendon, creating a scissoring effect on the tendon by the tibial collateral ligament and the medial tibial condyle. The presence of the semimembranosus-tibial collateral ligament bursa reduces the attrition of the tendon in these circumstances. Evidence for the protective effect of the semimembranosus-tibial collateral ligament bursa also is provided by the findings of Voshell and Brantigan⁸ and of Kerlan and Glousman that these maneuvers increased the pain when the bursa was inflamed.

The proximal (posterosuperior) end of the normal bursa can be found at the point at which the semimembranosus crosses the knee joint posteromedially; the distal (anteroinferior) end of the bursa is approximately two centimeters distal to this point and is located one to two centimeters inferior to the joint space in the average individual. When it is distended by effusion, the bursa can of course cover a larger area.

It should be possible to differentiate the pathological involvement of this bursa from that of the semimembranosus-gastrocnemius bursa, the distal end of which is one centimeter proximal to the joint space. The proximal end of the anserine bursa is two centimeters distal to the semimembranosus-tibial collateral ligament bursa and therefore is approximately three to four centimeters distal to the joint space.

A knowledge of the prevalence, size, shape, location, and relationships of the semimembranosus-tibial collateral bursa should help in the differential diagnosis of pain on the medial side of the knee.

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