Introduction
The adductor canal is an aponeurotic tunnel that courses between the anterior and medial compartments in the middle third of the thigh. The canal begins at the apex of the femoral triangle and extends to the adductor hiatus [1]. Its major contents are the superficial femoral artery, the nerve to vastus medialis, and the saphenous nerve. The latter two nerves are branches of the posterior division of the femoral nerve. Along with the medial and intermediate cutaneous nerves of the thigh and the lateral femoral cutaneous nerve the saphenous nerve contributes to the sensory distribution around the anterior aspect of the knee. This anatomic cadaveric study defined the course of the saphenous nerve and its divisions along the medial aspect of the knee. Landmark-based distance measurements were recorded in reference to the proximal border of the patella, medial border of the patella, medial epicondyle, medial femoral condyle, and posterior femoral condyle. The clinical implications of our findings suggest there is opportunity to obtain medial sensory analgesia during total knee arthroplasty when periarticular injections of bupivacaine derived medications are injected in the region of saphenous nerve proximal and posterior to the medial femoral condyle.

Methods
One left fresh-frozen cadaveric knee of an 87 year Caucasian woman with no evidence of prior injury was utilized for this project. The knee was stored at -20 degrees Celsius and thawed overnight prior to dissection.
Dissection to identify the course of the saphenous nerve was performed. A midline skin incision was initiated in the proximal thigh and continued distally past the pes anserine. Skin flaps were developed down to deep fascia and reflected medially and laterally, respectively. The sartorius muscle was identified, cut at its distal quarter, and reflected to expose the adductor canal. The saphenous nerve was identified proximally and followed distally into the adductor canal. The vastoadductor membrane was identified and preserved.

The main trunk of the saphenous nerve was identified as it emerged from the vastoadductor membrane along with the SBDGA. The nerve was diligently dissected to its bifurcation into sartorial and infrapatellar branches. The branches were dissected distally to the area where they pierced the deep fascia to become subcutaneous. A subvastus approach was used to expose the knee joint and medial structures. The most prominent point of the medial epicondyle was identified, and overlying soft tissue was removed to allow for accurate localization. The anterior and medial portions of the medial meniscus were excised. During dissection, we were careful to identify the course of the saphenous nerve and its branches in relation to bony landmarks. Landmark-based distance measurements were recorded in reference to the proximal border of the patella, medial border of the patella, medial epicondyle, medial femoral condyle, and posterior femoral condyle.

**Results**

The saphenous nerve emerged from the vastoadductor membrane 10.7 cm proximal and 0.5 cm posterior to the medial epicondyle (Figure 1). In relation to the patella, this distance was 7.5 cm proximal to the superior border of the patella and 6.1 cm posterior to the medial border of the patella. In relation to the distal femoral joint line, this distance was 13.4 cm proximal to the distal medial femoral condyle. These distances did not change with the knee flexed to 90 degrees.

After emerging from the vastoadductor membrane, the saphenous continued for 2 cm before bifurcating into infrapatellar (white arrow head) and sartorial branches (thin white arrow). The saphenous nerve travels for 2 cm before bifurcating into infrapatellar (white arrow head) and sartorial branches (thin white arrow).

After emerging from the vastoadductor membrane, the saphenous continued for 2 cm before bifurcating into infrapatellar and sartorial branches. This branch point was 8.7 cm proximal and 0.5 cm posterior to the medial epicondyle. In relation to the patella, this distance was 5.5 cm proximal to the superior border of the patella and 6.1 cm posterior to the medial border of the patella. In relation to the distal femoral joint line, this distance was 13.4 cm proximal to the distal medial femoral condyle. These values did not change with the knee in 90 degrees of flexion.
The sartorial branch was found to pierce the sartorial fascia anteriorly (Figure 5). It was located 2.9 cm posterior to the medial epicondyle. In relation to the patella, it was located 7.9 cm posterior to the medial border of the patella.

![Figure 5](image5.png)

Figure 5: After piercing the deep fascia to become subcutaneous, the sartorial branch (under scissor2/black arrow head) continues distally into the leg along with the long saphenous vein (white arrow head). Medial epicondyle (white star).

To our knowledge, the relationship of the vastoadductor membrane to the medial epicondyle has not been described. However, it has been described in relation to the adductor tubercle, a structure that is close in proximity to the medial epicondyle. Tubbs et al studied the vastoadductor membrane and the location of the VAM in relation to the adductor tubercle [5]. They found the length of the VAM to be 7.6 cm (range 5.5-15 cm) and the distance from the distal border of VAM to adductor tubercle to be 10 cm (range 7-15 cm). These measurements are consistent with ours. Although close in proximity, the adductor tubercle is not typically a palpable structure in most surgical exposures of the knee joint; therefore, we feel the medial epicondyle to be a more useful anatomical landmark.

The main trunk of the saphenous nerve continued for 2 cm before bifurcating into infrapatellar and sartorial branches. This branch point was 8.7 cm proximal to the medial epicondyle, 5.5 cm proximal to the superior border of the patella, and 11.4 cm proximal to the distal femoral joint line. These results are differed with those of Horn et al. who found that the bifurcation occurred 2.7 cm (range 2.1-3.4 cm) proximal to the superior border of the patella. In our specimen it was more than 2 cm more proximal than the high end of their range.

Multiple studies show the variable course and branches of the infrapatellar branch of the saphenous nerve [11-13]. After branching from the saphenous nerve, the infrapatellar branch travels in a medial to lateral direction as it courses proximal to distal. Kerver et al studied the infrapatellar branch and found that it does this at about a 45 degree angle with respect to the horizontal axis of the knee when the knee is extended and almost parallel to the joint when the knee is flexed to 90 degrees [12]. These findings were consistent with what we observed in our specimen. They also found that at the level of the mid-patella the infrapatellar branch is 52.2-54.2 mm away from the medial border of the patella; at the level of the inferior pole of the patella, the nerve is 43.3-44.3 mm from the medial margin of the patella ligament [12].

Kalthur et al found a variable course of the infrapatellar branch with respect to the point where the nerve pierces the fascia lata, the location of its main nerve trunk in relation to the patella, and the number and location of its terminal branches with respect to the patella and tibial tubercle [10]. They found the most common location for the nerve to become subcutaneous was anterior to the sartorius. This differed from what we observed in our specimen. The nerve was not described in relation to the adductor tubercle, a structure that is close in proximity to the medial epicondyle. Tubbs et al studied the vastoadductor membrane and the location of the VAM to be 7.6 cm (range 5.5-15 cm) and the distance from the distal border of VAM to adductor tubercle to be 10 cm (range 7-15 cm). These measurements are consistent with ours. Although close in proximity, the adductor tubercle is not typically a palpable structure in most surgical exposures of the knee joint; therefore, we feel the medial epicondyle to be a more useful anatomical landmark.

To our knowledge, the relationship between the infrapatellar branch and the distal femoral condyle or posterior femoral condyle has not been described. During its course anteriorly, it was located 3.1 cm inferior to the medial epicondyle and 0.4 cm inferior to the distal medial femoral condyle with the knee in 0 degrees of extension. With the knee flexed to 90 degrees the infrapatellar branch became more parallel to the horizontal knee axis. In this position, it was measured to be 2.5 cm inferior to the posterior femoral condyle and 5.2 cm inferior to the medial epicondyle.

**Discussion**

In our specimen, the saphenous nerve emerged from the vastoadductor membrane 10.7 cm proximal and 0.5 cm posterior to the medial epicondyle. In relation to the patella, this distance was 7.5 cm proximal to the superior border of the patella and 6.1 cm posterior to the medial border of the patella. With respect to the knee in extension, this distance was 13.4 cm proximal to the joint line at the distal medial femoral condyle. These results are consistent with those of Horn et al. who studied the anatomy of the saphenous nerve and its two branches as they exited the adductor canal [10]. They found that the distance from the proximal patella to the distal end of the adductor canal was 10.25 cm (range 7-11.5 cm). In addition, they found that the saphenous nerve bifurcated into sartorial and infrapatellar branches 6.6 cm (range 5-9 cm) posterior to the medial border of the patella.

![Figure 6](image6.png)

Figure 6: 3 1/2 inch (88.9 mm) spinal needle inserted parallel to the posterior condyle with the knee in 30 degrees of flexion. Hub of needle is at the medial epicondyle.

![Figure 7](image7.png)

Figure 7: 3 1/2 inch (88.9 mm) spinal needle inserted parallel to the posterior condyle with the knee in 90 degrees of flexion. Hub of needle is at the medial epicondyle.

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In our specimen the sartorial branch was found to pierce the sartorial fascia distal to the joint line. Dunaway et al. studied the location of the sartorial nerve in relation to the joint line [7]. They found that the nerve travels 17 mm (range 0-25 mm) posterior to the anterior border of the sartorius muscle and becomes subcutaneous or extrafascial anywhere from 37 mm proximal to 30 mm distal to the joint line. Thothonglor et al. found that in the majority of cases the sartorial branch emerged from the deep fascia separately from the infrapatellar branch [15]. Alternatively, they found in a smaller percentage of people the saphenous nerve emerged as a single trunk and later bifurcated. The results of this study were consistent with that of Arthornthurasook and Gaew-Im who found that in the majority of patients the piercing point of the sartorial nerve was distal to the medial epicondyle [14]. In our specimen the sartorial branch was located 7.9 cm posterior to the medial border of the patella at its midpoint and 2.9 cm posterior to the medial epicondyle. This differed from the results of Widicks et al. who studied the sartorial branch of the saphenous nerve in relation to the medial knee structures [8]. They found the perpendicular distance of the saphenous nerve to be 5.0 ± 1.1 cm medial to adductor tubercle.

The clinical implications of our findings suggest there is opportunity to obtain medial sensory analgesia during total knee arthroplasty when periartricular injections of bupivacaine derived medications are injected in the region of saphenous nerve proximal and posterior to the medial femoral condyle. In a review of the neuroanatomy of the knee, Guild revealed that there are specific periartricular sites that are highly innervated and should be infiltrated with local anesthetic to provide post-operative pain relief [16]. Our current study demonstrated the path of the saphenous nerve as it exits the adductor canal and bifurcates into the sartorial nerve and infrapatellar branch of the saphenous nerve. As noted by Benzon, the saphenous nerve has a more posterior, not medial, position relative to the medial femoral condyle [17]. This may be a reason for some inconsistent results with injections in the region of the saphenous nerve. Periartricular injection of the posterior medial capsular proximal to the medial femoral epicondyle, as well as injection deep and superficial to the insertion of the pes tendons as the nerve penetrates the sartorius, should provide sensory analgesia on the medial aspect of the knee.

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