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Atypical Origin of the Saphenous Nerve and a Variation of the Right Iliacus Muscle: A Case Report

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Abstract

During a routine cadaveric dissection of the posterior abdominal wall, variations of the bilateral lumbar plexus and a variant saphenous nerve originating in the lower abdomen were noted and documented. The description of a saphenous nerve originating at the level of the lumbar plexus is, to the best of our knowledge, the first of its kind. Further study revealed more variations at the root of the lumbar plexus and bilateral branching patterns. A variant iliacus muscle entrapping the superior portion of the femoral nerve was also observed on the right side within the abdominal cavity. These variations are discussed in the context of risk of clinical intervention in this anatomical region..

Keywords

Anatomical variation; Saphenous nerve; Lumbar plexus; Femoral nerve; Iliacus muscle

Introduction

The lumbar plexus provides both sensory and motor innervation to the pelvis and the lower extremities [1-3]. Most commonly, this plexus is comprised of the ventral primary rami of L1 through L4 and receives a contribution of the subcostal nerve, T12 [1]. This plexus is located posterior to the psoas major muscle and travels laterally and caudally over the posterior abdominal wall. In this region, the subcostal nerve gives rise to a communicating branch that joins L1 and its derivatives.

The first lumbar nerve, L1, divides into the iliohypogastric and ilioinguinal nerves. A branch from L1 joins a branch from L2 forming the genitofemoral nerve. This nerve pierces the psoas muscle and travels anteriorly and inferiorly [1-4]. The second, third and fourth lumbar

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nerves (L2, L3, L4) separate into anterior and posterior divisions that will form a few terminal branches of the lumbar plexus. The anterior division of the L2, L3, and L4 nerves form the obturator nerve which is found descending with the fibers of the psoas major muscle. The obturator accessory nerve is found in approximately 8.8% of people and arises from the anterior division of L3 and L4 [4]. L4 and L5 form the lumbosacral trunk, which joins the sacral plexus as a component of the superior gluteal, inferior gluteal, and sciatic nerves [1-3]. The posterior division forms two nerves; the lateral femoral cutaneous nerve arising from L2 and L3 fibers, and the femoral nerve from L2, L3, and L4 fibers [1-3]. The femoral nerve travels parallel to the psoas major muscle and over the iliacus muscle before passing below the inguinal ligament and into the lower extremity. It is within the upper thigh that the femoral nerve forms the saphenous nerve [5]. The saphenous nerve begins in the proximal thigh and travels to and through the adductor canal. After exiting the canal, it divides into the sartorial and the infrapatellar nerve which supplies skin and fascia on the antero-medial surface of the knee, leg, and foot [2,5].

This case report from an elderly female specimen documents a bilateral variation of the lumbar plexus which included an entrapment of the femoral nerve under a muscle slip from the iliacus muscle and a variation in the origin of the saphenous nerve. A saphenous nerve that originates at the level of the lumbar plexus has, to the best of our knowledge, yet to be described.

Materials and Methods

This cadaveric specimen study was performed in the human anatomy laboratory at Universidad Central del Caribe School of Medicine in Bayamón, Puerto Rico under the supervision of Dr. Wilson Veras Tavares, MD. A routine dissection of an elderly female cadaver was performed. The posterior abdominal wall was dissected, and the psoas major muscle was resected superiorly to access the lumbar plexus following Clemente's Anatomy Dissector [5]. Additional dissection of the femoral triangle and upper thigh was performed to access the femoral and the saphenous nerves.

Results

Dissection of the posterior abdominal wall revealed the following features. On the right posterior abdominal wall, the lumbar plexus emerged posteriorly to the psoas major muscle. The subcostal nerve was observed on the superior part of the posterior abdominal wall, but it did not contribute to the right lumbar plexus. The first lumbar nerve, L1, is divided into three terminal branches: the iliohypogastric nerve, the ilioinguinal nerve, and the genital branch of the genitofemoral nerve. The genital branch was seen in the posterior abdominal cavity, superior to the iliacus muscle, joining the femoral branch of the genitofemoral nerve provided by the posterior division of L2. L1 was also observed contributing branches towards the lateral femoral cutaneous nerve, the obturator nerve, and the femoral nerve.

Inferior to L1, the posterior division of L2 contributed branches to the lateral femoral cutaneous nerve and the femoral nerve, while the anterior division of L2 contributed to the obturator nerve. The posterior division branch of L2 contributing to the femoral nerve was

also providing a single branch towards the iliacus muscle. This was appreciated once we reflected the psoas muscle superiorly and cleaned the area of fascia. The posterior division of L3 provided branches towards the femoral nerve and its anterior division also contributed to the obturator nerve. No accessory obturator nerve was observed. The posterior division of L4 was noted to be contributing fibers to the femoral nerve while the anterior division contributed to the formation of the obturator nerve and the lumbosacral trunk with L5 (Figure 1).

Detailed study of both the femoral nerve and the lateral femoral cutaneous nerve revealed that the right femoral nerve traversed deep under a variant slip of iliacus muscle within the iliac fossa (Figure 2). The lateral femoral cutaneous nerve divided itself at the iliac fossa into two branches. The lateral branch continued as the lateral femoral cutaneous nerve while the medial L1-L3 branch descended toward the inguinal ligament and femoral triangle (Figure 2).

Superior to the inguinal ligament, the L1-L3 branch contributed laterally to the femoral nerve and continued its descent into the femoral triangle. At the femoral triangle, we observed this branch contributing once again towards the femoral nerve and, at the vertex of the triangle, the femoral nerve also contributed fibers to this branch. This L1-L3 branch continued its route with the femoral artery and provided nerve fibers to the sartorius muscle and to the vastus medialis of the quadriceps femoris muscle (Figure 3). Ultimately, this branch followed the same path that the saphenous nerve ordinarily takes.

In the left posterior abdominal wall, the plexus also emerged posterior to the psoas muscle (Figure 4). The subcostal nerve was in the superior part of the abdominal wall and contributed to the L1 branch of the lumbar plexus. Both the subcostal nerve and L1 formed two terminal nerves: the iliohypogastric nerve and the ilioinguinal nerve. L1 also contributed fibers to form the genitofemoral nerve with the anterior division of L2. The posterior branch of L2 provided fibers toward the femoral nerve and the lateral femoral cutaneous nerve, while the anterior branch of L2 provided for the obturator and the genitofemoral nerve. The anterior branch of L3 was contributing nerve fibers for the obturator and accessory obturator nerve, while the posterior branch of L3 was providing fibers to the lateral femoral cutaneous nerve and the femoral nerve. It was observed that the posterior division of L4 was giving fibers to the femoral nerve. The anterior L4 division contributed to the formation of the obturator nerve, the accessory obturator nerve, and the lumbosacral trunk with L5 (Figure 5).

After dissection of the lateral femoral cutaneous nerve, we noted that once it reached the superior border of the iliac fossa the nerve divided into a lateral and a medial branch. The lateral branch proceeded as the lateral femoral cutaneous nerve and descended laterally through the iliac fossa. The medial branch, composed of L1-L3, descended over the psoas muscle, towards the inguinal ligament, and into the femoral triangle (Figures 5-7). This branch continued independently and followed the femoral artery, providing fibers to the sartorius muscle and the vastus medialis of the quadriceps femoris muscle. It was also noted that the femoral nerve provided a medial and lateral branch. These branches traveled towards the inguinal ligament and the femoral triangle. The lateral branch contributed fibers towards the femoral nerve. As these branches descended through the femoral triangle,

they surrounded the femoral artery before converging and following said artery's path and continuing superficially into the leg.

Discussion

The lumbar plexus may present with numerable root and branching variations that may affect the fiber composition and trajectory of the nerves [4]. In this case study, we found two variations that are of importance. Firstly, a unique bilateral branch in its own fascia was observed originating from the lumbar plexus. It is composed of fibers from L1-L3 that begin in the posterior wall of the abdominal cavity with the lumbar plexus and follows the femoral nerve parallelly. This variant nerve travels through the adductor canal, pierces through the vasto-adductor membrane, and bifurcates into two branches. These two branches progress in the same route as the infra-patellar nerve and the sartorius nerve. Both branches are cutaneous and innervate the medial area of the thigh and the patellar area of the knee.

The path followed by the L1-L3 nerve, and the bilateral pattern of their innervation allow us to conclude that this is the saphenous nerve. Originating above the inguinal ligament and within the abdominal cavity, instead of below the inguinal ligament from the femoral nerve. After it passes the inguinal ligament, it travels with the femoral nerve through the femoral sheath before reaching the adductor canal and entering it. The origin and route were observed bilaterally.

To the best of our knowledge, the saphenous nerve arising from L1-L3 above the inguinal ligament has not been reported previously. Possible clinical implications for this variant saphenous nerve may include lumbar pain and iatrogenic effects during surgical procedures as a consequence of this variation [6-8]. This variation should also be considered when applying anesthesia to numb the lower leg or areas of the foot corresponding to its sensory distribution. Likewise, knowledge of anatomical variations such as this one can prevent unintended pain or damage during surgical interventions [6].

The second significant finding was a variant iliacus muscle on the right side that was entrapping the right femoral nerve. This variant muscle originated from the lateral half of the iliac crest and was covered in its own fascia. The femoral nerve passes under the muscle slip and continues its usual route under the inguinal ligament and into the thigh. Similar cases have been described in previous literature [7-10]. In these cases, nerve compression and irritation are major concerns [6, 10, 11]. This is due to the variant muscle and route increasing the tension on the femoral nerve. This may cause neuropathies, paresthesia, or muscle fatigue. Impingement or irritation of the femoral nerve should be suspected when there is pain in the hip and knee joint areas, and the L4 lumbar dermatome [6, 10, 11].

Conclusion

Variation of nerves is commonplace especially when studying the lumbar plexus region. In this case report we find two variations, one that may very well be a unique case and another that was previously described.

The first variation we discussed involves a unique origin of the saphenous nerve. Typically, the saphenous nerve arises from the femoral nerve below the inguinal canal in the thigh and passes through the adductor canal towards the leg. The route that the observed L1-L3 nerve follows, and the pattern of innervation are bilaterally the same as the saphenous nerve. This is, according to the information available, the first reported case of this variation. This observation is significant for surgical purposes and evaluating patients who suffer from chronic pain and paresthesia in the lower extremity. When applying anesthesia to the lower leg, a variation in the route or origin of the saphenous nerve may affect the application of the nerve block in question.

The second variation we identified, the variant iliacus muscle entrapping the femoral nerve, is a well-described anatomical variation and has been reported previously [7-10]. Chronic neuralgia and paresthesia may be caused by the entrapment and the subsequent irritation of the nerve [6, 10]. Had the nerve followed its most common course, it would not have encountered a structure that could potentially cause clinical symptoms. During the application of anesthesia and surgical procedures, it is important to bear in mind the possible anatomical variations that a patient may possess to avoid causing pain or iatrogenic effects after surgery. It is important to document and describe anatomical variations not only to take care of patients but also to encourage further study into subjects such as the development of these variations and the effects they may have on people.

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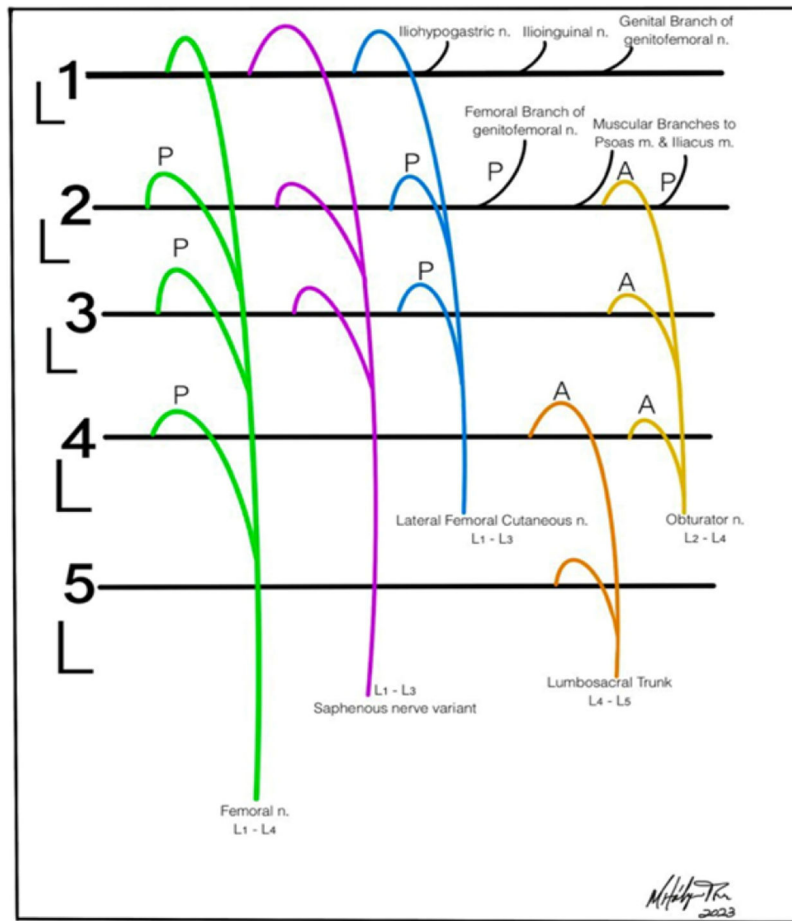


Figure 1).
 Nerve distribution of variant lumbar plexus of the right posterior abdominal wall.
 (A=Anterior Division; P=Posterior Division).

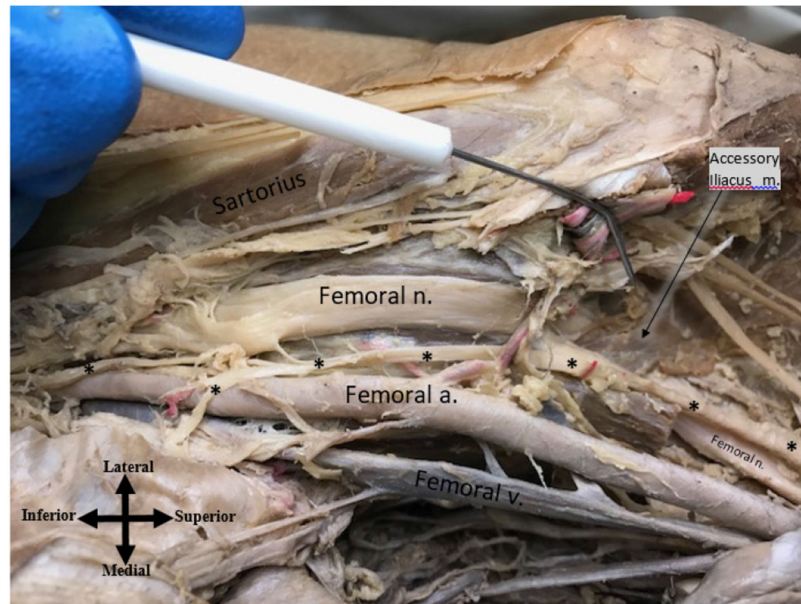


Figure 2).

Dissection of the right pelvic and femoral regions, showing the accessory iliaca muscle entrapping the femoral nerve (black arrow). The black asterisks (*) identifies L1-L3 saphenous nerve variant which is traveling parallel to the femoral nerve until it reaches the area beneath the inguinal ligament. It continues its path medially as it makes its way towards and into the adductor canal.

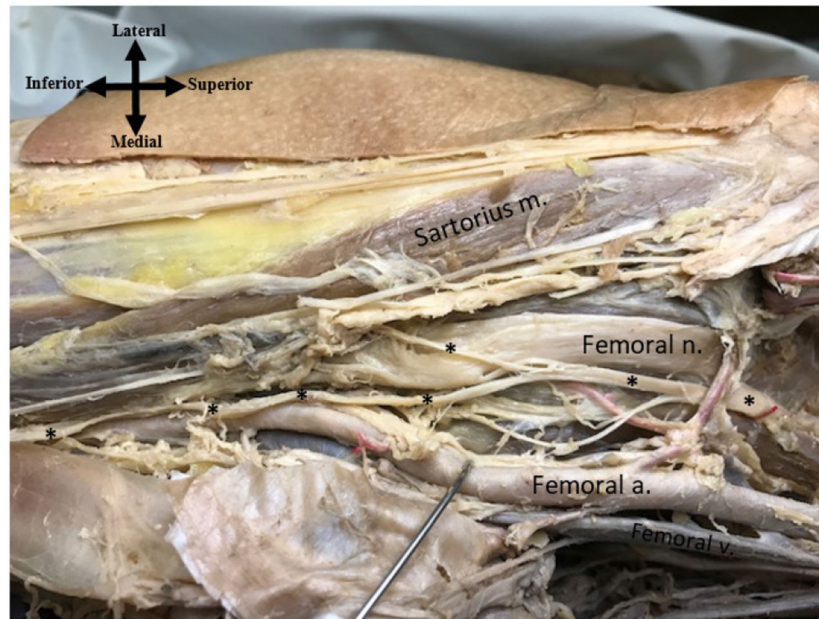


Figure 3). Dissection of the right pelvic and femoral regions, showing L1-L3 saphenous nerve variant route parallel and independent from the femoral nerve. Black asterisks (*) identify L1-L3 saphenous nerve variant which is providing fibers to the Sartorius muscle and continuing its path towards and then into the adductor canal.

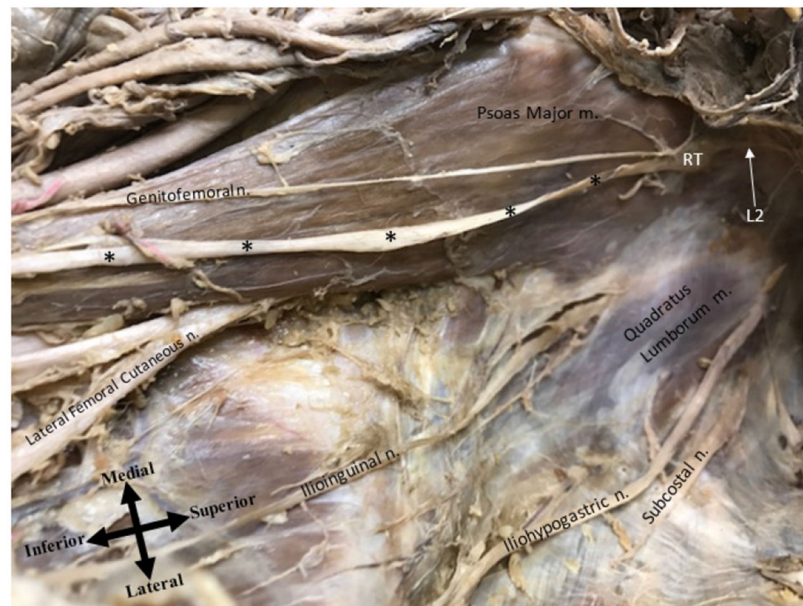


Figure 4).

Anterior view of the left posterior abdominal wall and lumbar plexus. Black asterisk (*) identifies the saphenous nerve variant passing between the psoas major and quadratus lumborum muscle after originating from L1-L3 roots (RT). It then moves anteriorly to cross over the psoas major muscle in its own fascia.

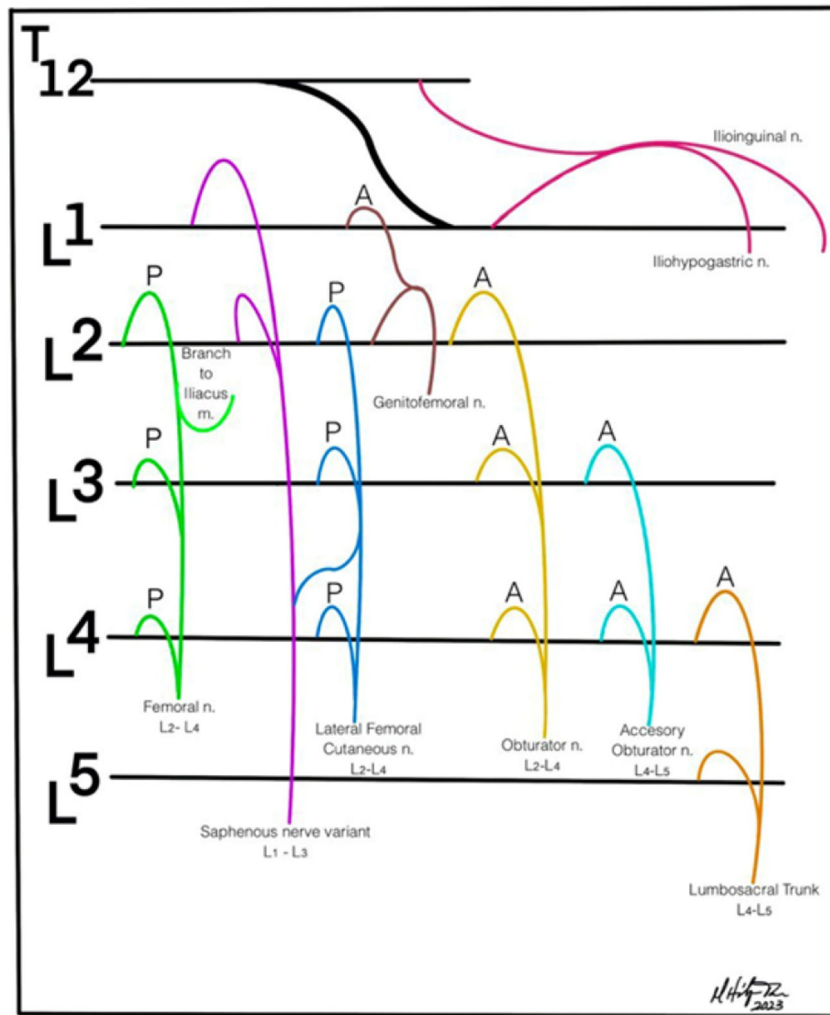


Figure 5). Nerve distribution of variant lumbar plexus of the left posterior abdominal wall. (A=anterior division; P=posterior division).

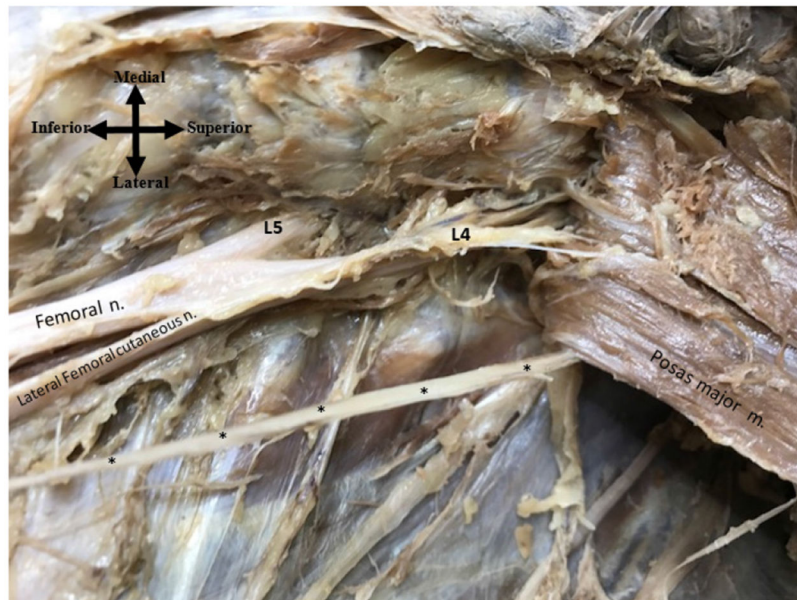


Figure 6).

Anterior view of the left posterior abdominal wall and lumbar plexus (L4-L5). The psoas major muscle was reflected superiorly to confirm the absence of contributing fibers from L4-L5 to the saphenous nerve variant. The black asterisk (*) identifies L1-L3 saphenous nerve variant.



Figure 7). Anterior view of the posterior wall of the left pelvic cavity. The dissection shows the route of L1-L3 saphenous nerve variant, accompanying the femoral nerve inferiorly passing under the inguinal ligament. The black asterisk identifies (*) L1-L3 saphenous nerve variant.