

ORIGINAL ARTICLE

Femoral Nerve in Femoral Triangle: A Morphometric Study with Clinical Relevance

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Abstract:

Background: Femoral nerve is a nerve of choice for femoral nerve blockade. It enters the femoral triangle at the midinguinal point. However, this point of entry need not be the same always. **Aim and Objectives:** This study is aimed at measuring the morphometry of the femoral nerve with the help of bony landmarks. **Material and methods:** Forty adult lower limbs were dissected and the morphometry of the femoral nerve was studied. **Results:** The mean distance from the Anterior Superior Iliac Spine (ASIS) to the pubic tubercle was 12.66 ± 1.48 cm. We found the FN from the ASIS at a mean distance of 6.38 ± 1.45 cm. Also, the FN was at a mean distance of 6.76 ± 1.12 cm from the pubic tubercle. The mean length of the FN trunk below the inguinal ligament, i.e., in the femoral triangle before the division was 2.19 ± 0.34 cm. However, in 8 lower limbs, the FN trunk was divided before entering the femoral triangle. **Conclusion:** The findings of our study serve as an enabling guide to the surgeons, neurologists and anesthetist's in detecting the FN for various clinical and surgical procedures.

Keywords: Anterior Superior Iliac Spine, Femoral Nerve Block, Inguinal Ligament, Morphometry, Pubic Tubercle

Introduction:

Femoral Nerve (FN) is the largest branch of the lumbar plexus which arises from the dorsal divisions of the second to fourth ventral rami. Usually the femoral nerve divides into anterior and posterior division in the femoral triangle after

passing under the inguinal ligament [1]. The main trunk of the femoral nerve is frequently accessed below the inguinal ligament for nerve block [2]. Most of the peripheral nerve blocks including femoral nerve block have become a prevalent, safe, and functioning method of ascertaining postoperative analgesia. The benefits of a femoral nerve block for inferior extremity surgery embrace decent postoperative analgesia and a reduction in the necessity of opioids [3].

In recent years there is an increase in percutaneous vascular interventional procedures. The femoral artery in the femoral triangle is frequently accessed and is the artery of choice because of many advantages such as easier cannulation, easier compression against the femoral head and the opportunity to repeat the procedure in the same patient. The femoral nerve, with its close relation to the femoral artery, often is susceptible to damage during such procedures[4-5]. The complications of percutaneous catheterization through the femoral artery and intravenous cannulation through femoral vein include nerve injury directly or through compression by hematoma or pseudo aneurysm. Other uncommon complications are arteriovenous fistula or arterial thrombosis [6-7].

Medical and surgical interventions in the femoral triangle can produce unintentional injury to the

femoral nerve that gives rise to a wide variety of symptoms can produce a variety of disabling symptoms extending from loss of sensation from the medial and anterior side of the thigh to weakness and paralysis of quadriceps femoris and loss of extension of knee joint [8].

Only limited studies have concentrated on variations in FN anatomy and few variations in the cutaneous sensory and muscular branches have intermittently been documented[9]. We directed this prospective, observational study to describe the nerve in the femoral triangle. In specific, we pursued to detect and define the morphometry of the FN and its distance from bony landmarks to avoid injury to the vascular structures lying nearby during FN block.

Material and Methods:

Forty adult human cadaveric lower limbs (25 males and 15 female), were used for the present study. The incision was made on the skin on the front of the thigh, it was reflected along with superficial fascia. The great saphenous vein and the superficial group of inguinal lymph nodes were dissected and removed, the fascia lata was cut to expose the femoral triangle. The inguinal ligament was identified and the boundaries of the femoral triangle were cleaned and preserved. The contents of the triangle were exposed by cleaning the fascia. The FN lying lateral to the femoral artery was identified. Its branching pattern was noted. The length of the FN below the inguinal ligament before it divided into anterior and posterior divisions was measured. Anthropological measurements were taken from the Anterior Superior Iliac Spine (ASIS) to the pubic tubercle. The distance from ASIS to the FN trunk, and the distance to pubic tubercle from the FN trunk was

also measured. The statistical analysis was done with the data using EZR software 64 bits, 5.0 version.

Results:

The mean distance from the ASIS to the pubic tubercle was 12.66 ± 1.48 cm. We found the FN from the ASIS at a mean distance of 6.38 ± 1.45 cm. Also, the FN was at a mean distance of 6.76 ± 1.12 cm from the pubic tubercle. The mean length of the FN trunk below the inguinal ligament, i.e., in the femoral triangle before the division was 2.19 ± 0.34 cm. However, in 8 lower limbs, the FN trunk was divided before entering the femoral triangle.

There was no significant difference between the length of FN trunk in males and females ($p=0.52$). But it was observed that the distance from ASIS to pubic tubercle is greater in males than in females ($p=0.0006$).

There is no significant difference in the length of the FN trunk below the inguinal ligament between right and left side ($p=0.15$). Also, there was found to be no significant difference in distance between ASIS and pubic tubercle between the right and left side ($p=0.323$).

There is no significant correlation between the length of the FN and the inguinal ligament ($p=0.43$). The co-relation co-efficient is 0.168, which denotes a weak positive relation between the two variables, i.e., length of the FN and inguinal ligament.

In our study, it was found that in 8 lower limbs, the FN divided into branches before entering the femoral triangle (Fig 4). The FN divided into anterior and posterior divisions 2.5cm – 3cm above the inguinal ligament (in the pelvis) and immediately divided into branches which entered the femoral triangle.

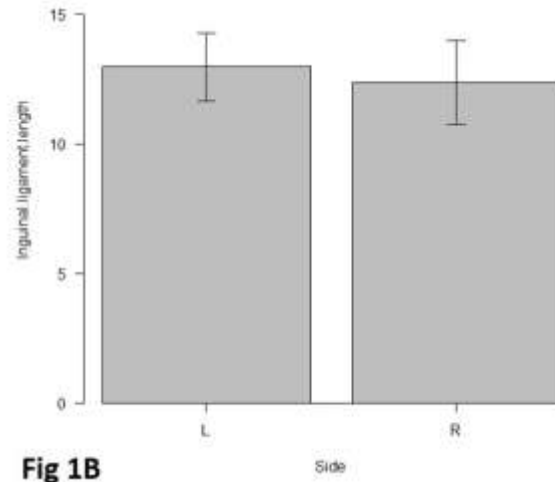
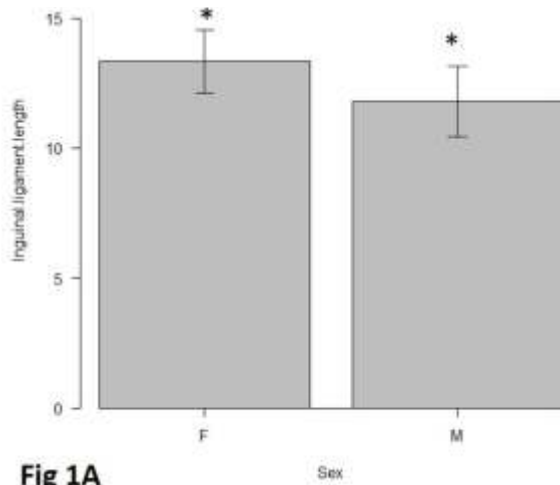


Fig. 1A: Comparison in the Distance between Anterior Superior Iliac Spine and Pubic Tubercle in Males and Females

Fig. 1B: Comparison in the Distance between the Anterior Superior Iliac Spine and Pubic Tubercle Right and Left.

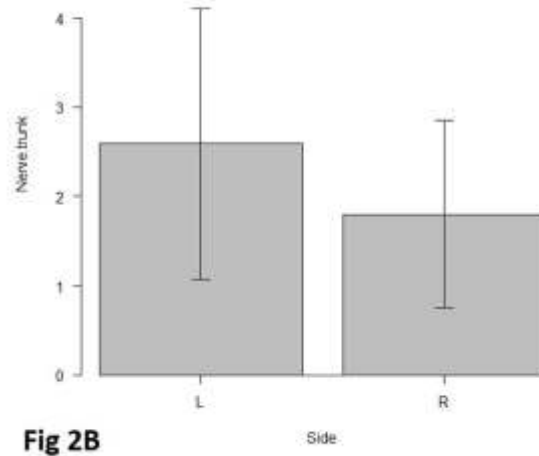
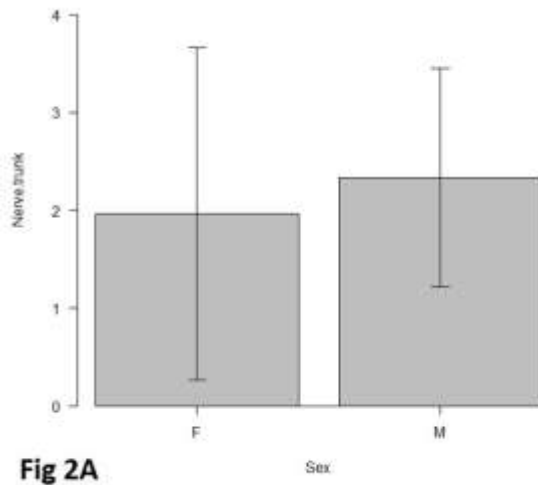


Fig. 2A: Comparison in Length of the Femoral Nerve between Males and Females

Fig. 2B: Comparison in Length of the Femoral Nerve between Right and Left Side

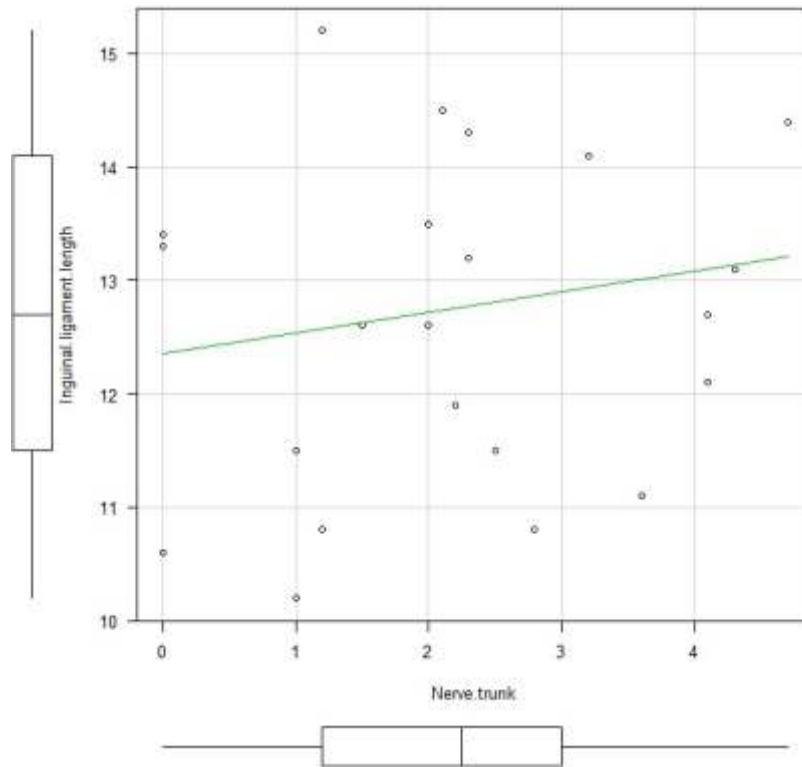


Fig. 3: Co-relation between the Length of the Inguinal Ligament and Nerve Trunk

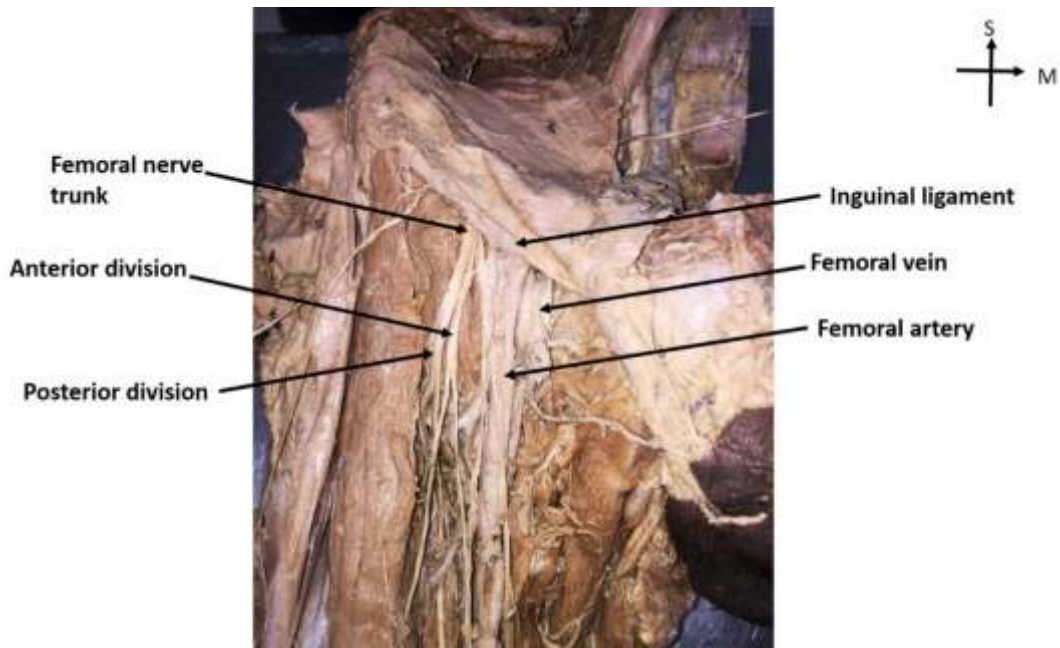


Fig. 4: Left Femoral Triangle showing the Femoral Nerve. The Divisions and the Branches Enter the Femoral Triangle

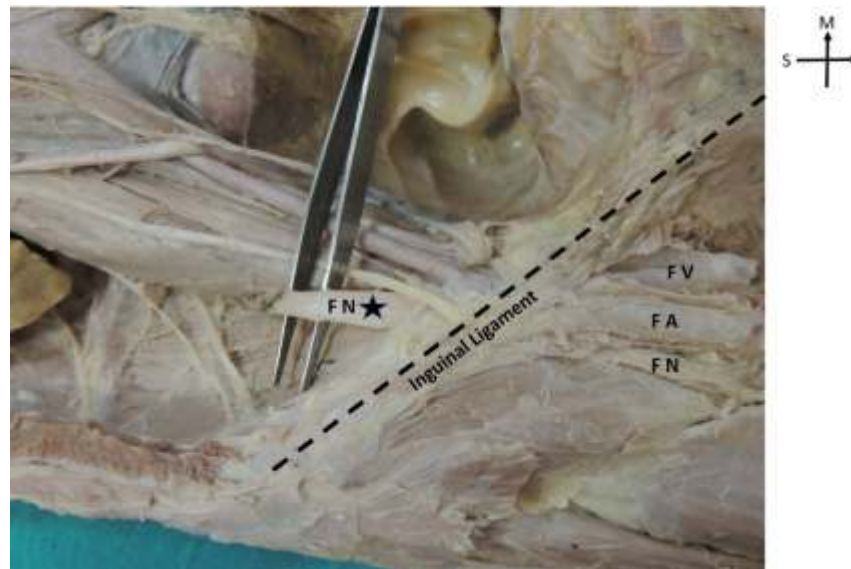


Fig.5: Left Femoral Nerve Seen Above the Inguinal Ligament and in the Femoral Triangle.

FN* Femoral nerve above the inguinal ligament, FN- Femoral nerve in the femoral triangle, FA- Femoral artery, FV- Femoral vein.

Discussion:

The FN is one of the largest branches of the lumbar plexus. After its course in the iliac fossa, it enters the femoral triangle by passing deep to the inguinal ligament. Then it divides into two divisions anterior and posterior after a short course and finally gives off muscular and sensory branches. A lot of information has been gathered regarding the variations in the origin of the FN from the lumbar plexus[10]. However, there is dearth in the morphometric observations of the FN in femoral triangle. It is a known fact that the FN is related to the femoral artery and femoral vein in the femoral triangle. Therefore, there are all possibilities for the FN being injured during the surgical procedures conducted on the femoral vessels [11-12]. In the study of Pateliya *et al.*, the mean distance of FN from ASIS was 4.6 ± 5 cm [13]. In our study, among the forty lower limbs, we found that, the point of emergence of the FN trunk with respect to the ASIS, was located at a mean distance of 6.38 ± 1.45

cm and with respect to the pubic tubercle, it was located at a mean distance of 6.76 ± 1.12 cm. These findings enable the treating physician/ surgeons/ anesthetists, to locate the trunk of the FN on the surface of the body of the patient. FN is most likely to be injured during trauma and pressure on the nerve due to the adjacent body parts or tumor [14]. In very rare cases, the FN could be injured during surgery while applying sutures or staples [15]. The pain due to the pressure could be referred to hip and knee joints, as L2-L4 dermatomes supply those regions[16, 17]. The FN injury has been reported upon transabdominal laparoscopic herniorrhaphy which was performed for a unilateral inguinal hernia [18]. All of iatrogenic injuries could be avoided by noting the morphometry and anthropometric measurements from various bony landmarks as reported in the present study.

In the study of Pateliya *et al.*, showed that the mean length of the FN trunk from the inguinal

ligament to its branching was 1.50 ± 0.47 cm [13]. In the present study, the FN trunk, below the inguinal ligament, in the femoral triangle, was found to be 2.19 ± 0.34 cm. However, in eight specimens, the length of the FN trunk was not noted because it divided at a variable distance above the inguinal ligament, in the iliac fossa. This variation must be noted. It has been observed that the FN, after its formation in the lumbar region, comes down into the iliac fossa. Here, it is sandwiched between the fascia Iliaca and the Iliacus muscle. This tight fascial compartment would lead to space occupying FN lesions. Any variations in the muscle or the branching pattern of the FN, could increase the chance of its compression, thereby being a primary cause of FN neuropathy [19]. Bilateral higher division of FN have been found previously [20, 21]. Therefore, the early division of the FN trunk must be kept in mind in order to avoid incomplete FN block.

In the present study, the length of inguinal ligament was significantly shorter in males than in females. This may be due to wider, bigger pelvis in females compared to narrower, vertical and more compact pelvis of males. There was no significant bilateral difference in length of inguinal ligament or the length of the FN trunk.

In the current study, we found that in 8 lower limbs, the FN divided into branches before entering the femoral triangle. In a study by Anloague PA and Huijbregts P, in 35.3% of the dissected lumbar plexuses specimens' FN was found to differ. It was observed that in these plexuses, the FN divided into two or three slips in the substance of the psoas major muscle; these slips joined to form the FN emerging from the pelvic cavity as it passed under the inguinal ligament [2]. In yet another study 25% of the dissected specimens showed variation in the origin of FN from the lumbar plexus. These

deviations included unusually lengthy L2 root, early division of the FN, where the FN was divided above the inguinal ligament [13]. A case was reported where the FN descended through the psoas major muscle and divided into two branches; anterior and posterior, 4.1 cm above the midpoint of the inguinal ligament [22]. In the present study only 20% of cases showed early division of FN above the inguinal ligament. There may have been variations in the formation of FN in other specimens but it was not explored as the current study mainly concentrated on the course of the nerve in the femoral triangle. Hence, 20% of early division of FN in existing study is less compared to prior studies.

The FN usually lies on the surface of the iliopsoas muscle below the inguinal ligament. The location of the FN deep within the iliopsoas muscle could be confused with a tendon on ultrasound examination. There are reports of cases of FN buried in the belly of iliopsoas muscle identified during ultrasound guided FN block [9]. There are possibilities of the FN being entrapped by the muscle fibers of iliacus or psoas major as the nerve passes in relation to these muscles, thereby applying massive pressure, which could result in ischemia and other complications [10,14]. However, in the current study, there were no FN trunks embedded in the iliopsoas. The FN in all the 40 lower limbs were clearly visible in the femoral triangle.

Conclusion:

This study provides normal morphometric data of FN in femoral triangle and its distance from various bony landmarks and also reports variations in the division of the FN trunk. The findings of our study serve as an enabling guide to the surgeons, neurologists and anesthetist's in detecting the FN for various clinical and surgical procedures.

References

1. Standing S. The Anatomical Basis of Clinical Practice. 40th ed. Livingstone C, editor. New York: Elsevier; 2008. 1080, 1351-1382.
2. Anloague PA, Huijbregts P. Anatomical variations of the lumbar plexus: a descriptive anatomy study with proposed clinical implications. *J Man Manip Ther* 2009;17(4):e107-114.
3. Kasibhatla RD, Russon K. Femoral nerve blocks. *J Perioper Pract* 2009;19(2):65-69.
4. El-ghanem M, Malik AA, Azzam A, Yacoub HA, Qureshi AI, Souayah N. Occurrence of Femoral Nerve Injury among Patients Undergoing Transfemoral Percutaneous Catheterization Procedures in the United States. *J Vasc Interv Neurol* 2017;9(4):54-58.
5. Patil VC, Patil HV, Avhad AB, Kulkarni AR. A Comparative Study of Diastolic Dysfunction by Echocardiography among Diabetic and Non-diabetic Subjects. *J Krishna Inst Med Sci Univ* 2020; 9(2): 50-66
6. Kent KC, Moscucci M, Gallagher SG, Dimattia ST, Skillman JJ. Neuropathy after cardiac catheterization: incidence, clinical patterns, and long-term outcome. *J Vasc Surg* 1994;19(6):1008-1113.
7. Kannan S. Femoral Nerve Palsy After Femoral Vein Cannulation. *Anesth Analg* 2000;90(5):1246-1247.
8. Moore AE, Stringer MD. Iatrogenic femoral nerve injury: a systematic review. *Surg Radiol Anat* 2011;33(8):649-658.
9. Woodworth G, Lee T, Ivie R, Becket B. Anatomical variation of the femoral nerve in the femoral triangle. *Reg Anesth Pain Med* 2019;rapm-2019-100599.
10. Astik RB, Dave UH. Anatomical variations in formation and branching pattern of the femoral nerve in iliac fossa: A study in 64 human lumbar plexuses. *Peoples J Sci Res* 2011;4(2):14-19.
11. Kim DH, Murovic JA, Tiel RL, Kline DG. Intrapelvic and thigh-level femoral nerve lesions: management and outcomes in 119 surgically treated cases. *J Neurosurg* 2004; 100(6):989-996.
12. Patil VC, Patil S, Sabale S, Agrawal V, Mhaskar D. Study of Percutaneous Coronary Intervention in Patient with Coronary Artery Disease at Tertiary Care Teaching Hospital. *J Krishna Inst Med Sci Univ* 2015; 4(4):82-93.
13. Pateliya UN, Rajat RM, Shah KP, Chudasma M, Patel J. Study of anatomical variation and branching pattern of the femoral nerve in 25 cadavers. *Int J Med Sci Public Health* 2015;4(4):573-576.
14. Vazquez MT, Murillo J, Maranillo E, Parkin IG, Sanudo J. Femoral nerve entrapment: a new insight. *Clin Anat* 2007;20:175-179.
15. Yu CC, Shih YJ, Tsai SJ. Femoral nerve injury following transfemoral angiography: a case report. *Tw J Phys Med Rehabil* 2008;36(4):227-234.
16. Spratt JD, Logan BM, Abrahams PH. Variant slips of psoas and iliacus muscles, with splitting of the femoral nerve. *Clin Anat* 1996;9(6):401-404.
17. D'costa S, Ramanathan LA, Madhyastha S, Nayak SR, Prabhu LV, Rai R. An accessory iliacus muscle: a case report. *Rom J Morphol Embryol* 2008;49(3):407-409.
18. Garcia-Urena MA, Vega V, Rubio G, Velaso MA. The femoral nerve in the repair of inguinal hernia: well worth remembering. *Hernia* 2005;9(4):384-387.
19. Galzio R, Lucantoni D, Zenobii M, Cristuib-Grizzi L, Gadaleta A, Caffagni E. Femoral neuropathy caused by iliacus hematoma. *Surg Neurol* 1983;20(3):254-257.
20. Das S, Vasudeva N. Anomalous higher branching pattern of the femoral nerve: a case report with clinical implications. *Acta Medica (Hradec Kralove)* 2007;50(4):245-246.
21. Saha S, Pakhiddey R. Bilateral High Branching Pattern of Femoral Nerve – A Clinico-Anatomical Study. *Int J Cur Res Rev* 2013;5(22):74-77.
22. Misulis KE. Lower back and lower limb pain. In: Bradley WG, Daroff RB, Fenichel GM, Jakovic J (eds.). *Neurology in Clinical Practice*. Philadelphia, Butterworth-Heinemann 2008.

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