

ANATOMICAL VARIATIONS OF FEMORAL NERVE AND ITS CLINICAL SIGNIFICANCE

Laigy Paul¹, Deepti Shastri²

Received : 06/09/2025
 Received in revised form : 19/10/2025
 Accepted : 04/11/2025

Keywords:
 Femoral nerve, Lumbar plexus.

Corresponding Author:
Dr. Laigy Paul,
 Email: laigyp@yahoo.co.in

DOI: 10.47009/jamp.2025.7.6.25

Source of Support: Nil,
 Conflict of Interest: None declared

Int J Acad Med Pharm
 2025; 7 (6); 133-136



¹Associate Professor, Department of Anatomy, Kanyakumari Medical Mission and Research Centre, Muttom, Tamilnadu, India.

²Professor, Department of Anatomy, Vinayaka Missions Kirupananda Variyar Medical college, Salem, Tamilnadu, India.

ABSTRACT

Background: Femoral nerve is the branch of lumbar plexus. Aim of this study was to find out the variations in formation and branching pattern of this nerve and correlate with their clinical relevance. **Materials and Methods:** For this study 30 formaldehyde cadavers were used, and the nerve was studied on both sides, thus making the sample size of 60. **Result:** Post fixed nerve found in 3 plexus (5%), Femoral nerve split into two branches in 19 plexus (31.66%) and it split into three branches in 2 (3.3%). Femoral nerve divides into four branches in 5 plexus (8.3%). This nerve gives many muscular branches in 2 plexus (3.3%). Variation in formation found in 3 plexus (5%) and variation in branching pattern in 27 plexus (45%). Total variation found in 28 plexus (46.66%). **Conclusion:** By this study an attempt is made to know the possible variations in the formation and branching pattern of femoral nerve and additional information which may help to decrease the risk of diagnostic and operative complications.

INTRODUCTION

The normal anatomy of the femoral nerve is described as a branch of lumbar plexus lying with in the substance of the posterior part of psoas major, anterior to the transverse processes of the lumbar vertebrae and in 'line' with the intervertebral foramina. It is formed by the union of the ventral rami of L₁, L₂, L₃ lumbar nerves and the fourth lumbar ventral rami, with a contribution from the T₁₂ ventral ramus. The first lumbar ventral ramus joined by a branch from the twelfth thoracic ventral ramus bifurcates, and the upper and larger part divides again

into the iliohypogastric and ilioinguinal nerves. The smaller lower part unites with a branch from the second lumbar ventral ramus to form the genitofemoral nerve. The second, third, and part of the fourth, lumbar ventral rami join the plexus and divide into ventral and dorsal branches. Ventral branches of the second to fourth rami join to form the obturator nerve. The main dorsal branches of the second to fourth rami join to form the femoral nerve. Small branches from the dorsal branches of the second and third rami join to form the lateral femoral cutaneous nerve. The accessory obturator nerve, when it exists, arises from the third and fourth ventral branches.^[2] [Table 1]

Table 1: Branches of lumbar plexus and their root values

Branches	Root value
Muscular	T ₁₂ , L ₁ -L ₄
Iliohypogastric nerve	L ₁
Ilioinguinal nerve	L ₁
Genitofemoral nerve	L ₁ , L ₂
Lateral femoral cutaneous nerve	L ₂ , L ₃
Femoral nerve	L ₂ , L ₃ , L ₄ (Dorsal divisions)
Obturator nerve	L ₂ , L ₃ , L ₄ (Ventral divisions)
Accessory obturator nerve	L ₂ , L ₃

Femoral nerve**Origin**

It is formed by the dorsal branches of the ventral rami of L₂, L₃, L₄ lumbar nerves, and is the largest branch of the lumbar plexus

Course and relations

The trunk of the nerve passes downward and laterally through the psoas major, and appears beneath the fascia iliaca between the tendon of psoas major and iliacus muscle.

Branches and Distribution

Femoral nerve splits into anterior and posterior divisions.

1. In the abdomen the femoral nerve provides three branches.
 - Branches to iliacus muscle
2. A branch to pectineus, which passes downward and medially behind the femoral sheath and supplies the lateral part of pectineus muscle
3. A few vascular branches to the upper part of femoral artery.^[3]

II. Branches from the anterior division are intermediate and medial femoral cutaneous branch and one muscular branch to sartorius.

III. Branches from the posterior division are saphenous nerve form subsartorial plexus and muscular branches to quadriceps femoris.^[4]

Aim of The Study

To understand the variations in the anatomy of the femoral nerve

objectives

1. To identify the variations in the formation of femoral nerve
2. To identify variations in the branching pattern of femoral nerve

MATERIALS AND METHODS

The study was carried out after due ethical clearance from the institution.

- 1) **Study design:** Cross sectional study
- 2) **Sample size:** 60 specimens
- 3) **Inclusion Criteria:** Adult human cadavers from the department of Anatomy with no evidence of surgical intervention on the abdomen and pelvic cavity.
- 4) **Exclusion Criteria:** Those specimens with evidence of surgical intervention on the abdomen or pelvis were excluded from the study.
- 5) **Methodology: Dissection Method:**

The femoral nerves were dissected by the method described in Cunninghams manual of practical anatomy, 15th edition.^[1]

Procedure

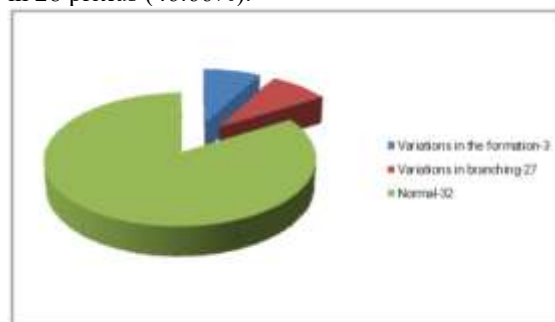
Anatomical variations in 60 specimens of femoral nerves were observed and studied in detail. The femoral nerve was seen to be found between the psoas and iliacus muscle.

RESULTS

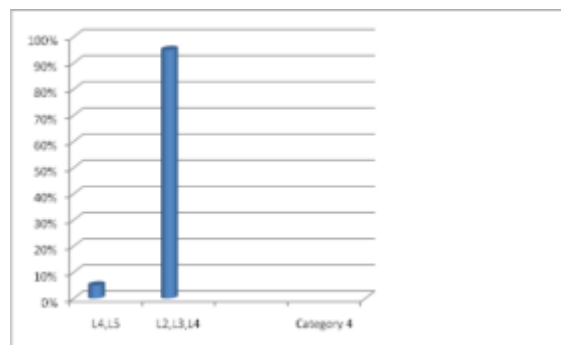
VARIATIONS IN THE FEMORAL NERVE (Pie chart. 5Bar diagram.)

In 3 out of 60 lumbar plexus (5%) the nerve received a twig from L5 nerve. In 19 plexus (31.66%) femoral nerve split into two branches. In 2 plexus (3.3%) it split into three branches. In 5 plexus (8.3%) femoral nerve divides into four branches. Variations in formation were noticed a total of 3 plexus (5%). Variations in branching pattern were noticed in a total

of 27 plexus (45%). Total variations were observed in 28 plexus (46.66%).



Pie chart 5: Observations in the femoral nerve



Bar diagram 5: Different origin of femoral nerve

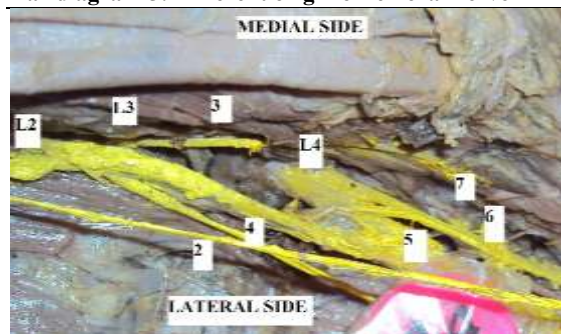


Figure 8: Multiple variations in lumbar plexus

L1, L2, L3, L4-Lumbar nerve roots, 1-Iliohypogastric nerve, 2-Ilioinguinal nerve, 3-Genitofemoral nerve, 4-Lateral femoral cutaneous nerve, 5-Femoral nerve, 6- Obturator nerve. Ilioinguinal nerve absent, Genitofemoral nerve originate from L3, Lateral femoral cutaneous nerve from L3, Femoral nerve splits into four slips and a twig from L5 present.



Figure 17: Femoral nerve split into four slips and genitofemoral nerve divide into genital and femoral branches just after its formation

L₁,L₂,L₃,L₄-Lumbar nerve roots, 1-Iliohypogastric nerve, 2-Ilioinguinal nerve, 3-Genitofemoral nerve, 3a,3b- branches, 4-Lateral femoral cutaneous nerve, 5- Femoral nerve, 5a,5b,5c,5d-Slips of femoral nerve. 6- Obturator nerve.

REVIEW OF LITERATURE

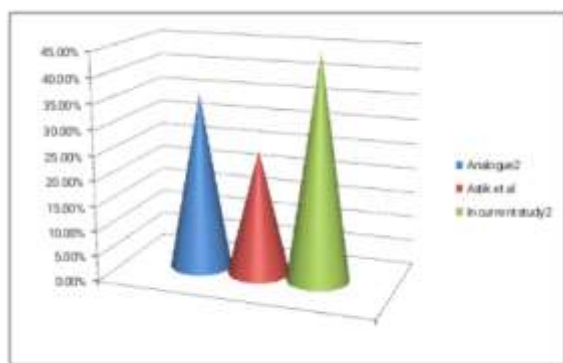
The normal anatomy of the lumbar plexus is formed in the substance of the posterior part of psoas major by the ventral rami of the first three lumbar nerves with part of the fourth, and a contribution from the T₁₂ nerve¹. In a case report described on the left side the plexus was postfixed and located posterior to the psoas major muscle. The femoral nerve was formed by the union of anterior rami of the L₂, L₃, L₄ and L₅ lumbar spinal nerves. On the right side the lumbar plexus was prefixed.^[5] Three of 136 plexus (2.2%) contained a variant slip of the iliacus and psoas major muscles that split the femoral nerve.^[6] Variant slips of iliacus and psoas major muscles split the femoral nerve into two or 3 separate slips in 35.3%,^[7] 7%⁴⁴ and 2.2% in one study.^[6] Anatomical variation in the femoral nerve was noted in 25% lumbar plexus. These variations included abnormally long L₂ root and early division of femoral nerve.^[8] A study described origin of nerve to pectineus from the femoral nerve within the abdomen with the medial cutaneous nerve of thigh.^[9] The femoral nerve bifurcated into two or three separate slips mostly within the mid –substance of the psoas major in a study.^[7] The variant slips of the iliacus and psoas major muscle split the femoral nerve into two or three slips in 35.3%.^[7] According to a study one of the two branches from the femoral nerve may be given off in the abdomen.^[10] In a study it was reported that there were cases of femoral nerve injury induced paralysis, the neuropathy being caused by iliac hematoma after anticoagulant treatment. It was also reported that the existence of some variant muscles or variations in branching pattern of the femoral nerve may increase the chances of nerve compression.^[11] Knowledge of early division of femoral nerve in iliac fossa is required to avoid incomplete femoral nerve block.^[12] Splitting of the femoral nerve by muscle fibers of iliacus was reported in a study. The topography of the femoral nerve in relation to the psoas major was investigated. In 3 plexus muscular fibers of the iliacus traversed between the trunks of the fetal femoral nerve.^[13] A study showed splitting of femoral nerve by lateral fibers of psoas major muscle in 2.5% and by muscle fibres of iliacus in 2.5% in fetal lumbar plexuses.^[13] Another case report detailed that the similar muscular variations of the iliacus and psoas muscles were splitting the femoral nerve.^[14] Accessory iliopsoas muscle splitting the left femoral nerve into two slips was noted in one study.^[14] A study reported 7% variation in lumbar plexus.¹⁵ A study found division of femoral nerve into two slips at variable distance above the midinguinal point.^[16] Femoral nerve variation was found in 12 (35.3%) of

the investigated lumbar plexus in one of the studies in 12 of which the femoral nerve was observed to bifurcate into two and three slips. In a case report it was mentioned that the femoral nerve received an extra twig from the lumbosacral trunk.^[17] The higher division of the femoral nerve in iliac fossa results in incomplete femoral nerve block. Variant origin of the femoral nerve branches has wide clinical relevance. When nerve to pectineus arises from medial aspect of the femoral nerve near the inguinal ligament, it passes behind the femoral sheath and enters the anterior aspect of the muscle.^[18] In 13 of the 18 specimens, the femoral nerve received its contributions from the L₂ to L₄ nerve roots and was formed at the L₄-L₅ disc space. During the transpsoas lateral surgical approach to the L₄-L₅ disc space, the femoral nerve should be considered to be at risk intraoperatively because of the position and size of currently available retractors.^[19]

The femoral nerve block is usually performed on the main trunk of the femoral nerve just below the inguinal ligament.^[20] Even though rare, transient lesion of the femoral nerve after mesh hernioplasty for a recurrent inguinal hernia was also reported.²¹ The femoral nerve may often be injured by suture or staples, tissue scar entrapment, local anaesthesia blockade or direct compression.^[22,23] The usual causes of femoral nerve dysfunction are direct injury (trauma), prolonged pressure on the nerve, and compression of the nerve by adjacent parts of the body or disease related structures such as tumor.^[24]

DISCUSSION

Lumbar plexus is described as the nerve plexus lying within the substance of the posterior part of psoas major, anterior to the transverse process of lumbar vertebrae in line with the intervertebral foramina. The variations in the lumbar plexus are not uncommon. The proper knowledge of the anatomical location of femoral nerve is important for anesthesia during surgical procedures. Femoral nerve was split into 2 branches among 19 plexus (31.66%) where as, among 2 plexus (3.3%) it was split into three slips and among 5 plexus (8.3%) it divided into four slips. Many muscular branches were given off from 2 plexus (3.3%). Total variation in the formation were in 3 plexus (5%) and total variations in the branching pattern were seen in 27 (45%) plexus. A study reported a variation of 25% in femoral nerve out of 64 lumbar plexuses.⁹ It divided into 2,3,4 or many slips during its course before it crossed inguinal ligament.²⁵ According to a study in 13 of the 18 specimens (72.2%) the femoral nerve was formed by L₂, L₃, L₄ nerve roots.¹⁹ In another study 21.5% were reported as postfixed.



Bar diagram 7: Variation in the branching pattern of femoral nerve

CLINICAL IMPORTANCE OF VARIATIONS OF FEMORAL NERVE

A better knowledge of the regional anatomy and its variations is essential for preventing lesions of the branches of the lumbar plexus. The variations defined in literature comprise some of the branches of the lumbar plexus which may be injured during certain surgical procedures, particularly in the lower abdominal region. Surgical complications have also implicated these nerves, emphasizing the importance of the development of a clear topographical map for use in their identification. The detailed knowledge of the possible variations of femoral nerve may have immense importance in various pelvic and pelvi-femoral surgeries.

CONCLUSION

A key to carry out therapeutic and diagnostic procedures successfully on femoral nerve depends on the knowledge of the possible variations of femoral nerve. Such neurological variations are not only more prone to iatrogenic injuries but they interfere in the correct interpretation of clinical conditions as well. Such variations of femoral nerve noticed in routine surgical procedures or in traumatic injuries should be included into the surgical training programmes to help avoid iatrogenic injuries.

Summary

The knowledge of variations of femoral nerve and their branching pattern is important for the clinicians in investigating the level of injury and to plan appropriate treatment. Out of 60 dissected specimens variations in the origin was observed in femoral nerve in 3 specimens. Variations in the branching pattern was noted in, femoral nerve in 27 specimens. If these are unrecognized, there is a risk of iatrogenic injury to the involved structures leading to unfavourable surgical outcomes.

REFERENCES

- Romanes GJ. *Cunninghams manual of practical anatomy*. Oxford. New York.1986; 15(2):183-184.
- Standring S. *Gray's anatomy. The anatomical basis of clinical practice*. London. Churchill and Livingstone. 2008;40: 1078-1079.
- Datta AK. *Essentials of human anatomy .Thorax and abdomen*. Current book international. Kolkata. 2008; 8(1): 164.
- Datta AK. *Essentials of human anatomy. Superior and Inferior extremities*. Current book international. Kolkata.2009;4(3):172-174.
- Erbil KM, Oderoglu S, Başar R. Unusual branching in lumbar plexus: Case report. *Okajimas Folia Anat Jpn*. 1999;76:55-59.
- Spratt JD, Logan BM, Abrahams PH. Variant slips of psoas and iliacus muscles, with splitting of the femoral nerve. *Clin. Anat*. 1996;9:401-404.
- Anloague PA, Huijbregts P. Anatomical Variations of the Lumbar Plexus: A Descriptive Anatomy Study with Proposed Clinical Implications. *The Journal of Manual & Manipulative Therapy*. 2009; 17(4): 107-114.
- Astik RB, Dave UH. Anatomical variation in formation and branching pattern of femoral nerve in iliac fossa. *People's Journal of Scientific Research*, 2011; 4(2): 14-19
- Macalister A. *Text-book of Human Anatomy*. Philadelphia. P. Blakiston. 1889; 467,493, 490.
- Paterson AM. The Pectineus and its Nerve Supply. *Journal of Anatomy and Physiology*. 1891; 26 (Pt 1): 43-47
- Galzio R, Lucantoni D, Zenobii M, Cristuib-Grizzi L, Gadaleta A, Caffagni E. Femoral neuropathy caused by iliacus hematoma. *Surgical Neurology*. 1983; 20 (3): 254- 257.
- Schultz P, Anker-Moller E, Dahl JB, Christensen EF, Spangsborg N, Fauno P. Postoperative pain treatment after open knee surgery: Continuous lumbar plexus block with bupivacaine versus epidural morphine. *Regional Anesthesia*. 1991; 16 (1): 34-37.
- Jakubowicz M. Topography of the femoral nerve in relation to components of the ilio-psoas muscle in human fetuses. *Folia Morphologica*. 1991; 50 (1-2): 91-101.
- Jelev L, Shivarov V, Surchev L. Bilateral variations of the psoas major and the iliacus muscles and presence of an undescribed variant muscle-accessory iliopsoas muscle. *Annals of Anatomy*. 2005;187:281-286.
- Vazquez MT, Murillo J, Maranillo E, Parkin IG, Sanudo J. Femoral nerve entrapment: A new insight. *Clinical Anatomy*. 2007; 20 (2): 175-179.
- 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.
- Gupta I, Majumdar S, Bhattacharya S, Amam AS, Ghosh S, Mandal L. An unusual formation of the Femoral nerve- A case Report. *Indian journal of Basic &Applied medical research*. June 2013; 2(7) : 668-672.
- Newell RLM. Pelvic girdle, gluteal region & hip joint . Standring S, H Ellis, JC Healy, D Jhonson, A Williams. *Gray's anatomy. The anatomical basis of clinical practice*. 2005;39: 1455.
- Timothy T. Davis, Hyun W. Bae, James M. Mok, Alexandre Rasouli , Rick B. Delamarter. Lumbar Plexus Anatomy within the Psoas Muscle: Implications for the Transpsoas Lateral Approach to the L4 - L5 disc. *The Journal of Bone &Joint Surgery*. August 2011; 93(16):1482.
- Ellis H, Feldman SA, Harrop Griffith W. *Anatomy for anaesthetists*. Blackwell publishing, Massachusetts. 2004;8 :188-191.
- 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: 989-996.
- Garcia-Urena MA, Vega V, Rubio G, Velasco MA. The femoral nerve in the repair of inguinal hernia: well worth remembering. *Hernia*. 2005; 9: 384-387.
- Nielsen KC, Klein SM, Steele SM. Femoral nerve blocks. *Techn Reg Anesth Pain Manag*. 2003; 7: 8-17.
- Femoral nerve dysfunction: MedlinePlus Medical Encyclopedia. <http://www.nlm.nih.gov/medlineplus/ency/article/000687.htm>. (accessed June 2011).
- Bardeen JR, Elting AW. A statistical study of the variations in the formation and position of the lumbo-sacral plexus in man. *Ant Anz*.1901; 19:124-128,209-232.