

ORIGINAL RESEARCH

Aberrant Saphenous Nerve - A Cadaveric Study with its Clinical Importance.

Nirmal Kumar K¹, KalyanaPanchakshari P², Srikanth K³, Anbarasan A⁴

¹Assistant Professor, Department of Anatomy, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth (Deemed to be University), Pondicherry, India.

²Assistant Professor, Department of Anatomy, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth (Deemed to be University), Pondicherry, India.

³Assistant Professor, Department of Vascular Surgery, Tirunelveli Medical College, Tirunelveli, Tamil Nadu, India.

⁴Senior Resident, Department of Cytogenetics, Christian Medical College, Vellore, Tamil Nadu, India.

ABSTRACT

Background: Saphenous nerve is the largest cutaneous nerve in the lower limb. It usually arises from the dorsal division of femoral nerve and innervates skin over patellar ligament, tibial side of leg, medial side of foot and ball of great toe. Saphenous nerve also responsible for mechanosensor functions in the knee joint. Evidence based research reported that saphenous nerve is prone to injury during interventional procedures. Knowledge about Aberrant saphenous nerve anatomy is essential for clinicians to perform interventional procedures in patients without complications. So the author of the present study aimed to explore the aberrant saphenous nerve anatomy in cadaveric lower limb specimens.

Materials and Methods: In the present study 50 (27 Right side and 23 left side) formalin-fixed embalmed cadaveric lower limb specimens were dissected in the Department of Anatomy, Mahatma Gandhi Medical College, Pondicherry, from 2019 to 2021. The saphenous nerve origin, course and branches were observed in all the specimens and any variations in the same were documented and analyzed.

Results: Out of 50 specimens, the saphenous nerve took origin from the anterior division of the femoral nerve along with the intermediate and medial cutaneous nerve of the thigh in 9 (18%) specimens. Aberrant course in the thigh was observed in 6 (12%) specimens. No variations were observed in the branching pattern of the saphenous nerve except Infrapatellar branch of saphenous nerve originated as 2 branches in 3 (6%) lower limb specimens in this study.

Conclusion: Variations in origin, course and branches of saphenous nerve observed in the present study had left side supremacy. Clinicians should be aware of such variations to perform procedures like femoral artery catheterization, saphenous nerve blockade and knee surgeries without complications.

Keywords: Saphenous nerve, Aberrant Saphenous nerve, Saphenous nerve blockade, Femoral artery catheterization, Popliteal aneurysm.

Corresponding Author: Dr Anbarasan A, Senior Resident, Department of Cytogenetics, Christian Medical College, Vellore, Tamil Nadu, India. anbuanat@gmail.com

INTRODUCTION

The saphenous nerve (L3, L4) is the most extended cutaneous branch from the dorsal division of the femoral nerve. In the femoral triangle, the saphenous nerve descends downwards lateral to the femoral artery. Later it enters the Hunter's canal, where it crosses the femoral artery anteriorly from the lateral to the medial side. It leaves the canal and pierces the deep fascia between the Sartorius and Gracilis muscle tendons to become superficial. Later it divides into infrapatellar and sartorial branches. The infrapatellar branch innervates the skin over the infrapatellar region. The sartorial branch supplies the skin over the medial aspect of the leg and foot up to the ball of the great toe. The great saphenous vein is closely related to the sartorial branch of the saphenous nerve in the leg.^[1-3]

Anatomical variations of the saphenous nerve could be due to embryological defect. Standard textbooks hardly mentioned variations in the saphenous nerves. However, these days, due to advancements in the medical techniques, the number of complications is also increasing. Injury to the saphenous nerve became customary during interventional procedures. In cardiac and other endovascular interventional procedures femoral artery in the femoral triangle is selected as a common site. So during such procedures, nerve injuries are common.^[4] Saphenous nerve blockade is usually done in the Hunter's canal to ease the post-operative pain in total knee arthroplasty and other knee surgeries.^[5] The most frequent neurological complication reported after the anterior cruciate ligament reconstruction and hamstring auto graft procedure was the loss of sensation over the infrapatellar region due to injury of the infrapatellar branch of the saphenous nerve (IPBSN).^[6-9] In vascular grafting procedures, the most preferred vein is the great saphenous vein. During such procedure, saphenous nerve neuralgia was reported as one of the complication.^[10] The complications mentioned above related to the saphenous nerve are under-reported and occurred due to a lack of sound knowledge about the aberrant anatomy of the saphenous nerve and structures intimately related to it. So the present study aims to make the clinicians aware about the aberrant saphenous nerve anatomy using human cadaveric lower limb specimens.

MATERIALS & METHODS

The present study was conducted in the department of Anatomy, Mahatma Gandhi Medical College, Pondicherry, between 2019 to 2021. 50 (27 Right side and 23 left side) formalin-fixed embalmed cadaveric lower limb specimens of unknown age and gender were included. Lower limbs specimens with any of the surgical interventions and trauma were excluded. Cunningham's manual for practical anatomy was used as guidance in dissecting the lower limb to explore the saphenous nerve. Thigh, leg and foot compartments were dissected and the saphenous nerve was traced from origin till its termination. Variations in origin, course and branches of saphenous nerve were observed and photographed.

RESULTS

Variation in Origin of Saphenous nerve

Usually, in the femoral triangle, the saphenous nerve originates from the posterior division of the femoral nerve. In this study, 9 (2 right side, 7 left side) (18%) out of 50 lower limbs specimens showed unusually origin of the saphenous nerve from the anterior division of femoral nerve along with intermediate and medial cutaneous nerve of the thigh.[Figure A and B]

Variation in the course of the saphenous nerve

Usually, in the Hunter's canal, the saphenous nerve crosses the femoral artery from the lateral to the medial side and pierces the deep fascia between the tendon of the Sartorius and gracilis

muscle to become superficial. In the present study, saphenous nerve remains lateral to the femoral artery throughout the entire length of Hunter's canal in 6 (2 right side, 4 left side) (12%) out of 50 lower limb specimens. Below knee it divided into infrapatellar and sartorial branches and followed the standard courses. [Figure B and C]

Variation in branches of the saphenous nerve

No variations were observed in the branching pattern of the saphenous nerve except Infrapatellar branch of saphenous nerve originated as 2 branches in 3 (6%) left lower limb specimens in the present study.[Figure C]



Figure A: Shows the unusual origin of the saphenous nerve in the right lower limb. AL- Adductor longus, SAM- Sartorius muscle, FA- Femoral artery, FN- Femoral nerve, FNAD- Femoral nerve anterior division, FNPD- Femoral nerve posterior division, SN- Saphenous nerve, ICNT- Intermediate cutaneous nerve of thigh, MCNT- Medial cutaneous nerve of thigh.

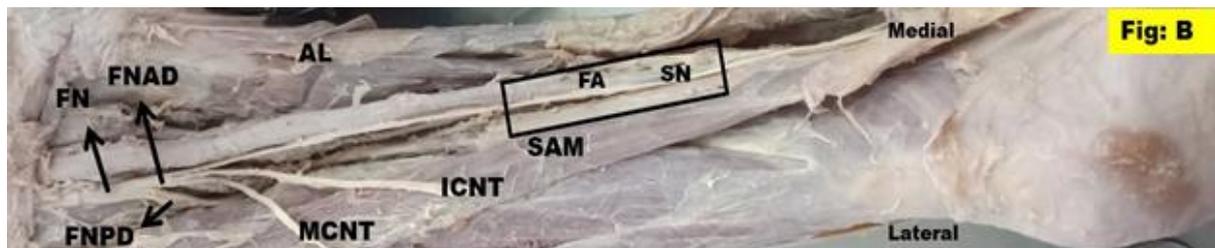


Figure B: Shows the unusual course of the saphenous nerve in right Hunter's canal. AL- Adductor longus, SAM- Sartorius muscle, FA- Femoral artery, FN- Femoral nerve, FNAD- Femoral nerve anterior division, FNPD- Femoral nerve posterior division, SN- Saphenous nerve, ICNT- Intermediate cutaneous nerve of thigh, MCNT- Medial cutaneous nerve of thigh. Black rectangular outline represents the Hunter's canal.

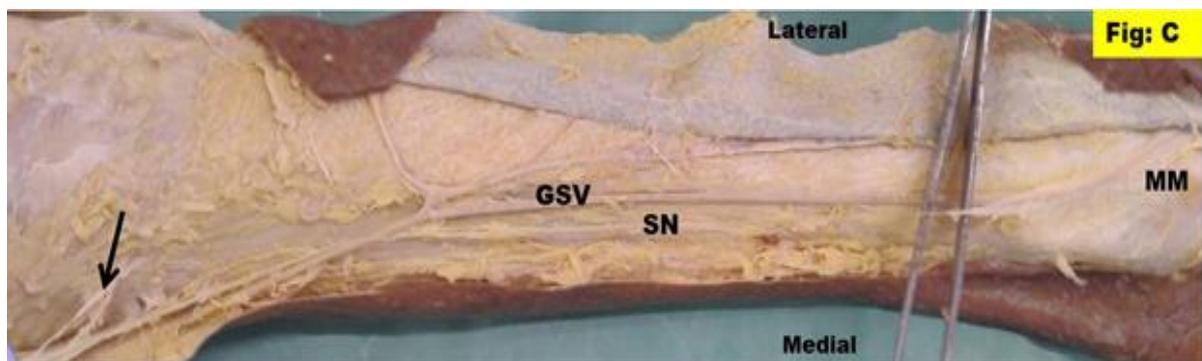


Figure C: Shows the course and branches of the saphenous nerve in left leg. GSV- Saphenous vein, SN- Saphenous nerve, MM- Medial malleolus, Black arrow- Infrapatellar branch of saphenous nerve.

DISCUSSION

The present study is one of the few cadaver based study to report the prevalence of origin, course and branches of aberrant saphenous nerve. It is essential to be aware of variations in the anatomy of the saphenous nerve because of its intimate relationship with the femoral artery, knee joint and great saphenous vein, where interventional procedures are commonly done. The saphenous nerve is the primary sensory supply to the anteromedial aspect of the knee, medial side of leg and medial margin of the foot up to the ball of the great toe.

Saphenous nerve variations could be due to embryological malformations. During the intrauterine life of the foetus around the 30th day, motor axons present in the anterior column of the spinal cord start sprouting. At the tips of every axon, a growth cone filopodia determine axon growth towards the target organs like skin, muscles and joints. The target tissues produce molecular markers, which attract the filopodia so that growing axons determine their location and organs to be innervated. If any unusual events occurred in the developmental pathway of growth cone filopodia related to motor axons from L1 to L4 spinal segments, variations in the anatomy of a peripheral nerve might occur,^[11] as noticed in the present study.

Hujbregts et al and Fuatunat et al^[12,13] reported that above the inguinal ligament psoas major muscle unusually divided the femoral nerve in 2 or 3 divisions. Below the inguinal ligament, variations in femoral nerve and its branches were not reported in previous literature. In the present study all specimens showed anterior and posterior division of femoral nerve in femoral triangle but in 9 specimens (2 right side, 7 left side) (18%) saphenous nerve originated from anterior division of femoral nerve along with medial and intermediate cutaneous nerve of the thigh. As Saphenous nerve is intimately related to the femoral artery in femoral triangle it may be prone to injury during femoral artery catheterization.^[12]

Saphenous nerve blockade is usually done in the distal third of the Hunter's canal. In the distal third of the Hunter's canal, the Saphenous nerve usually crosses the femoral artery from the lateral to the medial side and divided into the Infrapatellar branch of the saphenous nerve and sartorial branch.^[5,14] In the present study, the saphenous nerve in 6 (2 right, 4 left) (12%) lower limb specimens out of 50 laid lateral to a femoral artery within the Hunter's canal and branched into the Infrapatellar and sartorial branch outside the canal. To perform saphenous nerve block in the Hunter's canal successfully, above mentioned knowledge about the saphenous nerve is essential.

The saphenous nerve is the mechanosensor of the knee joint and it branches into infrapatellar nerves.^[15] Its anatomical position varies on the movements of the knee joint in humans.^[16] Richardo Barriel Mendes et al,^[17] reported that IPBSN originated as three branches in 70%, four branches in 7.5% and two branches in 22.5% specimens. In the current study, IPBSN originated as 2 branches in 3 (6 %) left lower limb specimens, which was close to Gali et al findings.^[18] Due to the high variability of IPBSN, its clinician's responsibility to be aware of all such variations during surgical procedures in the knee region to prevent or minimize post-operative complaints like pain, paresthesia, reduced mobility.

The results of the present study not defined the saphenous nerve variations according to the age and gender of the lower limb cadavers. The authors would recommend the researchers to further work on the saphenous nerve variations related to age and gender.

CONCLUSION

Variations in the anatomy of lower limb nerves are found coincidentally during the dissection. Nowadays, due to people's lifestyles, the number of interventional and surgical procedures increased proportionately. Injury to the saphenous nerve may happen during femoral artery catheterization, saphenous nerve blockade and hunter's canal procedures. In the present study, out of 50 lower limb specimens aberrant origin, course and branches of

Saphenous nerve was observed in 9(18 %), 6 (12%) and 3 (6%) respectively. So, sound knowledge about these variations is essential for clinicians particularly surgeons and radiologists to do their procedures without complications.

REFERENCES

1. Hunter LY, Louis DS, Ricciardi JR, O'Connor GA. The saphenous nerve: Its course and importance in medial arthroscopy. *Am J Sports Med.* 1979;7(4):227–30.
2. Janes LE, Fracol ME, Ko JH, Dumanian GA. Management of unreconstructable saphenous nerve injury with targeted muscle reinnervation. *Plast Reconstr Surg - Glob Open.* 2020;1–3.
3. Standring S. *Gray's anatomy: the anatomical basis of clinical practice.* 41st ed. New York: Elsevier Churchill Livingstone; 2016.
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 Jun;9(4):54–8.
5. Vanamala R, Hammer N, Soltani S, Lim K, Wyatt MC, Kieser DC. Anatomical Variations of the Saphenous Nerve in the Adductor Canal. *J Anesthesiol Clin Sci.* 2019;8(1):2.
6. Kapoor R, Adhikary SD, Siefring C, McQuillan PM. The saphenous nerve and its relationship to the nerve to the vastus medialis in and around the adductor canal: An anatomical study. *Acta Anaesthesiol Scand.* 2012;56(3):365–7.
7. Horteur C, Cavalie G, Gaulin B, Cohen Bacry M, Morin V, Cavaignac E, et al. Saphenous nerve injury after anterior cruciate ligament reconstruction: Reduced numbness area after ligamentoplasty using quadriceps tendon compared with hamstring tendon. *Knee.* 2020;27(4):1151–7.
8. Lee SR, Dahlgren NJP, Staggers JR, de Cesar Netto C, Agarwal A, Shah A, et al. Cadaveric study of the infrapatellar branch of the saphenous nerve: Can damage be prevented in total knee arthroplasty? *J Clin Orthop Trauma.* 2019 Mar;10(2):274–7.
9. Figueroa D, Calvo R, Vaisman A, Campero M, Moraga C. Injury to the infrapatellar branch of the saphenous nerve in ACL reconstruction with the hamstrings technique: Clinical and electrophysiological study. *Knee.* 2008;15(5):360–3.
10. Porr J, Chrobak K, Muir B. Entrapment of the saphenous nerve at the adductor canal affecting the infrapatellar branch - a report on two cases. *J Can Chiropr Assoc.* 2013 Dec;57(4):341–9.
11. Bharti A, Paranjpe VM, V Apte M. Variations in The Formation And Relation Of Median Nerve. *Int J Anat Res.* 2015 Sep 30;3(3):1298–301.
12. 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):107E-114E.
13. Unat F, Sirinturk S, Cagimni P, Pinar Y, Govsa F, NteliChatzioglou G. Macroscopic observations of muscular bundles of accessory iliopsoas muscle as the cause of femoral nerve compression. *J Orthop.* 2019;16(1):64–8.
14. Ahmad U, San AA, See CP, Taib CNM, Moklas MABM, Othman F. Discovery of anatomic variant of saphenous nerve from human cadaver dissection. *J Morphol Sci.* 2016;33(1):5–7.
15. Testut L, Latarjet A. *Tratado de anatomia humana.* Vol.1., 8th ed. Barcelona [etc.]: Salvat; 1984.
16. Tifford CD, Spero L, Luke T, Plancher KD. The Relationship of the Infrapatellar Branches of the Saphenous Nerve to Arthroscopy Portals and Incisions for Anterior

- Cruciate Ligament Surgery: An Anatomic Study. *Am J Sports Med.* 2000 Jul 30;28(4):562–7.
17. Mendes RB, Laranja VHF, Mogami SSV, Ramos MRF, Pires LAS, de Oliveira Figueiredo L, et al. Anatomical study of the infrapatellar branch of the saphenous nerve with applications to knee surgery. *Int J Morphol.* 2019;37(4):1258–61.
 18. Gali JC, Resina AF, Pedro G, Neto IAM, Almagro MAP, da Silva PAC, et al. Importance of anatomically locating the infrapatellar branch of the saphenous nerve in reconstructing the anterior cruciate ligament using flexor tendons. *Rev Bras Ortop (English Ed.)* 2014 Nov;49(6):625–9.