Original article:

Unusual anatomical variation in formation of sural nerve

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Abstract:

Background: Sural nerve is formed by communication of medial sural cutaneous nerve, that arise from tibial nerve in popliteal fossa and peroneal communicating nerve, a branch directly from common peroneal nerve or from lateral sural cutaneous nerve.The objective of this study was described an unusual and few reported anatomical variation in formation of sural nerve. ***Materials and Methods:*** The anatomical variation described was found during routine dissection performed by medical students of second semester in two maleembalbed adult cadavers of 75 and 65 years of age, respectivelyin the laboratory of Morphology of the University of Pamplona. ***Results and Discussion*****:** In the left lower limb, both medial sural cutaneous nerve, and lateral sural cutaneous nervewere absent. The sural nerve arose directly from the tibial nerve. It's observed a communicating branch between tibial nerve and common peroneal nerve. In the right lower limb, lateral sural cutaneous nerve was absent. The sural nerve arose directly from the common peroneal nerve.Peroneal communicating nerve was considered as absent in the two cases.Motor fiber from sural nerve to gastrocnemius muscle was observed in both lower limbs.***Conclusions:***The knowledge of the sural nerve (normal anatomy and variations in origin and course) is important in evaluating of the patients, as well explaining the different clinical findings necessary for accuracy treatment.

Keywords: Anatomical variation, common peroneal nerve; lateral sural cutaneous nerve; medial sural cutaneous nerve; peroneal communicating nerve; sciatic nerve, sural nerve; tibial nerve.

Bangladesh Journal of Medical Science Vol. 18 No. 03 July'19. Page : 508-512
DOI: https://doi.org/10.3329/bjms.v18i3.41618

Introduction:

The sural nerve (SN) is clinically important, as it is commonly used for nerve conduction studies, nerve biopsies, and as a convenient source for nerve grafting. The SN is a sensory nerve supplying the skin of the lateral and posterior part of the inferior third of the leg and lateral side of the foot. The SN, next to the small saphenous vein, extends downwards following the lateral margin of the tendon calcaneus. Later, it extends forward to the lateral part of the foot and the fifth toe passing behind the lateral malleolus. The SN gives off lateral calcaneal branches out on the outer part of the calcaneus[1].

The sural nerve innervates the cutaneous part ofthe posterolateral aspect of the lower third of the leg,the lateral malleolus,and the lateral side of the dorsal partof the foot to the fifth toe.This nerve can beeasily found about 10 cm above the calcaneus. Here,slightly lateral to the Achilles tendon, this nerveadheres to the lesser saphenous vein. Distally fromthis point the sural nerve runs between the lateralmalleolus and the calcaneus and continues to thefifth toe.The sural nerve is widely used for many therapeuticinterventions to determine nerve conductionvelocity, for nerve biopsy and during nerve graftingprocedures.This nerve is the most commonly used donor nervefor peripheral nerve reconstruction. The histologicalstructure of the graft should be compatible withthe nerve that will receive that graft [2].

The sural nerve is a branch from tibial nerve (TN) in the popliteal fossa, descends between the two heads of the gastrocnemius muscle, and pierces the deep fascia in the middle third of the posterior surface of the leg. It is usually joined by the peroneal communicating nerve (sural communicating nerve) which is a branch of common peroneal nerve (CPN). The sural nerve is formed by the union of medial sural cutaneous nervewith the peroneal communicating nerve. Some other authors describe that sural nerve is formed by the union of medial sural cutaneous nerve with the lateral sural cutaneous nerve. Because of these controversies the term sural

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nerve complex was coined by Ortiguela, which includes medial sural cutaneous nerve, lateralsural cutaneous nerve, peroneal communicating nerve, and sural nerve [3]. Medial sural cutaneous nerve originates from the tibial nerve in the popliteal fossa. It descends between the two heads of gastrocnemius muscle, deep to deep fascia covering the muscle. It becomes superficial by piercing the deep fasciaat the junction of middle and distal thirds of the leg. The nerve lies usually medially sometimes laterally to the short saphenous vein.The nerve joins the peroneal communicating saphenous vein. The nerve joins the peroneal communicating nerve to form sural nerve. When there is no communication between medial sural cutaneous nerve and peroneal communicating nerve, the medial sural cutaneous nerve supplies thelateral surface of the leg and gives off lateral branch to the heel and continues as lateral dorsal cutaneous nerve.Lateral sural cutaneous nerve originates from common peroneal nerve in popliteal fossa; it descends between deep fascia and lateral head of gastrocnemius muscle; at the middle of the calf it pierces is deep fascia to become subcutaneous [4]. Peroneal communicating nerve originates in the poplitealfossa either from lateral suralcutaneous nerve or directlyfrom the common peroneal nerve.The nerve communicateswith the medial sural cutaneous nerve to form sural nerve. The sural nerve is a sensory nerve of the lower limb thatsupplies the lower posterolateral part of the leg and lateralpart of the dorsum of the foot. It is generally described asa sensory nerve but may contain motor fibres. Thesural nerve is universally recognized by surgeons as a sitefor harvesting an autologous nerve graft. The nerve iswidely used for electrophysiological studies. The formationand distribution vary in different individuals.The sural nerveis the most frequent donor nerve used for peripheral nervegrafting. Despite the widespread use of the sural nerve, thereis scant attention reported in the literature about associateddonor site problem. The peroneal communicating nerve isreadily accessible to surgical harvest as it lies superficially.When there is a situation requiring limited length of nervegraft material, the peroneal communicating nerve alonecan be harvested and medial sural cutaneous nerve can bepreserved and associated symptomatic neuroma of the suralnerve will be diminished [4].

The sural nerve is characterized by great anatomical and topographical variability and is rarely involved in entrapment neuropathies. Sural nerve is vulnerable to injury as it is firmly fixed to the surrounding tissue in all its length and may be compressed and entrapped proximally and distally, leading to pain and sensory abnormalities in its distribution area. Some of the first reported cases in the literature were documented by Pringle et al. in 1974 [5]. The superficial anatomic location of the nerve predisposes for injury and entrapment neuropathies, although these conditions are uncommonly reported but may be undiagnosed. However, the main etiology of the sural nerve mechanical lesion and entrapment is fascial thickening and consequent nerve compression or fixation[6,7].The purpose of this paper was to describe an unusual and few reported anatomical variation in the formations of sural nerve.

Materials and Methods:

.A vertical incision was made from an approximately medial point of the infragluteal groove toa line, drawn horizontally, between the medial and lateral malleoli of the ankle region. Eachanatomical plane of the thigh and calf posterior regions was dissected from the skin to thefascias, from where they were recognized and the nerves of the calf region could beidentified. Nerves from the sural nerve were dissected using dissecting instruments. The described anatomic variations were dissected in a male cadaver of 75 and 65 years of age, respectively. Measurements were taken with assistanceof a slidingVernier caliper, accurate to 1 mm during the course of the anatomical dissection. The topographic details were examined and the variations were recorded and photographed. The history of the individual and the cause of death are not known.

Ethical clearance: This work was previously approved by the Ethics Committee in Research and Environmental Impact of the University of Pamplona, conformed by resolution 030 of January 16 of 2014 and Resolution No. 008430 of 1993 of October 4 of the Ministry of Health of Republic of Colombia by which regulates the scientific, technical and administrative norms for health research.

Results:

In the left lower limb of the male cadaver of 75 years of age, both MSCN and LSCN were absent. The SN arose directly from the tibial nerve. It's observed a communicating branch between tibial nerve and common peroneal nerve, this branch obliquely crossing the popliteal fossa (medial toward lateral) has a length of 13,5cms and diameter of 2.18 mm (measurement performed with digital caliper which has the accuracy of 0,01 mm/0,0005"). Figure 1.

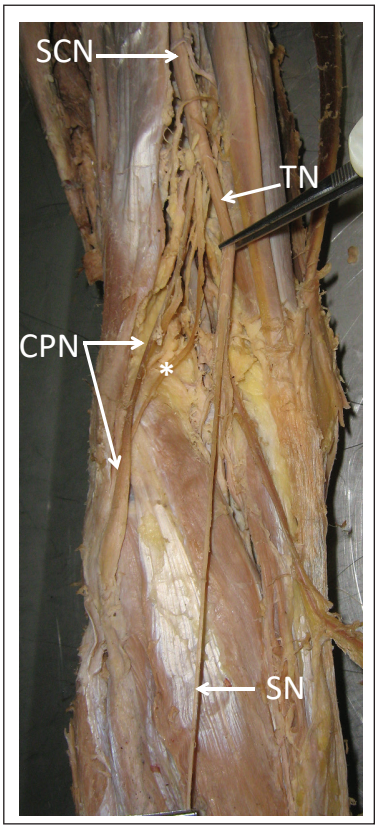

Figure 1

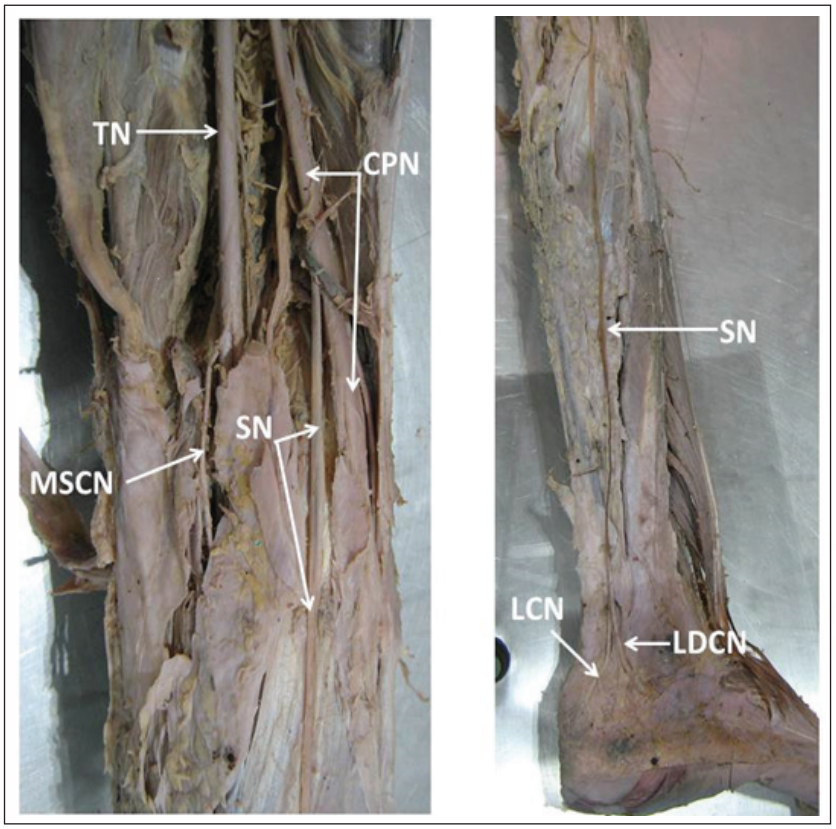

Figure 2

Figure 1. Showing variation in the formation of the sural nerve in left lower limb. SCN: Sciatic nerve; CPN: common peroneal nerve; TN: tibial nerve; SN: sural nerve arose directly from the tibial nerve; asterisk: communicating branch between tibial nerve and common peroneal nerve.

In the right lower limb of the male cadaver of 65 years of age, lateral sural cutaneous nerve was absent. The SN arose directly from the common peroneal nerve. PCN was considered as absent Figure 2.

Figure 2. Showing variation in the formation of the sural nerve in right lower limb. CPN: common peroneal nerve; TN: tibial nerve; SN: sural nerve arose directly from the common peroneal nerve; MSCN: medial sural cutaneous nerve; LDCN: lateral dorsal cutaneous nerve; LCN: lateral calcaneal nerve.

In the two lower limbs, PCN was considered as absent.In the two lower limbs, at a point 6.5 cm proximal to the tip of the lateral malleolus, the sural nerve was found to be a mean of 25.5 mm, posterior to the edge of the fibula. In the hindfoot, the sural nerve curved distal to the malleolus in all specimens. The trunk was located at a mean distance of 13,5 mm, posterior and 13,5 mm inferior to the tip of the malleolus along the “malleolar line” (a vertical line parallel to the fibular shaft and through the tip of themalleolus). Along this line, the sural nerve was commonly situated superficial and slightly inferior to theperoneal tendons.Motor fiber from SN to GM was observed in both lower limbs

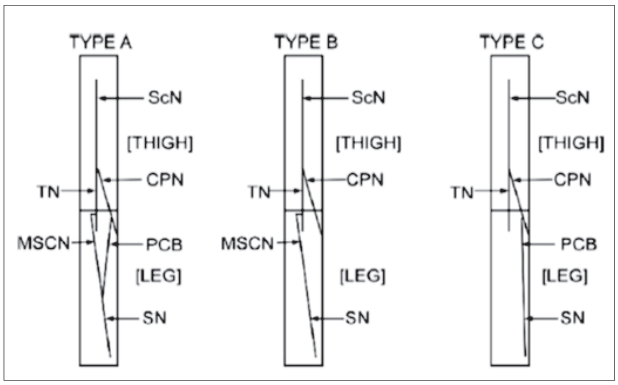

Figure 3. Schematic diagram showing the different types of formation of the sural nerve as described by Huelke (1957). ScN: Sciatic nerve, TN: Tibial nerve, CPN: Common peroneal nerve, MSCN: Medial sural cutaneous nerve, PCB: Peroneal communicating branch or PCN: peroneal communicating nerve (from reference 8).

Discussion:

Nerve conduction studies are important diagnostic tools to evaluate the integrity and function of the peripheral nervous system. The sural nerve is one of the most commonly examinednerves by nerve conduction studies, mainly for the diagnosis of polyneuropathy, but it is also useful in the evaluation of focal nerveinjury of the lumbosacral plexus and the sciatic and tibial nerves. The sural nerve is traditionally described by three different formationtypes, designated A, B, and C[8]. Type A, themost common type, is formed by the union between the medialsural cutaneous nerve (MSCN), which is a branch of the tibial nerve, and the peroneal communicating branch (PCB) of the commonperoneal nerve, while type B is the direct continuation ofthe MSCN with the PCB absent, and type C is formed by the PCBonly. The union in type A may take place anywhere betweenthe popliteal fossa and the lateral malleolus[9]. When the SN was formed only by the PCN it was defined asType D[1]. Figure 3. Numerous cadaverstudies have been conducted worldwide documenting theanatomical variations of the sural nerve [10-13]. In one of these, sural nerve conduction studies from healthy adults weredone in addition to the cadaver studies showing highly variable sural nerve formation. Recently, an ultrasoundstudy of anatomic variants of the sural nerve has shown similar variations as the cadaver studies [14]. Thesestudies have mainly focused on surgical implications such asreconstruction of peripheral nerves, since the sural nerve is commonly used for nerve biopsies as well as a convenient source fornerve grafting.

Studies showed that the SN may course either intramuscularly or subfascially. During the regular dissection, a precise assessment of the frequency of this muscular course is important because of the possibility of this nerve being confused with included fascia instead of the muscular course. As shown by the foregoing literature reports, there are many cases in which the SN or its branches are surrounded by fascia or scar tissue the sural nerve followed a transmuscular course, which corresponded to a frequency of 6.7% of all legs and 10% of the cadavers. The SN pierced the gastrocnemius muscle (GM) along with the small saphenous vein (SSV) instead of passing superficial to it[15,16].

In the present case the left SN coursed subfascially and was stuck in between the lateral and medial heads of GM, additionally the left SN was thicker than the right.It was evident that the left GM was atrophic. This variant course of the SN might produce pain during the contraction of the GM or altered sensation over the area of its distribution. Due to the generated pain, GM might be less frequently used than it supposed to be, and this may cause atrophy. Though the SN is considered to be a sensory nerve, motor fibers have been found in 4.5% of cases [17]. In the present case,motor fiber from SN to GM was observed in both lower limbs.

Clinically, the sural nerve is used in sensory nerve grafting for therapeutic purposes because of its long course; it is also used in nerve conduction velocity studies for diagnostic purposes. The sural nerve is usually recognized by the surgeons as a site for harvesting an autologous nerve graft and for nerve biopsies in case of neuropathies as it is superficial, readily accessible and largely sensory [13]. Sural nerve grafts are used to restore the muscle tone in fascial nerve palsy.

Pieces of sural nerve are often used for nerve grafts in procedures such as repairing nerve defects resulting from wounds and located by surgeons in relation to the small saphenous vein. Because of variations in the level of formation of sural nerve, the surgeons may have to perform incisions in both the legs and then select the better specimen [15]. Clinically, the SN is widely used for both diagnostic (biopsy and nerve conduction velocity studies) and therapeutic purposes (nerve grafting). Thus, a detailed knowledge of the anatomy of the SN and its contributing nerves are important in carrying out these and other procedures, the same approach should be taken for other nerves and blood vessels too.[18-20]

Conclusion:

The anatomical variations and complexity of the sural nerve it makes significantly difficult to establish an anatomical standard. The variation of the sural nerve is an important surgical consideration and the knowledge of kind of entrapment as well as the variability of the peripheral nerve distribution is very important in general medicine,neurosurgeo ns,neurologists, general surgery,plastic surgery, sport medicine, physical therapy, clinical and surgical procedures, orthopaedists, physiatrists, physiotherapists, in electrophysiological studiesfor planning safety operative approach and minimize the risk of nerve injury and allows better insight into

diagnoses, treatmentand procedures it is involving the nerve and surrounding anatomical structures.

Acknowledgements:

The author thanked to the University of Pamplona for research support and/or financial support; at National Institute of Legal Medicine and Forensics Sciences and ErasmoMeoz University Hospital in Cúcuta, North of Santander, Colombia for the donation of cadavers identified, unclaimed by any family, or persons responsible for their care, process subject to compliance with the legal regulations in the Republic of Colombia.

Conflict of interest: Nil

Author's contribution:

Idea owner of this study: Humberto Ferreira Arquez
Study design: Humberto Ferreira Arquez
Data gathering: Humberto Ferreira Arquez
Writing and submitting manuscript: Humberto Ferreira Arquez
Editing and approval of final draft: Humberto Ferreira Arquez

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