



## STUDY OF DEVELOPMENT OF SURAL NERVE COMPLEX IN HUMAN CADAVERS

### Anatomy

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### ABSTRACT

**Background:** Sural nerve is a sensory nerve mainly that supplies the posterolateral part of foot. Sural nerve complex is contributed from both tibial and common peroneal nerve. The components which form are Medial sural cutaneous nerve, Lateral sural cutaneous nerve, Peroneal communicating nerve and sural nerve. **Material and Methods:** Materials of study consists of 50 lower limbs specimens of 16 male and 9 female adult cadavers. Method adopted is by dissecting on the posterior aspect of the lower limb extending from middle of thigh to meeting point between two malleoli in the department of Anatomy, at GMC, Purnia, Bihar. Study duration of two and half years.

### KEYWORDS

Sural nerve, Medial sural cutaneous nerve, Lateral sural cutaneous nerve, Common peroneal nerve.

### INTRODUCTION

The sural nerve is a sensory nerve of lower limb that supplies lower posterolateral part of leg and lateral part of dorsum of foot. (1, 2, 3), The medial sural cutaneous nerve, lateral sural cutaneous nerve, peroneal communicating nerve and sural nerve proper form the components of sural nerve complex. (1, 4), Sural nerve complex is contributed from both Tibial and Common peroneal nerves. Tibial nerve is larger terminal division of sciatic nerve. It descends along the popliteal fossa to the distal border of popliteus muscle, passing anterior to the arch of soleus with popliteal artery and continuing into the leg. (3) While in the fossa, tibial nerve gives muscular branches and also gives medial sural cutaneous nerve which is joined by the peroneal communicating branch of the common peroneal nerve at a highly variable level to form the sural nerve complex. This nerve supplies the lateral side of the leg and ankle. Occasionally posterior femoral cutaneous nerve of thigh also contributes in the formation of sural nerve. Medial sural cutaneous nerve arises from the tibial nerve in popliteal fossa, usually a little below the level of knee joint, and runs downwards in the groove between two heads of gastrocnemius most superficial muscle of the calf. (5) It commonly pierces the deep fascia proximally in the leg and is joined by peroneal communicating branch of the common peroneal nerve. It descends lateral to tendocalcaneus in proximity with the small saphenous vein, to the region between the lateral malleolus and calcaneus. The common peroneal nerve, lateral smaller terminal branch of sciatic nerve begins at the superior angle of the popliteal fossa and follows closely the medial border of biceps femoris tendon along the superolateral boundary of popliteal fossa. The lateral sural cutaneous nerve (lateral cutaneous nerve of calf) arises on the lateral head of gastrocnemius from the common peroneal nerve in popliteal fossa and descends deep to the deep fascia. It descends along the lateral aspect of the upper half of the leg. Lateral sural cutaneous nerve often gives rise to a peroneal communicating branch, which supplies the skin on the medial side of the lower part of the calf before joining the medial sural cutaneous nerve to form the sural nerve. Sural nerve is formed by communication of medial sural cutaneous nerve, arising from tibial nerve in popliteal fossa and peroneal communicating nerve, a branch directly from common peroneal nerve or from lateral sural cutaneous nerve. Sural nerve may be formed without communication between these branches and then it is only a continuation of medial sural cutaneous nerve. Sural nerve is widely used for electrophysiological studies to know the conduction velocity distribution compared to the fiber size distribution. NCS (nerve conduction studies) are done in focal neuropathies to know the conduction velocity, action potential and amplitude. It is also considered in diagnosis of focal neuropathies, compressive lesions, traumatic nerve lesions and diffuse polyneuropathic (diabetic, uremic, metabolic, and immune) conditions. It can be used as an aid in diagnosing neuromuscular junction disorders, and also in their prognosis using repetitive nerve stimulation. The dorsal nerve conduction studies in diabetic children may have value to determine the neuropathy in earlier stages. Sural nerve is a pure sensory nerve except for the unmyelinated autonomic fibres. The fibre spectrum and

ultra structure of fetal sural nerves were described by Ochoa in 1971 and in adults by Ochoa and Mair in 1969. The three dimensional distributions of Schwann cells associated with unmyelinated nerve fibres in adult human sural nerves has been analysed by Carlson and Behse in 1980. Sural nerve biopsy is one of the most common procedures employed in evaluation of peripheral nerve disorders.

### OBJECTIVES

To study the formation and course of the Sural nerve and measuring the length till lateral malleolus. To study the origin, course of Medial sural cutaneous nerve and Lateral sural cutaneous nerve and Peroneal communicating nerve.

### Review of Literature

The sural nerve is a sensory nerve of lower limb that supplies lower posterolateral part of leg and lateral part of dorsum of foot (3, 7). It is a cutaneous branch from tibial nerve in the popliteal fossa, descends between the two heads of gastrocnemius muscle and pierces the deep fascia in the middle third of the posterior surface of leg. It is usually joined by the peroneal communicating nerve which is a branch of Common peroneal nerve. Many other authors describe that sural nerve is formed by the union of medial sural cutaneous nerve with the peroneal communicating branch. (1, 5, 10, 18, 19). Sural branches of posterior femoral cutaneous nerve (posterior cutaneous nerve of thigh) are two terminal twigs that supply the skin of the posterior leg to various extents and communicate with the sural nerve. (13, 5) Because of these controversies the term sural nerve complex has been coined. It is larger, medial terminal branch (from the ventral branches of the fourth and fifth lumbar and first to third sacral ventral rami) of sciatic nerve. It descends along the back of thigh and popliteal fossa to the distal border of popliteus muscle, passing anterior to the arch of soleus with popliteal artery and continuing into the leg. where it is lateral to popliteal vessels, becoming superficial to them at the knee and crossing to the medial side of the artery. Distally in the fossa it is overlapped by the junction of the two heads of gastrocnemius it then descends to the point midway between the medial malleolus and calcaneal tendon, In the leg the tibial nerve descends with the posterior tibial vessels to lie between the heel and the medial malleolus, ending under the flexor retinaculum by dividing into medial and lateral planter nerves. The sural nerve is the most frequent donor nerve used for peripheral nerve grafting. It is particularly advantageous because it provides a generous length of expandable nerve and is of ideal caliber for revascularization and for interfascicular graft replacement. (1) Sensory nerve conduction studies (NCS) are an indispensable component of the electrodiagnostic examination. They evolved from mixed NCS, and were initially described by Dawson in 1950. Bergman et al (1988) stated that several variations have been reported in the formation and distribution of branches of tibial and sural nerves. The point of union of a branch of tibial, the medial sural cutaneous with the peroneal communicating branch, is subjected to wide variation. Williams DD (1954) in his study has reported that MSCN was absent in 0.39% of cases. A condition was found in which the MSCN of a left leg

was quite short, ending in the skin on the medial side of the superior 1/3 of the leg. In this case peroneal communicating nerve functioned as sural nerve. Shankar N et al (2010) has reported the origin of MSCN from the sciatic nerve in 1 out of 38 cases, (2.6%). Bannister et al (1995) has explained LSCN as a cutaneous branch arising often from a common trunk with peroneal communicating nerve (sural communicating nerve) from CPN Harvesting just one of these not only would present histologic false representation of the entrapment neuropathy as a systemic disease, but also would preserve lateral ankle sensibility.

## MATERIAL AND METHODS

The study consists of fifty lower limb specimens in twenty five cadavers. All male and female complete cadavers are included in the study. Specimens obtained for the study are from Dept of anatomy at Government medical college, Purnia, Bihar. Study duration of two and half years. The data was collected by dissection method by using dissection instruments and parameters (measurements) were obtained by using measuring tape.

The dissection was done as follows,

A horizontal incision was made at the junction of middle and lower 1/3<sup>rd</sup> of the thigh and another at lower end of lateral malleolus. These two incisions were joined by vertical incision. A thin flap of skin was reflected on either side. Then the superficial fascia was exposed in distal 1/3<sup>rd</sup> of the leg, the sural nerve was identified along the side of lesser saphenous vein. Sural nerve was then traced upwards to study its formation and site of piercing the deep fascia and this point was measured from bony point, fibular head. The deep fascia was exposed and the medial sural cutaneous nerve was traced between the two heads of gastrocnemius muscle, till its origin from the tibial nerve in popliteal fossa. The peroneal communicating branch was then traced upwards from the point of union with medial sural cutaneous nerve up to its origin either from lateral sural cutaneous nerve or directly from trunk of common peroneal nerve. The origin of components of sural nerve complex was noted.

## RESULTS

The sural nerve complex was dissected and observed in fifty formalin fixed lower limb specimens. Study was done in 16 male and 9 female cadavers. The components which formed the sural nerve were determined as MSCN, LSCN, PCN and SN proper. Sural nerve is formed by the union of medial sural cutaneous nerve and PCN lying with the small saphenous vein near the lateral margin of tendocalcaneus, it continues distally to the interval between the lateral malleolus and the calcaneus. This was observed in 72% of specimens. The MSCN was observed in all 50 specimens. The nerve takes origin from the tibial nerve in popliteal fossa and descended between 2 heads of gastrocnemius deep to the deep fascia covering the muscle. The MSCN communicates with peroneal communicating nerve at various levels. MSCN in its course lies superficial to the gastrocnemius muscle and deep to the fascia covering the muscle. In the present study it was observed that in 11 specimens MSCN showed a variable course. MSCN had a transmuscular course, it was entrapped in its course between the two heads of gastrocnemius. In specimens 6, 8, 9, 27, 32, 35 MSCN was partly entrapped within the muscle. In one of the specimens (S50), LSCN crossed the MSCN in the lower part of the back of leg and supplied the skin medial to the MSCN. Peroneal communicating arises from the CPN commonly either directly or along with LSCN, and communicates with the MSCN usually in lower 3<sup>rd</sup> of leg to form the sural nerve. It may be absent and then its function is either taken by MSCN or LSCN. In the present study, the sites of union of the MSCN with PCN components were observed. In type A the site of union of the MSCN and the PCN is extremely variable. This union may take place anywhere between the popliteal fossa and the lateral malleolus. Sural nerve formation is explained according to the origin as of three types and also its levels of formation differ in the leg. In one of the specimen there was twice communication and hence twice formation of sural nerve. In the present study conducted on south Indian cadavers, it was observed that the symmetrical type of distribution (60%) was lower when compared to the other studies. This could be probably due to the small sample size and study group is from Indian population. Symmetrical Type A form of SN was seen in 9 cases of male and in 2 cases of female. When compared in both the sexes, Type A was commonly found.

## Distribution Of Symmetry And Asymmetry In Sn

	Male	Female
<b>Symmetry</b>	10 (62.5%)	5 (55.6%)
<b>Asymmetry</b>	6 (37.5%)	4 (44.4%)
<b>Total</b>	16 (100.0%)	9 (100.0%)
<b>Inference</b>	Distribution of Symmetry and Asymmetry is statistically similar between male and female with P=1.000 (Chi-square test)	

Symmetrical type of distribution in formation of SN was seen in 15 and asymmetrical type was seen in 10 cadavers. Among male cadavers symmetrical distribution was seen in 10 and in females it was seen in 5 cadavers.

## DISCUSSION

The sural nerve is a sensory nerve of lower limb that supplies lower posterolateral part of leg and lateral part of dorsum of foot. The components which formed the sural nerve were determined as MSCN, LSCN, PCN and SN proper. (3,17). It is a cutaneous branch from tibial nerve in the popliteal fossa, descends between the two heads of gastrocnemius muscle and pierces the deep fascia in the middle third of the posterior surface of leg. The available literature regarding the description of the sural nerve and its formation is controversial. According to the studies of Williams DD (1954), Hollinshead (1958), Coert and Dellon (1994), Ulutku et al (2000), the typical sural nerve is formed by union of MSCN with the PCN, branch of CPN. On the other hand Bannister et al (1995) reported that the sural nerve is a branch of tibial nerve in the popliteal fossa and usually joined by a peroneal communicating nerve arising from CPN. (3) They considered the MSCN itself as sural nerve. Ortiguela et al have described that the MSCN originated from the posterior surface of the tibial nerve within popliteal fossa and was present in all the cases. Some authors have reported that MSCN was absent in 1- 2 cases. Pyun SB et al and Mahakkanukrauh P et al have found SN as a continuation of MSCN in 15.4% and 32.2% of cases respectively. Pimentel et al have reported an anomalous transmuscular course of MSCN in 6.7% of legs. (49) Similarly in the present study there was an incidence of transmuscular course of MSCN in 11 specimens that accounted for 22%. Williams DD (1954) in his study has reported a condition in which the MSCN of a left leg was quite short, ending in the skin on the medial side of the superior 1/3 of the leg. Lateral sural cutaneous nerve (lateral cutaneous nerve of calf) arises as one of the cutaneous branch of Common peroneal nerve often from a common trunk along with PCN. (3) Ortiguela et al found LSCN present in 95% of cases LSCN was seen arising from a common trunk of CPN in seven male cadavers (21.9%), among which five were in left leg and two in right leg. Similar type of origin was seen in a single left leg of a female cadaver (5.6%). Incidence of origin of LSCN from the common trunk was seen more in males. beneath the deep fascia and terminated by giving cutaneous branches. The nomenclature applied to the lateral sural cutaneous nerve contribution is confusing. It is termed the peroneal (fibular) communicating branch by some authors. (Ortiguela et al., 1987; April 1990; Mcminn, 1994; Woodburne and Burkel, 1994; chung, 1995; Hall Craggs, 1995; Leonard, 1995; Snell, 1995; Rosse and Gaddum Rosse, 1997; Moore and Dalley, 1999. In the present study it is considered as PCN. Ortiguela et al coined the term 'Sural nerve Complex' to the nerve that consisted of 4 named components, the MSCN, LSCN, PCN and SN. Ortiguela et al (1987) found that sural nerve was formed by union of the MSCN and the PCN in 80% of specimens and the sural nerve represented the continuation of the MSCN in 20% of cases. Observations on symmetry in the formation of the sural nerve in both legs of the same body are presented in table. The symmetrical group had the same type of formation in both legs, while the asymmetrical group had the anastomotic type (A) in one leg and a non anastomotic type (B or C) in the other leg. Huelke (1957) observed that among 150 bodies, 124 nerve patterns were symmetrical and 26 were asymmetrical. In the present study conducted on south Indian cadavers, it was observed that the symmetrical type of distribution (60%) was less when compared to the other studies. This could be probably due to the small sample size and study group was from Indian population.

## CONCLUSION

The sural nerve is a sensory nerve of lower limb that supplies lower posterolateral part of leg and lateral part of dorsum of foot. Its formation includes many components in variable proportions. It also differs in the site of union of these components. But yet it is consistently present in all the cases with a constant location just above

the lateral malleolus. Length of the SN also varies and this expansible length of the nerve helps in nerve grafting procedures which may require more than 9 cm of length.

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