



## Study of sciatic nerve and it's variations in human cadavers

### Anatomy

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### ABSTRACT

**Introduction:** Sciatic nerve (SN) is the longest and widest single nerve with root value of L4 to S3 and consisting of two components namely the tibial and common peroneal. Variations in the level of division of SN as well as relationship between SN to piriformis are not uncommon phenomena. Hence, this study is planned to study sciatic nerve and its variations in human cadavers.

**Material and Methods:** This is an observational descriptive study. Sixty lower limb specimens from 30 formalin fixed human cadavers were enrolled in the study. Gluteal regions and the posterior aspect of thigh on both sides are dissected to expose the SN. Variations in the SN and their relationship to piriformis muscle are observed.

**Result:** In 15% of specimens SN variations are found and out of them 11.67% are related to Piriformis. Of the 30 cadavers studied, 5 cadavers (16.66%) showed variations in the SN and out of 5, four cadavers (13.33%) showed bilateral variations. According to Beaton and Anson's classification of relation of SN variation to piriformis muscle, 83.33% (53) belongs to type I, 5% (3) to type II and 6.67% (4) to type III category. High division of SN found in 3.33% (2) of specimens.

**Conclusion:** In 15% of specimens SN variations are found and out of them 11.67% are related to piriformis. According to Beaton and Anson's classification, 88.33% of type 1, 5% of type 2 and 6.67% of type 3 variations in relation to piriformis muscle were found. Anatomical knowledge about variations in the level of division of the SN and the location where SN leaves the pelvis is of great importance to clinician.

### KEYWORDS:

common fibular nerve, greater sciatic foramen, piriformis muscle, sciatic nerve, tibial nerve

### Introduction

Sciatic nerve (SN) is the longest and widest single nerve in the human body. So, it is often involved in the clinical situations like trauma, tumors, vascular lesions in neighborhood structures, entrapment syndromes, hip or femur surgery or lower limb anesthetic blocks<sup>[1,2,3]</sup> The word sciatic is derived from a Greek word "Ischiadicus". SN is also known as the ischiadic nerve or ischiatic nerve. Sciatic nerve has two components namely the tibial and common peroneal component and both of them initially form a common trunk from the lumbosacral plexus.<sup>[4]</sup> Normally, the SN enters the gluteal region from the pelvic cavity by passing through the greater sciatic foramen under the piriformis muscle. It descends beneath the gluteus maximus muscle, between the ischial tuberosity and greater trochanter of femur and reaches the back of the thigh. Commonly at the apex of popliteal fossa (PF) the SN bifurcates (85-89%) into Tibial nerve (TN) and Common Peroneal nerve (CPN).<sup>[4]</sup> Piriformis (PM) is the key muscle of the gluteal region.<sup>[4]</sup> Variations in the level of division of SN as well as relationships between SN to piriformis are not uncommon phenomena and previous studies also reported them.<sup>[3,5-19]</sup>

There are 2 important aspects with regard to SN variations, first, its position in relation to piriformis muscle and secondly, the location where it divide into its terminal branches. In some cases SN may emerge above the piriformis or through the muscle. While in other variants its branches, CFN and TN may lie on either side of the muscle, or one branch either above or below or one branch passing through the piriformis (the most common Variant).

It is known that each anatomical variation may reflect a different and a case-specific clinical presentation. These anatomical variations may contribute to piriformis syndrome, sciatica, coccygodynia and muscle atrophy.<sup>[5]</sup> High division of SN may lead to incomplete block of

SN during usual popliteal block anaesthesia. Clinical manifestations may vary according to type of anatomical variant present in body. This requires a detailed description of anatomical variations. Variations of the SN and also its relations to the piriformis muscle according to Beaton and Anson classification will help clinicians as well as surgeons in treating conditions related to SN. Hence, this study is planned to study sciatic nerve and its variations in human cadavers.

### Materials and methods:

This is an observational, descriptive study, performed during April 2015 to March 2017 in the Department of Anatomy, Government Medical College, Akola, Maharashtra, India. Sixty lower limb specimens from thirty formalin fixed human cadavers without any history of previous lower limb trauma or surgery were used for this study. Out of 30 cadavers, 26 were male and 4 were female. All the cadavers are numbered in a sequential manner. All cadavers were examined and further dissected by reflecting skin, fat, and gluteus maximus muscle in order to identify the anatomy of the SN and its relation to the piriformis muscle (PM). The anatomical relationship between the SN and the PM was detected and classified according to the Beaton and Anson classification; type I, undivided SN below the PM; type II, one division of SN through and the other below the PM; type III, one division above and the other below the PM; type IV, undivided SN through the PM; type V, one division through and the other above the PM; type VI, undivided nerve above the PM.<sup>[6]</sup> Dissection of the posterior compartment of the thigh is also done to observe the course of SN. All the details were recorded and photographs were taken. Numerical data presented in tables with percentage.

### Result:

Thirty formalin fixed cadavers comprising of 60 lower limbs were

enrolled in the study. Fifty one specimens (85%) showed normal anatomy of SN and PM. Nine specimens (15%) showed variations in the SN. Table 1 shows the type of variation of SN observed in the nine specimens. Table 2 shows the details of the variations of the SN in relation to PM. Out of the 30 cadavers, 5 (16.66%) showed variations in the SN and out of 5, 4 (13.33%) showed bilateral variations and one (3.33%) showed unilateral variation of SN. Table 3 shows the summary of variations of SN observed in the five cadavers with variations.

In the present study, according to Beaton and Anson's classification of relation of SN variation to PM, 83.33% (53) belongs to type I, 5% (3) to type II (Figure 1) and 6.67% (4) to type III category (Figure 2).

High division of SN in the gluteal region immediately below piriformis found in 3.33% (2) of specimens (Figure 3).

**Table 1: Type of variations of the sciatic nerve observed in 9 gluteal and posterior compartment of thigh regions**

Type of sciatic nerve variation observed in 9 regions	No. of specimens showing variations of sciatic nerve	Percentage of variation
Variations of sciatic nerve in relation to piriformis muscle	07	11.67%
High division of sciatic nerve( In the gluteal region immediately below piriformis)	02	3.33%
Total	09	15%

**Table 2: Variations of the sciatic nerve in relation to piriformis muscle**

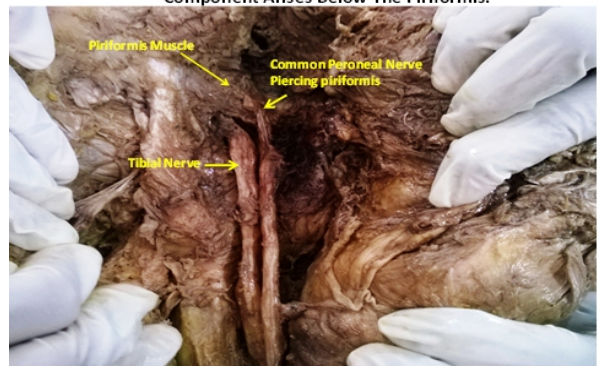
Type of sciatic nerve variation in relation to piriformis	No. of specimens showing variations of sciatic nerve	Percentage of Variation
Common peroneal component pierces the piriformis and tibial component arises below the piriformis.	03	5.00%
Common peroneal component arises above the piriformis and tibial component arises below the piriformis	04	6.67%
Total	07	11.67%

**Table 3: Summary of variations of sciatic nerve observed in the present study**

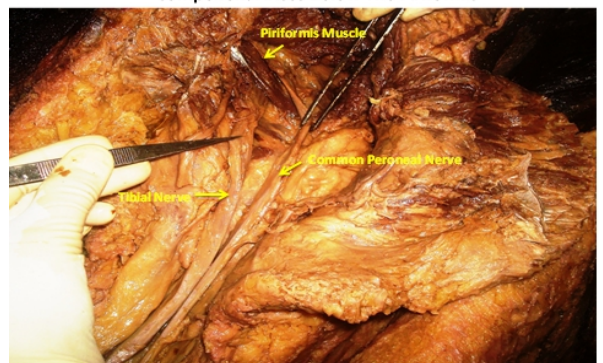
Cadaver no	Right side	Left side	Inference
Cadaver 5	Normal pattern of sciatic nerve is observed in this side	Common peroneal component pierces the piriformis and tibial component arises below the piriformis.	Unilateral variation of sciatic nerve is observed
Cadaver 11	High division of sciatic nerve into tibial and common peroneal nerves just below the piriformis	High division of sciatic nerve into tibial and common peroneal nerves just below the piriformis	Bilateral variation of sciatic nerve is observed
Cadaver 15	Common peroneal component pierces the piriformis and tibial component arises below the piriformis	Common peroneal component pierces the piriformis and tibial component arises below the piriformis	Bilateral variation of sciatic nerve is observed

Cadaver 21	Common peroneal component arises above the piriformis and tibial component arises below the piriformis	Common peroneal component arises above the piriformis and tibial component arises below the piriformis	Bilateral variation of sciatic nerve is observed
Cadaver 26	Common peroneal component arises above the piriformis and tibial component arises below the piriformis	Common peroneal component arises above the piriformis and tibial component arises below the piriformis	Bilateral variation of sciatic nerve is observed
Number of cadaver(s) with bilateral variations of sciatic nerve - 4 (8 regions)			
Number of cadaver(s) with unilateral variation of sciatic nerve - 1 (1 region)			
Hence nine gluteal and flexor compartment of thigh regions, in five cadavers showed variations of sciatic nerve in this present study.			

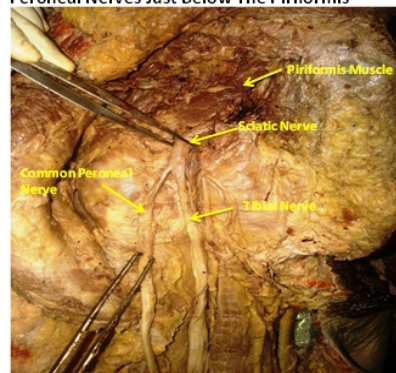
**Fig 1: Common Peroneal Component Pierces And Tibial Component Arises Below The Piriformis.**



**Fig.2: Common Peroneal Component Arises Above And Tibial Component Arises Below The Piriformis**



**Fig.3: High Division Of Sciatic Nerve Into Tibial And Common Peroneal Nerves Just Below The Piriformis**



**Discussion:**

Sciatic nerve, the largest branch of lumbosacral plexus is composed of ventral and dorsal divisions of ventral rami of L4 to S3 spinal nerves. The tibial component is from the ventral branches of ventral rami of L4 to S3 spinal nerves. The common peroneal component is from the dorsal branches of ventral rami of L4 to S2 spinal nerves. During embryological development, nerves of the lower limb form two plexuses, namely lumbar and sacral at the base of limb bud. Dorsal and ventral components are formed later from these plexuses.

Sciatic nerve is formed by the close downward movement of large dorsal (common peroneal) and the ventral (tibial) components during development [20] and hence the common peroneal and tibial components can separate from each other at various levels from their origin. [20,21,22]

Most of the text books of Anatomy, Orthopedic and Surgery state that the SN bifurcation levels are important in clinical and treatment aspects. Normally undivided SN passes out through greater sciatic foramen below piriformis and divides at the apex of the popliteal fossa (85 to 89 %). [23]

Piriformis is key muscle of gluteal region. It originates from the anterior border of the second to fourth sacral segment, from the upper margin of the greater sciatic notch, and from the sacrotuberous ligament to the greater trochanter of femur. [24]

Various studies are available in the literatures regarding SN variations. The two terminal branches of SN may arise directly from the sacral plexus. [21] Previous study found 15 to 30% variations of the SN relation to piriformis muscle. [3] We found 11.67% SN variation in relation to piriformis which is similar to the study by Anbumani T.L et al. [25]

Beaton and Anson have classified the relation of SN to piriformis muscle in 120 specimens in 1937 and 240 specimens in 1948 into six types. Their classification is as follows:

- Type 1: Undivided nerve below undivided muscle
- Type 2: Divisions of nerve between and below undivided muscle
- Type 3: Divisions above and below undivided muscle
- Type 4: Undivided nerve between heads
- Type 5: Divisions between and above heads
- Type 6: Undivided nerve above undivided muscle

Observations of previous studies and our study on SN variations in relation to piriformis are given in Table 4.

**Table 4: Observations of previous studies and our study on sciatic nerve variations in relation to piriformis**

Name of investigator	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Beaton & Anson [6] 120 cadavers	84.20%	11.70%	3.30%	0.80%		
Beaton & Anson [26] 240 cadavers	90%	7.10%	2.10%	0.80%		
Pecina [27] 130 cadavers		6.15%				
Chiba [8] 514 extremities		34%				
Sayson et al [17]						Only 1 case
Uluutku & Kurtođlun [19] 25 fetuses	74%	16%	10%			
Moore & Dalley [14] 650 extremities		12.20%	0.50%			
Ozaki et al [15]						Only 1 case

Machado et al [12] 100 fetus extremities		16%	2%			
Ugrenovic et al [18] 100 fetuses	96%	2.50%	1.50%			
Pokorny et al [3] 91 cadavers	79%	14.30%	4.40%	2.20%		
Guvencer et al [28] 50 extremities	76%	16%	8%			
Anbumani T.L et al [25] 50 extremities	90%	4%	4%			
Present study	88.33%	5%	6.67%			

Type 4, type 5 and type 6 of Beaton and Anson's classification were not found in our study. Babinski [5] and Mas et al [13] reported a rare variation of common peroneal nerve passing under the piriformis and tibial nerve passing under the superior gemellus however such type of variation is not found in our study. In the present study, the common peroneal emerged by piercing the piriformis and tibial component emerged below the piriformis in 3 specimens (5%). One such case was reported by Deopujari et al [29] and Anbumani T.L et al [25] in their study, where common peroneal emerged by piercing the piriformis and tibial nerve emerged below the piriformis, with one of the branches of inferior gluteal artery running between the two nerves which is not found in our study.

Published studies have reported the high division of SN in gluteal region and percentage were 11.11% [22], 16.30% [1], 48% [28] and 27.5%. [18] Anbumani T.L et al [25] observed high division of SN in 8% of specimens, 4% of SN divided in the gluteal region and 4% in the mid-high region. In present study, 3.33% of specimens showed high division of SN. Knowledge of this variation is important to anaesthetists as popliteal block will not be successful in these patients with high division.

The scope of anatomical variations cannot be limited to variants or anomalies; it also represents "normal" variation among specific population. Although, the sample size was small in our study, observations of this study can be used for meta-analysis to find out anatomical prevalence of variation.

**Conclusion:**

In 15% of specimens SN variations were found and out of them 11.67% were related to piriformis. According to Beaton and Anson's classification, 88.33% of type 1, 5% of type 2 and 6.67% of type 3 variations in relation to piriformis muscle were found. The anatomical knowledge about variations in the level of division of the SN and the location where it leaves the pelvis is of great importance to medical professionals during posterior hip surgeries, sciatic nerve decompression, total hip replacement, sciatic nerve injury during deep intramuscular gluteal injections and failed sciatic nerve block during anaesthetic procedures.

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