

SCIATIC NERVE AND ITS VARIATIONS: AN ANATOMICAL STUDY

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ABSTRACT

Background and Aims: The Sciatic nerve is the widest nerve of the body, consists of two components namely tibial and common peroneal components, derived from the lumbosacral plexus from the ventral rami of L₄ to S₃ spinal nerves. The Sciatic nerve usually enters the gluteal region under the piriformis muscle. The purpose of this study is to identify the variations in the course and branching pattern of the sciatic nerve and its relation to the piriformis muscle which may lead to various clinical manifestations like non-discogenic sciatica.

Materials and Methods: 50 gluteal regions and posterior compartment of thigh from 25 formalin fixed adult cadavers are used for this study, of which one is a female cadaver. Gluteal regions and the posterior aspect of thigh on both sides are dissected to expose the sciatic nerve. Variations in the sciatic nerve and their relationship to piriformis muscle are observed.

Results: 41 gluteal regions and posterior compartments of thigh (82%) showed normal anatomy of sciatic nerve and also piriformis muscle. 9 regions (18%) showed variations in the sciatic nerve, of which 5 regions (10%) showed variation of sciatic nerve in relation to piriformis muscle. Other details are explained further in the article.

Conclusion: A proper knowledge about the variations of sciatic nerve, its relation to piriformis muscle is must for medical professionals during posterior hip surgeries, sciatic nerve decompression, total hip replacement, sciatic nerve injury during deep intramuscular gluteal injections, failed sciatic nerve block during anaesthetic procedures etc.

KEY WORDS: Sciatic nerve, Piriformis muscle, Piriformis syndrome.

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INTRODUCTION

Sciatic is a Greek word derived from "Ischiadichus" and hence it is called as ischiadic nerve. Sciatic nerve is the widest nerve of the body, consisting of two components namely the tibial and common peroneal component, both of which initially form a common trunk from the lumbosacral plexus. 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 [1]. Usually the sciatic nerve 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. At the

superior angle of popliteal fossa, sciatic nerve divides into tibial and common peroneal nerves [1].

Piriformis is the key muscle of the 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 [2]. Variations in the exit of sciatic nerve in relation to piriformis muscle may lead to nerve compression, which may result in piriformis syndrome. High division of sciatic nerve may lead to incomplete block of sciatic nerve during popliteal block anaesthesia. Clinical manifestations may vary according to type of anatomical variant. This study aims at observing the variations of the sciatic nerve and also its relations to the piriformis muscle according to Beaton and Anson classification.

MATERIALS AND METHODS

Fifty lower limb specimens from twenty five formalin fixed cadavers without any gross pathology are used for this study. The cadavers belong to the Department of Anatomy of our institution. This study includes twenty four male cadavers and one female cadaver. All the cadavers are numbered in a sequential manner. Dissection of gluteal region is done exposing the gluteus maximus muscle. Gluteus maximus is elevated to show the structures under cover of it. Piriformis muscle and the relation of sciatic nerve and its branches to the muscle are well observed and recorded. Dissection of the posterior compartment of the thigh is done to

observe the course of sciatic nerve and its branching pattern.

RESULTS

25 formalin fixed cadavers comprising of 50 lower limbs are used for this study. 41 specimens (82%) showed normal anatomy of sciatic nerve and also piriformis muscle. 9 regions (18%) showed variations in the sciatic nerve. Table 1 shows the type of variation of sciatic nerve observed in the nine regions. Table 2 shows the details of the variations of the sciatic nerve in relation to piriformis muscle. Table 3 shows the branching pattern of sciatic nerve in 50 lower limbs.

Of the 25 cadavers studied, 5 cadavers (20%) showed variations in the sciatic nerve, of which four cadavers (16%) showed bilateral variations and one cadaver (4%) showed unilateral variation of sciatic nerve. Table 4 shows the summary of variations of sciatic nerve observed in the five above mentioned cadavers.

In the present study, according to Beaton and Anson’s classification of relation of sciatic nerve variation to piriformis muscle, 90% (45 specimens) belongs to type I, 4% (2 specimens) belongs to type II and 4% (2 specimens) belongs to type III category. In one left sided gluteal region, common peroneal and tibial nerves branched directly from the lumbosacral plexus. The common peroneal nerve pierced the piriformis and tibial nerve entered under the piriformis. The rootlets forming the common peroneal and tibial nerves are seen in the gluteal region.

Type of sciatic nerve variation observed in 9 regions		No. of specimens showing variations of sciatic nerve	Percentage of variation	Additional features
Variations of sciatic nerve in relation to piriformis muscle		5	10%	One of sciatic nerve in these 5 specimens also showed trifurcation of the nerve at the level of superior angle of popliteal fossa.
High division of sciatic nerve	In the gluteal region immediately below piriformis	2	4%	
	In mid-thigh	2	4%	
Total		9	18%	

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

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	Additional features
Common peroneal nerve pierces the piriformis and tibial nerve runs under the piriformis. Both the nerves run separately throughout. The rootlets forming the tibial and common peroneal nerves are seen in the gluteal region.	1	2%	One of the roots of lumbosacral plexus, forming the common peroneal nerve is seen arising below the piriformis, which later joins with the rest of the roots of the common peroneal nerve, which enters the gluteal region by piercing the piriformis muscle.
Common peroneal component pierces the piriformis and tibial component arises below the piriformis.	2	4%	These two components join inferior to piriformis and bifurcate at the superior angle of popliteal fossa
Common peroneal component arises above the piriformis and tibial component arises below the piriformis.	2	4%	These two components join inferior to piriformis. In one specimen, sciatic nerve is bifurcated, and in another specimen, sciatic nerve is trifurcated at the superior angle of popliteal fossa
Total	5	10%	

Type of branching of sciatic nerve	No. of specimen(s) showing branching pattern of sciatic nerve	Percentage
Tibial component and common peroneal component arises directly from lumbosacral plexus and runs separately throughout, without joining.	1	2%
Trifurcation of sciatic nerve	1	2%
Bifurcation of sciatic nerve	48	96%
Total	50	100%

Table 3: Branching pattern of sciatic nerve.

Table 4: Summary of variations of sciatic nerve observed in the present study.

Cadaver number	Right side	Left side	Inference
Cadaver number 1	High division of sciatic nerve into tibial and common peroneal nerves just below the piriformis	The roots of lumbosacral plexus forming the common peroneal and tibial nerves are observed in the gluteal region. Common peroneal nerve pierces the piriformis and tibial nerve runs below the piriformis. Both the nerves run separately throughout.	Bilateral variation of sciatic nerve is observed in this cadaver
Cadaver number 4	Common peroneal arises above the piriformis and tibial component arises below the piriformis. Both components join inferior to piriformis and trifurcate into tibial nerve, Sural nerve and Common peroneal nerve at the superior angle of popliteal fossa.	Common peroneal pierces the piriformis and tibial component arises below the piriformis. One of the branch of inferior gluteal artery runs between these two nerves, over the piriformis muscle. Both components join inferior to piriformis.	Bilateral variation of sciatic nerve is observed in this cadaver. Trifurcation of sciatic nerve is observed on right side
Cadaver number 10	Normal pattern of sciatic nerve is observed in this side	High division of sciatic nerve into tibial and common peroneal nerves just below the piriformis.	Unilateral variation of sciatic nerve is observed in this cadaver
Cadaver number 16	Common peroneal arises above the piriformis and tibial component arises below the piriformis. Both components join inferior to piriformis.	High division of sciatic nerve into tibial and common peroneal nerves in the posterior compartment of thigh, 9 cm from ischial tuberosity	Bilateral variation of sciatic nerve is observed in this cadaver
Cadaver number 22	High division of sciatic nerve into tibial and common peroneal nerves in the posterior compartment of thigh, 11 cm from ischial tuberosity	Common peroneal pierces the piriformis and tibial component arises below the piriformis. Both components join inferior to piriformis.	Bilateral variation of sciatic nerve is observed in this cadaver
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.			

Figure 1 to figure 5 illustrates the sciatic nerve variations observed in this study.

Fig. 1: Left Gluteal region- showing common peroneal nerve (CPN) piercing the piriformis muscle (P) and tibial nerve (TN) passing under the piriformis. The arrows point out the rootlets of tibial (RTN) and common peroneal nerves (RCPN).

SG- superior gemellus; OI- obturator internus; IG- inferior gemellus.

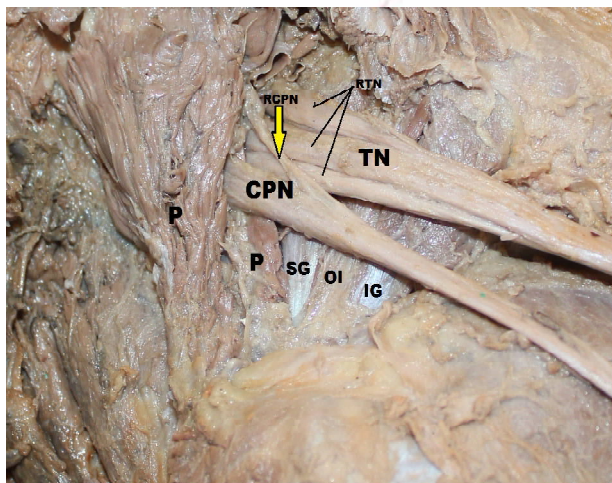


Fig. 2: Left Gluteal region- showing the showing common peroneal nerve (CPN) piercing the piriformis muscle (P) and tibial nerve (TN) passing under the piriformis. A branch of inferior gluteal artery (IGA) runs between the CPN and TN.

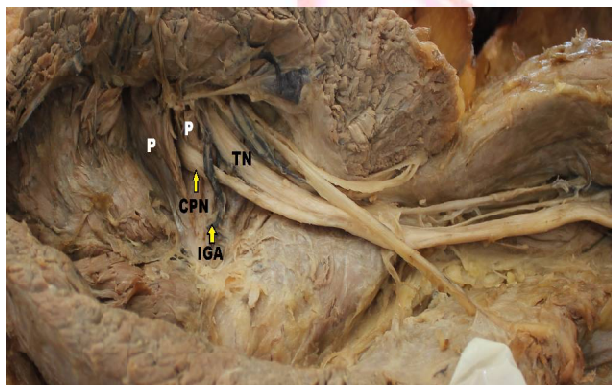


Fig. 3: Right Gluteal region- showing the showing common peroneal nerve (CPN) emerging above the piriformis muscle (P) and tibial nerve (TN) passing under the piriformis.

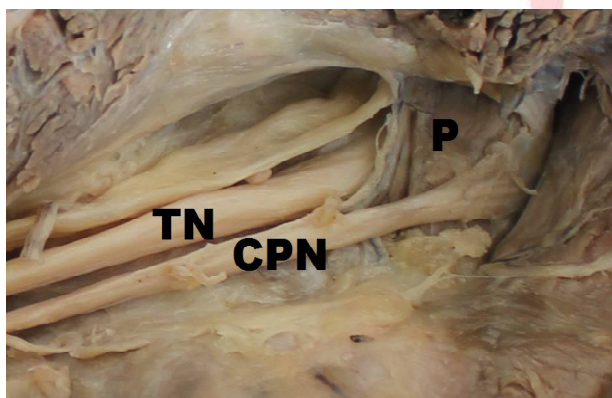


Fig. 4: Left Gluteal region- showing high division of Sciatic nerve (SN) into tibial nerve (TN) and common peroneal nerve (CPN) under the piriformis muscle (P).

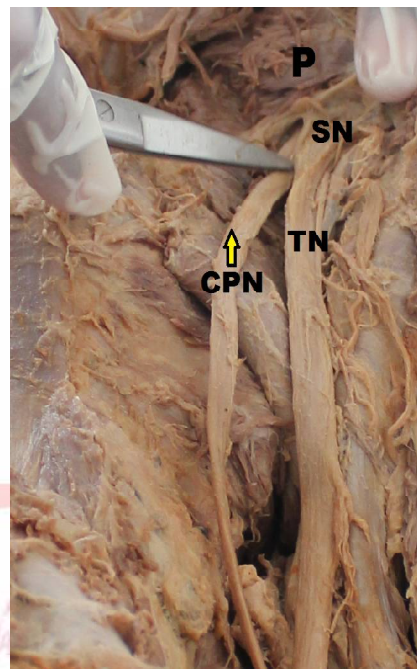


Fig. 5: Right popliteal fossa- showing trifurcation of Sciatic nerve (SN) into tibial nerve (TN), Sural nerve (Su) and common peroneal nerve (CPN).

ST- Semitendinosus muscle; BF- Biceps femoris muscle.



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. 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 [3] and hence the common peroneal and tibial components can separate from each other at various levels from their origin [3,4,5]. Various studies are available in the literatures regarding sciatic nerve variations. The two terminal branches of sciatic nerve may arise directly from the sacral plexus [4].

The present study shows one specimen (2%), where the terminal branches of sciatic nerve arose from the lumbosacral plexus directly and runs separately throughout the course. The common peroneal nerve pierced the piriformis and tibial nerve emerged below piriformis. The rootlets of both nerves are seen in gluteal region. In a study by Shewale et al, 2.22% of specimens studied showed the common peroneal and tibial nerve to emerge separately below the piriformis muscle. The tibial nerve was in rootlet stage [5].

15 to 30% of the sciatic nerve variations in relation to piriformis muscle are reported in the previous studies [6]. The sciatic nerve variation in relation to piriformis is 10% in this present study. Beaton and Anson have classified the relation of sciatic nerve 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

Comparison of previous works on sciatic nerve variation in relation to piriformis muscle to the present study is given in table 5.

Table 5: Comparison of previous works on sciatic nerve variation in relation to piriformis muscle to the present study according to Beaton and Anson classification.

Name of investigator	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Beaton & Anson [7] 120 cadavers	84.20%	11.70%	3.30%	0.80%		
Beaton & Anson [8] 240 cadavers	90%	7.10%	2.10%	0.80%		
Pecina [9] 130 cadavers		6.15%				
Chiba [10] 514 extremities		34%				
Sayson et al [11]						One case
Uluutku & Kurtođlun [12] 25 fetuses	74%	16%	10%			
Moore & Dalley [13] 650 extremities		12.20%	0.50%			
Ozaki et al [14]						One case
Machado et al [15] 100 fetus extremities		16%	2%			
Ugrenovic et al [16] 100 fetuses	96%	2.50%	1.50%			
Pokorny et al [6] 91 cadavers	79%	14.30%	4.40%	2.20%		
Guvencer et al [17] 50 extremities	76%	16%	8%			
Present study	90%	4%	4%			

Specimens of type 4, type 5 and type 6 category of Beaton and Anson's classification is not found in our study. A rare variation of common peroneal nerve passing under the piriformis and tibial nerve passing under the superior gemellus has been reported by Babinski [18] and Mas et al [19]. This variation is not found in this present study.

In the present study, one of the branches of inferior gluteal artery was seen traversing the piriformis muscle in between the common peroneal and tibial components of sciatic nerve in one specimen. The common peroneal emerged by piercing the piriformis and tibial component emerged below the piriformis. One such case was reported by Deopujari et al [20] 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. Aneurysm of such artery may lead to sciatic nerve compression.

Various studies have reported about the high division of sciatic nerve in gluteal region. Shewale et al [5] has reported 11.11% of sciatic nerve division in the gluteal region. Prakash et al [21] has reported 16.3% sciatic nerve division in gluteal region. Guvencer et al [17] has reported that 48% of sciatic nerve divides in the gluteal region. Ugrenovic et al [16] has reported 27.5% of high division of sciatic nerve.

In the present study, high division of sciatic nerve is found in 8% of specimens. 4% of sciatic nerve divided in the gluteal region and 4% in the mid-thigh region.

Trifurcation of sciatic nerve is rarely cited in the literatures. In the present study, trifurcation of sciatic nerve into tibial nerve, sural nerve and common peroneal nerve at the superior angle of popliteal fossa in a right lower limb of a female cadaver is seen in one (2%) specimen. Trifurcation of sciatic nerve into tibial, common peroneal and abnormal trunk in the middle of popliteal fossa has been cited in the literature [22]. The abnormal trunk further divided into lateral cutaneous nerve of calf and peroneal communicating nerve [22]. Bilateral trifurcation of sciatic nerve in the middle of popliteal fossa into tibial, superficial peroneal and deep peroneal nerves has also been reported [23].

In this present study,

1. Sciatic nerve variations are found in 18% of specimens.
2. 10% of sciatic nerve variations are related to piriformis.
3. Roots forming tibial and common peroneal nerves are seen in the gluteal region and the nerves are formed from the lumbosacral plexus directly and run separately in one left lower limb (2%).
4. 90% of type 1, 4% of type 2 and 4% of type 3 variations of sciatic nerve in relation to piriformis muscle are observed according to Beaton and Anson's classification.
5. One of the inferior gluteal artery branches was found in between the common peroneal and tibial components over the piriformis muscle in one specimen.
6. High division of sciatic nerve are found in 8% of specimens
7. Trifurcation of sciatic nerve is a rare entity and in the present study, one specimen on the right side of a female cadaver (2%) showed trifurcation of sciatic nerve into tibial nerve, sural nerve and common peroneal nerve.

CONCLUSION

A good knowledge about the anatomical variations in the formation, course and division of sciatic nerve is important for surgeons, orthopedicians, anaesthetists and other medical professionals to avoid surgical complications, to prevent failure of sciatic block, to prevent sciatic nerve injury during deep intramuscular injections etc. Variation of the sciatic nerve in relation to piriformis or superior gemellus muscle may lead on to nerve compression. Piriformis syndrome may occur due to the variant relation of sciatic nerve to the piriformis muscle. However, anatomical variations in the sciatic nerve and its relation to the piriformis muscle do not seem to be solely responsible for the piriformis syndrome.

To conclude, accomplishment of this study has contributed to the subject of sciatic nerve variations, by confirming previous studies and has also brought out few rare conditions, thereby emphasizing the need for profound anatomical knowledge, for good clinical outcomes.

Conflicts of Interests: None**REFERENCES**

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