
ORIGINAL ARTICLE**Study of Variations in the Divisions, Course and Termination of the Sciatic Nerve***A. D. Shewale¹, R. R. Karambelkar^{1*}, B. N. Umarji²**¹Department of Anatomy, Institute of Medical Sciences and Research, Vidyagiri, Mayani-415102, Tal. Khataav, Dist. Satara, (Maharashtra), India; ²Department of Anatomy, Krishna Institute of Medical Sciences University, Karad – 415110, (Maharashtra), India*

Abstract:

Background: The sciatic nerve is the largest and thickest branch of lumbosacral plexus. It has a long course in the pelvic cavity and in the lower extremity. It separates into its two branches, the tibial and common peroneal nerves outside the pelvis. But the division can occur at any level from the sacral plexus to the inferior part of the popliteal fossa. These anatomical variations in division may cause nerve compression resulting in sciatica, piriformis syndrome, and coccygodynia. *Aim:* The aim of this study is to observe the variations in division of sciatic nerve as compared to known facts. *Methods:* The study was performed on cadavers. The inferior extremities of 45 cadavers were examined and variations of division of sciatic nerve were noted and classified. *Results:* The highest incidence of sciatic nerve variation was observed in its termination. In 11.11% of cases the sciatic nerve was found to be divided in the gluteal region. In 11.11% specimens, the common peroneal nerve pierced the piriformis muscle. *Conclusion:* The higher division of sciatic nerve can result in the involvement of only one out of the two divisions for the sciatic neuropathy. It is important to consider the higher divisions while performing popliteal block anaesthesia.

Key words: Sciatic nerve, sciatica, piriformis, common peroneal nerve, tibial nerve.

Introduction:

The sciatic nerve is the thickest nerve in the body. It is almost 2 cm wide and 0.5 cm thick at its origin near the sacral plexus. It is the largest branch of the lumbosacral plexus and consists of lumbosacral fibres originating from L₄, S_{1,2,3} spinal segments. The nerve leaves the pelvis through the greater sciatic foramen below the piriformis muscle. Then it descends on the posterior surface of the obturator internus, two gemelli and quadratus femoris muscle and divides into its two divisions the tibial and common peroneal nerve. The division is generally seen near the superior angle of popliteal fossa. These two nerve trunks are enveloped by a common fascial sheath representing epineurium of the nerve [1].

The sciatic neuropathy is a result of injuries to the sciatic nerve leading to neurological deficit. Its long course in lower extremity makes it vulnerable to nerve injury from various causes [2]. Several authors have reported variations of its division into tibial and common peroneal nerve from the sacral plexus to the lower part of popliteal fossa [3, 4, 5]. These anatomical variations may contribute to the piriformis syndrome, sciatica, coccygodynia and muscle atrophy [6].

It is important for clinicians to know the various levels of divisions of the sciatic nerve because it is known that each variation in division

has its specific clinical presentation. There is a close relationship between the sciatic nerve and piriformis muscle. The piriformis may compress the sciatic nerve and cause piriformis syndrome [7].

Material and Methods:

A total 45 properly embalmed cadavers (30 males and 15 females) were studied during routine dissection classes in the Dept. of Anatomy KIMSU, Karad. Both the inferior extremities were carefully dissected in order to expose the sciatic nerve and its divisions. Following proper exposure of the pelvis, the evidence of variation in the sciatic nerve was recorded. The sciatic nerve is studied for

1. Its exit through greater sciatic foramen with its relation with piriformis muscle
2. Termination of sciatic nerve into its two divisions.

The variations are divided under following groups.

A) Exit through greater sciatic foramen-

- E1- Single, undivided sciatic nerve below piriformis
- E2- Separate rootlets of tibial nerve along with common peroneal nerve below piriformis (Fig. 1)
- E3- Separate tibial and common peroneal nerve below piriformis (Fig. 2)
- E4- Separate components, common peroneal nerve piercing piriformis.
- E5- Separate components, common peroneal nerve passing above piriformis (Fig. 3)

B) Divisions of sciatic nerve-

- D1- At gluteal region (Fig. 4)
- D2- At upper part of thigh
- D3- At middle part of thigh

D4 - Lower part of thigh near superior angle of popliteal fossa

D5- Lowermost, in the popliteal fossa posterior to knee joint (Fig. 5)



Fig. 1 Showing E2 Pattern

**Pi - Piriformis Muscle, T - Tibial Component
CP - Common Peroneal Component**

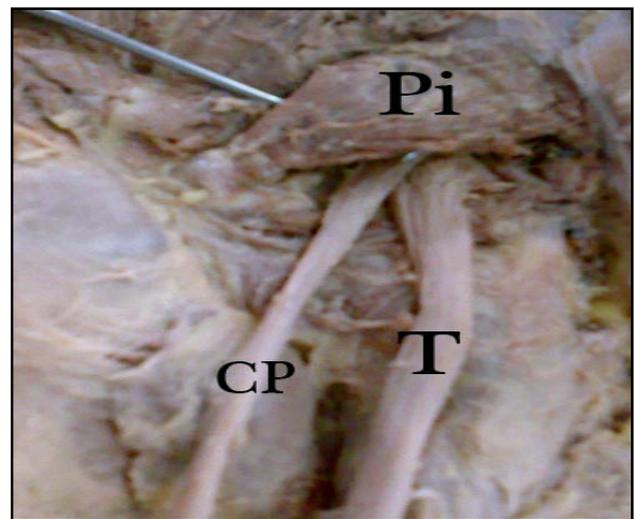


Fig. 2 Showing E3 Pattern

**Pi - Piriformis Muscle, T - Tibial Component
CP - Common Peroneal Component**



Fig. 3 Showing E5 Pattern, Bilaterally
 Pi - Piriformis Muscule, T - Tibial Component
 CP - Common Peroneal Component

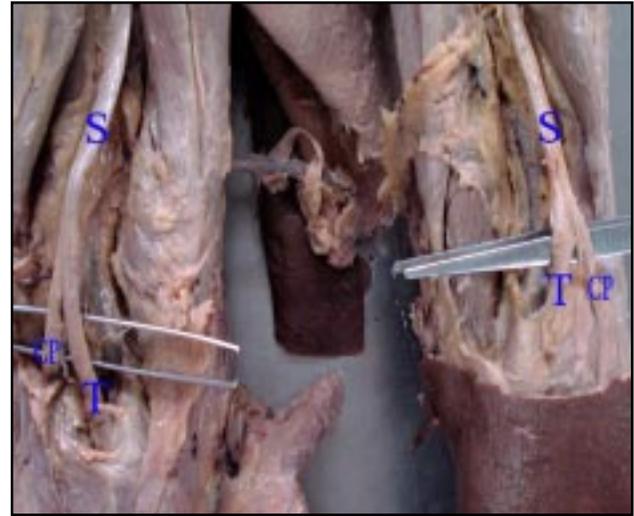


Fig. 5 Showing D5 Pattern, Bilaterally
 S - Sciatic Nerve, T - Tibial Component
 CP - Common Peroneal Component

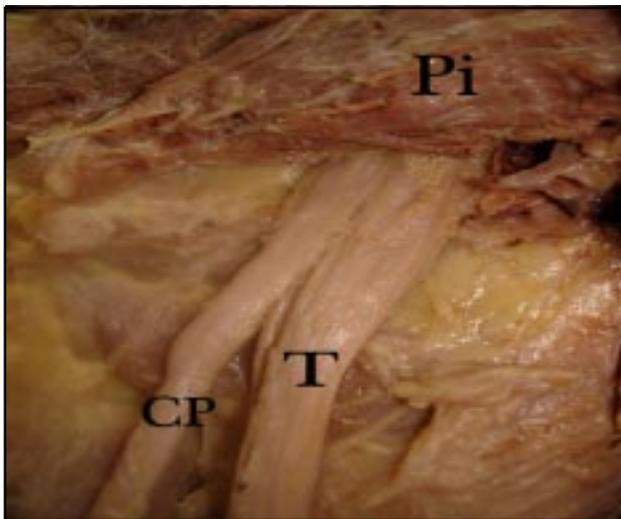


Fig. 4 Showing D1 Pattern
 Pi - Piriformis Muscule, T - Tibial Component
 CP - Common Peroneal Component

Observation and Results:

The sciatic nerve exited the pelvis through the greater sciatic foramen below piriformis as a single nerve without division in 66 of the 90 gluteal regions (73.33%). In 2 specimens (2.22%) both the nerves were separate and the tibial nerve was in separate rootlet form. In 10 specimens (11.11%) both the components were in the infrapiriform compartment but separately emerging while in 10 specimens (11.11%) the components were separate but the common peroneal nerve was piercing the piriformis muscle. Only in 2 specimens (2.23%) the common peroneal nerve was passing above the piriformis and tibial nerve below the muscle.

From the Table 1 it is obvious that in males and females E1 pattern is the most common and E4 pattern is seen more on the right side. While E5 pattern is only seen in females bilaterally.

Table 1- showing variation in exit pattern of sciatic nerve

Exit through greater sciatic foramen												
Male (30)						Female (15)					Total	
	Right (30)	%	Left (30)	%	Total %	Right (15)	%	Left (15)	%	Total %	90	%
E1	23	76.67	22	73.33	75.00	11	73.33	10	66.67	70.00	66	73.33
E2	0	0.00	1	3.33	1.67	0	0.00	1	6.67	3.33	2	2.22
E3	3	10.00	4	13.33	11.67	1	6.67	2	13.33	10.00	10	11.11
E4	4	13.33	3	10.00	11.67	2	13.33	1	6.67	10.00	10	11.11
E5	0	0.00	0	0.00	0.00	1	6.67	1	6.67	6.67	2	2.22

Table 2- showing variation in termination pattern of sciatic nerve

Level of Division of sciatic nerve												
Male (30)						Female (15)					Total	
	Right (30)	%	Left (30)	%	Total %	Right (15)	%	Left (15)	%	Total %	90	%
D1	3	10.00	2	6.67	8.33	3	20.00	2	13.33	16.67	10	11.11
D2	2	6.67	2	6.67	6.67	1	6.67	1	6.67	6.67	6	6.67
D3	1	3.33	1	3.33	3.33	1	6.67	1	6.67	6.67	4	4.44
D4	22	73.33	23	76.67	75.00	9	60.00	9	60.00	60.00	63	70.00
D5	2	6.67	2	6.67	6.67	1	6.67	2	13.33	10.00	7	7.78

Table 2 shows that the common site of division is near the superior angle of popliteal fossa in both sexes, but it can occur in the upper part of thigh and gluteal region also. In females the lowermost division is seen more in popliteal fossa on left side.

Discussion:

The sciatic nerve is the largest branch of the lumbosacral plexus. It usually divides at the upper angle of the popliteal fossa. A number of variations in the course and distribution of the sciatic nerve have been reported. Bifurcation into its two major divisions, tibial and common peroneal may occur anywhere between the lum-

bosacral plexus and lower part of thigh. The two terminal branches of the sciatic nerve may arise directly from the sacral plexus [8].

During embryological development at the base of the limb bud, the nerves contributing to the lower limb form two plexuses, lumbar and sacral. Later as the elements from each of these plexuses grow out into the limb, they get subdivided into dorsal and ventral components for the dorsal and ventral musculature. The sciatic nerve is formed when the large dorsal component of the sacral plexus (common peroneal) and ventral component (tibial) move downwards close together [9]. Hence depending upon the development it is possible that the common

peroneal and tibial nerves separate from each other at different levels from their origins, in the gluteal region, the posterior compartment of the thigh or the popliteal fossa.

Various studies have reported the levels of division of sciatic nerve into tibial nerve and common peroneal nerve. In our study the sciatic nerve has terminated in the gluteal region in 11.11% cases. In males in 10% specimens on right side and 6.67% specimens on left side it has terminated in gluteal region while in females 20% right sided and 13.33% left sided nerves have terminated in the gluteal region. In the study of Prakash et al 2010 [10] 16.3% of specimens have shown the division in the gluteal region. Guvencer et al [11] have examined 50 gluteal regions in 25 cadavers and observed that in 48 % of specimens sciatic nerve has been dividing in gluteal region. Ugrenovic et al 2005 [12] have found high division of sciatic nerve in 27.5% of the specimens in a study performed in 100 fetuses.

When the nerve divides in the pelvis, the common peroneal nerve usually pierces the piriformis muscle. Mouret [13] has concluded that in case of high division of sciatic nerve the common peroneal nerve passes through the piriformis muscle. Odijama and Kurihara 1963 [14], have found the common peroneal nerve to pierce the piriformis muscle more commonly in males and on left side. It is correlating with our study. The sciatic nerve may get divided into the common peroneal nerve and the tibial nerve in the pelvis and each nerve can leave the pelvis using a separate route. Moore et al [4] have reported that common peroneal nerve passing through the piriformis and tibial nerve passing below piriformis is in 12.2% of specimens.

Chiba [15] has reported that common peroneal nerve passing through the piriformis is in 34% of cases in 514 extremities. In our study it has been found in 11.11% of specimens.

Previous anatomical studies have demonstrated 15.30% variation in the relationship between the piriformis and sciatic nerve [16]. The existence of variation has also been reported in many case reports [4-6, 15].

Machado et al 2003 [17] have performed a dissection in 100 fetuses and have reported three types of variations -

A) Type I - The common peroneal nerve penetrating the piriformis and tibial nerve passing under piriformis.

B) Type II - Common peroneal nerve passing above piriformis and tibial nerve below piriformis.

C) Type III - Sciatic nerve piercing piriformis muscle.

The passage of sciatic nerve through the piriformis has also been reported by Pecina 1979 [18] in 22% of 130 cadavers. It has included penetration of the piriformis by the sciatic nerve in 5% and piriformis piercing by common peroneal nerve in 17% specimens. Ugrenovic et al [12] have found high division of the sciatic nerve in 27.5% of the specimens in a cadaveric study performed in 100 fetuses. The sciatic nerve has been seen leaving the pelvis below piriformis in 96% of 200 gluteal regions. The common peroneal nerve has been seen passing below the piriformis in 2.5% of specimens and common peroneal passing above piriformis and tibial nerve below piriformis in 1.5 % of cadavers.

Beaton and Anson 1937 [19], have classified variations of the piriformis and sciatic nerve in

120 specimens in 1937 and in 240 specimens in 1938. Their classification is known as the Beaton and Anson [19] classification. It is as follows -

Type I - Undivided nerve below undivided muscle

Type II - Divisions of nerve between and below the undivided muscle

Type III - Division above and below undivided muscle.

Type IV - Undivided nerve between heads of piriformis

Type V - Divisions between and above the heads

Type VI - Undivided nerve above undivided muscle

Pokorny et al [16] using 91 fresh cadavers have modified the Beaton and Anson [19] classification and stated that the first variation namely the undivided nerve below undivided muscle was the most common type and seen in 79.1% of the specimens. In our study it has been found in 76.67% on right and 73.34% on left side in males while in females it has been 73.34% on right and 66.67% on left side.

In our study Type III variation has been found only in females on both the sides in 6.66% of specimens. Type IV, V and VI variations are not found in our study at all but one more variation has been observed of rootlets of tibial nerve coming out separately below piriformis in 3.33% males and 6.66% females on left side.

Acute sciatic neuropathies commonly result from hip arthroplasty, hip fracture or dislocations. The extent of involvement and neurological deficits vary depending on the level of division of sciatic nerve. A high division of sciatic nerve can result in the escape of either the tibial nerve or common peroneal nerve from one of

the above mentioned variation.

Conclusion:

The knowledge regarding the level of division of sciatic nerve and its mode of exit is of great importance. Abnormal course and division may lead to sciatic neuropathy.

References:

1. Standring S, editor. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 40th ed. 2008. Churchill-Livingstone: Elsevier. ISBN 978-0-443-06684-9.
2. Yuen EC, So YT. Sciatic neuropathy. *Neurol Clin* 1999; 17:617-31.
3. Ross C, Gaddum-Rosse P, Hollinshead WH. Hollinshead's Textbook of Anatomy. 5th ed. Philadelphia: Lippincott-Raven Publishers, 1997: p324-651.
4. Moore KL, Dalley AF. Clinical Oriented Anatomy, 4th edition, Baltimore Lippincott Williams and Wilkins 1999: p558.
5. Arifoolu Y, Sargon MF, Tanyeli E, Yazar F. Double superior gemellus together with double piriformis and high division of the sciatic nerve. *Surg Radiol Anat* 1997; 19: 407-408.
6. Babinski MA, Machado FA, Costa WS. A rare variation in the high division of the sciatic nerve surrounding the superior gemellus muscle. *Eur J of Morphol* 2003; 41(1): 41-42.
7. Broadhurst NA, Simmons N, Bond MJ. Piriformis syndrome: Correlation of muscle morphology with symptoms and signs. *Arch Phys Med Rehabil* 2004; 85(12): 2036-9.
8. Bergman RA, Afifi AK, Miyauchi R. Compendium of human anatomical variations. Baltimore, Urban and Schwarzenberg 1988:

- p146.
9. Demiryurek D, Bayramoglu A, Erbil M, Aldur MM, Mustafa ES. Bilateral divided piriformis muscle together with the high division of the sciatic nerve. *Gazi Med J* 2002; 13:41-4.
 10. Prakash, Bhardwaj AK, Devi MN, Sridevi NS, Rao PK Singh G. Variations in the high division of the sciatic nerve and relationship between the sciatic nerve and the piriformis. *Singapore Med J* 2010; 51(9):721.
 11. Guvencer M, Iyem C, Akyer P, Tetik S, Naderi S. Variations in the high division of the sciatic nerve and relationship between the sciatic nerve and the piriformis. *Turk Neurosurg* 2009; 19(2): 139–144.
 12. Ugrenovic S, Jovanovic I, Krstic V, Stojanovic V, Vasovic L, Antic S, Pavlovic S: The level of the sciatic nerve division and its relations to the piriform muscle. *Vojnosanit Pregl* 2005; 62(1):45–49.
 13. Mouret J. Rapports des muscles pyramidaux avec le nerf sciatique. *Montpell Med.* 1893(2):230-3.
 14. Odajama G, Kurihara T. Supplementary findings to the morphology of the piriformis muscle. *Excerpta Med* 1963; 12: 9-17.
 15. Chiba S. Multiple positional relationships of nerves arising from the sacral plexus to the piriformis muscle in humans. *Kaibogaku Zasshi* 1992; 67(6): 691–724.
 16. Pokorny D, Jahoda D, Veigl D, Pinskerova V, Sonsa A. Topographic variations of the relationship of the sciatic nerve and the piriformis muscle and its relevance to palsy after total hip arthroplasty. *Surg Radiol Anat* 2006; 28(1): 88–91.
 17. Machado FA, Babinski MA, Brasil FB, Favorito LA, Abidu-Figureiedo M, Costa MG. Anatomical variations between sciatic nerve and piriform muscle during fetal period in human. *Int J Morphol* 2003; 21(1): 29–35.
 18. Pecina M. Contribution to the etiological explanation of the piriformis syndrome. *Acta Anat (Basel)* 1979; 105(2):181–187.
 19. Beaton LE, Anson BJ. The relation of the sciatic nerve and its subdivisions to the piriformis muscle. *Anat Rec* 1937; 70(1): 1–5.

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