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To Investigate the Variations of the Sciatic Nerve

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Abstract
Background: To investigate the variations of the sciatic nerve. **Material and Methods:** The study material employed consists of 50 cadavers that have been preserved in formalin, and these cadavers are the property of the Anatomy department of School of Medical Sciences &Research, Sharda University and NIIMS, Greater Noida. The present study comprises a sample of 40 male cadavers and 10 female cadavers. One hundred gluteal regions were dissected, revealing the gluteus maximus muscle. The study involved the observation and documentation of anatomical structures situated beneath the Gluteus maximus, as well as the division of the sciatic nerve in relation to the piriformis muscle. **Results:** Among the sample of 50 cadavers that were examined, it was observed that 10 of them, accounting for 20% of the total, exhibited variations in the structure or arrangement of the sciatic nerve. According to the classification proposed by Beaton and Anson, our study found that 80% (80 regions) of the sample belonged to type I, 11% (11 regions) belonged to type II, 3% (3 regions) belonged to type III, and 1% (1 region) belonged to type VI. Additionally, our study observed that 5% (5 specimens) of the common peroneal and tibial components of the sciatic nerve exhibited independent courses after originating separately from the ventral and dorsal divisions of the sacral plexus. **Conclusion:** The symptoms of compression neuropathy typically vary based on the extent of nerve involvement.
Keywords: Cadavers, Beaton and Anson, Gluteal regions, Piriformis, Sciatic Nerve.

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Introduction

The term "sciatic nerve" (SN) is derived from the Greek word "Ischiadicus" and refers to the widest and longest nerve in the human body, which originates from the sacral plexus. The sacral plexus is established within the pelvic region through the interconnection of the anterior divisions of spinal nerve roots ranging from L4 to S3. The width of the object is approximately 2 centimeters and it is located in close proximity to the sacral plexus. Typically, the nerve emerges from the greater sciatic foramen, traverses the pelvis, and enters the gluteal region by passing beneath the piriformis muscle as a singular nerve encased within a solitary epineural sheath.[1] The sciatic nerve (SN) divides into two branches, namely the tibial nerve (TN) and the common peroneal nerve (CPN), at the superior angle of the popliteal fossa. The sciatic nerve provides innervation to the hamstrings muscles, as well as sensory supply to the hip and knee joints. Additionally, its branches serve as both motor and sensory innervation to the leg and foot. The central focus of variation lies in the association between SN and the piriformis muscle.[2,3] Occasionally, the sacral nerve (SN) may bifurcate into its terminal branches while

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still within the pelvic region, resulting in multiple pathways exiting the pelvis. The nerves in the lower limb are categorized into different types based on their natural pathway and their proximity to the piriformis muscle. The topography and division of SN exhibit notable variations. The occurrence of a higher level of division of the sciatic nerve is a relatively common phenomenon, whereby the nerve may bifurcate into its terminal branches at various locations within the thigh or pelvis. In the latter scenario, the branches or entirety of the nerve may emerge in a location that is either below, above, or through the piriformis muscle. The high division of the sciatic nerve (SN) can occur unilaterally or bilaterally, often causing nerve compression and resulting in piriformis syndrome. The presence of a variant course of the sciatic nerve increases the risk of unintentional injury during surgical procedures in the gluteal region, potentially leading to complications such as coccygodynia.[4] Unintentional injury or compression of the sciatic nerve (SN) results in paralysis or weakness of the muscles in the thigh, as well as significant sensory impairments. Every instance of anatomical variation represents a distinct and context-dependent manifestation that necessitates a comprehensive delineation of diverse types of anatomical variations.[5]

Beaton and Anson classification listed below:

Category I: sciatic nerve beneath muscle
Category II: branches of sciatic nerve between and beneath the muscle
Category III: one branch of sciatic nerve above and other below muscle
Category IV: sciatic nerve between heads
Category V: one branch of sciatic between and another above heads
Category VI: sciatic nerve above the muscle.[6,7]

Piriformis syndrome primarily arises from nerve compression, which is predominantly caused by variations in the bifurcation of the sciatic nerve in relation to the piriformis muscle. The occurrence of partial block of the sciatic nerve during the administration of anesthesia, specifically through a popliteal block, can be attributed to the presence of a high division of the sciatic nerve. The clinical manifestations exhibit variability based on the specific type of variation.

Methodology

The study material employed consists of 50 cadavers that have been preserved in formalin, and study was conducted in Department of Anatomy of SMS & R Sharda University and NIIMS, Greater Noida. The present study comprises a sample of 40 male cadavers and 10 female cadavers. One hundred gluteal regions were dissected, revealing the gluteus maximus muscle. The study involved the observation and documentation of anatomical structures situated beneath the Gluteus maximus, as well as the division of the sciatic nerve in relation to the piriformis muscle.

RESULTS

The study material employed consists of 50 cadavers that have been preserved using formalin. These cadavers collectively comprise a total of 100 specimens specifically focusing on the lower limbs. Eighty percent of the regions examined displayed the sciatic nerve and piriformis muscle in their typical anatomical configuration. A total of 20 regions, accounting for 20% of the sample, exhibited inconsistencies in the sciatic nerve as presented in [Table 1].

Table 1: Normal and variation in sciatic nerve specimens

	Number of Specimens (Limbs)	Percentage (%)
Normal	80	80
Variations	20	20
Total	100	100

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[Table 2] illustrates the analysis of the variations observed in the sciatic nerve in relation to the piriformis muscle. Among the sample of 50 cadavers that were examined, it was observed that 10 of them, accounting for 20% of the total, exhibited variations in the structure or arrangement of the sciatic nerve. According to the classification proposed by Beaton and Anson, our study found that 80% (80 regions) of the sample belonged to type I, 11% (11 regions) belonged to type II, 3% (3 regions) belonged to type III, and 1% (1 region) belonged to type VI. Additionally, our study observed that 5% (5 specimens) of the common peroneal and tibial components of the sciatic nerve exhibited independent courses after originating separately from the ventral and dorsal divisions of the sacral plexus.

Table 2: Sciatic nerve and piriformis muscle variations

Category	**Types of sciatic nerve and piriformis muscle variations**	**Count of specimens with variations of sciatic nerve**	**Variation Percentage (%)**
I	Undivided nerve (sciatic) below undivided muscle (piriformis)	80	80
II	CPN permeates the piriformis and TN emerges below the piriformis	11	11
III	CP N emerges above and TN below the piriformis	3	3
IV	Undivided nerve (Sciatic Nerve) above undivided muscle (Piriformis)	1	1
	High division of sciatic nerve	5	5

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Fig.-1.Sciatic Nerve dividing in popliteal fossa-

Normal course.

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Fig-2.Sciatic Nerve with Common peroneal division and tibial tibial division exiting above and below pyriformis respectively

Fig-3.Sciatic Nerve with division at higher level.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 08, 2023

DISCUSSION

The largest division of the lumbo-sacral plexus is known as the sciatic nerve (SN). The consideration of division level holds significance in both clinical and treatment contexts. The anatomical textbooks and journals did not find any significant differences in the arrangement or division of the sciatic nerve between males and females, and therefore did not observe any such variations. The sacral plexus's dorsal and ventral components undergo a simultaneous downward shift, resulting in the formation of the SN.[8] During posterior hip surgeries, there is a notable occurrence of high division in the sciatic nerve, which can lead to complications such as sciatica, nerve injury resulting from deep intramuscular injections, piriformis syndrome, failed sciatic nerve block during anesthesia, and other related injuries.[9] Various clinical presentations can be observed in cases of compression involving the undivided spinal nerve (SN), common peroneal nerve (CPN), and trigeminal nerve (TN). The Sciatic nerve is formed by the ventral and dorsal divisions of spinal nerves L4 to S3. During development, these divisions undergo a close downward displacement, resulting in the separation of the large dorsal (common peroneal) and ventral (tibial) components at different levels from their emergence.[6,7] A substantial body of research exists on the topic of sciatic nerve abnormalities. The Common Peroneal and Tibial nerves have the potential to originate directly from the sacral plexus as separate entities.[7] In our research, a total of 50 cadavers were examined to investigate variations in the sciatic nerve. Among these cadavers, 10 (22%) exhibited variations in the sciatic nerve. The classification system used in our study, proposed by Beaton and Anson, categorized the observed variations into different types. Specifically, 80% (80 regions) of the specimens were classified as type I, 11% (11 regions) as type II, 3% (3 regions) as type III, and 1% (1 region) as type VI. Additionally, 5% (5 specimens) of the cadavers displayed a unique characteristic where the common peroneal and tibial components of the sciatic nerve ran independently along the entire course, having originated separately from the ventral and dorsal divisions of the sacral plexus. Ugrenovic et al,[10] Beaton and Anson,[11] Pokorny et al,[12] Beaton and Anson,[13] and Uluutku and Kurtoglun,[14] reported comparable findings.

Table 3: Comparison of variations of sciatic nerve with other studies

	Category(%)					
Name of authors	**I**	**II**	**III**	**IV**	**V**	**VI**
Ugrenovic S et al,[10] 100 Foetuses	96.0	2.5	1.5	-	-	-
Beaton and Anson,[11] 240 cadavers	90	7.10	2.10	0.80	-	-
Pokorny et al,[12] 91 cadavers	79	14.30	4.40	2.20	-	-
Beaton and Anson,[13] 120 cadavers	84.20	11.70	3.30	0.80	-	-
Uluutku & Kurtoglun,[14] 25 fetuses	74	16	10	-	-	-
Present Study	80	11	3	-	-	1

The current study demonstrates that 5 specimens (5%) exhibit an independent course of the common peroneal and tibial components of the sciatic nerve. These components emerge separately from the ventral and dorsal roots of the sacral plexus, which are visibly located in the gluteal region. In a study conducted by Shewal et al., it was found that 2.22% of the study material demonstrated the separate emergence of both branches of the Sciatic nerve beneath the piriformis muscle.[15]

CONCLUSION

The symptoms of compression neuropathy typically vary based on the extent of nerve involvement. This can include whether the entire nerve is affected or only specific divisions of the nerve, with the latter being more common in cases of high nerve branching. The diagnosis

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and treatment approach for the compression of the tibial/common fibular division of the sciatic nerve would differ from that of the compression of the entire sciatic nerve. Additionally, there exists the potential for block failure. A comprehensive understanding of these disparities will facilitate the recognition and resolution of complications encountered in diverse fields such as orthopedics, neurology, radiology, anesthesia, and physiotherapy.

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