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Original Research

Anatomical Variations of the Sciatic Nerve Divisions in Relation to the Piriformis Muscle and Clinical Implications: A Human Cadaveric Study

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Abstract
Background: The sciatic nerve is the largest nerve in the human body, formed by the union of five nerve roots (L4- S3) arising from the lumbosacral. The present study was conducted to assess variations of the sciatic nerve.
Materials & Methods: The present cross-sectional study was carried out on 80 lower extremities from 40 formalin fixed cadavers were examined during routine dissection. Anatomical variations were classified based on the Beaton and Anson classification system as Type-1: undivided nerve below undivided muscle b) Type-2: divisions of nerve between and below undivided muscle c) Type-3: divisions above and below undivided muscle d) Type-4: undivided nerve between heads e) Type-5: divisions between and above heads f) Type-6: undivided nerve above undivided muscle.
Results: Type 1 was found in 65 out of 80 (81.25%) lower limbs and is the most common variation in the adult cadaveric studies examined, followed by type 2 in 8, type 3 in 3, type 4 in 2, and type 5 in 2, respectively, as defined by the present study. The difference was significant ($P< 0.05$).
Conclusion: Clinical significance stems from the sciatic nerve's location, bifurcation, and distribution. Because the sciatic nerve is frequently used in routine medical procedures like anaesthesia, rehabilitation, orthopaedics, and neurology, its lengthy course renders it susceptible to damage.
Key words: Sciatic nerve; Common Peroneal Nerve; Tibial Nerve; Piriformis muscle

Introduction

The sciatic nerve is the largest nerve in the human body, formed by the union of five nerve roots (L4- S3) arising from the lumbosacral [1]. It carries two nerve components, namely: the tibial component (L4, 5, S1, S2, and S3) and the common-peroneal component (L4, 5, S1, and S2). This nerve, in normal anatomy, enters the gluteal region from the pelvis through the greater sciatic foramen, passing inferior to the piriformis muscle [2]. Various authors and researchers have found the variations in the level of bifurcation of sciatic nerve into tibial nerve and common fibular nerve from the sacral plexus to the popliteal fossa [3]. Unilateral or bilateral congenital higher divisions of sciatic nerve may lead to compression of sciatic nerve resulting in various clinical conditions during the lifespan of a person like sciatica, piriformis syndrome, sleeping foot, failure/sparing of sciatic nerve block in lower limb surgeries etc [4]. Sciatica is the pain caused by a compression or irritation of the sciatic nerve. Symptoms of sciatica include pain, numbness, tingling and weakness. Piriformis syndrome is one of the causes of sciatica which occur secondary to compression of sciatic nerve due to abnormal form and position of the piriformis muscle [5].
Aims and objectives: The present study was conducted to assess variations of the sciatic nerve.

Materials & Methods

The present cross-sectional study was carried out on 80 lower extremities from 40 formalin fixed cadavers of different medical colleges in Bihar (Jannayak Karpoori Thakur Medical College and Hospital, Madhepura, Jawaharlal Nehru Medical College, Bhagalpur and Sri Krishna Medical College and Hospital, Muzaffarpur) that

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were examined during routine dissection of both genders. Ethical clearance was obtained before starting the study.

Keeping power (1-beta error) at 80% and confidence interval (1-alpha error) at 95%, the minimum sample size required was 60 samples; therefore, we included 80 (more than the minimum required number of cases) lower extremities from 40 formalin fixed cadavers in the present study. The duration of the study was from October 2021 to August 2023.In all 80 lower extremities, the sciatic nerve's bifurcation into the tibial and common fibular nerves was observed and recorded. The gluteal area was dissected layer by layer, wherein the gluteus maximus was exposed and the skin, surface fascia, and deep fascia were reflected. The structures it covered were then exposed when the gluteus maximus was reflected from its origin. The piriformis muscle and sciatic nerve were clean areas nearby. Furthermore, to assess variations in the sciatic nerve's bifurcation level, the popliteal fossa and the posterior compartment of the thigh were also dissected and cleaned [6]. The gluteal regions of these cadavers were carefully dissected, and the gluteus maximus muscle was retracted to expose the piriformis muscle and sciatic nerve. In order to further expose the sciatic nerve's course in the posterior compartment of the thigh, the posterior compartment of the thigh was dissected, and the semitendinosus muscle was separated from the long head of the biceps femoris. The sciatic nerve variation pattern in relation to the piriformis and the frequency and distribution of sciatic nerve bifurcation loci were examined, identified, recorded, and photographed. The Beaton and Anson classification system[7], which divides structural variations of the sciatic nerve with the piriformis muscle in the gluteal area into six (6) categories, was used to identify and classify anatomic variants:

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.

Statistical Analysis: Data thus obtained were subjected to statistical analysis by using Microsoft excel 16 and the Chi-Square tests. P value < 0.05 was considered significant.

Results

The present cross-sectional study was carried out on 80 lower extremities from 40 formalin-fixed cadavers of different medical colleges in Bihar. Out of 40 cadavers, 35 were males and 5 were females (Table I, Figure I).

Table I: Demographic distributions of study cadavers

Number of cadavers (n=40)	Side of lower extremities(n=80)	
	Right side	Left side
Male (n=35)	35	35
Female(n=5)	5	5

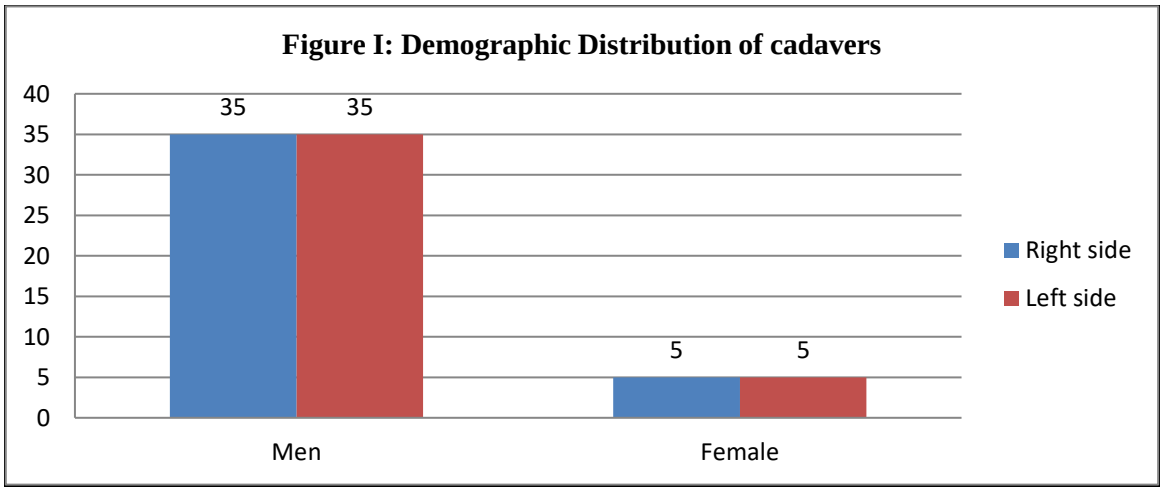

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Table II: Relationship between the sciatic nerve and piriformis muscle according to the Beaton and Anson classification system

Type	Number of lower extremities falling into a particular type N=80)	Percentage	P value
Type 1	65	81.25%	0.01
Type 2	8	10%	
Type 3	3	3.75%	
Type 4	2	2.5%	
Type 5	2	2.5%	
Type 6	0	0	
Type 7	0	0	

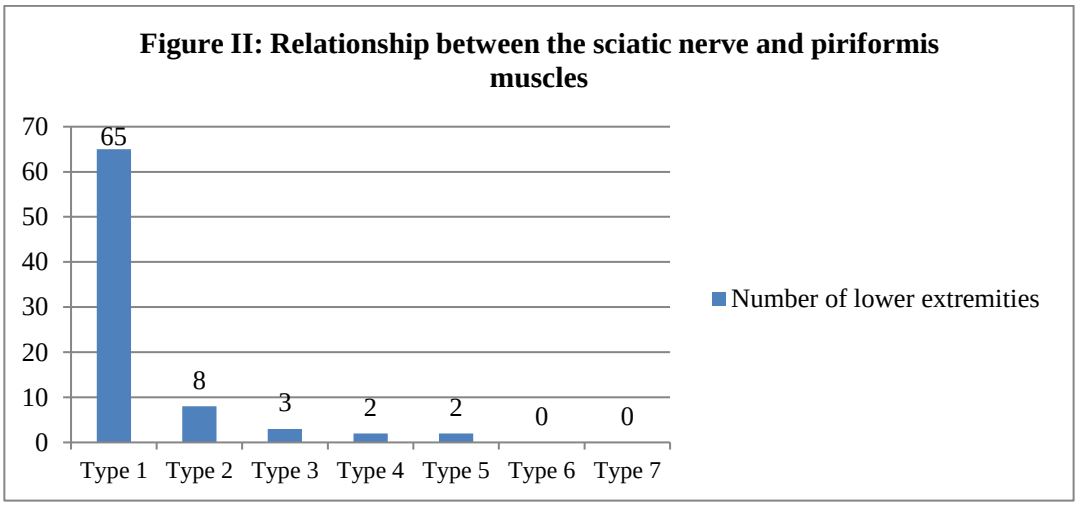

Table: II, figure II shows that Type 1 was found in 65 out of 80 (81.25%) lower limbs and is the most common variation in the adult cadaveric studies examined, followed by type 2 in 8, type 3 in 3, type 4 in 2, and type 5 in 2, respectively, as defined by the present study. The difference was significant (P< 0.05).

Table III: Characteristics of the cadaveric studies observed by different author(s)

Author(s) (year of study)	Sample size	Type 1 N (%)	Type 2 N (%)	Type 3 N (%)	Type 4 N (%)	Type 5 N (%)	Type 6 N (%)	Total variations, N (%)
Beaton and Anson[7] (1937)	240	216 (90%)	17 (7%)	5 (2%)	2 (0.8%)	-	-	24 (10%)
Pećina[12] (1979)	130	102 (78.5%)	27 (20.8%)	1 (0.7%)	-	-	-	28 (21.5%)
Pokorný D et al.[14] (2006)	91	72 (79.1%)	13 (14.3%)	4 (4.4%)	2 (2.2%)			19 (20.9%)
Güvençer et al.[9] (2009)	50	38 (76%)	7 (14%)	4 (8%)	-	-	-	11 (24%)
Patel et al.[18] (2011)	86	81 (94.2%)	5 (5.8%)	-	-	-	-	5 (5.8%)
Sabnis[19] (2012)	140	139 (99.3%)	-	1 (0.7%)	-	-	-	1 (0.7%)
Prathiba et al.[17] (2013)	100	92 (92%)	3 (3%)	1 (1%)	-	-	-	4 (4%)
Adibatti et al.[20] (2014)	50	47 (94%	3 (6%)	-	-	-		3 (6%)
Lewis et	102	90 (88.2%)	9	3 (2.9%)	-	-	-	12 (11.8%)

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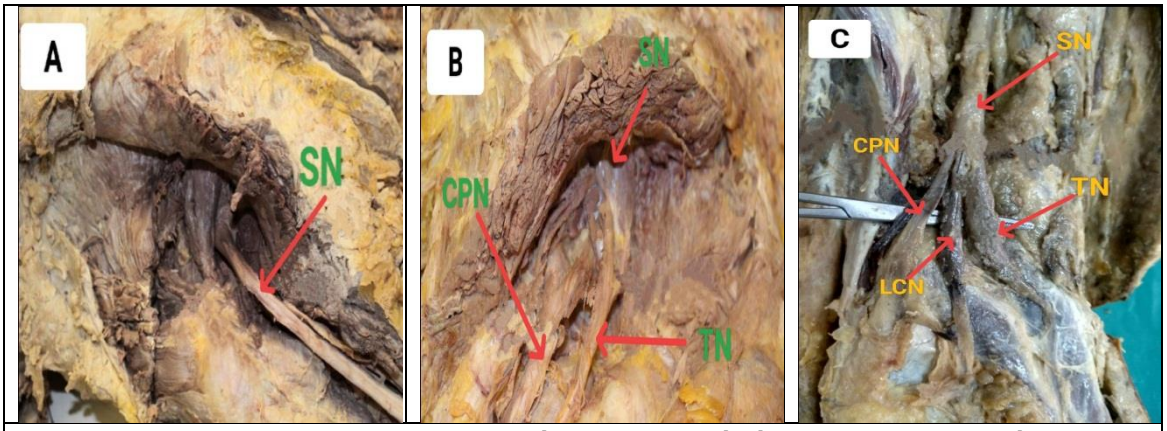
al.[10] (2016)			(8.8%)					
Present study	50	65 (81.25%)	8 (10%)	3 (3.75%)	2 (2.5%)	2 (2.5%)	-	9 (18%)



SN = Sciatic Nerve; CPN = Common Peroneal Nerve; TN= Tibial Nerve; LCN = Lateral Cutaneous Nerve

Figure A: sciatic nerve having no branch

Figure B: sciatic nerve divided into two branches: common peroneal nerve and Tibial nerve

Figure C: sciatic nerve divided into three branches: Common Peroneal Nerve, Tibial Nerve, and Lateral Cutaneous Nerve branches

Discussion

The sciatic nerve is 2 cm wide at its origin and is the thickest nerve in the body. Sciatic nerve leaves the pelvis enters into the gluteal region via the greater sciatic foramen below piriformis.[8] Afterwards, it passes between the greater trochanter and ischial tuberosity and descends into the posterior compartment of thigh and divides into the tibial nerve and common fibular nerve at a varying level proximal to the knee.[9,10] The tibial nerve is medial and consists of ventral divisions of anterior primary rami of L4, L5, S1, S2, S3, while common fibular nerve is lateral and consists of dorsal divisions of anterior primary rami of L4, L5, S1, S2.[11,12] The sciatic nerve supplies the muscles of back of thigh, muscles of leg and foot and mostly whole of the skin of leg. It divides mostly at the apex of the popliteal fossa in the lower part of the posterior compartment of thigh.[13,14]The present study was conducted to assess variations of the sciatic nerve. We found that type 1 was seen in 65, type 2 in 8, type 3 in 3, type 4 in 2 and type 5 in 2 case. Javia et al.[15] in their study a total of 102 lower extremities from 51 formalin fixed cadaver were divided into six groups (Group A to F), according to the level of bifurcation of sciatic nerve into tibial nerve and common fibular nerve; in the pelvis (Group A), in the gluteal region (Group B), in the upper (Group C), middle (Group D) and lower (Group E) part of posterior compartment of thigh, in the popliteal fossa (Group F). Numbers and percentages of the lower extremities falling in particular group were calculated and table was formed accordingly. They found 24 (23.53%) lower extremities in Group A, 4 (3.92%) in Group B, 2 (1.96%) in Group C, 3(2.95%) in Group D, 48(47.06%) in Group E and 21(20.59%) in Group F. The lower part of posterior compartment of thigh was the most common (47.06%), within the pelvis prior to exit into the gluteal region is the second most common (23.53%) and the upper part of posterior compartment of thigh was the least common (1.96%) level of bifurcation of sciatic nerve into tibial nerve and common fibular nerve.

Atoni et al.[16] examined and identified sciatic nerve variations in relation to the piriformis muscle, its prevalence, pattern and the course of its bifurcation loci. 28 formalin fixed male cadavers comprising 56 lower limbs were used for this study. Dissection of the gluteal region and posterior compartment of the thigh was conducted to expose the sciatic nerve. Variations in the sciatic nerve anatomy, their relationship to the piriformis muscle and points of bifurcation, and other observable features were noted and recorded. Fifty-two lower limbs (93%) showed normal anatomy of the sciatic nerve. Four regions (7.1%) showed variations in the morphology of the sciatic nerve. Of these, one (1.8%) showed a variation of the sciatic nerve with the piriformis muscle. This single case showed a common peroneal nerve emerging on the left between the heads of a double piriformis muscle - a variant not described in the original Beaton and Anson classification, with the tibial nerve deep to the muscle. In two other limbs, the sciatic nerves showed a normal relationship with the piriformis, but had

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variations in the bifurcation loci (bilateral). The divisions were in upper third and middle third of the right and left thighs respectively.

Limitations of the study

The limitation of the study is the small sample size and short duration of study.

Conclusion

Authors found that clinical significance stems from the sciatic nerve's location, bifurcation, and distribution. Because the sciatic nerve is frequently used in routine medical procedures like anaesthesia, rehabilitation, orthopaedics, and neurology, its lengthy course renders it susceptible to damage.

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