

Anatomical Variations in the Bifurcation of the Sciatic Nerve, A Cadaveric Study and its Clinical Implications

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Abstract

Descriptions of Entrapment Neuropathies involving the peripheral nerves are relatively common, especially in Sciatic nerve (SN). Sciatic nerve is the largest nerve in the body. It originates from the sacral plexus from L4-S3 roots in form of two nerve trunks. The Tibial nerve (TN) and Common Peroneal nerve (CPN) are encompassed by single epineural sheath and eventually separates. Variations in the level of bifurcation of the Sciatic nerve are common and being reported by several authors. It is broad and flat at its origin, peripherally it becomes rounded. The bifurcation into its two major trunks TN and CPN may occur anywhere between the sacral plexus and popliteal space. Significant number of variations in the bifurcation, course, relation and distribution of its branches were encountered in sciatic nerve. These variations may cause nerve compressions under other anatomic structures, resulting in non discogenic sciatica. The aim of this study was to provide and define the level of the SN exit, its divisions and its anatomical variation obtained from human cadavers. The differences in the exit of these two branches are important in clarifying clinical etiology.

Keywords: Sciatic nerve; Tibial nerve; Common peroneal nerve; Piriformis; Sciatica; Anatomic variation; Popliteal block

Introduction

Sciatic is Greek word derived from "Ischiadicus". The sciatic nerve is also known as the ischiadic nerve or ischiatic nerve, is a large nerve in humans and other animals. It is the longest and widest single nerve in the human body. The sciatic nerve is comprised of five nerves. It is formed on the right and left hand side of the lower spine. It is derived from the spinal nerves L4-S3. It contains fibers from both the anterior and posterior divisions of the lumbosacral plexus. It runs from each side of the lower spine, deep in the gluteal region, back of the thigh all the way down to the foot via its branches, connecting the spinal cord with the leg and foot muscles. It supplies nearly the whole of the skin of the leg, the muscles of the back of the thigh, and those of the leg and the foot. Commonly at the apex of popliteal fossa (PF) the sciatic nerve bifurcates (85-89%) into Tibial nerve (TN) and Common Peroneal nerve (CPN). Pain caused by a compression or irritation of the sciatic nerve is called sciatica. The sciatica symptoms include nerve pain, numbness, tingling, and weakness. It may include inability to walk depending upon the where the pressure of the sciatic nerve occurs. Investigations are CT-scan, MRI, EMG (electrical activity of the muscle) and Nerve conduction test and Blood tests are routinely done to identify nerve pathology.

This present study was to describe and analyze sciatic nerve variation in relativity to the statistical analysis. The knowledge of the variation in the level of bifurcation of the sciatic nerve should be kept in consideration while performing surgical exploration. Clinical significance and some relevant previous studies will be presented in this work. A frequent variation in this regard calls for Surgeons attention to avoid error in treatment.

Materials and Methods

50 gluteal regions were examined in 25 formalin fixed cadavers with no pathology during the period of 2 years. Twenty of the cadavers were male and five were female. The Gluteus maximus was elevated to explore the piriformis and the sciatic nerve. Following the proper exposure the location of the SN and its exit from pelvis and the level of

the SN division were all recorded. Normally Sciatic nerve bifurcates at the superior angle of popliteal fossa in 80-90% of individuals.

Observations

Variations in SN bifurcation were seen in 4 cadavers that is in three males and one female. Totally six lower limbs showed variation in the division of sciatic nerve (Figures 1-5). Male cadaver on the left lower limb showed that sciatic nerve divided in the pelvis, CPN nerve emerged through the bifid piriformis and TN below the muscle (Figure 2). Male cadaver had variation in both the limbs. On the right, sciatic nerve divided at the ischial tuberosity and on the left, Sciatic nerve divided in pelvis and both TN and CPN emerged below the piriformis (Figure 3). Male cadaver showed bilateral variation. Sciatic nerve on the right side divided about 50 mm above the popliteal crease (0-150 mm) but below the superior angle of popliteal fossa. On the left side Sciatic nerve divided at the level of the popliteal crease (Figure 4). Female cadaver on the right side, sciatic nerve divided in the pelvis, CPN emerged above the piriformis and TN below the muscle (Figure 5).

Discussion

Most of the text books of Anatomy, Orthopedic and Surgery state that the sciatic nerve 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 %) [1]. Interpretation of the nerve variation in the limbs requires a consideration of Phylogeny and development of the

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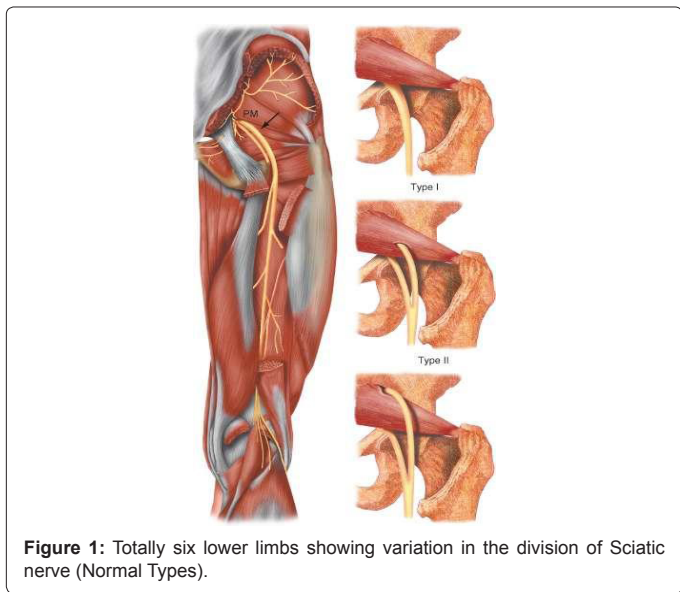


Figure 1: Totally six lower limbs showing variation in the division of Sciatic nerve (Normal Types).

The present study showed b and c type which was demonstrated by Bergman et al. [2]. Topographic variations of the relationship of the sciatic nerve and piriformis muscle and its relationship was studied by Pokorny et al. [3]. The authors studied 91 cadavers and found an atypical relationship in 19 cadavers (20%). In their study, individual variations were found. According to them SN exist below the piriformis muscle in 79.1% cases, SN separates into divisions, one branch passing through the muscle and other below it (14.3%). An unsplit nerve passes through piriformis muscle (2.2%). The incidence of anatomical variation of both SN and piriformis is 15-30%.

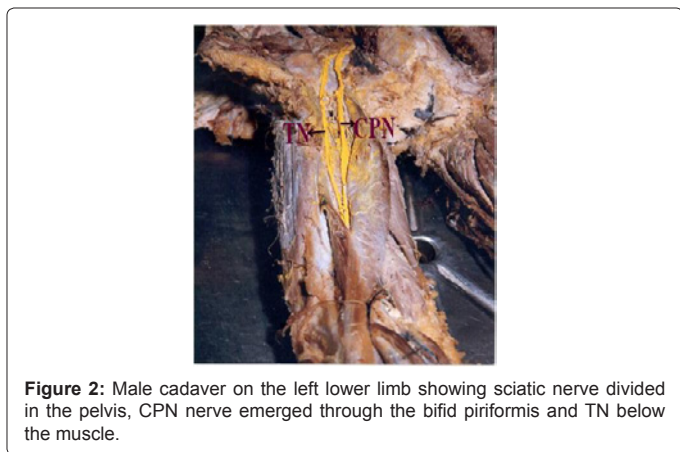


Figure 2: Male cadaver on the left lower limb showing sciatic nerve divided in the pelvis, CPN nerve emerged through the bifid piriformis and TN below the muscle.

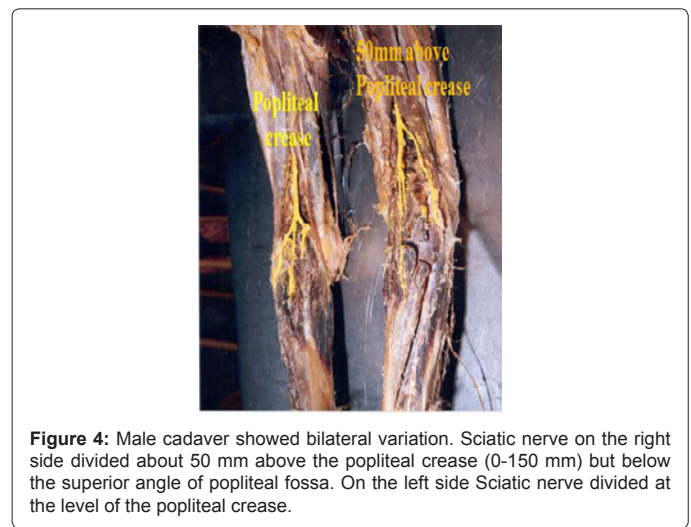


Figure 4: Male cadaver showed bilateral variation. Sciatic nerve on the right side divided about 50 mm above the popliteal crease (0-150 mm) but below the superior angle of popliteal fossa. On the left side Sciatic nerve divided at the level of the popliteal crease.

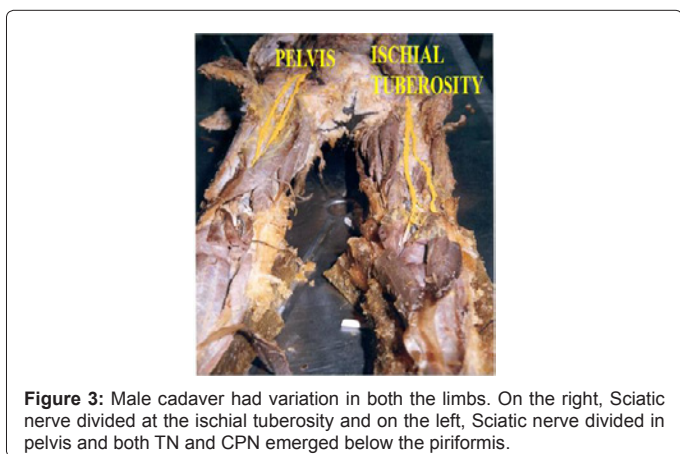


Figure 3: Male cadaver had variation in both the limbs. On the right, Sciatic nerve divided at the ischial tuberosity and on the left, Sciatic nerve divided in pelvis and both TN and CPN emerged below the piriformis.

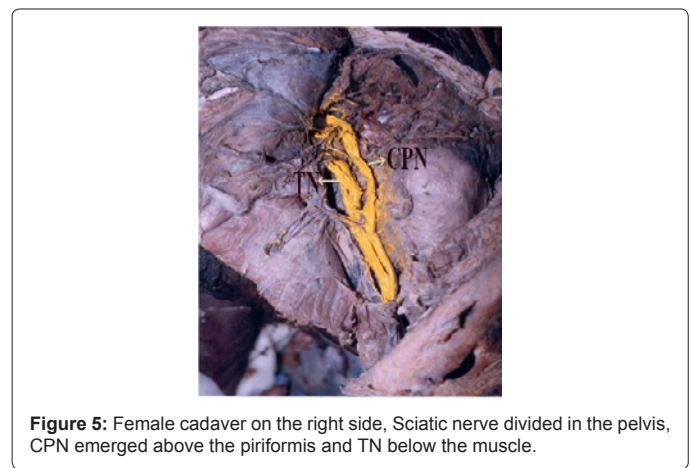


Figure 5: Female cadaver on the right side, Sciatic nerve divided in the pelvis, CPN emerged above the piriformis and TN below the muscle.

sacral plexus. This study builds on previous reports in literature and re-emphasises the importance of identifying sciatic nerve bifurcation levels. Its pattern of bifurcation on the right and left side and male and female were not of significant in anatomy texts and journals. Height of an individual and level of bifurcation of the nerve are not related [2] (Figure 6).

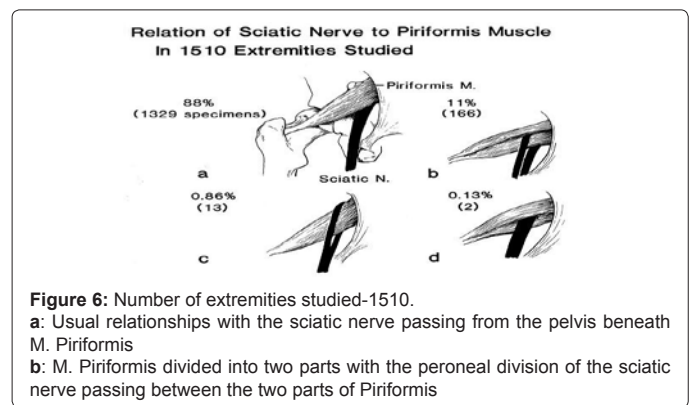


Figure 6: Number of extremities studied-1510. a: Usual relationships with the sciatic nerve passing from the pelvis beneath M. Piriformis b: M. Piriformis divided into two parts with the peroneal division of the sciatic nerve passing between the two parts of Piriformis

The level of the sciatic nerve division and its relation to the piriformis muscle was also studied by Ugrenovic et al. [4]. According to them SN left the pelvis through the infrapiriform foramen in 192 lower limbs (96% cases), while in 8 lower limbs (4%) the variable relations between SN and piriformis muscle were detected. CPN penetrated the piriformis and left the pelvis in 5 limbs (2.5%) and TN left the pelvis through the infrapiriform foramen. In 3 limbs (1.5%) CPN was present above the piriformis and TN was below the piriformis. The present study showed atypical relationship in 4 cadavers, but in 6 lower limbs it showed (12%) atypical relationship.

Sharma et al. [5] observed in routine dissection of 60 years male cadaver that two divisions of SN were separate in the gluteal region on both the sides with TN passing below the piriformis and CPN piercing the piriformis muscle. The high division may account for failures in the popliteal block. Similar feature was observed in our one male cadaver. The division of the SN in the popliteal fossa is related to anatomical implications for popliteal nerve blockade. Vloka et al. [6] concluded in their studies that SN divided at a mean distance ranging from 0-115 mm above the popliteal fossa. An ideal popliteal block is by insertion of the needle at 100 mm above the popliteal crease i.e. proximal to division of SN. Saleh et al. [7] mentioned in their studies that SN division occurs at a variable level about the 50-180 mm above the knee and may account for frequent failures with popliteal blocks.

The present study had a male cadaver with bilateral variation in the division of SN in the popliteal region. On the left side SN divided exactly at the popliteal crease, and on the right, SN divided at about 50 mm from the popliteal crease. It is a rare finding. According to the classical teaching the popliteal block is done by insertion of the needle at 100 mm above the popliteal crease. Variations in the high division of the SN and relationship between the SN and the Piriformis were studied by Guvencer et al. [8]. Their study included 25 male cadavers. Their results was that in 52% of cases the SN exited as whole nerve without any division, whereas in 48% a high division was observed. According to them, 24% of cases CPN left the pelvis above and TN below the piriformis and 24% of cases followed different route. Our study also included 25 cadavers, 20 were male and 5 were female cadavers. The results of anatomical variations were only seen in 4 cadavers in our study with high division of SN in 4 lower limbs (8%). The differences in their exit routes of these two nerves are important clinical etiology of sciatica and require reviewing the Piriformis syndrome. A rare variation in the high division of the SN surrounding the superior gemellus muscle was observed by Babinski et al. [9]. In their paper they described a new anatomical variation in which the CPN passed superior and TN inferior to superior gemellus muscle. Such variations may contribute piriformis syndrome, coccygodynia and muscle atrophy. This type of variation was not seen in our study. Arifoglu et al. [10] reported a case with double superior gemellus and double piriformis muscles associated with the SN dividing high and passing between two Piriformis. It has not previously been described in the literature. Supernumerary superior gemellus and piriformis muscles may exert pressure on the SN and should be taken into account by the clinicians. Similar SN divisions were not found in our cadavers.

To conclude, the present study was done in 25 cadavers (50 lower extremities). The variations were seen in 6 lower limbs (12%) with the frequency, as shown in (Figures 3-6). However, it may rarely be separated within the pelvis. In such cases, the tibial nerve and the common fibular nerve may leave the pelvis through different routes. These variations may cause nerve compressions under other anatomic structures, resulting in non-discogenic sciatica. The aim of

this study was to define the level of the SN exit and of the SN division. The present study had high terminal division of sciatic nerve in the posterior femoral region i.e. at the level of ischial tuberosity or in the pelvis (detected in 8% of the cases). Clinically, it must be kept in mind during performing of popliteal block anesthesia. We describe another anatomical variation in which CPN passed through the bifid piriformis and TN below piriformis. Such anatomical variation may attribute for piriformis syndrome or coccygodynia and muscle atrophy. The deep gluteal region is often encountered when performing injections and hip replacement surgeries. Diagnosis of nerve anomalies is done by using imaging techniques. The piriformis and SN anomalies have ranged from 1.5-35.8% in dissected human specimens as published in literature [11]. Sciatic Endometriosis is rare condition detected by MRI, where there is cyclic pain vary with menstrual cycle. It is treated by local excision. In untreated cases there is a cicatricial change in SN, which requires radical surgery. Amputation at knee, care to be taken to isolate sciatic artery and then tied without nerve fibers otherwise there may be severe pain in the stump or severe bleeding.

Conclusion

The sciatic nerve is frequently involved in daily medical practice of neurology, orthopedics, rehabilitation and anesthesia. Sciatic neuropathy is the result of injuries, leading to neurological defects. Its long course makes it vulnerable to nerve injury. Even in this era the cadaver is the best means to study anatomy. The main essence of this study is to get some information on variation of the sciatic nerve anatomy. The principal author was confronted with SN and its bifurcation variations in the routine cadaveric dissections while teaching the undergraduate students. This study systematically reviews previous studies from the literature. It emphasizes proper clinical implications, for the surgeons to practice efficient surgical recombination and avoid errors. Treatment aimed at maximizing the mobility of the lower extremity.

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References

1. Standring S (2005) Gray's Anatomy 39th Edition: The Anatomical Basis of Clinical Practice. *AJNR* 26: 2703-2704
2. Bergman RA, Afifi AK, Miyauchi R (1972) Human Anatomic Variation: Opus III: Nervous System Variations in Relation of Sciatic Nerve to M. Piriformis. *Anatomy atlases*.
3. Pokorný D, Jahoda D, Veigl D, Pinskerová V, Sosna A (2006) 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* 28: 88-91.
4. Ugrenović S, Jovanović I, Krstić V, Stojanović V, Vasović L, et al. (2005) The level of the sciatic nerve division and its relations to the piriform muscle. *Vojnosanit Pregl* 62: 45-49.
5. Sharma T, Singla RK, Lalit M (2010) Bilateral eventration of sciatic nerve. *JNMA J Nepal Med Assoc* 50: 309-312.
6. Vloka JD, Hadžić A, April E, Thys DM (2001) The division of the sciatic nerve in the popliteal fossa: anatomical implications for popliteal nerve blockade. *Anesth Analg* 92: 215-217.
7. Saleh HA, El-fark MM, Abdel-Hamid GA (2009) Anatomical variation of sciatic nerve division in the popliteal fossa and its implication in popliteal nerve blockade. *Folia Morphol (Warsz)* 68: 256-259.
8. GUVENÇER M, İYEM C, AKYER P, TETİK S, NADERİ S (2009) Variations in the high division of the sciatic nerve and relationship between the sciatic nerve and the piriformis. *Turk Neurosurg* 19: 139-144.

9. Babinski MA, Machado FA, Costa WS (2003) A rare variation in the high division of the sciatic nerve surrounding the superior gemellus muscle. *Eur J Morphol* 41: 41-42.
10. Arifoglu Y, Sürücü HS, Sargon MF, Tanyeli E, Yazar F (1997) Double superior gemellus together with double piriformis and high division of the sciatic nerve. *Surg Radiol Anat* 19: 407-408.
11. Smoll NR (2010) Variations of the piriformis and sciatic nerve with clinical consequence: a review. *Clin Anat* 23: 8-17.