

ANATOMICAL STUDY OF COURSE, RELATION, DIVISION AND MODE OF TERMINATION OF SCIATIC NERVE

Anatomy

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ABSTRACT

INTRODUCTION: Sciatic nerve is the largest nerve in the human body which arises from the sacral plexus. It enters the gluteal region just below the piriformis muscle and divides into the tibial nerve and common peroneal nerve at the superior angle of the popliteal fossa. But the division can occur at any level which may leads to the many clinical conditions. Current study was designed to know the course, relation, division and mode of termination of sciatic nerve. The knowledge of variations in emergence and division of the sciatic nerve is clinically important during surgical procedures to prevent injury to the nerve thus preventing conditions like piriformis syndrome, sciatica etc.

KEYWORDS

Sciatic nerve, Course, Relation, Termination

INTRODUCTION

Sciatic nerve [SN], also known as ischiatic nerve or ischiadic nerve, supply the vast majority of the motor and sensory function to the lower limb (18). After arising from the lumbosacral plexus, it runs along the back of the thigh then dividing into tibial nerve [TN] and the common peroneal (fibular) nerves [CPN] at a varying level proximal to the knee joint. The point of bifurcation of the sciatic nerve is very variable. The commonest site is the junction of the middle third and lower third of the back of the thigh, near the apex of the popliteal fossa, but division may occur at any point above this and rarely may occur below it (20).

Sciatic nerve is frequently involved in daily medical practice of neurology, orthopedics, rehabilitation and anesthesia. Sciatica neuralgia is defined as pain in the distribution of the sciatic nerve. As per the most accurate definition, it is a form of radicular pain, and is described as a disease of the peripheral nervous system. The term 'sciatica' may cause confusion as it has been used to describe any pain, including referred, felt in the leg along the distribution of the sciatic nerve. The vast majority of patients presenting with sciatica, have a spinal cause, such as disc herniation or rupture causing impingement of L5 or S1 nerve roots. Other common causes include spinal stenosis, degenerative disc disease, and spondylolisthesis. There are also many non-spinal causes or sciatica, which are less common. These include piriformis syndrome, trauma, post-operative complications, gynecologic conditions, and herpes zoster. Symptoms include mid-buttock pain that radiates down the leg, most often unilaterally. The patient often experience paresthesias in a dermatomal distribution, either L5 or S1 depending on where the sciatic nerve is being irritated. Weakness and changes in reflexes are less commonly seen (9).

Studies regarding relationship of sciatic nerve with piriformis helps in understanding piriformis syndrome, which is an under diagnosed cause of gluteal and leg pain by some physicians, but according to some authors it is vastly over diagnosed. The close relation of the muscle to the sciatic nerve makes it possible to trauma and inflammation in which it is represented as sciatic pain. If regional anatomy is not known to the physician then the identification of the syndrome and accurate diagnosis are usually difficult (6).

Piriformis syndrome not only occurs due to piriformis hypertrophy, inflammation or irritation, but also may be caused by congenital variations of the piriformis and the SN. It occurs secondary to the compression of the SN by an abnormal piriformis. In other words, the compression of the unsplit SN, the CPN and the compression of the TN may cause different clinical pictures (24).

This syndrome may also occur in sportsmen who require excessive use of the gluteal muscles (e.g.-in ice skaters, cyclists & rock climbers). Any traumatic injury to the gluteal region is associated with hypertrophy and spasm of the piriformis muscle. It leads to sciatic nerve entrapment. In females also, during pregnancy uterus may press the roots of sciatic nerve and can damage it. So awareness of such variations of sciatic nerve is important clinically and therapeutically (10).

MATERIAL AND METHOD

Material for the present study comprised of 30 embalmed adult human cadavers (25 male cadavers and 5 female cadavers) to study 60 lower limbs obtained from the department of Anatomy of our Institute. The limbs were dissected as per guidelines given by Romanes GJ in Cunningham Manual of Practical Anatomy to expose sciatic nerve from its exit from greater sciatic foramen in gluteal region up to its termination (19).

Width of sciatic nerve as it emerges from greater sciatic foramen was measured with the vernier caliper. Its relation with the piriformis muscle at its exit from the greater sciatic foramen was noted whether it comes below, above or through the piriformis muscle and if it has divided into its terminal branches within the pelvis which branch (Tibial/CPN) and its relation with the piriformis muscle.

Termination of the sciatic nerve was studied as follows:

- Mode of termination of the sciatic nerve was seen whether it bifurcates or trifurcates.
- Its level of termination was seen whether at the junction of middle or lower thirds of the thigh, anywhere in the popliteal fossa (apex, middle or lower) or whether at higher level near its exit from greater sciatic foramen or within the pelvic cavity.
- Terminal branches i.e. Tibial nerve and Common Peroneal nerve were seen.
- Any communication between these two branches was seen.
- Any variation at this level was observed.

Statistical analysis was done using the chi-square test and values $p < 0.05$ were considered significant.

RESULTS AND DISCUSSION

1. The width of the sciatic nerve

In the present study the width of the sciatic nerve at its exit from greater sciatic foramen was measured. The mean width was 1.47 ± 0.27 cm on left side and 1.50 ± 0.28 cm on right side. The difference between the two sides was statistically insignificant (p value 0.760). Brooks et al (6) found the width of sciatic nerve to be 19.463 ± 5.238 mm on left side and 19.451 ± 5.246 mm on right side. The difference between the 2 studies may be attributed to the racial factors as earlier study was done on Brazilian cadavers.

II. Relation of sciatic nerve with piriformis at its exit from greater sciatic foramen

Out of the dissected lower limbs in only three limbs the common peroneal nerve pierces the piriformis muscle and the tibial nerve emerges below the piriformis muscle. In rest of the cadaveric limbs the sciatic nerve emerges undivided below the piriformis muscle (Figure1).

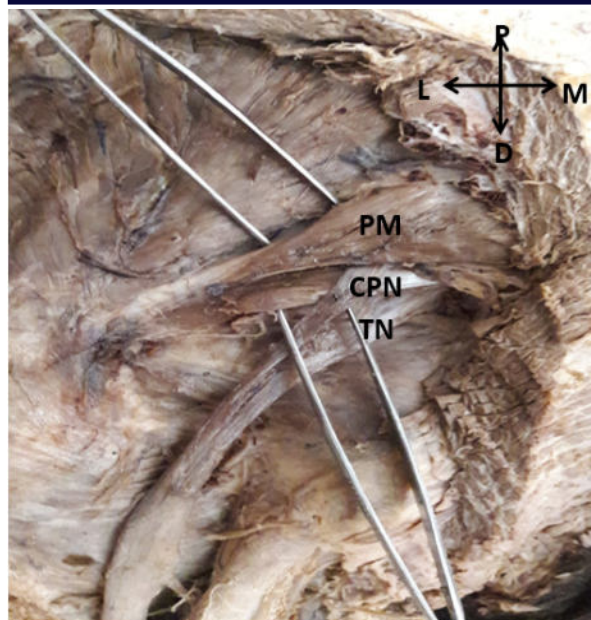


Figure 1 Entrapment of sciatic nerve with common peroneal nerve (CPN) piercing piriformis muscle (PM) and tibial nerve (TN) emerging below it.

Various authors have reported many variations of sciatic number in relation to the piriformis muscle in different populations. Work done by Beaton and Anson (2) and Beaton (3) reported different levels of the division of the sciatic nerve out of which highest percentage was noted for the undivided sciatic nerve passing below the piriformis muscle. However they also reported the division of the sciatic nerve occurring between and below, above and below the undivided piriformis muscle and the undivided nerve passes between two heads of piriformis muscle. Similar kind of variations have also been reported in other studies on the different populations (8, 11, 14, 16, 17, 21, 25-27). Some authors have documented only the division of the sciatic nerve occurring between and below the piriformis (7, 13, 15). However Sayson et al (22) came with different results from the above studies. Their study found a single case with the undivided sciatic nerve was passing above the undivided piriformis muscle.

Piriformis syndrome is not common and is often undiagnosed reason for pain buttock and leg regions. The cause behind this pain is because of the anatomic abnormalities of the piriformis muscle which has resulted in the irritation of the sciatic nerve (4, 12). As the sciatic nerve comes out of the greater sciatic notch in the gluteal region abnormally, it can be entrapped. So the surgeons while dealing with the piriformis syndrome should keep these differences in their mind as 5-6% of the patients with the back and the leg pain are referred for the treatment (23). However, physician can misdiagnose if this regional anatomy is not (6). So, for the importance of surgeons this study deals with the exits of the sciatic nerve while passing through greater sciatic foramen as the surgical interventions and the deep intramuscular injections are given in this area (1). Comparing the higher division of the sciatic nerve with the lower division of the sciatic nerve, the higher division of the sciatic nerve can escape from one of the aforementioned causes, which can result in the reduction of the neurological deficits. One of the consequence of the high division of the sciatic nerve is that it can cause the failure of the popliteal block anesthesia (8).

III. Terminal branches/termination

a) Mode of termination:

The sciatic nerve was bifurcating into the tibial nerve and the common peroneal nerve in 25 (83.33%) cases on left side and 28 (93.33%) cases on right side. Whereas trifurcation into the tibial nerve, the common peroneal nerve and the sural nerve was seen in 5 (16.67%) cases on the left side and 2 (6.67%) cases on the right side (Figure 2). The difference between the two sides was statistically insignificant (P value 0.228). It was also noticed that female cadavers showed bifurcation in all right limbs whereas one limb on left side showed trifurcation.

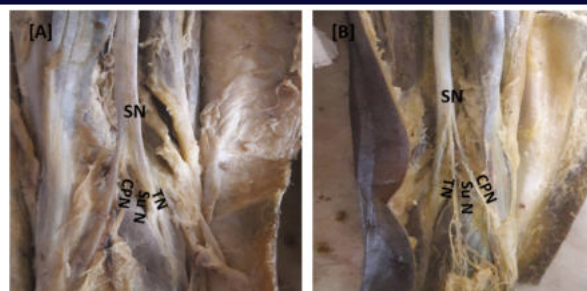


Figure 2 Trifurcation of sciatic nerve (SN) into tibial nerve (TN), common peroneal nerve (CPN) and sural nerve (SuN); [A] Left side; [B] Right side of the same cadaver

Berihu and Debeb (5) studied 56 lower limbs and noticed that 5 lower limbs (9%) showed trifurcation i.e. tibial nerve, common peroneal nerve and sural nerve. Trifurcation of the sciatic nerve is rarely cited in the literature. It is important to know the usual bifurcation anatomy and possible variations of sciatic nerve and its branches which will help the radiologist and the surgeons to interpret about the structures they have encountered and for the treatment of patients with sciatica and other related problems. Knowledge is likely to result in more accurate, expeditious and effective diagnosis and treatment of diseases related to nerve problems with consequent reduction in paralysis of the extremities and disabilities (5).

b) Level of termination

Sciatic nerve terminated at the superior angle of the popliteal fossa in 25 (83.33%) cases on the left side and 24 (80.0%) cases on the right side, at the middle 1/3rd of the thigh in 4 (13.33%) cases on the left side and 4 (13.33%) cases on the right side and in the pelvis in 1 (3.33%) case on the left side and 2 (6.67%) cases on the right side among which one limb was of the female cadaver. The difference between the two sides was statistically insignificant (P value 0.838). No communication between two branches was seen at any level.

Lately Grewal et al (10) classified the relation of sciatic nerve or its branches with the piriformis at their exit from the greater sciatic foramen as well as the level of the division of the sciatic nerve after its exit from the greater sciatic foramen, as follows:

Group A- Division of the SN in the pelvis and its two divisions (CPN and TN) emerging in the different relations with the piriformis muscle.

Type 1: Both CPN and TN infrapiriformis

Type 2: CPN through piriformis and TN infrapiriformis

Type 3: Both CPN and TN through piriformis.

Type 4: CPN suprapiriformis and TN infrapiriformis

Type 5: CPN suprapiriformis and TN through piriformis.

Group B- Division of the SN after its exit from the greater sciatic foramen: This group divided into three subgroups B1, B2 and B3 depending upon the relation of the main trunk of the SN with the piriformis muscle.

B1- SN emerging below the piriformis muscle

B2- SN emerging through the piriformis muscle

B3- SN emerging above the piriformis muscle

Now all these subgroups are classified into the different types depending upon the level of division of the SN after its exit from the greater sciatic foramen.

Type 1- Division of the SN in the gluteal region i.e. between its exit from the greater sciatic foramen and the gluteal fold.

Type 2- Division at the junction of the gluteal region and the upper 1/3rd of thigh

Type 3- Division in the upper 1/3rd of the thigh

Type 4- Division at junction of the upper and middle 1/3rd of the thigh

Type 5- Division in the middle 1/3rd of the thigh

Type 6- Division at the junction of the middle and lower 1/3rd of the thigh which is also the superior angle of the popliteal fossa

Type 7- Division in the lower 1/3rd of the thigh which is equivalent to the upper half of the popliteal fossa

Earlier different authors had given different incidence of level of the division of the sciatic nerve which is compared with the present study

according to the Grewal et al (10) classification in Table 1.

Table 1 Showing comparison of incidence of different levels of division of sciatic nerve

Authors	In pelvis (%)			Gluteal region (%)	In upper 1/3rd of thigh (%)	Junction of upper middle 1/3rd of thigh	In middle 1/3rd of thigh (%)	In superior angle of popliteal fossa (%)	Lower 1/3rd of thigh (upper 1/2 of popliteal fossa) (%)
	Group A Type 1 (Both IP)	Group A Type 2	Group A Type 4 (CPN-SP&IN-IP)	Group B1 Type1	Group B1 Type 3	Group B1 Type 4	Group B1 Type 5	Group B1 Type 6	Group B1 Type 7
Prakash et al ⁽¹⁵⁾			17.40	2.30	3.50	-	2.30		40.7+34.9
Ogengó et al ⁽¹³⁾	9.80		2.40	2.40	-	-	10.40	67.10	
Saritha et al ⁽²¹⁾	2	2	2	2	-	-	-	92	
Desalegn & Tesfay ⁽⁸⁾	2.80		5.50	92					
Berihu & Debeb ⁽⁵⁾	9		2						
Sangram et al ⁽²⁰⁾	14		-	4	-	-		82	
Grewal et al ⁽¹⁰⁾	6.7		3.3	-	20		6.7	63.30	-
Present study	5						13.33	81.66	

Piriformis muscle syndrome or non-discogenic sciatica is a neuromuscular condition caused by the compression of the sciatic nerve between the piriformis and the superior gemellus. This syndrome is characterized by the sensitivity, motor and trophic disturbances in the region of distribution of the trapped component of the sciatic nerve.

Piriformis syndrome is categorized into two types. The one with the anatomic cause like split piriformis muscle, split sciatic nerve or an anomalous sciatic nerve pathway are classified under the primary piriformis syndrome. The other which results from precipitating causes like the macro trauma, micro trauma, ischemia are included in the secondary piriformis syndrome. Patients with the piriformis syndrome, 15% among them are the primary piriformis syndrome. Sciatic nerve is also commonly injured during the intramuscular injection and is also vulnerable to injury in the posterior dislocation of the hip joint and during the total hip replacement surgery. Injuries to the sciatic nerve leads to the flail foot and finally causes difficulty in the walking (10).

CONCLUSION

Many classifications described earlier were overlapping, so our study followed the recent Grewal et al (10) classification for considering all the variants of the SN bifurcation. SN is the nerve which is most commonly involved in the daily practice of neurology, rehabilitation, anesthesia and orthopedics. Owing to long course of the sciatic nerve, makes it vulnerable to injury. The main focus of this study was to access the information regarding the variation in anatomy of the sciatic nerve. Knowledge regarding the various levels is crucial for surgeons while performing the procedures like the hip joint dislocation, its replacement and hemiarthroplasty. Moreover it has been also seen that the sciatic nerve is mostly injured during the intramuscular injection resulting in the flail foot which finally cause difficulty in the walking.

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