

## STUDY OF VARIATION IN THE HIGH DIVISION OF SCIATIC NERVE AND ITS RELATIONSHIP WITH THE PIRIFORMIS MUSCLE

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### Abstract

Sciatic nerve which is a branch of sacral plexus divides into its terminal branches i. e. tibial and common peroneal in the posterior compartment of the thigh. But sometimes rarely it divides in pelvis and exit through pelvis by different routes. Because of this variant course it bears varied relationship with muscles of gluteal region. The nerve may be compressed by muscles or vessels. This results in Sciatica of non discogenic variety. So the aim of this study is to define level of exit and division of sciatic nerve.

**Key words:** Sciatic Nerve, Sciatica, Greater Sciatic Foramen, Gluteal Region, Piriformis Syndrome.

### Introduction

The Sciatic nerve (SN) is formed in the pelvis by joining of ventral division of anterior primary rami of L4- S3 spinal nerve roots. It is 2 cm wide at its origin near sacral plexus. The sciatic nerves leave the pelvis through the greater sciatic foramen below the piriformis. The nerve passes along the back of the thigh, and divides into the tibial (TN) and common peroneal nerves (CPN) proximal to the knee (22). There is a close relationship between the SN and the intrapelvic muscles (especially piriformis) along its course (9). The piriformis, one of the intrapelvic muscles, may compress the SN and cause the piriformis syndrome (PS) (3, 6, 17, 20, and 21). PS not only occurs

due to piriformis hypertrophy, inflammation or irritation, but also may be caused by congenital variations of the piriformis and the SN. Previous studies reported a variety of different anatomic relations between the SN or its terminal branches and the piriformis (1, 2, 4, 7, 8, 10–16, 18–20, 23, 24). The undivided nerve may emerge above the piriformis or through the muscle. The major divisions of the nerve may lie either side of the muscle, or (the most common variant) one division either above or below. The evidence of each variation may cause different clinical presentation. It is known that each anatomical variation may reflect a different and a case-specific clinical presentation. This requires a detailed

description of anatomical variations. The aim of this study was to define the level of the SN exit, and to determine the level of the SN division.

### Material and Method

This study was conducted during routine dissection of medical undergraduates on 50 gluteal regions of 25 adult male cadavers fixed with formalin were evaluated. The gluteus maximum was elevated to explore the piriformis, the superior gemellus, the obturator internus, the inferior gemellus and the quadratus femoris. Following proper exposure of the pelvis, the evidence of variation in the SN was recorded. The location where the SN exits the pelvis and the level of the SN division were all recorded.

### Results

It is observed that, SN exited the pelvis through the greater sciatic foramen below the piriformis muscle without any variation in 35 of the 50 gluteal regions (70%). The SN exited the pelvis as an undivided nerve in 29 gluteal regions (58%) (Figure 1). There was evidence of high division of the SN in 24 gluteal regions (48%). The TN and the CPN leave the pelvis through the infra piriform portion of greater sciatic foramen (IP) together within the different sheath in 10 out of 24 gluteal regions with high division (20%) (Figure 2). In the remaining 14 gluteal regions with high division (28%), one of the branches left the pelvis following a different route (Figures 3: A and B). The CPN passed through the piriformis and the TN through the IP in eight gluteal regions (bilaterally on one of the cadavers and unilaterally on six cadavers) (16%) (Figure 3: A). The CPN passed through the supra piriform portion of greater sciatic for a men (SP) and the TN through the IP in three gluteal regions (one unilateral and one bilateral) (6%) (Figure 3: B).

### Discussion

The piriformis syndrome is one of the causes of the non-discogenic sciatica. It occurs secondary to the compression of the sciatic nerve (SN) by an abnormal piriformis. The presence of variations in the relationship between the SN and the piriformis may contribute to the occurrence of the piriformis syndrome. The type of variation may reflect the clinical presentation of the piriformis syndrome. In other words, the compression of the unsplit SN, the CPN and the compression of the TN may cause different clinical pictures. This study demonstrated the existence of high SN division in 48% of the cases. In some gluteal regions the TN and CPN passed through infrapiriform portion of greater sciatic foramen with different sheaths (20%). Other gluteal regions with high division shows exit of TN and CPN through different routes. Both conditions may facilitate SN compression. Previous anatomical studies demonstrated 15–30% variation in the relationship between the piriformis and the SN (20). The existence of variation was also reported in many case reports (1, 2, 7, 8, 10–16, 18–20, 24) (Table 1). The comparison of the previously published results and those of the current study revealed a higher rate of high division in the current series. The SN may be divided into the CPN and the TN in the pelvis, and each nerve can leave the pelvis using a separate route. Moore (15) reported that CPN passed through the piriformis, and the TN passed through the IP in 12.2% of the specimens, and that the CPN passed through the SP, and the TN passed through the IP in 0.5% of the specimens in a study conducted on 650 extremities (Table I). Chiba (8) reported that CPN passed through the piriformis in 34% of the cases in another study using 514 extremities. The rate of this variation was higher than other published rates (4, 24) (Table I).

Machado et al (14), performed a gluteus dissection in 100 fetuses and reported three types of variation, including type 1 where the CPN penetrated the piriformis and the TN passed under the piriformis (16%), type 2 where the CFN passed above the piriformis and the TN passed under the piriformis and type 3 where the SN penetrated the piriformis (Table I). The passage of the SN through the piriformis was also reported by Pecina (18) in 22% of 130 cadavers. It included penetration of the piriformis by the SN in 5%, and presence of the piriformis with two heads in 17%. The same rate was reported to be 7% by Beaton (4) (Table I).

Ugrenovic et al. (23) found high division of the SN in 27.5% of the specimens in a cadaveric study performed in 100 fetuses. The SN left the pelvis through the IP in 96% of 200 gluteal regions. The CPN passed through the IP in 2.5% of the specimens, and the CPN passed through the SP and the TN passed through the IP in 1.5% of the cadavers.

Beaton & Anson classified variations of the piriformis and SN in 120 specimens in 1937 and in 240 specimens in 1938 (4, 5). Their classification, known as the Beaton & Anson classification, is as follows:

**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

Pokorny et al. (19), using 91 fresh cadavers modified the Beaton & Anson classification and stated that the first variation, undivided nerve below undivided muscle, was the most common type, and seen in 79.1% of the specimens.

Type 2 variation was reported in one case by Arifoğlu et al. (1), and by Kırıcı and Ozan (11). There were 7 cases of type 2 variation in the current series (14%). A type 4 variation, an extremely rare variation, was reported by Chen (7), and by Kosukegawa et al. (12). There was no type 4 variation in the current series. The type 6 variation, a variation defined hypothetically by Beaton & Anson (4), was reported in one case by Ozaki et al. (16) and Sayson et al. (20).

### Conclusion

The knowledge regarding the level of division of the SN and the location where it leaves the pelvis is of great importance. The abnormal passage of the SN, the CPN, and the TN, either through the supra piriform or below the superior gemellus may facilitate compression of these nerves. Further radiological studies addressing the aforementioned variations should be carried out in cases with atypical sciatica.

### References

1. Arifoğlu Y, Sargon MF, Tanyeli E, Yazar F: Double superior gemellus together with double piriformis and high division of the sciatic nerve. *Surg Radiol Anat* 19: 407–408, 1997
2. 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* 41(1): 41–42, 2003
3. Barton PM: Piriformis syndrome: A rational approach to management. *Pain* 47: 345–352, 1991
4. Beaton LE, Anson BJ: The relation of the sciatic nerve and its subdivisions to the piriformis muscle. *Anat Rec* 70: 1–5, 1937
5. Beaton LE: The sciatic nerve and piriform muscle: Their interrelation a possible cause of coccygodynia. *J Bone Joint Surgery Am* 20: 686–688, 1938
6. Broadhurst NA, Simmons N, Bond MJ: Piriformis syndrome: Correlation of

- muscle morphology with symptoms and signs. *Arch Phys Med Rehabil* 85: 2036–2039, 2004
7. Chen WS: Bipartite piriformis muscle: An unusual cause of sciatic nerve entrapment. *Pain* 58: 269–272, 1994
  8. Chiba S: Multiple positional relationships of nerves arising from the sacral plexus to the piriformis muscle in humans. *Kaibogaku Zasshi* 67(6): 691–724, 1992
  9. Guvencer M, Akyer PŞ, İyem C, Tetik S, Naderi S: The topographic location and the relation of the piriformis muscle and the sciatic nerve. *Surg Radiol Anat* 30: 467–474, 2008
  10. Kırıcı Y, Yazar F, Ozan H: The neurovascular and muscular anomalies of the gluteal region: an atypical pudendal nerve. *Surg Radiol Anat* 21(6): 393–396, 1999
  11. Kırıcı Y, Ozan H: Double gluteus maximus muscle with associated variations in the gluteal region. *Surg Radiol Anat* 21(6): 397–400, 1999.
  12. Kosukegawa I, Yoshimoto M, Isogai S, Nonaka S, Yamashita T: Piriformis syndrome resulting from a rare anatomic variation. *Spine* 31(18): 664–666, 2006
  13. Machado FA, Babinski MA, Brasil FB, Favorito LA, Abidu- Figureiedo M, Costa MG: Anatomical variations between sciatic nerve and priform muscle during fetal period in human. *Int J Morphol* 21(1): 29–35, 2003
  14. Mas N, Ozekşi P, Ozdemir B, Kapakin S, Sargon MF, Celik HH, Yener N: A case of bilateral high division of the sciatic nerves, together with a unilateral unusual course of the tibial nerve. *Neuroanatomy* 2: 13–15, 2003
  15. Moore KL, Dalley AF: *Clinical Oriented Anatomy*, 4th edition, Baltimore Lippincott Williams&Wilkins, 1999, 558
  16. Ozaki S, Hamabe T, Muro T: Piriformis syndrome resulting from an anomalous relationship between the sciatic nerve and piriformis muscle. *Orthopedics* 22(8): 771–772, 1999
  17. Papadopoulos EC, Khan SN: Piriformis syndrome and low back pain: A new classification and review of the literature. *Orthop Clin Am* 35: 65–71, 2004
  18. Pecina M: Contribution to the etiological explanation of the piriformis syndrome. *Acta Anat (Basel)* 105:181–187, 1979
  29. 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* 28: 88–91, 2006
  20. Sayson SC, Ducey JP, Maybrey JB, Wesley RL, Vermilion D: Sciatic entrapment neuropathy associated with an anomalous piriformis muscle. *Pain* 59: 149–152, 1994
  21. Silver JK, Leadbetter WB: Piriformis syndrome: Assessment of current practice and literature review. *Orthopedics* 21(10): 1133–1135, 1998
  22. Standring S: *Gray’s Anatomy, The anatomical basis of clinical practice*. 39. edi. Spain: Elsevier Churchill Livingstone, 2005: 1403,1404,1446
  23. 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.* 62(1): 45–49, 2005
  24. Uluutku MH, Kurtoğlu Z: Variations of nerves located in deep gluteal region. *Okajimas Folia Anat Jpn* 76(5): 273–276, 1999

**Table I:** Variations in the High Division of the Sciatic Nerve and Relationship Between the Sciatic Nerve and Piriformis

	<b>Type 1</b>	<b>Type 2</b>	<b>Type 3</b>	<b>Type 4</b>	<b>Type 5</b>	<b>Type 6</b>
Beaton & Anson (4) 120 cadavers	84.2%	11.7%	3.3%	0.8%		
Beaton (5) 240 cadavers	90%	7.1%	2.1%	0.8%		
Beaton (5) 240 cadavers	74%	16%	10%			
Moore&Dalley (16) 650 extremities		12.2%	0.5%			
Chiba (8) 514 extremities		34%				
Machado et al. (14) 100 fetus extremities		16%	2%			
Pecina (19) 130 cadavers		6.15%				
Ugrenovic et al. (24) 100 fetuses	96%	2.5%	1.5%			
Pokorny et al. (20) 91 cadavers	79.1%	14.3%	4.4%	2.2%		
Ozaki et al. (17)						Only one case
Sayson et al. (21)						Only one case
<b>Current study 50 extremities</b>	70%	16%	6%			



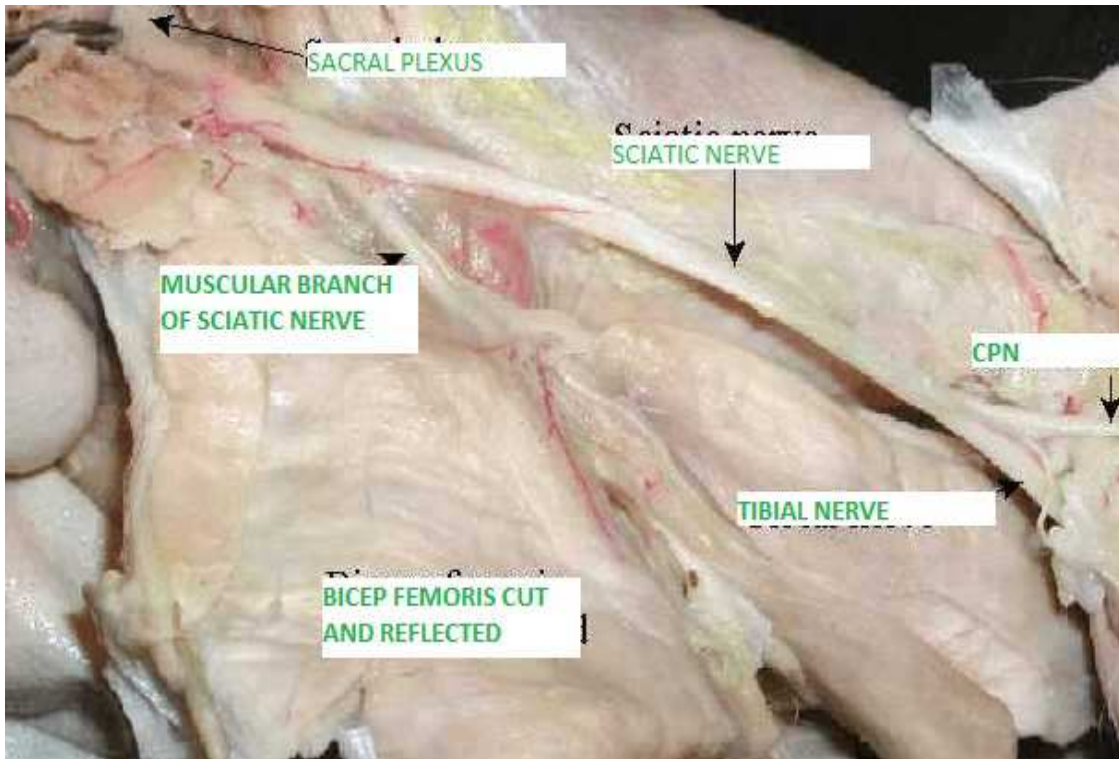


Figure 1: A- The sciatic nerve undivided passing below the piriformis (PM).

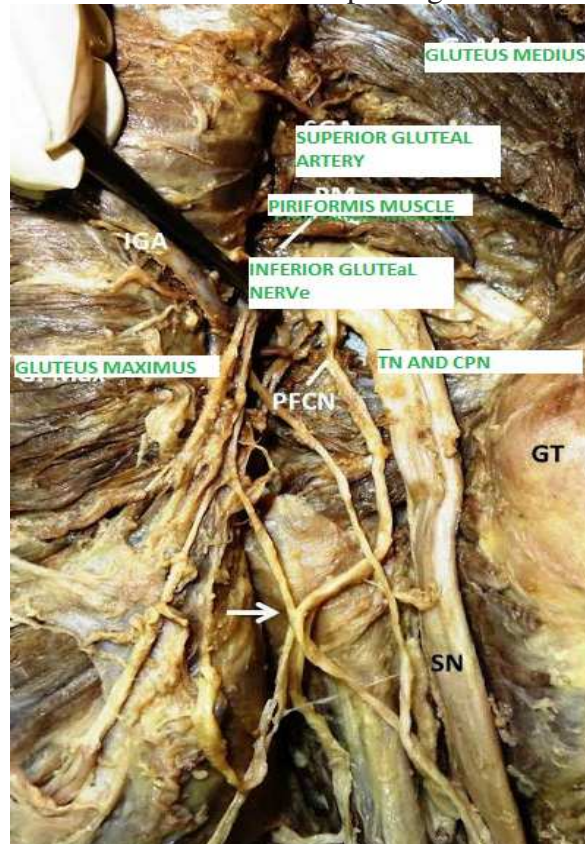
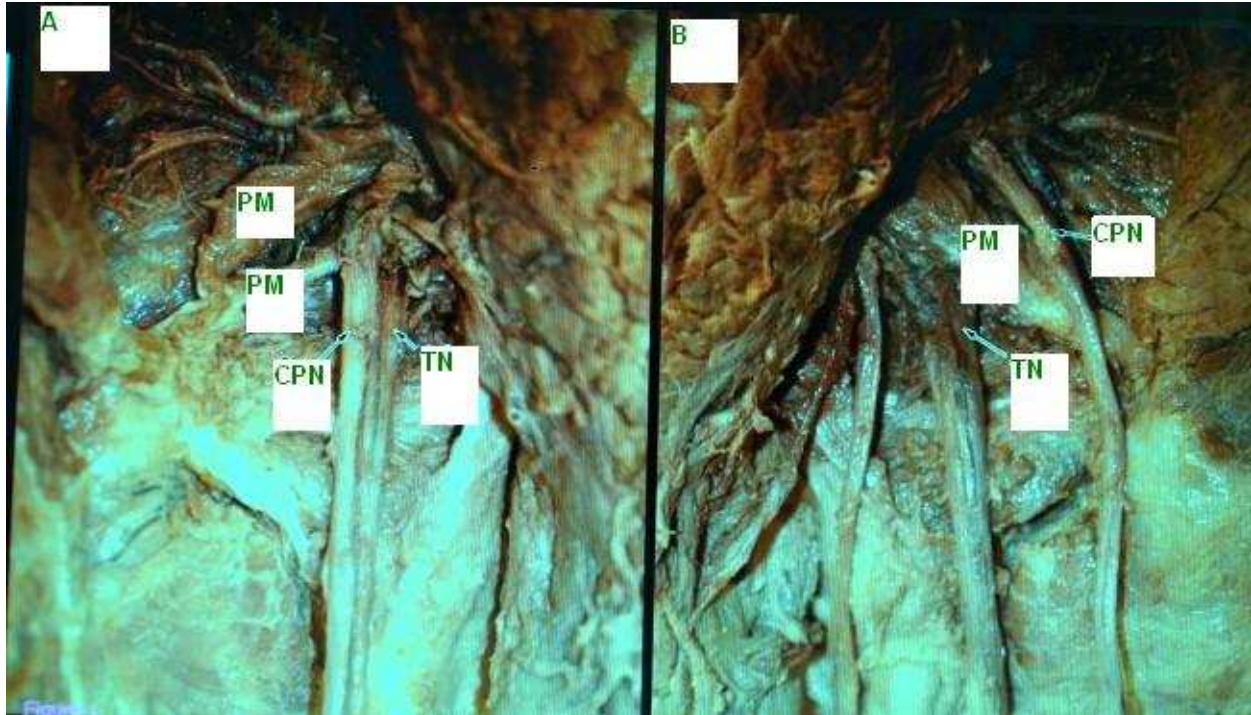


Figure 2: The common peroneal nerve (CPN) and tibial nerve (TN) passing below the piriformis (PM) .



**Figure 3:** A- The common peroneal nerve (CPN) passing through the piriformis (PM) and the tibial nerve passing below piriformis.  
B- The common peroneal nerve (CPN) passing through suprapiriform portion of greater sciatic notch and the tibial nerve (TN) below piriformis(PM).