

A cadaveric study bifurcational anatomical variations of sciatic nerve

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Abstract:

Introduction : Sciatic nerve, the largest nerve of the human body, bifurcates into tibial nerve and common fibular nerve at any level from the pelvis to the popliteal fossa. The sciatic nerve presents variations in its level of bifurcation in relation to piriformis muscle. **Aim:** The aim of this study was to observe and define the level of the bifurcation of sciatic nerve and its anatomical variations obtained from human cadavers. **Materials & Methods:** In the present study observations of 36 gluteal regions in 18 formalin-fixed adult male cadavers during undergraduate practical dissection in the department of Anatomy, S.V. Medical College, and Tirupathi were presented.

Results : Percentage incidence of normal site of bifurcation was 83% and of high division was 17%.

Conclusion: Variations in the level of bifurcation of sciatic nerve into tibial nerve and common fibular nerve is not uncommon. The thorough knowledge of variations in the level of bifurcations of sciatic nerve will help in early diagnosis and treatment of sciatic nerve entrapment or neuropathies thereby reducing the associated morbidities.

Keywords: Anatomic variation; Sciatic nerve; Piriformis

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I. Introduction :

Sciatic nerve is also known as the ischiadic nerve or ischiatic nerve. It is the longest and widest nerve in the human body [2 cm wide at the origin near sacral plexus]. Sciatic nerve (SN) is formed in the pelvis by the union of anterior divisions of L4-S3 spinal nerve roots [1]. It leaves pelvis via the greater sciatic foramen, below the piriformis muscle. It then descends between greater trochanter and ischial tuberosity, in posterior compartment of thigh. It commonly (85-90%) divides into the tibial and common fibular nerves at a varying level proximal to the knee.

Various studies reported a variety of anatomic relations between the bifurcation of Sciatic nerve [SN] or its terminal branches and the piriformis [1, 2, 4, 7, 8]. The undivided nerve may emerge above the piriformis or through the muscle. These anatomical variations may contribute to piriformis syndrome, sciatica, foot drop and coccydynia. This should be taken into account by clinicians while planning interventions around the sciatic nerve and its division in the lower extremity. Each anatomical variation reflects a diverse clinical presentation. The aim of this study was to describe and analyze the level of the division of SN in relation to piriformis and to compare with the previous studies.

II. Materials And Methods:

In the present study, dissections of 36 gluteal regions were examined in 18 formalin fixed adult male cadavers used for student dissection in the department of Anatomy, S.V. Medical College, Tirupathi during the academic year 2012-13. We observed variation in the bifurcation of the sciatic nerve on both sides.

The gluteus maximus was elevated to explore piriformis, superior gemellus, obturator internus, inferior gemellus and quadratus femoris. Following proper exposure of the pelvis, the evidence of variation in the SN was recorded. The observations on SN at pelvic exit and at the level of division were recorded. Normally Sciatic nerve bifurcation occurs at the superior angle of popliteal fossa in 85-90% of individuals. The variations in the division were classified using Beaton & Anson and Bergman classification [5].

III. Observations :

Three types of course of sciatic nerve is observed when it comes out of the lesser pelvis to gluteal region and in different relation with Piriformis muscle.

Type I: Sciatic nerve as a single trunk comes out below piriformis.

Type II: Sciatic nerve already divided in pelvis and its two divisions comes out below piriformis.

Type III : High division of sciatic nerve just below the piriformis

Of the 36 limbs studied, 2 limbs (5.5%) showed variations in the sciatic nerve. The bifurcations were classified and compared with Beaton & Anson classification. 94.5 % of the cadavers showed Type I bifurcation. In the present study in one cadaver the sciatic nerve divided within the piriformis muscle in the right gluteal region (Fig.1), a variation which was not classified in Beaton & Anson classification.

One cadaver showed another variation in bifurcation in the form of division of sciatic nerve 4cm below the piriformis muscle over the Quadratus femoris in the left gluteal region (Fig.2). According to Beaton and Anson, this is classified as Type 1 by Beaton & Anson classification and Type A by Bergman classification. The percentage incidence of normal site of bifurcation is 94.5% and that of high division is 5.5%.

| Type of sciatic nerve variation observed in 36limbs | | No. of specimens showing variations of sciatic nerve | Percentage of variation |
|--|--|--|-------------------------|
| Variations of sciatic nerve in relation to piriformis muscle | | 1 | 2.7% |
| High division of sciatic nerve | In the gluteal region immediately below piriformis | 1 | 2.7 % |
| | In mid-thigh | | |
| Total | | 2 | 5.5 % |

| Cadaver number | Right side | Left side | Remarks |
|------------------|--|--|--|
| Cadaver number 1 | High division of sciatic nerve into tibial and common peroneal nerves beneath the piriformis and its two divisions comes out below piriformis. | Normal pattern of sciatic nerve is observed in this side | This pattern was not classified in Beaton & Anson classification. |
| Cadaver number 2 | Division of sciatic nerve 4cm below the piriformis muscle over the Quadratus femoris in the left gluteal region | Normal pattern of sciatic nerve is observed in this side | this is classified as Type 1 by Beaton & Anson classification and Type A by Bergman classification |

IV. Discussion :

In the literature various reports on the level of sciatic nerve division into tibial and common peroneal nerves were available. Many authors have attempted classification of high divisions of sciatic nerve and the common classifications followed are that of Beaton & Anson's [5] and Bergman classification [6].

The observations of present study were compared with those reported in literature. The pattern of bifurcation is not dependant on the sex of the individual, height, and no side preponderance was observed in the present study which correlates with the observations of previous studies.

Beaton & Anson classified variations of the piriformis and SN in 120 specimens in 1937, and in 240 specimens in 1938. Their classification, known as the Beaton & Anson classification⁵, 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

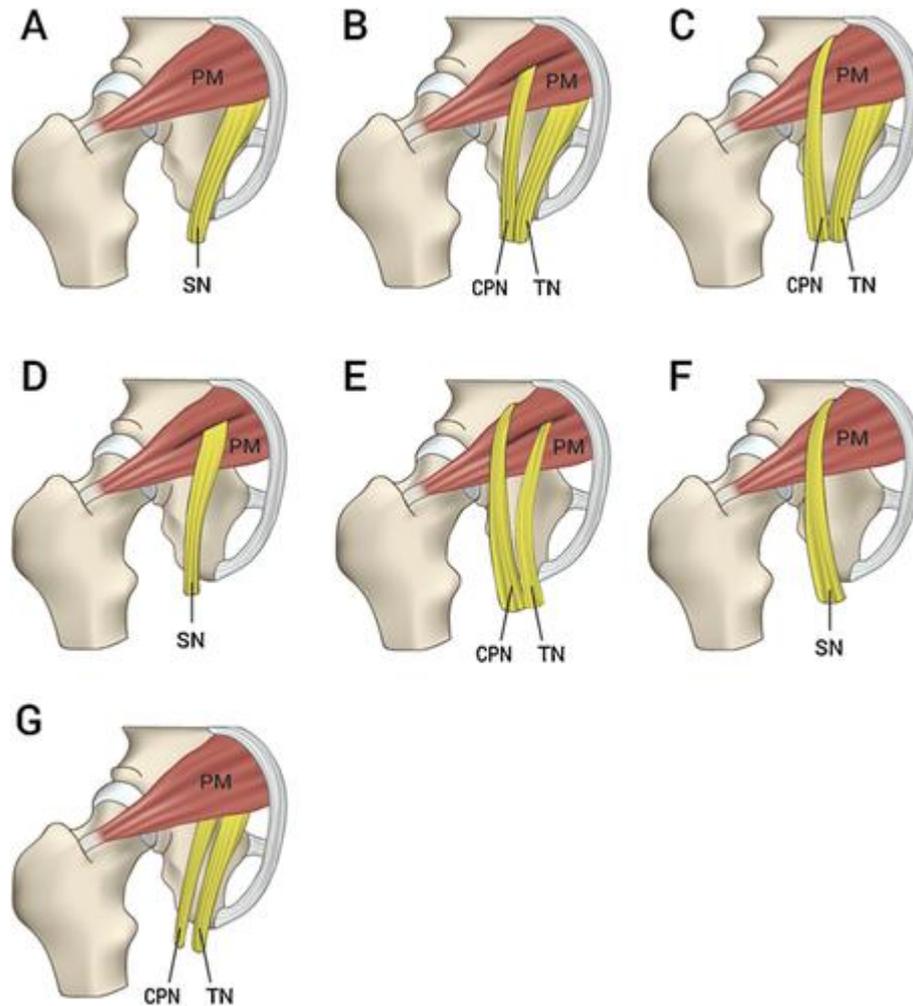


Fig 1. Patterns of Sciatic Nerve exit and relationship to the Piriformis Muscle. Types A–G. SN, Sciatic Nerve; PM, Piriformis Muscle; TN, Tibial Nerve; CPN, Common Peroneal Nerve.

Tomaszewski et al [12] in Surgical anatomy of the sciatic nerve: A meta- analysis described seven patterns of SN exit and relationship to the Piriformis which was similar to Beaton & Anson classification, they have observed a new pattern Type G in which SN divides in the pelvis, both CPN and TN coursing separately below the Piriformis which was similar to our study (Fig.1).Patterns of SN exit and relationship to the PM by Tomaszewski were classified as follows

- Type A—SN exits the pelvis undivided below the PM.
- Type B—SN divides in the pelvis, CPN pierces the PM, and TN lies below the PM.
- Type C—SN divides in the pelvis, CPN courses over the PM, and TN lies below the PM.
- Type D—SN exits the pelvis undivided piercing the PM.
- Type E—SN divides in the pelvis, CPN courses over the PM, and TN pierces the PM.
- Type F—SN exits the pelvis undivided coursing over the PM.
- Type G—SN divides in the pelvis, both CPN and TN coursing separately below the PM.

Pokorny et al.⁸, in a study of 91 fresh cadavers, modified the Beaton & Anson classification and observed that the first variation, undivided nerve below undivided muscle, was the most common type, and seen in 79.1% of the specimens.

The type 6, a variation defined hypothetically by Beaton & Anson⁵, was reported in one case by Ozaki et al⁹ and Sayson et al¹⁰.

Bergman reported common peroneal division passing through the piriformis in 12% of 420 dissected gluteal regions. The Topographic variations of the sciatic nerve with reference to piriformis muscle reported by Bergman et.al., is as follows

A: Usually with the sciatic nerve passing from the pelvis beneath m. piriformis

B: M. piriformis divided into two parts with the peroneal division passing between the two parts of piriformis
 C: The peroneal division passes over m. piriformis and the tibial division passes beneath the undivided muscle
 D: entire nerve passes through the divided m. piriformis
 E: The sciatic nerve exiting the greater sciatic foramen along the superior surface of the piriformis muscle
 The passage of the Tibial Nerve under the superior gemellus is also rare variation, which was not described by Beaton & Anson⁵. This variation, to our knowledge, was only reported by Babinski⁷, and Mas et al. in one case. This variation may be named as Beaton & Anson type 7.

Table 1: Variations in the High Division of the Sciatic nerve and relationship between the Sciatic nerve and the Piriformis – as reported in literature.

| | Type 1 | Type 2 | Type 3 | Type 4 | Type 5 | Type 6 |
|--|---------------|--------|--------|--------|--------|---------------|
| Beaton & Anson ⁵ (120 cadavers) | 84.2% | 11.7% | 3.3% | 0.8% | | |
| Uluutku&Kurtoğlu (25 fetuses) | 74% | 16% | 10% | | | |
| Moore&Dalley (650 extremities) | | 12.2% | 0.5% | | | |
| Chiba (514 extremities) | | 34% | | | | |
| Machado et al ⁷ (100 fetus) Extremities | | 16% | 2% | | | |
| Pecina (130 cadavers) | | 6.15% | | | | |
| Ugrenovic et al. (100 fetuses) | 96% | 2.5% | 1.5% | | | |
| Pokorny et al. ⁸ (91 cadavers) | 79.1% | 14.3% | 4.4% | 2.2% | | |
| Ozaki et al. ⁹ | | | | | | Only one case |
| Sayson et al. ¹⁰ | | | | | | Only one case |
| Current study (12 extremities) | 94.5 % | | | | | |

| Author | Undivided nerve from the pelvis | Division in the gluteal region | Division in the thigh | Division in the popliteal fossa |
|-----------------------|---------------------------------|--------------------------------|-----------------------|---------------------------------|
| Beaton ⁵ | 90% | | | |
| Guvencer ² | 52% | | | |
| Pokorny ⁸ | 79% | | | |
| Ugrenovic | 96% | 27.5% | | 72.5% |
| Ewa Okraszewska | 81% | 19% | | 62% |
| Kukiriza | 77.5% | | | |
| Prakash | 83% | 2.3% | 46.5% | 35% |
| Present study | | 2.7 % | 2.7 % | 94.5 % |

[Table 2]: Level of bifurcation of sciatic nerve as compared with other studies.

In the present study, the first variation piriformis is divided into two parts and the sciatic nerve is divided into two in between heads the sciatic nerve is divided into two nerves by piercing the piriformis muscle representing the high division of sciatic nerve—showing Beaton & Anson type-1 but Bergman Type-D.

The second variation was on the right side,, the sciatic nerve is coming down below without piercing and after running 4 cm , in the upper part of the thigh, it is divided into two divisions , tibial nerve and common peroneal nerve, representing the high division of sciatic nerve—showing Beaton & Anson type-1 but Bergman Type-A.

V. Conclusion :

The sciatic nerve is frequently involved in daily medical practice of neurology, orthopaedics, rehabilitation and anaesthesia and the anatomical knowledge regarding variation in level of bifurcation of the sciatic nerve in relation to the piriformis muscle is of great importance. A comprehensive knowledge of variant

bifurcational anatomy of the sciatic nerve is vital to avoid inadvertent injury during gluteal region surgeries, posterior hip surgeries, avoiding its injury during deep intramuscular injections, in the diagnosis of sciatica and also during accurate sciatic nerve block in anesthesia. This study emphasizes the significance of thorough knowledge of variations in the level of bifurcations of sciatic nerve and will help in early diagnosis and treatment of sciatic nerve entrapment or neuropathies thereby reducing the associated morbidities following surgical exploration.

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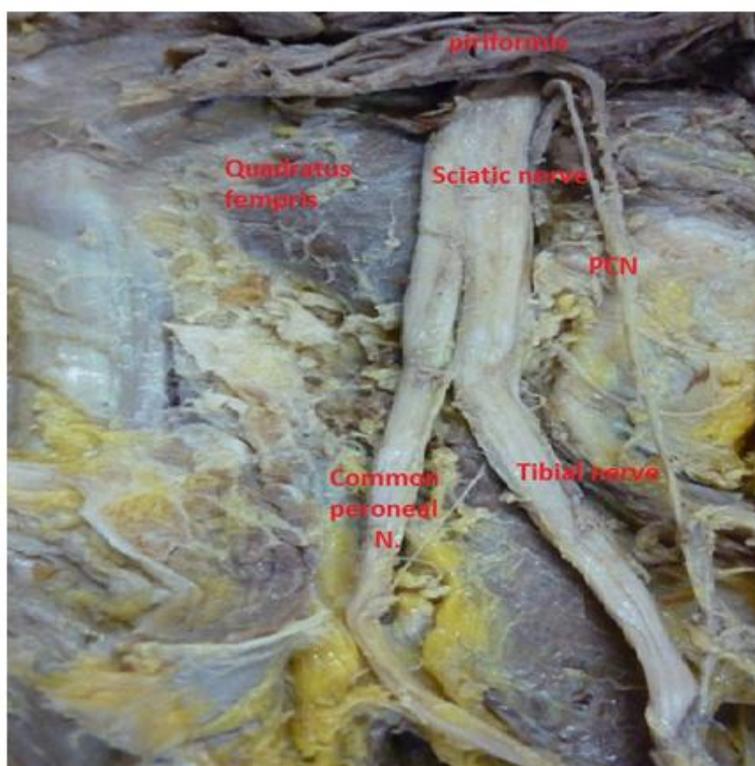


FIG.1: Observations on the left lower limb

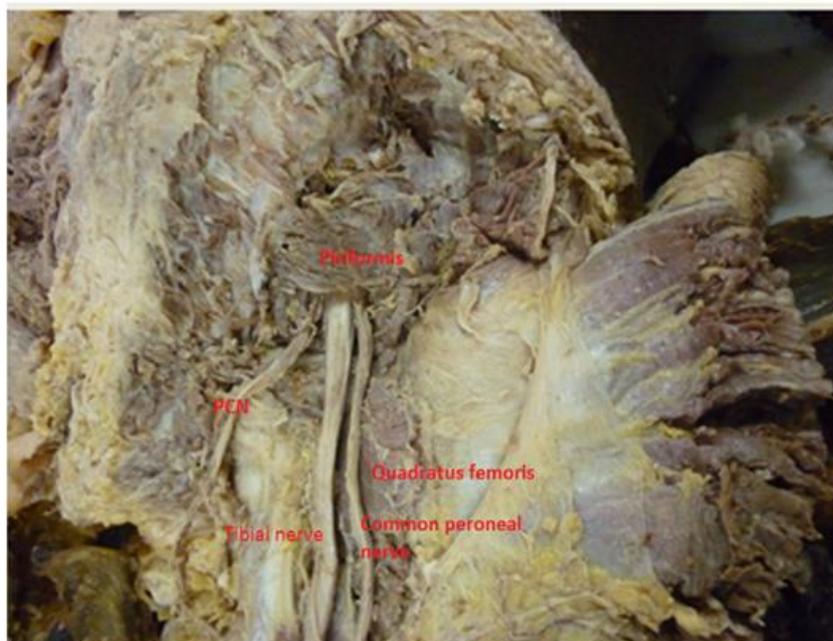


FIG.2: Observations on the Right side

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