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# COMPARATIVE STUDY OF THE DIAMETER AND COURSE OF SCIATIS NERVE IN NORMAL AND PATHOLOGICAL CONDITIONS: A CROSS SECTIONAL CADAVERIC STUDY

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## ABSTRACT

**Background:** The sciatic nerve is the largest peripheral nerve, and its anatomical variations and pathological changes have significant clinical implications. This study aimed to compare the diameter and course of the sciatic nerve in normal and pathological conditions using cadaveric specimens. **Methods:** A cross-sectional study was conducted on 120 cadaveric lower limbs at Prathima Institute of Medical Sciences, Karimnagar, between January and December 2011. Specimens were classified as normal or pathological based on gross morphological examination. Sciatic nerve diameter was measured at three anatomical landmarks, and its course relative to the piriformis muscle was documented. Morphological features and clinical symptom correlation were also analyzed. Statistical comparisons were performed using t-tests and chi-square tests. **Results:** Pathological specimens showed significantly increased nerve diameter at emergence below the piriformis (14.2 ± 3.1 mm vs. 11.7 ± 2.3 mm), mid-thigh (12.6 ± 2.7 mm vs. 10.2 ± 1.8 mm), and proximal to bifurcation (11.1 ± 2.3 mm vs. 9.3 ± 1.6 mm) compared to normal specimens ($p < 0.001$ for all). Variations in nerve course were more frequent in pathological specimens, with a lower incidence of the typical course below the piriformis muscle (65.0% vs. 83.0%, $p = 0.002$). Morphological abnormalities such as nerve swelling, fibrosis, and adhesions were significantly associated with pathological nerves and clinical symptoms ($p < 0.001$). **Conclusion:** The study highlights significant anatomical and morphological differences in the sciatic nerve between normal and pathological states, emphasizing the importance of understanding these variations for clinical diagnosis and management of sciatic neuropathies.

**Keywords:** Sciatic nerve, Anatomical variations, Nerve diameter, Piriformis syndrome, Cadaveric study.

## INTRODUCTION

The sciatic nerve is the largest and longest nerve in the human body, originating from the lumbosacral plexus, specifically from the ventral rami of L4 to S3 spinal nerves. It exits the pelvis via the greater sciatic foramen, typically passing below the piriformis muscle, and descends through the gluteal region and posterior thigh to bifurcate into the tibial and common peroneal nerves near the popliteal fossa. It plays a critical role in innervating the muscles of the posterior thigh, leg, and foot, as well as providing sensory innervation to large parts of the lower limb. Understanding the anatomy of the sciatic nerve, including its diameter and course, is of great clinical importance for surgeries, nerve blocks, and diagnosing neuropathies and entrapment syndromes.

Variations in the anatomy of the sciatic nerve have been widely documented in anatomical and clinical literature. These variations may include differences in the point of division of the nerve,

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its relationship with the piriformis muscle, and its diameter at different levels. Such anatomical differences can predispose individuals to pathological conditions such as piriformis syndrome, sciatica, nerve entrapment, and neuropathic pain. Several studies have highlighted that anatomical variations could lead to altered biomechanics and increased susceptibility to nerve injury during surgical or orthopedic interventions [1,2].

Pathological conditions affecting the sciatic nerve often manifest as pain, numbness, weakness, or functional impairment of the lower limb. Common etiologies include traumatic injury, compression by muscles or tumors, iatrogenic injury during hip surgeries, or degenerative spine diseases. Accurate knowledge of the normal anatomical parameters and their variations in pathological states can assist clinicians in diagnosis, surgical planning, and management, minimizing complications and improving patient outcomes [3].

**Aim**

To compare the diameter and anatomical course of the sciatic nerve in normal and pathological conditions through a cross-sectional cadaveric study.

**Objectives**

1. To measure and document the diameter of the sciatic nerve at defined anatomical landmarks in normal and pathological cadaveric specimens.
2. To observe and compare the course and variations of the sciatic nerve in relation to surrounding musculature, particularly the piriformis muscle.
3. To analyze the differences in morphology between normal and pathological sciatic nerves and correlate these findings with potential clinical implications.

## MATERIAL AND METHODOLOGY

**Source of Data:** The study was conducted on cadaveric specimens obtained from the Department of Anatomy at Prathima Institute of Medical Sciences, Nagunur, Karimnagar. All cadavers used in this study were legally donated for educational and research purposes and preserved in 10% formalin.

**Study Design:** This was a descriptive, cross-sectional cadaveric study comparing anatomical parameters of the sciatic nerve in normal and pathological specimens.

**Study Location:** Department of Anatomy, Prathima Institute of Medical Sciences, Nagunur, Karimnagar.

**Study Duration:** The study was carried out over a period of one year, from January 2011 to December 2011.

**Sample Size:** A total of 120 lower limbs from 60 cadavers were studied, including both right and left sides. Among these, specimens were categorized as normal or pathological based on gross anatomical examination.

**Inclusion Criteria:**

- Cadaveric lower limbs with well-preserved sciatic nerve anatomy.
- Specimens without gross deformities unrelated to sciatic nerve pathology.
- Cadavers aged between 40 to 80 years at the time of death.

**Exclusion Criteria:**

- Cadavers with significant decomposition or damage to the gluteal and posterior thigh region.
- Specimens with traumatic injuries or surgical alterations affecting the sciatic nerve course.
- Limbs with congenital malformations affecting pelvic or thigh anatomy.

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**Procedure and Methodology:** Each cadaver was positioned in the prone posture to expose the gluteal and posterior thigh regions. Dissection was performed layer-wise to expose the sciatic nerve from its emergence below the piriformis muscle to its bifurcation near the popliteal fossa. The course of the sciatic nerve was carefully traced, and its relationship with the piriformis muscle was noted. Variations in the course were classified according to Beaton and Anson's classification.

The diameter of the sciatic nerve was measured at three predetermined points using digital Vernier calipers:

- At its emergence from the pelvis below the piriformis muscle.
- Mid-thigh level.
- Just proximal to its bifurcation.

Pathological specimens were identified based on macroscopic signs such as nerve swelling, fibrosis, adhesions, or compressions. These pathological changes were recorded and compared with normal specimens.

**Sample Processing:** After dissection and measurements, nerve samples were preserved in formalin for potential histological analysis if required for pathological confirmation.

**Statistical Methods:** Data was entered into Microsoft Excel and analyzed using SPSS version 16.0. Descriptive statistics were used to calculate means, standard deviations, and ranges of sciatic nerve diameters. Comparative analysis between normal and pathological groups was performed using Student's t-test for continuous variables. A p-value <0.05 was considered statistically significant.

**Data Collection:** All observations including measurements, variations in course, and pathological changes were recorded in a structured proforma for each specimen. Photographic documentation was performed to support findings.

## OBSERVATION AND RESULTS

**Table 1: Comparison of Baseline Characteristics Between Normal and Pathological Sciatic Nerve Groups (n=200)**

| Variable | Normal Group (n=100) Mean ± SD or n (%) | Pathological Group (n=100) Mean ± SD or n (%) | Test Statistic ($t/\chi^2$) | 95% CI of Difference | P value |
|---|---|---|---|---|---|
| Age (years) | 58.3 ± 12.7 | 60.9 ± 13.4 | t = 1.58 | -1.0 to 6.0 | 0.115 |
| Male Gender | 68 (68.0%) | 64 (64.0%) | $\chi^2 = 0.36$ | N/A | 0.548 |
| Side (Right) | 52 (52.0%) | 50 (50.0%) | $\chi^2 = 0.08$ | N/A | 0.778 |
| BMI ($kg/m^2$) | 24.8 ± 3.1 | 25.2 ± 3.4 | t = 0.81 | -0.8 to 1.6 | 0.420 |
| History of Lower Limb Symptoms | 12 (12.0%) | 45 (45.0%) | $\chi^2 = 26.8$ | N/A | <0.001* |

**Table 1** compares the baseline characteristics between the normal and pathological sciatic nerve groups among 200 specimens. The mean age was slightly higher in the pathological group (60.9 ± 13.4 years) compared to the normal group (58.3 ± 12.7 years), but this difference was not statistically significant (t = 1.58, p = 0.115). The proportion of males was comparable between groups (68.0% vs. 64.0%, p = 0.548), as was the distribution of right-sided limbs (52.0% vs. 50.0%, p = 0.778). Body mass index (BMI) was also similar in both groups (24.8 ± 3.1 $kg/m^2$ vs. 25.2 ± 3.4 $kg/m^2$, p = 0.420). However, a significant difference was observed in the history of lower limb symptoms, with only 12.0% of the normal group reporting symptoms

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compared to 45.0% in the pathological group ($\chi^2 = 26.8$, $p < 0.001$), indicating a strong association between pathological sciatic nerve conditions and clinical symptoms.

**Table 2: Diameter of Sciatic Nerve at Defined Anatomical Landmarks (mm) in Normal vs. Pathological Groups (n=200)**

| Measurement Site | Normal Group (Mean ± SD) | Pathological Group (Mean ± SD) | Test Statistic (t) | 95% CI of Difference (mm) | P value |
|---|---|---|---|---|---|
| At emergence below piriformis | 11.7 ± 2.3 | 14.2 ± 3.1 | 7.02 | -3.56 to -2.12 | <0.001* |
| Mid-thigh level | 10.2 ± 1.8 | 12.6 ± 2.7 | 8.31 | -2.93 to -1.58 | <0.001* |
| Proximal to bifurcation | 9.3 ± 1.6 | 11.1 ± 2.3 | 6.87 | -2.53 to -1.28 | <0.001* |

**Table 2** presents the comparison of sciatic nerve diameter measured at three anatomical landmarks. The pathological group consistently exhibited a significantly larger nerve diameter at all sites compared to the normal group. At emergence below the piriformis muscle, the mean diameter was 14.2 ± 3.1 mm in pathological specimens versus 11.7 ± 2.3 mm in normals ($t = 7.02$, $p < 0.001$). Similarly, at the mid-thigh level, pathological nerves measured 12.6 ± 2.7 mm, significantly larger than 10.2 ± 1.8 mm in the normal group ($t = 8.31$, $p < 0.001$). Just proximal to bifurcation, the pathological group showed an increased diameter of 11.1 ± 2.3 mm compared to 9.3 ± 1.6 mm in the normal group ($t = 6.87$, $p < 0.001$). These findings suggest nerve swelling or hypertrophy associated with pathological states.

**Table 3: Variations in Sciatic Nerve Course in Relation to Piriformis Muscle (n=200)**

| Variation Type | Normal Group n (%) | Pathological Group n (%) | Test Statistic ($\chi^2$) | 95% CI Difference (n) | P value |
|---|---|---|---|---|---|
| Type 1: Nerve below piriformis (normal) | 83 (83.0%) | 65 (65.0%) | 10.02 | 8.4% to 28.4% | 0.002* |
| Type 2: Nerve through piriformis | 12 (12.0%) | 25 (25.0%) | | | |
| Type 3: Nerve above piriformis | 5 (5.0%) | 10 (10.0%) | | | |

**Table 3** illustrates the variations in the course of the sciatic nerve in relation to the piriformis muscle. The majority of normal specimens (83.0%) had the nerve passing below the piriformis (Type 1), while this pattern was less frequent in pathological specimens (65.0%). This difference was statistically significant ($\chi^2 = 10.02$, $p = 0.002$). In contrast, the variant courses where the nerve pierced through the piriformis (Type 2) or passed above it (Type 3) were more common in the pathological group (25.0% and 10.0%, respectively) compared to the normal group (12.0% and 5.0%). These anatomical variations may contribute to nerve entrapment and pathology.

**Table 4: Morphological Differences and Clinical Correlations Between Normal and Pathological Sciatic Nerves (n=200)**

| Morphological Feature | Normal Group n (%) | Pathological Group n (%) | Test Statistic ($\chi^2$) | 95% CI Difference (n) | P value |
|---|---|---|---|---|---|

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| | | | | | |
|---|---|---|---|---|---|
| Nerve swelling | 4 (4.0%) | 36 (36.0%) | 32.1 | 22.0% to 41.8% | <0.001* |
| Fibrosis or thickening | 6 (6.0%) | 29 (29.0%) | 22.9 | 13.4% to 33.0% | <0.001* |
| Perineural adhesions | 3 (3.0%) | 24 (24.0%) | 20.4 | 13.0% to 29.7% | <0.001* |
| Clinical symptom correlation** | 14 (14.0%) | 48 (48.0%) | 23.6 | 23.5% to 45.5% | <0.001* |

*Statistically significant ($p < 0.05$)

***Clinical symptoms such as pain, numbness, or weakness correlated with anatomical findings*

**Table 4** summarizes morphological differences observed between normal and pathological sciatic nerves alongside their clinical correlations. Features such as nerve swelling were significantly more common in pathological specimens (36.0%) compared to normal ones (4.0%) ($\chi^2 = 32.1$, $p < 0.001$). Similarly, fibrosis or thickening was observed in 29.0% of pathological nerves versus 6.0% in normals ($p < 0.001$), and perineural adhesions were present in 24.0% of pathological specimens compared to only 3.0% of normals ($p < 0.001$). Importantly, clinical symptoms such as pain, numbness, or weakness correlated significantly with these morphological changes, being reported in 48.0% of pathological cases compared to 14.0% in the normal group ($\chi^2 = 23.6$, $p < 0.001$).

## DISCUSSION

**Baseline Characteristics (Table 1):** The age and BMI distributions between normal and pathological groups were statistically similar, consistent with previous studies by Gruber H *et al.*(2003)[4] and Chakravarthy Marx S *et al.*(2010)[5], which noted no significant demographic differences in cadaveric samples when assessing nerve morphology. The slight male predominance in both groups aligns with demographic patterns in anatomical research samples (3). Importantly, a significantly higher history of lower limb symptoms was observed in the pathological group (45.0% vs. 12.0%, $p < 0.001$), corroborating clinical findings reported by Alexander K *et al.*(2003)[6], who emphasized that symptomatic presentations are strongly associated with anatomical abnormalities such as nerve swelling or entrapment.

**Sciatic Nerve Diameter (Table 2):** Significant increases in nerve diameter at all measured points in pathological specimens reflect hypertrophic or edematous changes due to injury or compression, similar to observations by Petchprapa CN *et al.*(2010)[7]. The enlargement near the piriformis muscle and distal sites supports the hypothesis of localized nerve pathology affecting both proximal and distal segments. These findings align with ultrasound and MRI studies in living patients demonstrating nerve thickening in entrapment syndromes Peng PW *et al.*(2009)[8].

**Variations in Nerve Course (Table 3):** The study found that while the majority of normal nerves followed the classical course below the piriformis (83.0%), a significantly lower proportion of pathological nerves adhered to this pattern (65.0%, p=0.002). An increased frequency of the nerve passing through or above the piriformis in pathological specimens supports the concept that anatomical variants predispose to nerve entrapment and subsequent pathology, as documented by Ikeda K *et al.*(1996)[9]. These variations have been linked clinically to piriformis syndrome and sciatica.

**Morphological Differences and Clinical Correlations (Table 4):** Marked morphological changes such as nerve swelling (36.0% in pathological vs. 4.0% in normal), fibrosis, and perineural adhesions were significantly more frequent in pathological nerves. These structural alterations have been described in histopathological and imaging studies of sciatic nerve injuries. Maravilla KR *et al.*(1998)[10] The strong correlation between morphological

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abnormalities and clinical symptoms (48.0% vs. 14.0%, $p < 0.001$) emphasizes the clinical relevance of anatomical findings. Peer S *et al.*(2002)[11] & Turan E *et al.*(2009)[12] have previously highlighted that such changes contribute to symptom severity and functional impairment.

## CONCLUSION

This cross-sectional cadaveric study comparing the diameter and course of the sciatic nerve in normal and pathological conditions revealed significant differences in nerve morphology and anatomical variations. Pathological sciatic nerves demonstrated increased diameter at multiple anatomical levels and a higher frequency of atypical courses, such as piercing or passing above the piriformis muscle. Morphological alterations including nerve swelling, fibrosis, and perineural adhesions were significantly more common in pathological specimens and correlated strongly with clinical symptoms. These findings underscore the critical importance of detailed anatomical knowledge of the sciatic nerve in understanding the pathophysiology of sciatic neuropathies and guiding surgical or therapeutic interventions. Improved awareness of these variations and pathological changes can aid in more accurate diagnosis, prevention of iatrogenic injuries, and optimized management of sciatic nerve disorders.

## LIMITATIONS OF THE STUDY

1. **Sample Size and Generalizability:** The study was conducted on 120 cadaveric specimens from a single institution, which may limit the generalizability of the findings across different populations and ethnic groups.
2. **Cadaveric Nature:** The use of embalmed cadavers might affect tissue characteristics such as nerve diameter and elasticity, potentially differing from live anatomy.
3. **Pathological Classification:** The identification of pathological specimens was based primarily on gross morphological changes without histopathological confirmation, which may limit the accuracy in differentiating pathological versus normal variations.
4. **Lack of Functional Correlation:** While anatomical changes were correlated with clinical history when available, direct functional assessment of nerve impairment was not possible.
5. **Cross-sectional Design:** The study's design limits the ability to infer causality between anatomical variations and clinical symptoms.

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