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Exit Pattern of Sciatic Nerve: A Cadaveric Study of Nigerians

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ABSTRACT

We carried out a study on the exit pattern of the Sciatic nerve in a sample of Nigerian cadavers. Two hundred and eighty two (282) gluteal regions from one hundred and forty one (141) cadavers were dissected using the protocols designed in Cunningham's dissection manual (15th Edition) and Finley's Interactive Cadaveric Dissection Guide. There were no significant differences in the exit pattern of the Sciatic nerve between the left and right gluteal regions. However the nerve showed significant variations in exit pattern between cadavers. In two hundred and sixty five limbs (94%), the Sciatic nerve emerged as a single trunk at the inferior border of the Piriformis muscle. While in one (1) limb (0.4%), it emerged divided at the inferior border of Piriformis muscle. Patterns were found to be symmetrical in most cadavers, while it was asymmetrical from one gluteal region to the other in other cadavers. Findings from this study will be relevant in many areas of medical and surgical practice including Orthopaedics, Neurology, physical therapy, Anaesthetics and pain management. Data from this study will also assist as baseline for further research on the clinical anatomy of the Sciatic nerve in Nigeria

Keywords: Sciatic nerve, Cadavers, Exit pattern, Gluteal region

List of abbreviations

CFN = Common fibular nerve

TN = Tibial nerve

IBP1 = Single nerve trunk at the inferior border of Piriformis muscle

IBP2 = Divided nerve at the inferior border or margin of the Piriformis muscle

PP1 = Single nerve piercing Piriformis muscle

P1/2P = Divided nerve with CFN piercing the centre of the Piriformis muscle and TN below the muscle

PL1/3P = Divided nerve with CFN piercing the inferior 1/3 of the Piriformis muscle and TN below the muscle

INTRODUCTION

The Sciatic nerve located in the posterior thigh is derived from the lumbosacral plexus (L4, 5, S1–3)¹. It is formed when the large dorsal component of the sacral plexus (common fibular) and ventral component (Tibial) come together².

The relationship of the Sciatic nerve with the Piriformis muscle as it emerges from the pelvis varies considerably depending on many factors, including, race and sex³. The exit pattern of the Sciatic nerve from the pelvis could be below or above or it could exit by

piercing the piriformis¹.

In healthy humans, the Sciatic nerve controls gait and movement in the lower limb.

In approximately 12% of people, Sciatic nerve leaves the pelvis as a single nerve.

In these cases, the Tibial nerve passes inferior to the Piriformis muscle, and the Common fibular nerve pierces the muscle or passes superior to it⁴.

In 17% of populations, the Piriformis muscle is pierced by parts of or all of the Sciatic nerve⁵. With regards to the way the nerve emerges from the pelvis in relation to the Piriformis muscle, several variations have been documented, but the most common type occurs when the Common fibular nerve pierces the Piriformis muscle⁵. This has been found to occur in 81% of individuals⁵. The nerve has been observed to emerge at the inferior border of the Piriformis muscle as a single nerve trunk^{6, 7, 8, 9, 10, 11 & 12}. Other Authors have reported a pattern where it emerged as a divided nerve. In this pattern, the Tibial and Common fibular divisions emerged separately at the inferior margin of the Piriformis muscle^{9, 10, 11, 12 & 13}. Also in other studies, the

Sciatic nerve emerged as a single nerve trunk by piercing the Piriformis muscle^{7,8}. Research has also revealed that in situations where division of the nerve occurred in the pelvis, the main trunk emerged with the Common fibular nerve piercing Piriformis muscle, with the Tibial nerve passing below the muscle^{8,9,12,13,22}. Also in pelvic divisions, Sciatic nerve have been reported to exit with the Tibial nerve emerging at the inferior margin of the Piriformis muscle, while the Common fibular passed above^{8,9,10,12}.

The current study examined the exit pattern of the Sciatic nerve in Nigerians. Findings are expected to assist in surgical management of many related conditions including piriformis syndrome (sciatica) and other entrapment neuropathies.

MATERIALS AND METHODS

The study involved 282 lower extremities harvested from 141 embalmed adult Nigerian cadavers, aged between 20 and 60 years of age.



PM = Piriformis muscle, SN = Sciatic nerve

Figure 1: Diagram illustrating the Sciatic nerve emerging undivided at the inferior margin of the Piriformis muscle

The specimens were obtained from the Department of Human Anatomy of various South-South, South-East and South-Western Universities in Nigeria. There were no obvious physical deformities or direct trauma to the Hip joints and the lower limbs. The gluteal regions were dissected following the dissection protocol established by^{14&15}.

RESULTS

Introduction

The purpose of this study was to determine the exit pattern of Sciatic nerve in relation to the Piriformis muscle.

Five (5) exit patterns were observed and categorized as hereunder:

- i. As shown in Figure 1, the Sciatic nerve emerged as a single nerve trunk at the inferior border of the Piriformis muscle (IBP1)

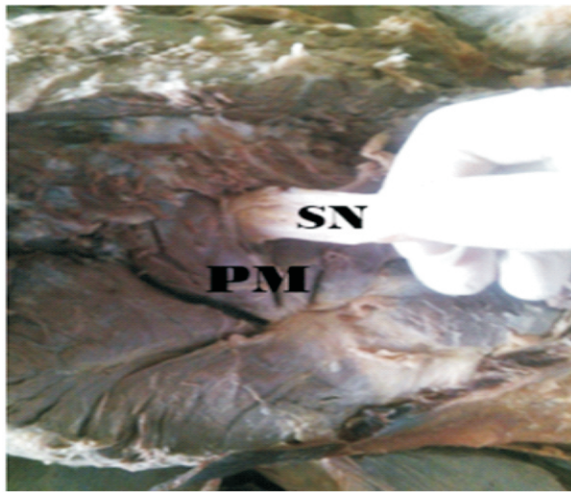
- ii. Figure 2 shows the Sciatic nerve dividing before exiting. Two trunks (Tibial and Common fibular nerves) emerge at the inferior border of the Piriformis muscle (IBP2) as separate trunks.



PM = Piriformis muscle, TN = Tibial nerve, CFN = Common Fibular Nerve

Figure 2: Diagram illustrating Sciatic emerging already divided at the inferior border of the Piriformis (IBP2)

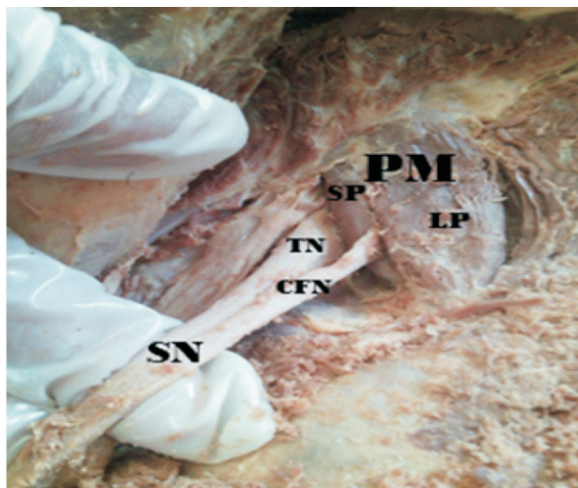
- iii. In Figure 3, the Sciatic nerve pierced the Piriformis muscle as an undivided nerve (Pp1)



PM = Piriformis muscle, SN = Sciatic nerve

Figure 3: Diagram illustrating Sciatic nerve emerging undivided nerve by piercing the Piriformis muscle (Pp1)

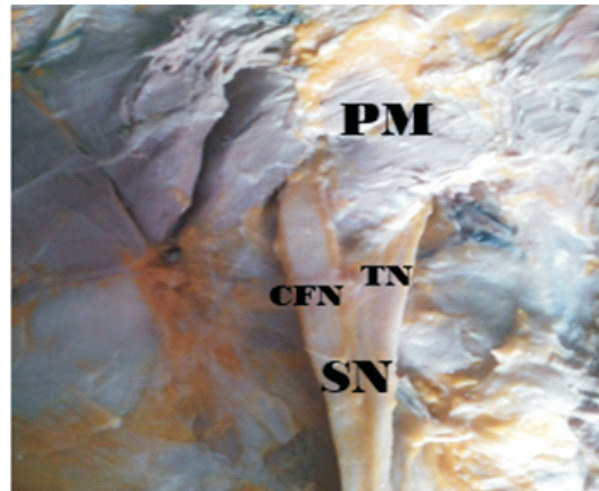
- v. This pattern is similar to the previous one, but different; the Common fibular nerve pierced the Piriformis muscle at its inferior 1/3, while the Tibial nerve passed below the muscle (PL1/3P) [Figure 5].



PM = Piriformis muscle, SP = Smaller part, LP = Larger part, TN = Tibial nerve, CFN = Common fibular nerve, SN = Sciatic nerve

Figure 5: Diagram illustrating Sciatic nerve emerging divided, with the Common fibular nerve piercing the Piriformis muscle at its inferior 1/3 and Tibial nerve passing below (PL1/3P)

- iv. In this pattern, the Sciatic nerve emerged from the pelvis already divided. One division; the Common fibular nerve pierced the Piriformis muscle at its centre, while the Tibial nerve passed below the muscle (P1/2P) [Figure 4].



PM = Piriformis muscle, SN = Sciatic nerve, TN = Tibial nerve, CFN = Common fibular nerve

Figure 4: Diagram illustrating Sciatic nerve emerging already divided in the pelvis, with the Common fibular nerve piercing the Piriformis muscle at its centre half and Tibial nerve passing below (P1/2P)

DATAANALYSIS

The observed exit patterns were presented in frequency distribution tables and percentages as observed on the left and right gluteal regions [Table 1]. Chi-square analysis was used to test the association between the left and right side in the observed exit patterns [Table 2]. Symmetrical and asymmetrical relationship between each pattern on the left and right side was presented in Table 3a and b. Comparison with previous studies is presented in Table 4a-d.

Table 1: Exit patterns of Sciatic nerve

Exit patterns	Side	Frequency	Percentage (%)	N	Percentage (%)
Pattern A	Left	132	93.62	265	93.97
	Right	133	94.33		
Pattern B	Left	-	-	1	0.35
	Right	1	0.71		
Pattern C	Left	1	0.71	1	0.35
	Right	-	-		
Pattern D	Left	6	4.26	7	2.48
	Right	1	0.71		
Pattern E	Left	2	1.42	8	2.84
	Right	6	4.26		
Total				100	100

Pattern A = Single nerve trunk at the inferior border of piriformis (**IBP1**), **Pattern B**= Divided nerve at the inferior border or margin of the piriformis (**IBP2**), **Pattern C** = Single nerve piercing piriformis (**PP1**), **Pattern D**= Divided nerve with CFN piercing the centre of the piriformis and TN below the muscle (**P1/2P**), **Pattern E**= Divided nerve with CFN piercing the inferior 1/3 of the piriformis and TN below the muscle (**PL1/3P**).

Pattern A is most observed pattern, while pattern B and C were the least observed

Table 2: Chi-square test of association between the exit patterns of the Sciatic nerve and on each side of the gluteal region

Side	Exit patterns of the sciatic nerve (Gluteal portion)				Chi-square analysis			
	Pattern A (%)	Pattern B (%)	Pattern C (%)	Pattern D&E (%)	df	χ^2_{cal}	P-value	Remark
Right	133 (94.33)	1 (0.71)	-	7 (4.96)	3	2.07	0.56	Not significant
Left	132 (93.62)	-	1 (0.71)	8 (5.67)				
Total	265 (93.97)	1 (0.35)	1 (0.35)	15 (5.32)				

Pattern A = Single nerve at the inferior border of the piriformis **IBP1**, **Pattern** = Divided nerve at the inferior border of the piriformis muscle **IBP2**, **Pattern C** = Single nerve piercing the piriformis **PP1**, **Pattern D&E** = Divided nerve, with CFN piercing the piriformis muscle, and TN passing below the muscle **2PIB**.

No significant difference in exit pattern of sciatic nerve on the left compared to the right at $p < 0.05$

Table 3a: Symmetric and asymmetric relationship in exit patterns of Sciatic nerve in relation to Piriformis muscle in both limbs

Exit pattern	Side	N	Pattern A (%)	Pattern B (%)	Right Pattern C (%)	Pattern D (%)	Pattern E (%)
Pattern A	Left	132	128 (96.97)	-	-	1 (0.76)	3 (2.27)
Pattern B	Left	-	-	-	-	-	-
Pattern C	Left	1	1 (100)	-	-	-	-
Pattern D	Left	6	3 (50)	-	-	-	3 (50)
Pattern E	Left	2	2 (100)	-	-	-	-

Pattern A = Single nerve trunk at the inferior border of piriformis (**IBP1**), **Pattern B**= Divided nerve at the inferior border or margin of the piriformis (**IBP2**), **Pattern C** = Single nerve piercing piriformis (**PP1**), **Pattern D**= Divided nerve with CFN piercing the centre of the piriformis and TN below the muscle (**P1/2P**), **Pattern E**= Divided nerve with CFN piercing the inferior 1/3 of the piriformis and TN below the muscle (**PL1/3P**).

Five (5) exit patterns were observed on the left limb. The patterns were symmetrical and as well asymmetrical when compared to the right limb.

Table 3b: Symmetry and asymmetry in exit patterns of sciatic nerve between the right and left gluteal regions

Exit pattern	Side	N	Pattern A (%)	Pattern B (%)	Left Pattern C (%)	Pattern D (%)	Pattern E (%)
Pattern A	Right	133	127 (95.49)	-	1 (0.75)	4 (3.01)	1 (0.75)
Pattern B	Right	1	-	-	-	-	1 (100)
Pattern D	Right	1	1 (100)	-	-	-	-
Pattern E	Right	6	3 (50)	-	-	3 (50)	-

Pattern A = Single nerve trunk at the inferior border of piriformis (**IBP1**), **Pattern B**= Divided nerve at the inferior border or margin of the piriformis (**IBP2**), **Pattern C** = Single nerve piercing piriformis (**PP1**), **Pattern D**= Divided nerve with CFN piercing the centre of the piriformis and TN below the muscle (**P1/2P**), **Pattern E**= Divided nerve with CFN piercing the inferior 1/3 of the piriformis and TN below the muscle (**PL1/3P**).

Four (4) pattern were observed on the right limb. The patterns were symmetrical as well as asymmetrical when compared to the left limb.

Table 4a: Comparison between previous studies and the current study on the exit of Sciatic nerve at the inferior border of Piriformis muscle (IBP1)

Authors	Number of limbs	Study population	Pattern A (%)
Okraszewska <i>et al.</i> , 2002	36	Polish	69
Ugrenovic <i>et al.</i> , 2005	200	-	96
Guvencer <i>et al.</i> , 2009	50	-	52
Mustafa <i>et al.</i> 2009	50	-	52
Ogeng'o <i>et al.</i> , 2011	164	Kenya	80
Muthu <i>et al.</i> , 2011	50	India	100
Shewale <i>et al.</i> , 2013	90	India	73
Pokorny <i>et al.</i> , 2013	182	-	79
Prathiba <i>et al.</i> , 2013	100	India	92
Kathe <i>et al.</i> , 2014	60	India	75
Desalegn and Tesfay, 2014	36	Ethiopia	92
Current study	282	Nigeria	94

Table 4b: Comparison between previous studies and the current study on the exit of divided Sciatic nerve at the inferior border of Piriformis muscle (IBP2)

Authors	Number of limbs	Study population	Pattern B (%)
Okraszewska <i>et al.</i> , 2002	36	Poland	11.1
Mustafa <i>et al.</i> 2009	50	Turkey	24.0
Ogeng'o <i>et al.</i> , 2011	164	Kenya	9.8
Yusuf and Tasneem, 2011	2	Philippines	50
Saritha <i>et al.</i> , 2012	50	India	2.0
Shewale <i>et al.</i> , 2013	90	India	11.1
Kathe <i>et al.</i> , 2014	60	India	11.7
Desalegn and Tesfay, 2014	36	Ethiopia	2.8
Current study	282	Nigeria	0.4

Table 4c: Comparison between the previous studies and the current study on the exit of undivided Sciatic nerve piercing Piriformis muscle (Pp1)

Authors	Number of limbs	Study population	Pattern C (%)
Pecina, 1979	260	-	5.0
Pokorny <i>et al.</i> , 2013	182	-	2.2
Prathiba <i>et al.</i> , 2013	100	India	1.0
Kathe <i>et al.</i> , 2014	60	India	3.3
Current study	282	Nigeria	0.4

Table 4d: Comparison between the previous studies and the current study on the exit of divided Sciatic nerve with the Common fibular nerve piercing Piriformis muscle at its centre half or inferior 1/3, with Tibial nerve passing below (P1/2P & PL1/3P)

Author	Number of limbs	Study population	Pattern D and E (%)
Pecina, 1979	130	-	17.0
Chiba, 1992	514	-	34.0
More and Dalley, 1999	640	-	12.2
Okraszewska <i>et al.</i> , 2002	36	Poland	5.6
Pokorny <i>et al.</i> , 2006	182	-	14.3
Shailesh and mitesh, 2011	86	India	5.8
Yusuf and tanseem, 2011	2	Philippines	50.0
Ogeng'o <i>et al.</i> , 2011	164	Kenya	7.9
Saritha <i>et al.</i> , 2012	50	India	2.0
Prathiba <i>et al.</i> , 2013	100	India	3.0
Shewale <i>et al.</i> , 2013	90	India	11.1
Kathe <i>et al.</i> , 2014	60	India	6.7
Current study	282	Nigeria	5.0

DISCUSSION

Studies on Sciatic nerve, especially its exit pattern in relation to the piriformis muscle have been done on various populations. Five (5) exit patterns were observed, 5 on the left and 4 on the right. Symmetric and asymmetric relationships were observed between the left and right exit patterns, as well as between the right and left exit patterns. Observed differences in exit pattern between the left and the right Sciatic nerve were not significant at $p < 0.05$ using Chi-square analysis.

Pattern A

In this study, Sciatic nerve was observed to emerge at the inferior border of the Piriformis muscle as a single nerve [Figure 1]. This pattern occurred with the highest frequency (94%) [Table 1] and when compared with previous studies, a number of Authors reported similar findings. Our results however contradict those of ^{7,9,11,18,19}. The observed differences, could be due to the sample size, the population studied among others.

Pattern B

Similarly the nerve emerged divided (Tibial and Common fibular nerves) at the inferior border of the Piriformis muscle [Figure 2]. This pattern was observed in 0.4% of the cadavers [Table 1]. Some

previous studies ^{10,20,23} reported similar findings. There are however dissimilarities compared with other studies ^{7,9,12}. Though the current study utilized a much larger sample size, this pattern was observed in only one (1) cadaver, compared with many other studies employing smaller samples of cadavers ^{7,9}. The observed differences could be therefore be ascribed to differences in population studied.

Pattern C

Also the Sciatic nerve was observed to pierce (passing through) the Piriformis muscle as a single [Figure 3]. This pattern occurred with the same frequency as pattern B (0.4%) [Table 1]. Similar to this observation was the findings of ^{7,8,17}. All except ⁷ reportedly observed this pattern in one (1) cadaver and same with the current study. However ²¹ made dissimilar findings. Differences could be by chance or sample based. And going through the trends or published figures, exit of an undivided Sciatic nerve by piercing Piriformis muscle remains the least observed pattern, but has a serious clinical significance, as it is implicated in sciatica.

Patterns D and E

In these patterns the Sciatic nerve was observed to emerge into the gluteal region from the pelvis already divided. One division; the Common fibular pierced the

Piriformis muscle either at its centre half or inferior one third (1/3), while the Tibial nerve passed below the muscle [Figure 4 and 5]. These patterns were the second most observed (5.0%) [Table 1]. A handful of authors^{7,8,12, 13,19} reported similar findings. But^{4,17,21} among others reported otherwise.

Observed differences could be due to sample size and may not be as a result of the population involved in the study. This is because the findings of the current study is much similar to those of^{7,13} who studied Indian, Polish and Kenyan respectively. Pattern D and E were observed more on the left limb in the current study, in line with the findings of²², who also observed that the Common fibular nerve pierced the Piriformis muscle more commonly in males and on left limb.

CONCLUSION

This research focused on the exit patterns of Sciatic nerve in a sample of Nigerian cadavers.

From the results the exit patterns of Sciatic nerve and the proportion in which they occur in Nigerian cadavers varies. Sciatic nerve emerging at the inferior border of the Piriformis muscle as a single nerve was the most common pattern observed in this study (94%). While Sciatic nerve emerging by piercing Piriformis muscle as a single nerve as well as Sciatic nerve emerging divided at the inferior border of Piriformis was the least observed pattern (0.4% each). Findings of our study will be helpful to better understand some of the problems frequently encountered in Neurology, Orthopaedics, physical therapy and pain management.

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