

STUDY ON ANATOMICAL RELATIONSHIPS AND VARIATIONS BETWEEN THE SCIATIC NERVE AND PIRIFORMIS MUSCLE

VICENTE EJD¹, VIOTTO MJS², BARBOSA CAA³ & VICENTE PC⁴

¹ School of Physical Therapy, Center of Health Sciences, Federal University of Juiz de Fora, Juiz de Fora, MG - Brazil

² Department of Morphology and Pathology, Federal University of São Carlos, São Carlos, SP – Brazil

³ Municipal Health Secretariat, São Carlos, SP – Brazil

⁴ School of Veterinary Medicine and Zootechnia, Universidade Estadual Paulista Julio de Mesquita filho, Botucatu, SP - Brazil

Correspondence to: Eduardo José Danza Vicente, Universidade Federal de Juiz de Fora UFJF, Centro de Ciências da Saúde, Faculdade de Fisioterapia, Campus Universitário, Martelos, CEP 36016-130, Juiz de Fora, MG - Brazil, e-mail: edujdv@yahoo.com.br and eduardo.vicente@ufjf.edu.br

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ABSTRACT

Context: Piriform muscle syndrome can be caused by abnormal passage of the sciatic nerve or one of its parts through the belly of the piriform muscle. Objective: To analyze the anatomical and measurement relationships between the piriform muscle and the sciatic nerve in order to contribute towards better anatomoclinical understanding of the gluteal region. Method: Twenty adult cadavers of both sexes were used. The sciatic nerve and piriform muscle were dissected, measured and photodocumented. Results: The sciatic nerve was seen to be a single trunk passing through the lower margin of the piriform muscle in 85% of the 40 gluteal regions, and 15% showed bilateral variation characterized by the passage of the common fibular nerve through the piriform muscle. The data obtained did not show any statistically significant differences.

Key words: piriform syndrome; sciatic nerve; piriform muscle; anatomical relationships.

INTRODUCTION

The anatomic relationships between the sciatic nerve and piriformis muscle, as well as their variations, have been described by many authors^{1,2,3} and correlated with the origin of the signs and symptoms of the nervous compression syndrome^{3,4}. The “piriformis muscle syndrome”, a term that refers to a type of sciatic pain related to an abnormal condition of the piriformis muscle with a frequent traumatic origin, was initially described by Yeoman⁵. This syndrome represents a clinical entity characterized by sensitive, motor and trophic disturbances in the region of the sciatic nerve anatomical distribution^{3,6}.

There is not a common cause that determines the occurrence of this syndrome, although there are descriptions of traumas or trauma history⁷ in, approximately, half of the cases⁸. However, among the causes, it can be mentioned the abnormal passage of the sciatic nerve through the piriformis muscle, leading to the presence of sciatalgy consequent to compression of this nerve and of the concomitant arteries^{6,7,9,10}.

Apparently, there is discord among authors in relation to the incidence of the sciatic nerve passage through the piriformis muscle^{2,6,11,12}.

In reference to the topographic location of the sciatic nerve after its entrance in the gluteal region, Lockhart et al.¹³ describe that this nerve goes down towards the thigh at the midpoint between the sciatic tuberosity and the greater trochanter of the femur, a little closer to the first osseous salience.

Considering the above mentioned information about the topographic relationships between the sciatic nerve and piriformis muscle as a possible etiology for the Piriformis Muscle Syndrome, as well as the assertion of Robinson¹⁴ that this syndrome is not rare, the objectives of this work were to study and describe the anatomical relationships between the sciatic nerve and the piriformis muscle, giving special attention to the incidence of the sciatic nerve passage through the piriformis muscle or over its superior margin, to correlate the prevalence of the possible variations with the right and left antimeres, and to describe the metric relationships between

the sciatic nerve and the piriformis muscle as well as between the sacrotuberous ligament and greater trochanter of the femur.

METHODS

Forty right and left gluteal regions of 20 cadavers of white adult individuals, 16 male and 4 female, pertaining to the Anatomy Laboratory of de Federal University of São Carlos, were used in this study.

These cadavers, maintained in a 10% solution of formol, had its gluteal region dissected, in accordance with the stratigraphic planes, using the appropriate surgical instruments (clamps, bistouries with fixed and mobile blades, separators, scissors, etc.).

After the dissections were completed, the gluteal regions were schematized and photo documented, and the following measures were taken using a pachymeter with a 0.05 mm precision:

1. Thickness of the sciatic nerve at the inferior margin of the piriformis muscle;
2. Extrapelvic length of the piriformis muscle, taking the sacrotuberous ligament and the apex of the greater trochanter of the femur as reference points;
3. Extrapelvic thickness of the piriformis muscle at the midpoint of its belly;
4. Distance between the lateral border of the sacrotuberous ligament and the medial margin of the sciatic nerve. This measurement was carried out taking as reference the lateral border of the ligament, at the level of its attachment to the sciatic tuberosity;
5. Distance between the apex of the greater trochanter of the femur and the sciatic nerve lateral margin.

Subsequently, independent t tests were used to compare:

1. The extrapelvic length and thickness of the piriformis muscle at the midpoint of its belly, in the right and left antimeres;
2. The distances between the sciatic nerve medial border and the sacrotuberous ligament lateral margin and between the sciatic nerve medial border and the greater trochanter apex in the right and left antimeres;

RESULTS

In the forty dissected gluteal regions, named here as specimens, the relationship types found between piriformis muscle and the sciatic nerve were: 1° Non-variant relationship, in which the sciatic nerve emerged at the gluteal region (Figure 1) and, 2° Variant relationship, in which the nerve emerged divided at the gluteal region, with its common fibular portion crossing the piriformis muscle and the tibial portion passing through the inferior margin of the muscle (Figures 2A; B; C; D).

The variant relationship, observed only in the male cadavers, occurred bilaterally. In two cadavers (4 specimens),

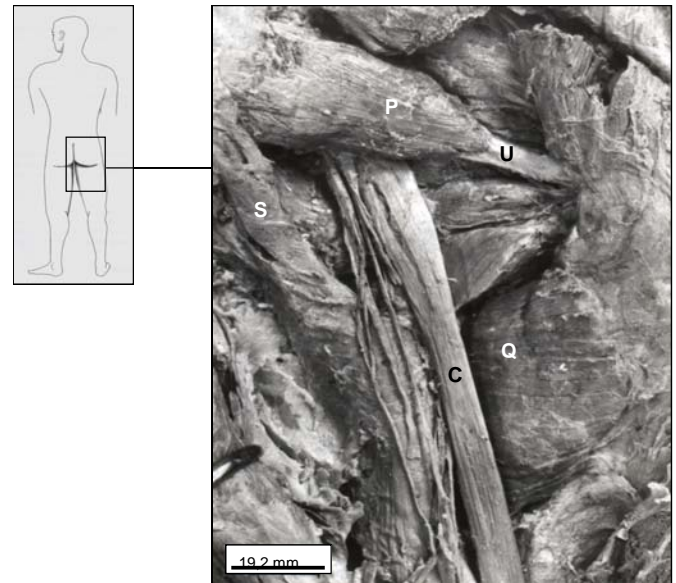


Figure 1. Non-variant gluteal region, showing piriformis muscle (P), single attachment tendon (U), sciatic nerve (C), sacrotuberous ligament (S) and quadratus muscle of the thigh (Q).

the piriformis muscle presented 2 bellies, a superior larger one which is partially superposed to an inferior smaller one. The inferior belly presented tendinous fibers, which formed a tendon (in two specimens) (Figure 2A) or extended along its inferior (Figure 2B) or superior (Figure 2C) border.

In the variant specimens, the sciatic nerve, after emerging at the gluteal region, behaved differently in its course towards the thigh posterior portion, in the right and left antimeres. It was observed that the common fibular and tibial portions joined together at the level of the gemellus superior muscle, in the right antimere, in two specimens (Figure 2A); at the medium third level of the quadratus femoris muscle, in the right antimere (Figure 2B); at the superior border of the gemellus superior muscle, in the left antimere (Figure 2C), or they were maintained separated, in the left antimeres of two specimens (Figure 2D) and, thus, continued in their descending course.

In 80% of the cases (34 specimens), the relationship was non-variant and, in 15% (6 specimens), the relationship was variant (Table 1). In reference to the thickness of the sciatic nerve at the level of the piriformis inferior border, the non-variant and variant relationships in the right and left antimeres, presented statistically significant differences, as the variant relationships presented greater values (Table 2).

Table 1. Type of relation found in the right and left antimeres and its percentage.

Type	Right	Left	%	Total
Non-variant	17	17	85	34
Variant	03	03	15	06
Total	20	20	100	40

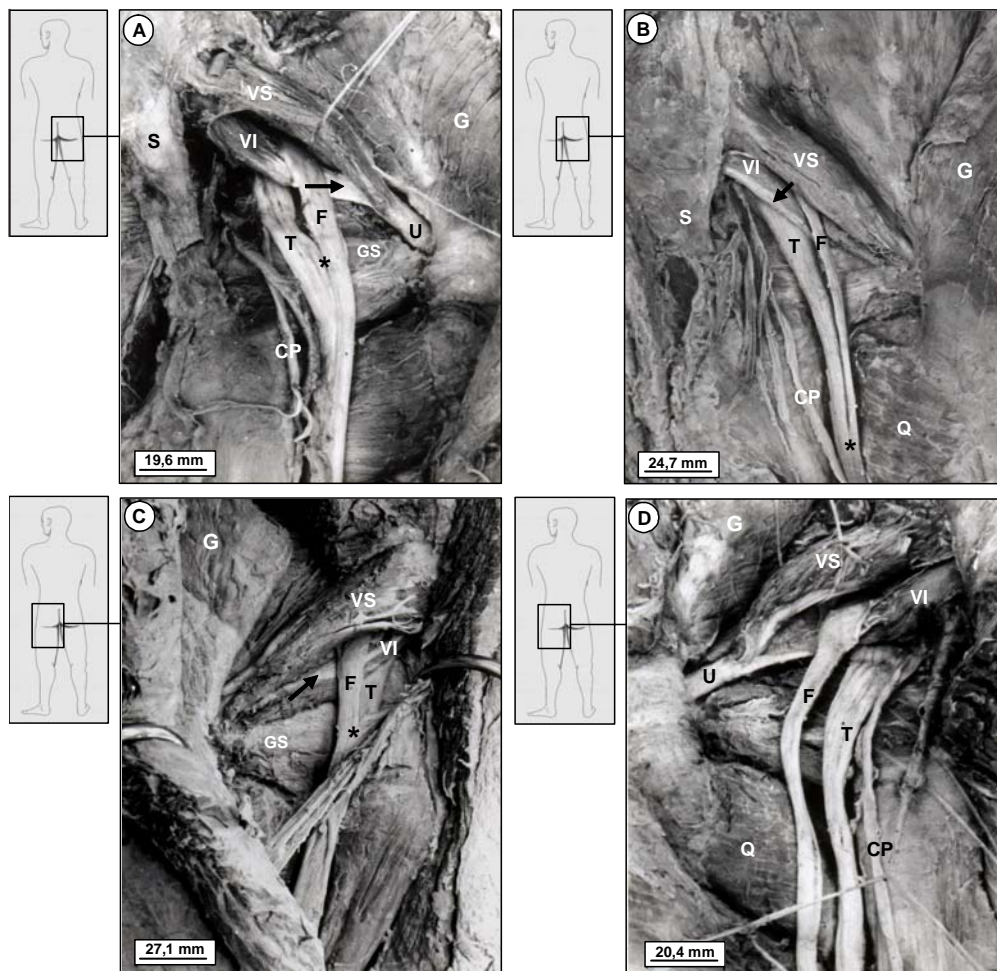


Figure 2. Variant gluteal regions, showing middle gluteal muscle (G), upper belly of the piriformis muscle (VS), lower belly of the piriformis muscle (VI), common fibular nerve (F) and tibial nerve (T). A: Note the formation of a tendon (arrow) in the lower belly of the piriformis muscle, which joins to the single attachment tendon (U), and also the junction of the sciatic nerve (*) and the superior gemellus muscle (GS); posterior cutaneous nerve of the thigh (CP) and sacrotuberal ligament (S). B: Note tendinous fibers (arrow) at the lower margin of the lower belly of the piriformis muscle and also the junction of the sciatic nerve (*) in the middle third of the quadratus muscle of the thigh (Q); posterior cutaneous nerve of the thigh (CP) and sacrotuberal ligament (S). C: Tendinous fibers (arrow) at the upper margin of the lower belly of the piriformis muscle and the junction of the sciatic nerve (*) at the upper margin of the superior gemellus muscle (GS). D: Single attachment tendon (U) of the piriformis muscle and separate sciatic nerve; posterior cutaneous nerve of the thigh (CP) and quadratus muscle of the thigh (Q).

Table 2. Width (mm) of the sciatic nerve close to the inferior border of the piriformis muscle in the right and left antimeres of the non-variant and variant relations.

Side	Type	N	Mean	Standard Deviation	Standard Error	Test T	DF	P
Right	Non - variant	17	18.852	4.452	1.080	- 2.53*	18	0.021
	Variant	3	26.433	6.764	3.905			
Left	Non - variant	17	22.335	5.955	1.444	- 2.03*	18	0.056
	Variant	3	29.700	3.966	2.289			

* Significant 5%

The comparison of the piriformis muscle extrapelvic length and thickness between the right and left antimeres did not show any statistically significant difference (Table 3). The distances between the sciatic nerve medial margin and the

sacrotuberous ligament lateral margin and between the sciatic nerve lateral border and greater trochanter apex, in the right and left antimeres, did not present statistically significant differences either (Table 4).

Table 3. Extrapelvic length and width of the piriformis muscle in the midpoint of its belly, in the right and left antimeres.

Measure	Side	N	Mean	Standard Deviation	Standard Errors	Test T	DF	P
Length	Right	20	76.380	8.255	1.846	-1.502^{ns}	19	0.150
	Left	20	79.510	10.117	2.262			
Width	Right	20	22.980	6.230	1.393	1.361^{ns}	19	0.189
	Left	20	21.835	4.729	1.058			

^{ns} Not significant**Table 4.** Distance between the medial margin of the sciatic nerve and lateral margin of the sacrotuberal ligament and between the lateral margin of the sciatic nerve and apex of the greater trochanter, in the right and left antimeres.

Distance	Side	N	Mean	Standard Deviation	Standard Error	Test T	DF	P
Medial margin of the sciatic nerve and lateral margin of the sacrotuberal ligament	Right	20	17.290	4.685	1.048	-0.34^{ns}	19	0.734
	Left	20	17.855	7.271	1.626			
Lateral margin of the sciatic nerve and apex of the greater trochanter	Right	20	32.660	6.125	1.370	-0.28^{ns}	19	0.781
	Left	20	33.225	8.086	1.808			

^{ns} Not significant

DISCUSSION

The tibial and common fibular nerves represent two portions, inside the sciatic nerve, which are manifested at the origin of this nerve during the early stages of the embryonic development and maintain their identity throughout their extension, even though joined together in a common nerve by a connective tissue sheath¹⁵. Previous studies by Mandiola et al.¹¹, with full term human embryos, evidenced that the sciatic nerve is constituted as a single trunk, in the plexus, in 48% of the cases, whereas the remain percent corresponds the separated existence of the tibial and common fibular nerves in the sacral plexus.

The separation that occurs during the embryonic development may remain in the adult, influencing the topographic relationships between the sciatic nerve and the piriformis muscle at the gluteal region.

In the present study, in 85% of the cases, it was observed a non-variant anatomical relationship between the sciatic nerve and piriformis muscle. This findings accord with the literature which reports the passage of the entire nerve through the infrapiriformis foramen in 80 to 90% of the cases^{2,16,17}.

The single variation found (15% of the observations) was that in which the sciatic nerve emerged dividedly at the gluteal region, with its tibial portion always passing through the inferior border of the piriformis muscle. The common fibular portion, in contrast, was found crossing the non-

divided muscle in 2 specimens or passing between the two bellies of the divided muscle, in contact with tendinous fibers, in 4 specimens.

This type of variation was also the most frequently found by Pace & Nagle⁸, Pecina⁶, Gabrielli et al.². Differently, other variation types are described by these authors, however less frequently. In these cases, the whole sciatic nerve can penetrate the piriformis muscle⁸, or the common fibular nerve may extend through the superior border and the tibial nerve through the inferior border of this muscle².

This variation between the sciatic nerve and the piriformis muscle, which leads to nerve compression sciatalgia^{6,9,10}, causes the piriformis syndrome⁵. However, this nervous compression is not a clinical entity present only when one or both portions of the sciatic nerve cross the piriformis tendinous fibers but also when they cross the muscular fibers.

In this work, 4 of the 6 variant specimens presented the fibular portion of the sciatic nerve in contact with tendinous fibers of one the piriformis bellies. Pecina⁶ observed the sciatic nerve crossing the tendinous portion in 15% of the anatomic specimens. In these individuals, the stretching of the piriformis muscle, consequent to thigh internal rotation, could lead to nervous compression⁶. The other 2 studied specimens presented the sciatic nerve fibular portion crossing the piriformis muscular fibers. This specific condition led several researchers to treat this syndrome in a non-conservative way,

sectioning the piriformis muscle fibers in order to minimize the nervous compression effects^{4,8,9,14}.

The present study suggests that there is no antimere prevalence in reference to variations occurrence in the anatomic relationships between the sciatic nerve and piriformis muscle, what accords with the previous descriptions by Bardeen & Elting¹⁵. Nevertheless, the left side was more variable in the studies by Trotter¹⁸ and Odajima & Kurihara¹⁹, whereas the studies by Berkol et al.²⁰ and, afterwards, by Gabrielli et al.², identified the right side as the most variable one. All variant specimens in this study proceeded from male cadavers, differently from Odajima & Kurihara¹⁹, who observed a greater incidence of this variation in male specimens, and from Pace & Nagle⁸, who observed this greater incidence in female specimens.

When the sciatic nerve arose as single trunk, it continued its entire course at the gluteal region. In the variant specimens, after entering the gluteal region, the common fibular and tibial portions continued divided in the left antimeres in two specimens. In the other ones, even in different levels, the separated portions united to each other, near to the gemellus superior muscle and quadratus femoris muscle. In the researched literature, references related to the level of union of the sciatic nerve separated portions at the gluteal region were not found. The descriptions are generic, stating that when the two sciatic nerve portions arise separated in the plexus, they can simply extend parallel through the rest of the thigh, or they may unite above the piriformis muscle by a connective tissue sheath, exactly like when they do not arise separated¹⁷.

Among the measurements carried out, only the sciatic nerve thickness presented a significant statistical difference, when the right and left antimeres were compared, with variant and non-variant relationships. The sciatic nerve thickness at the level of the piriformis muscle inferior border was 18.85 mm on the right side and 22.32 mm on the left side, in the non-variant relationships. However, Williams et al.²¹ attributed a thickness of 20.0 mm to the sciatic nerve at its apparent origin. In variant relationships, the average thicknesses found were 26.46 mm on the right side and 29.68 mm on the left side.

The mean extrapelvic length of the piriformis muscle found was 76.37 mm in the right antimeres and 79.50 mm in the left antimeres. These results are similar to those demonstrated by Gabrielli et al.² in which the observed piriformis length was 71.90 mm and 72.80 mm, in the right and left antimeres, respectively. The average values for piriformis muscle thickness at the midpoint of its belly were 21.82 mm, in the right antimeres, and 20.95 mm, in the left antimeres. These are the sole data about this measure in the specific literature.

The mean distances observed between the medial margin of the sciatic nerve and the lateral border of the sacrotuberous ligament were 17.27 mm and 17.83 mm in the right and left

antimeres, respectively. The nerve's lateral border was located at a 32.66 mm distance from the apex of the greater trochanter, on the right side, and at a 33.22 mm distance, on the left side. Although the researched literature did not present similar descriptions, it seems that these data are in agreement with the classical description which stated that the sciatic nerve main extension lies on the posterior surface of the ischium bone, between the sciatic tuberosity and greater trochanter of the femur, a little closer to the first osseous salience^{13,17,22}.

Knowing the high division of the sciatic nerve as well as its course is important to surgical approach, in cases of lesions which affect its gluteal or femoral portions²³. Other authors associate the abnormal passage of the sciatic nerve across the piriformis muscle with a nervous compression syndrome, specifically the Piriformis Muscle Syndrome^{4,6,9,14,24}.

In conclusion, it is believed that the accomplishment of this work has brought contributions to the specific topic, both by confirming previously described data and by adding new observations, in order to improve the anatomical and clinical knowledge about the gluteal region.

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