

Anatomical variations of the sciatic nerve in a group of Brazilian cadavers*

Variações anatômicas do nervo ciático em um grupo de cadáveres brasileiros

Joseph Bruno Bidin Brooks¹, Cristiano Augusto Cruz Silva², Sônia Aparecida Soares¹, Margareth Reiko Kai², Richard Halti Cabral¹, Yara Dadalti Fragoso¹

* Received from Universidade Metropolitana de Santos. Santos, SP.

SUMMARY

BACKGROUND AND OBJECTIVES: The sciatic nerve is often involved in conditions of pain. It is a long nerve, prone to injuries that are the consequence of trauma, inflammation and entrapment. One possible cause of sciatic pain derives from the piriformis muscle, which maintains a very close anatomical relationship with the sciatic nerve. The objective of the present study was to evaluate the characteristics of the sciatic nerve and its relationship to the piriformis muscle in a group of Brazilian cadavers.

METHOD: Anatomical dissection of 40 human limbs with detailed studies of the sciatic nerve and the piriformis muscle.

RESULTS: Anatomical variations of the relationship between the sciatic nerve and the piriformis muscle were rare. Data on the sciatic nerve length and width showed similar results to those from the literature.

CONCLUSION: The piriformis syndrome is a painful condition considered by many to be associated to anatomical variations of the relationship between the sciatic nerve and the piriformis muscle. The rarity of such variations, in the present series and in the studies published by other groups, suggests that the painful syndrome may often occur without the anatomical variations.

Keywords: Lower limbs, Pain, Piriformis muscle, Sciatic nerve.

RESUMO

JUSTIFICATIVA E OBJETIVOS: O nervo ciático frequentemente se encontra envolvido em situações de dor. É um nervo longo, propenso a lesões que podem ser consequência de trauma, inflamação e aprisionamento. Um causa possível de dor ciática deriva do músculo piriforme, que mantém estreita relação anatômica com o nervo ciático. O objetivo do presente estudo foi avaliar as características do nervo ciático e de sua relação com o músculo piriforme em um grupo de cadáveres brasileiros.

MÉTODO: Dissecção anatômica de 40 membros inferiores com estudo detalhado do nervo ciático e do músculo piriforme.

RESULTADOS: As variações de relação anatômica entre o nervo ciático e do músculo piriforme foram raras. Dados de comprimento e largura do nervo ciático foram semelhantes àqueles descritos na literatura.

CONCLUSÃO: A síndrome do piriforme é uma condição dolorosa, considerada por muitos como sendo relacionada às variações anatômicas entre o nervo ciático e o músculo piriforme. A raridade de tais variações, tanto no presente estudo como em publicações por outros grupos, sugere que a síndrome dolorosa possa ocorrer frequentemente sem que existam variações anatômicas.

Descritores: Dor, Membros inferiores, Músculo piriforme, Nervo ciático.

1. Medical Lectures, Departments of Physiology, Anatomy and Neurology, Universidade Metropolitana de Santos. Santos, SP, Brazil.

2. Departments of Neurology and Neurophysiology, Hospital do Servidor Publico Estadual de São Paulo. São Paulo, SP, Brazil.

Correspondence to:
Joseph Bruno Bidin Brooks, MD.
Rua da Constituição 374
11015-470 Santos, SP.
Phone-Phax: +55 13 3226-3400
E-mail: joseph3b@gmail.com

INTRODUCTION

The sciatic nerve is frequently involved in daily medical practice of neurology, orthopedics, rehabilitation and anesthesia. The anatomy of the sciatic nerve and its relationship with the piriformis muscle are better studied in cadavers^{1,2}. Recording the findings of such anatomical studies may help in understanding piriformis syndrome, a condition that according to some physicians is well established, but according to others does not even exist³.

Piriformis syndrome is an underdiagnosed cause of gluteus and leg pain, but according to some authors it is vastly overdiagnosed⁴. The piriformis muscle is closely related to the sciatic nerve, which makes it possible that trauma and inflammation in the piriformis muscle might be clinically represented by sciatic pain⁵. Identification of the syndrome and accurate diagnosis are usually difficult, especially if the regional anatomy is not known by the physician. Although originally described in 1947⁶, the existence of the piriformis syndrome is still contested by some authors⁴. However, a very comprehensive recent review of the literature on piriformis syndrome⁵ has pointed towards confirming the existence of this syndrome as a clinical entity, albeit still somewhat unknown in the medical world.

The piriformis muscle is flat and pear-shaped, originating from the anterior border of the second to fourth sacral segment, from the upper margin of the greater sciatic notch, and from the sacrotuberous ligament⁷. With the leg extended, the piriformis is mainly an external rotator for the hip, but when the leg is flexed, it is a hip abductor⁸.

The long and thick sciatic nerve is prone to injuries, and a variety of conditions may originate sciatic pain. One of them seems to be entrapment by the piriformis muscle³. The relationship between the piriformis muscle and the sciatic nerve is variable, since the undivided nerve may emerge above the muscle or through the muscle. The major divisions of the nerve may lie on either side, above or below the muscle⁹.

The anatomical relationship between the sciatic nerve and the piriformis muscle has been classified using a six-category classification system¹⁰. The type "A" relationship is considered to be the normal one between the sciatic nerve and piriformis muscle, while types "B" to "F" are variants that may lead to piriformis syndrome. A clear schematic representation of these types A-F can be found in the recent and detailed work². This work included a systematic review and meta-analysis of the literature, assessing the prevalence of anatomical variations from 18 anatomical studies on over 6,000 limbs².

It is important not to confound the A-F classification of the relationship between the sciatic nerve and the piriformis muscle with the A-F classification of sciatic nerve division into tibial and common peroneal nerves¹. To make matters more confusing, in approximately 12% of the cases, the common fibular and tibial divisions of the nerve separate proximally to or at the level of the piriformis⁷. In brief, regarding sciatic nerve division, Group A consists of sciatic nerve division proximally to its exit in the gluteal region. In Group B, it divides in the gluteal region. In Groups C, D and E, it divides in the upper, middle and lower regions of the back of the thigh, respectively. In Group F, the sci-

atic nerve divides in the popliteal fossa. Once these two classifications are well understood, it is clear that they are totally independent, despite the initial idea that the A-F categories could be the same.

In order to recognize the piriformis syndrome and to be able to address it with proper knowledge, it is important to have good understanding of the anatomy of the region and its variations. Several studies on cadavers have been carried out² but, unfortunately, data from Brazilian studies are still scarce¹¹.

The aim of the present study was to report on the anatomical findings from Brazilian cadavers and to compare these variations with those reported in the literature.

METHOD

After approved by the Ethics Committee of Universidade Metropolitana de Santos, SP, Brazil, on October 13, 2009 (2009-18), forty limbs from 20 adult cadavers of mixed ethnic origins were studied (16 males and four females). The cadavers belonged to the Anatomy Department of Universidade Metropolitana de Santos, SP, Brazil. No clinical data on them was available, and therefore, it was not known whether any of them had presented piriformis syndrome when alive.

The cadavers had been kept in 10% formalin, and their gluteal region was dissected using precise surgical instruments. After dissection, the gluteal regions were photo-documented and the following measurements were made using a 0.05 mm precision pachymeter: 1. Relationship between the sciatic nerve and the piriformis muscle; 2. Width of the sciatic nerve at the lower margin of the piriformis muscle; 3. Extra-pelvic length of the piriformis muscle, taking the reference points of the sacrotuberous ligament and the apex of the major femoral trochanter; 4. Extra-pelvic width of the piriformis muscle at the midpoint of the muscle; 5. Distance between the lateral margin of the sacrotuberous ligament and the sciatic nerve margin. For this measurement, the reference point was the lateral margin of the ligament, close to the point of fixation into the sciatic tuber and 6. Distance between the apex of the greater femoral trochanter and the lateral margin of the sciatic nerve.

RESULTS

The results are summarized in tables 1 to 4. Table 1 shows the prevalence of anomalies of emergence and division of the sciatic nerve in relation to the piriformis muscle, comparing the results from the systematic review of the literature with the findings from the present study. In the present study, there was a much higher prevalence (>

80%) of the type A variation, i.e. the “normal” relationship between the sciatic nerve and the piriformis muscle. Table 2 presents the width of the sciatic nerve at the lower margin of the piriformis muscle on the right and left sides, showing a significant difference in nerve width between the two sides. Table 3 shows the extra-pelvic length of the piriformis muscle in the right and left limbs, taking the reference points of the sacrotuberous ligament and the apex of the greater femoral trochanter. Table 4 presents

the distance between the lateral margin of the sacrotuberous ligament and the sciatic nerve margin, using the lateral margin of the ligament, close to the point of fixation into the sciatic tuber, as the reference point. Table 4 also shows the distance between the apex of the greater femoral trochanter and the lateral margin of the sciatic nerve. Figure 1 shows dissection images of the normal and variant relationships between the sciatic nerve and the piriformis muscle.

Table 1 – Relationship between the sciatic nerve and the piriformis muscle.

Types	Variations	Smoll 2010	Present Study
A	The sciatic nerve emerges below the piriformis muscle (“normal”)	5,038 (83.1%)	36 (90%)
B	The sciatic nerve divisions pass through and below the piriformis muscle	829 (13.8%)	0
C	The sciatic nerve divisions pass through and above the piriformis muscle	78 (1.4%)	0
D	The sciatic nerve passes above the piriformis muscle	32 (0.7%)	4 (10%)
E	The sciatic nerve divisions pass above and below the piriformis muscle	5 (< 0.1%)	0
F	The sciatic nerve emerges through the piriformis muscle	5 (< 0.1%)	0

Comparison between the meta-analysis findings ([ref] Smoll 2010) and the results from the present study on 40 limbs from Brazilian cadavers. Types A-F are those described by Beaton and Anson¹⁰.

Table 2 – Width of the sciatic nerve (mm) at the lower margin of the piriformis muscle.

Side	Type	N	Mean	Standard Deviation	Standard Error	Student’s t-test	p-value
Right	Not variant	18	19.451	5.246	2.408	-3.21	0.03
	Variant	2	28.824	8.921	3.976	-2.94	0.064
Left	Not variant	18	19.463	5.238	2.401	-3.10	0.04
	Variant	2	28.817	8.912	3.973	-2.91	0.064

Table 3 – Extra-pelvic length and width of the piriformis muscle in the right and left limbs, taking the reference points of the sacrotuberous ligament and the apex of the greater femoral trochanter.

	Type	N	Mean	Standard Deviation	Standard Error	T test	p-value
Length	Right	20	74.518	7.251	1.464	1.39	0.129
	Left	20	78.454	9.223	1.932		
Width	Right	20	23.19	6.112	1.228	1.24	0.164
	Left	20	22.37	5.24	1.194		

Table 4 – Distance between the lateral margin of the sacrotuberous ligament and the sciatic nerve margin, using the lateral margin of the ligament, close to the point of fixation into the sciatic tuber, as the reference point.

	Side	N	Mean	Standard Deviation	Standard Error	Student’s t-test	p-value
Medial margin of sciatic nerve	D	20	17.974	4.955	1.114	-0.27	0.712
Lateral margin of sacro tuberous ligament	E	20	18.42	5.161	1.317		
Medial margin of sciatic nerve	D	20	18.121	7.942	1.734	0.22	0,794
Apex of greater trochanter	E	20	30.264	6.437	1.536		

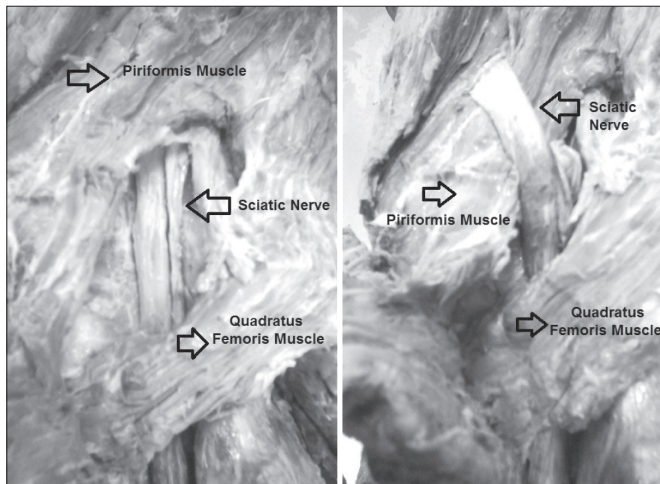


Figure 1 - A) The sciatic nerve emerges below the piriformis muscle (“normal”); B) The sciatic nerve passes above the piriformis muscle (“variation”).

DISCUSSION

It is unclear whether the anatomical variations in the relationship between the sciatic nerve and the piriformis muscle are responsible for the pain experienced in piriformis syndrome, since asymptomatic patients might have these variations, while symptomatic patients might not have them⁷. In fact, there is still a tendency to envisage parallel existence of “sciatic-piriformis anomalies” and “piriformis syndrome”. Whether the relationship between nerve and muscle is really cause and consequence of the pain remains to be defined². However, it is only through detailed study of the regional anatomy that these doubts may one day be clarified.

The present study has confirmed the data in the worldwide literature, with regard to the “normal” type A relationship between the sciatic nerve and the piriformis muscle. This type of relationship, with the sciatic nerve emerging below the piriformis muscle was prevalent in our population, just as it was in all other similar studies that were systematically². Variants of this “normal” type A relationship are indeed so rare that hundreds of limbs would have to be studied in order to identify variations B-F in a population. Variations in sciatic nerve width and length are not unknown¹¹, and possibly do not represent an anomaly. The relatively small number of limbs studied in the present work does not allow for statistical comparisons and conclusions between normal and variant relationships between nerve and muscle. The essence of this study was descriptive, in order to obtain more informa-

tion on variations of the sciatic nerve anatomy. However, taking into consideration data from the present work and from the literature on the subject, it is fair to say that the piriformis syndrome possibly does not depend on abnormal relationships between the sciatic nerve and the piriformis muscle, or it would be an extremely rare pain-generating condition. In fact, even in a situation of normal relationship between the sciatic nerve and the piriformis muscle, any condition affecting the muscle (e.g., inflammation or trauma) could indirectly affect the nerve. This idea seems to be particularly supported by the good pain relief results achieved when low doses of botulinum toxin are injected into the piriformis muscle of patients with typical signs and symptoms of the piriformis syndrome¹².

CONCLUSION

Piriformis syndrome is a rare pain-generating condition, and only detailed study of sciatic nerve anatomy and its anatomical relationship with the piriformis muscle is likely to shed light on the questions regarding the syndrome. Anatomical variations in the relationship between the sciatic nerve and the piriformis muscle do not seem to be solely responsible for the piriformis syndrome.

REFERENCES

1. Prakash, Bhardwaj AK, Devi MN, et al. Sciatic nerve division: a cadaver study the Indian population and review of the literature. *Singapore Med J* 2010;51(9):721-3.
2. Smoll NR. Variations of the piriformis and sciatic nerve with clinical consequence: a review. *Clin Anat* 2010;23(1):8-17.
3. Halpin RJ, Ganju A. Piriformis syndrome: a real pain in the buttock? *Neurosurgery* 2009;65(4 Suppl):A197-202.
4. Stewart JD. The piriformis syndrome is overdiagnosed. *Muscle Nerve* 2003;28(5):644-6.
5. Hopayian K, Song F, Riera R, et al. The clinical features of the piriformis syndrome: a systematic review. *Eur Spine J* 2010;19(12):2095-109.
6. Robinson DR. Piriformis syndrome in relation to sciatic pain. *Am J Surg* 1947;73(3):355-8.
7. Kirschner JS, Foye PM, Cole JL. Piriformis syndrome, diagnosis and treatment. *Muscle Nerve* 2009;40(1):10-8.
8. Rodrigue T, Hardy RW. Diagnosis and treatment of piriformis syndrome. *Neurosurg Clin N Am* 2001;12(2):311-9.
9. Güvençer M, Akyer P, Iyem C, et al. Anatomic

considerations and the relationship between the piriformis muscle and the sciatic nerve. *Surg Radiol Anat* 2008;30(6):467-74.

10. Beaton LE, Anson BJ. The sciatic nerve and the piriformis muscle: Their interrelation a possible cause of coccygodynia. *J Bone Joint Surg* 1938;20:686-88.

11. Vicente EJD, Viotto MJS, Barbosa CAA, et al. Study on anatomical relationships and variations between the sciatic nerve and piriform muscle. *Rev Bras*

Fisioter 2007;11(3):227-32.

12. Yoon SJ, Ho J, Kang HY, et al. Low-dose botulinum toxin type A for the treatment of refractory piriformis syndrome. *Pharmacotherapy* 2007;27(5):657-65.

Presented in August 15, 2011.

Accepted for publication in November 25, 2011.

No conflicts of interest to declare, this work was carried out without any public or private financial support.