ONLINE FIRST

This is a provisional PDF only. Copyedited and fully formatted version will be made available soon.

ISSN: 0015-5659

e-ISSN: 1644-3284

Evaluation of the sciatic nerve location regarding its relationship to the piriformis muscle

Authors: Perin Wan-ae-loh, Thanasil Huanmanop, Sithiporn Agthong, Vilai Chentanez

DOI: 10.5603/FM.a2019.0140

Article type: ORIGINAL ARTICLES

Submitted: 2019-11-13

Accepted: 2019-12-17

Published online: 2019-12-30

Evaluation of the sciatic nerve location regarding its relationship to the piriformis muscle

Running head: Sciatic nerve localization

Perin Wan-ae-loh[1], Thanasil Huanmanop[2], Sithiporn Agthong[2], Vilai Chentanez[2]

[1]Medical Science Program, Faculty of Medicine, King Chulalongkorn Memorial Hospital, Chulalongkorn University, Bangkok, Thailand

[2]Department of Anatomy, Faculty of Medicine, King Chulalongkorn Memorial Hospital, Chulalongkorn University, Bangkok, Thailand

Address for correspondence: Vilai Chentanez, MD, PhD, Department of Anatomy, Faculty of Medicine, King Chulalongkorn, Memorial Hospital, Chulalongkorn University, Bangkok 10330, Thailand, tel: 66-860701084, e-mail: fmedvct@gmail.com

Abstract

Background: The localization of sciatic nerve (SN) is essential for the achievement of several procedures performed in the gluteal region. This study proposed to investigate the location of SN regarding its relationship to the piriformis (PM) by the line joining the posterior superior iliac spine (PSIS), ischial tuberosity (IT) and greater trochanter (GT).

Material and methods: SN-PM relationship was examined in 204 specimens from102 embalmed cadavers (55 males, 47 females). Distances between PSIS, IT and GT were measured. Midpoints of SN at the lower edge of PM (S1) and IT-GT line (S2) were marked. Perpendicular line from S1 to PSIS-GT (S1-R) and to PSIS-IT (S1-Q), were created and measured. Distances of PSIS-R, PSIS-Q (S1) and IT-S2 were measured and calculated into percentage of PSIS-GT, PSIS-IT and IT-GT lengths respectively.

Results: Regarding the classification of Beaton and Anson, three types of SN-PM relationship (a, b and c) were obtained. The percentage of type a, b and c was 74.02, 22.55 and 3.43 respectively. Symmetrical SN-PM relationship was found in 75.49%.The mean length of PSIS-IT, PSIS-GT and IT-GT in all types was 129.63±11.89 mm, 151.34±14.78 mm and 73.02±10.20 mm respectively. A statistically significant difference was found between types a and b (p = 0.013) in PSIS-IT length, whereas mean length of IT-GT and

PSIS-GT showed no statistically significant difference between SN-PM types. PSIS-IT line passed SN at the lower edge of PM (S1) in 112specimens (54.90%). In these cases, S1 and Q were the same point. A statistically significant difference was also found between types a and b (p = 0.023) in PSIS-Q (S1) length. The mean lengths of PSIS-Q (S1), PSIS-R and IT- S2 in term of percentage of PSIS-IT, PSIS- GT and IT-GT line in all types were 60.06±5.90 %, 54.19±6.10 %, and 37.87±8.27 %, respectively. The mean lengths of S1-R and S1-Q were 30.07±8.30 mm and 6.54+7.99 mm. Therefore, SN at S1 could be located at the point of 54.19±6.10 %of PSIS-GT length (R) with a distance of 30.07±8.30 mm perpendicular to PSIS-GT line (S1-R). Since the PSIS-IT line did not pass SN at S1 in every case, therefore, it might not be suitable for localizing SN at S1. SN at S2 could be located at the point of37.87±8.27 % of IT-GT line. No significant difference was found between types.

Conclusions: SN can be localized by PSIS-GT and IT-GT lines without statistically significant difference between types (a,b,and c) of SN-PM relationship.

Key words: greater trochanter, ischial tuberosity, localization, piriformis muscle, posterior superior iliac spine, sciatic nerve

INTRODUCTION

The sciatic nerve (SN) is the largest peripheral nerve in the body. Normally, it exits from the pelvis through the greater sciatic foramen and passes under the piriformis muscle (PM). PM is a triangular shaped muscle which is located on the ventral surface of sacrum and sacrotuberous ligament and runs diagonally downwards to insert on the greater trochanter (GT) [3]. After the SN passes under PM, it travels between GT and ischial tuberosity(IT) toward the back of thigh. The SN bifurcates into tibial (TN) and common fibular nerve (CFN) usually at the apex of the popliteal fossa. SN serves an important role in controlling muscles of the back of the thigh, leg and foot. It also receives sensation from the skin of entire lower leg, as well as the foot. Furthermore, it provides articular branches to the joints of lower limb [8, 20].

The most common relationship between the SN and the PM is an undivided SN passing under the triangular shape of PM [8]. In 1937, Beaton and Anson conducted a study in 120 cadavers and categorized the form of relationship between SN and PM intosix types (Fig. 1) [3]. Tomaszewski et al., (32) reported a Metaanalysis from 45 studies and 7068 limbs to evaluate the type of SN-PM relationship. They depicted 85.2% of type a, 9.8% of type b, and 1.9% of type c. Type d, f, and g were found in less than 1%[32]. Previous studies revealed that, the deviation from normal anatomical relationship might increase the risk of tension injury, direct injury to nerve during operation, and sciatic nerve palsy [22, 29, 32]. Moreover, a previous study revealed that 16.2% of piriformis syndrome patients were associated with anatomical variation of SN-PM relationship [27].

Accurate data of the SN's location is essential for achievement of medical procedures performed in the gluteal region, including sciatic nerve block, gluteal intramuscular injection and percutaneous transgluteal drainage for pelvic abscess treatment [9, 27]. Furthermore, these data also help to reduce the chance of iatrogenic injury. Injury to SN can produce a wide range of problems from minor to complete sensory and motor impairments [11, 30]. Therefore, previous studies paid attention to use several landmarks to locate the position of SN including sacrotuberous ligament and GT [34], IT, ischial spine and GT [12] and acetabulum [10]. In 2015, Robert Haładaj and his colleagues also provided information about the distance from the medial edge of SN and apex of IT and the distance from the lateral edge of SN to GT [13]. In addition, posterior superior iliac spine (PSIS), GT and IT were used as the landmarks in CT scan to locate SN [9]. However, there is no report concerning SN surface location in each type of SN-PM relationship. This study aimed to explore the relationship of SN-PM and provided the surface location of SN by the lines joining PSIS, IT and GT in each type of SN-PM relationship.

MATERIALS AND METHODS

This study was performed in two hundred and four formalin-fixed specimens of gluteal region and posterior thigh from one hundred and two Thai cadavers (55 male and 47 female) supported by Department of Anatomy, Faculty of Medicine, Chulalongkorn University. The average age of the cadavers was 74.94 ±11.94 years (range 41-99). All cadavers did not have lesions and had no history of operation at the gluteal region and posterior thigh. Subcutaneous fatty tissue and the gluteus maximus muscle were removed to expose PM and SN. The anatomical relationship between SN and PM were evaluated and classified according to Beaton and Anson into type a, b, c, d, f and g (Fig 1).

To determine the location of SN, the most prominent point of PSIS, the lowest point of IT, and the outermost point of GT were identified and marked. Then, the lines joining these bony landmarks were created as PSIS-IT, PSIS- GT and IT-GT lines (Fig.2). The midpoint of SN at the lower edge of PM and where it crossed the IT-GT line was marked as S1and S2 respectively. In atypical cases (type b, c, d, f and g) S1 was marked at the midpoint between the divisions of SN. The perpendicular lines from S1 to PSIS-GT (S1-R) and PSIS-IT lines (S1-Q) were created (Fig. 2). The lengths of PSISIT, PSIS- GT, IT-GT, S1-R, S1-Q lines, the distances of PSIS-Q (S1), PSIS-R and IT- S2, were measured by standardized digital Vernier caliper (GuangLu ® 0-100 mm; range100 mm, resolution 0.01 mm). Each parameter was measured three times. The same digital Vernier caliper was used to assure the measurement consistency. All measurements were done by the same investigator.

Statistical analysis

Statistical analysis was performed by using IBM SPSS software version 22.0. Mean and standard deviation (SD) of each parameter was obtained. The data were analyzed with regard to type of SN-PM relationship. Shapiro-Wilk test was used to determine the distribution of the data. The statistical difference between types was analyzed by using One-Way ANOVA in normally distributed data. In case of non-normally distributed data, Kruskal-Wallis Test was applied.

Ethical consideration

This cadaveric study has been approved by the Institutional Review Board (IRB)of the Faculty of Medicine, Chulalongkorn University (IRB NO. 593/59).

RESULTS

Anatomical relation between the SN and the PM

According to the classification of Beaton and Anson [3], three types of the relationship between SN-PM were observed in 204 specimens including type a, b and c(Fig1).The prevalence of each type is shown in Table 1.The typical course of SN or type a, in which the undivided SN passed below the undivided PM (Figure 3A), was observed in 151 specimens (74.02%). Type b, in which the CFN emerged between the separated parts of PM and the TN came out from the lower edge of PM (Figure 3B), was found in 46 specimens (22.55%).Type c, in which CFN passed through the upper edge and the TN passed through the lower edge of the undivided PM (Figure 3C), was found in 7 specimens (3.43%). In addition, special characteristic of CFN formation was observed in 2 cases of type c. In the first case, CFN was formed by the joining of one branch passing the upper edge of PM and the other passing the lower edge of PM (Figure 4A). In the second case, CFN was formed by two branches passing through the upper edge of PM and one branch passing through the lower edge of PM (Figure 4B).Symmetrical SN-PM relationship was found in 75.49% of cases. Details of prevalence in each type are shown in Table 2.

The length of PSIS-IT, PSIS- GT, IT-GT, S1–R , S1–Q lines, the distances of PSISQ(S1), PSIS-R and IT- S2

The results and analysis of the lengths of PSIS-IT, PSIS- GT, IT-GT, S1–R , S1–Q lines, the distances of PSIS-Q, PSIS-R and IT- S2 are illustrated in terms of mean ±SD in Table 3. The mean length of PSIS-IT in types a, b and c was 128.01±11.22, 133.64±13.24 and 38.12±6.58 mm respectively. A statistically significant difference was found between types a and b (p = 0.013) in PSIS-IT length, whereas mean length ofIT-GT and PSIS-GT showed no statistically significant difference between SN-PM types. PSIS-IT line passed SN at the lower edge of PM in 112 specimens (54.90%)(Table 4, Figure 5A). In these cases, Q and S1 were the same point.

The results of the SN location related to the bony landmarks are provided in Table 3. The mean lengths of S1-R and S1-Q were 30.07±8.30 mm and 6.54+7.99 mm. A statistically significant difference was found in PSIS-Q(S1) between type a and b(p=0.023). The mean length of PSIS-Q (S1), PSIS-R and IT- S2 was calculated into percentage of PSIS-IT, PSIS-GT, IT-GT length, respectively. The mean percentage of these parameters in all types was 60.06±5.90, 54.19±6.10, and 37.87±8.27, respectively (Table 5). Surface localization of SN at S1 and S2 is illustrated in Figure 2. S1 was located at the point of 54.19±6.10 % of PSIS-GT line(R) with a distance of 30.07±8.30mm perpendicular to PSIS-GT line (S1-R). S1 could also be located by PSIS-IT line. It was located at the point of 60.06±5.90% PSIS-IT line (Q or S1) with a distance of6.54+7.99 mm (S1-Q) perpendicular to PSIS-IT line. S2 was located at the point of37.87±8.27 % of IT-GT line. No significant difference was found between types.

DISCUSSION

The classification by Beaton and Anson was used to identify the anatomical relationship between the SN and the PM in this study [3]. 74% of cases had the typical type (type a). The atypical relationships were found in 26%. This was in agreement with one previous study in Thai population [29]. Highly variable prevalence of 1.5 to 35.8%of atypical relationship was reported in different races [7, 31]. In the current study, it was interesting that type b and c were found in more than one-fourth of the samples and was more common in male. A Metaanalysis according to geography showed that type b had higher prevalence in Asian population than Caucasian, and African [32]. Prevalence of type of SN-PM relationship in different ethnics including the result of this study is shown in Table 6 [1-4,6,7,12,16,18,19,21,23-28,33].This issue is clinically important because type b and c might be the cause of primary piriformis syndrome due to the nerves that pass through the muscle fibers or tendon which could compress the nerve [5, 14]. These types of relationship could increase the risk of direct trauma on CFN since it has a close relationship to the muscles around the hip joint and because the position of CFN is more superficial [32]. Two cases of special characteristic of CFN formation reported in this study might also be at risk of compression. In addition, type b and c are more likely susceptible to tension injury from traction and manipulation. Furthermore, these variations could be the cause of SN palsy after hip surgery [15]. In some cases of hip replacement surgery, tenotomy of muscle’tendons around the pelvis inserted at the trochanter was necessary to perform. This procedure could be the cause of muscle contraction and compression of the SN or its branch [28].Navarro and colleagues proposed that anatomical variations were the primary cause of SN palsy after surgery, especially in the posterior approach [22]. It might be due to the external rotator of the hip including the PM being cut, which would lead to SN injuries [22, 27]. Moreover, in the case of SN block, anesthetic could affect only one branch of the SN in the atypical case [32]. Furthermore, symmetrical SM-PM relationship was found in a high prevalence (75.49% of cases). Awareness of symmetrical patterns should be emphasized. Although, type d, f, and g were not found in this study, the possibility of these relationships should be considered during operative procedure to avoid SN injury.

Although there were many reports about the location of the SN, they did not take the difference of the location of the SN in each type of SN-PM relationship into account [3, 15, 17, 22, 32]. In this study, the location of SN was specified by referring to surrounding bony landmarks which could be easily palpated from the skin of the gluteal region including PSIS, IT, and GT. Mean length of the line joining between bony landmarks according to clinical practice, including PSIS-IT, IT-GT, and PSIS-GT, was reported in this study. The PSIS-IT length in typical type (a) was significantly shorter than type b. This was in agreement with a previous report in the Polish [13].The midpoint of SN was selected in order to avoid the problem of unequal size of SN between specimens. Statistical analyses indicated no significant difference of the measured parameters between three types of SN-PM relationship except PSIS-IT and PSIS-Q (S1) between types a and b ($p<0.05$). This might be due to the occurrence of bifurcation of SN in type b. When comparing our results to those of Currin et al (CT study), which used the same landmarks, there were some inconsistencies [9]. In this study, the PSISIT line passed SN in only 54.90% of cases whereas in the CT study, all PSIS-IT line passed SN. The dissimilarity might be due to the differences in study method and the selected view for measurement. In addition, the studies in different races might yield different results.

For the accuracy and easy application in clinical practice, the position of SN is calculated into the percentage of the length of the line joining the PSIS, IT and GT. The percentage of these lines did not have statistically significant differences between three types of SN-PM relationship. Regarding parasacral approach or Mansour technique of SN block, PSIS-IT was used as the reference line. Sixty millimeters from PSIS is the point of needle insertion [17]. Nevertheless, the result of this study suggested the different value. The position of SN was located at 60% of PSIS-IT or about 80 mm from PSIS. Moreover, the result from this study showed that PSIS-IT line might either pass or not pass the SN. Therefore, PSIS-IT line may not be appropriate as a reference line. The other technique of SN block is the posterior approach or Labat, in which 50 mm of perpendicular line was drawn to the middle point on PSIS-GT to determine the needle insertion point [17]. In this study, R was perpendicular to the midpoint of SN on PSIS-GT line. The result of this study indicated that R point was approximately located at the midpoint of PSIS-GT line. It confirmed the landmark that has been used in current clinical setting [17].However, the S-R length in this study which was equal to the length of perpendicular line, differed. The mean length of S-R was about 30 mm which was less than current clinical value (50 mm). Moreover, subgluteal approach is another technique of sciatic nerve block. The position of SN is determined by GT-IT line. Four centimeter perpendicular to the midpoint of this path is used as the needle insertion point [17]. The result of this study was dissimilar to the current clinical value. The position of SN was approximately located on 40% of GT-IT length from IT. The localization of SN could be applied in all types of SN-PM relationships. The difference of position of the SN from other studies or the normal value used in clinical setting might be due to the differences in method of measurement and ethnicities [9, 13, 17, 30].These morphometric data will be useful while performing any procedures in the gluteal region to avoid SN injury in Asian population.

CONCLUSIONS

The anatomical relationship between the SN and the PM and the location of SNwere identified in this study. Three types of the relationship, type a, b and c, werefound. The most prevalent was type a followed by type b and c respectively. Most of the parameters had no statistically significant different between types of SN-PM relationship. Knowledge of the anatomical variation of the SN-PM relationship and location of the SN may reduce the number of SN injuries and optimize the efficacy of medical procedures.

Acknowledgements

The authors would like to express our sincere appreciation to all those who have donated their bodies for medical study and research. Special thanks are extended to the technical staffs of the Department of Anatomy, Faculty of Medicine, Chulalongkorn University for their support in cadaveric care.

References

1. Anbumani T.L, Thamarai Selvi A, Anthony Ammal S. Sciatic nerve and its variations: an anatomical study. International Journal of Anatomy and Research 2015;3(2):1121-1127, doi: 10.16965/ijar.2015.175.
2. Bardeen KV. A statistical study of the variations in the formation and position of the lumbosacral plexus in man. Anat Anz. 1901;19:209–238.
3. Beaton LE, Anson BJ. The relation of the sciatic nerve and of its subdivisions to the piriformis muscle. Anat Rec. 1937; 70(1):1-5, doi: 10.1002/ar.1090700102.
4. Benzon HT, Katz JA, Benzon HA,et al. Piriformis syndrome: anatomic considerations, a new injection technique, and a review of the literature. Anesthesiology 2003; 98(6):1442-1448, doi: 10.1097/00000542-200306000-00022,Index in Pubmed:12766656.
5. Boyajian-O'Neill LA, McClain RL, Coleman MK, et al. Diagnosis and management of piriformis syndrome: an osteopathic approach. J Am Osteopath Assoc. 2008; 108(11):657-664, doi: 10.7556/jaoa.2008.108.11.657, index in Pubmed: 19011229.
6. Budhiraja V, Rastogi R, Jain SK, et al. Variant relation of the sciatic nerve to the piriformis muscle: a cadaveric study from North India. Revista Argentina de AnatomÍa ClÍnica 2016; 8(1):38-42, doi: 10.31051/1852.8023.v8.n1.14206.
7. Chiba S. Multiple positional relationships of nerves arising from the sacral plexus to the piriformis muscle in humans. KaibogakuZasshi. 1992; 67(6):691-724, index in Pubmed: 1296428.
8. Chung KW, Chung HM. BRS Gross Anatomy (7th ed.). Lippincott Williams & Wilkins, a Wolters Kluwer business, Philadelphia 2012:102-14.
9. Currin SS. Mirjalili SA, Meikle G, et al. Revisiting the surface anatomy of the sciatic nerve in the gluteal region. Clin Anat. 2014; 28(1):144-149, doi:10.1002/ca.22449, index in Pubmed: 25131147.
10. Dikici F, Kale A, Ugras AA, et al. Sciatic nerve localization relative to the position of the hip, an anatomical study. Hip int. 2011; 21(2):187-191, doi: 10.5301/HIP.2011.6491, index in Pubmed: 21462152.
11. Geyik S. Geyik M, Yigiter R, et al. Preventing sciatic nerve injury due to intramuscular injection: ten year single-center experience and literature review.Turk Neurosurg.2017; 27(4):636-640, doi: 10.5137/1019-5149.JTN.16956-16.1, index in Pubmed: 27593812.

12. Güvençer M, Akyer P, İyem C, et al. Anatomic considerations and the relationship between the piriformis muscle and the sciatic nerve. SurgRadiol Anat. 2008; 30(6):467-474, doi: 10.1007/s00276-008-0350-5, index in Pubmed: 18458807.
13. Haładaj R, Pingot M, Polguj M, et al. Anthropometric study of the piriformis muscle and sciatic nerve: a morphological analysis in a polish population. Med SciMonit. 2015; 21:3760-3768, doi:10.12659/msm.894353, index in Pubmed: 26629744.
14. Hopayian K, Song F, Riera R, et al. The clinical features of the piriformis syndrome: a systematic review. Eur Spine J. 2010; 19(12):2095-2109, doi: 10.1007/s00586-010-1504-9.
15. Kanawati AJ. Variations of the sciatic nerve anatomy and blood supply in the gluteal region: a review of the literature. ANZ J Surg. 2014; 84(11):816-819, doi: 10.1111/ans.12675, index in Pubmed: 24842563.
16. Lee CS, Tsai TL. The relation of the sciatic nerve to the piriformis muscle. Taiwan Yi Xue Hui ZaZhi. 1974; 73(2):75–80, index in Pubmed: 4527572.
17. Longnecker DE, Newman MF, Brown DL, et al. Anesthesiology (2nd ed.). McGrew-Hill, New York 2012: 843-844.
18. Ming-Tzu Pa. The relation of the sciatic nerve to the piriformis muscle in the Chinese. Am J Phy Anthropol 1941; 28(4):375-380, doi:10.1002/ajpa.1330280403.
19. Misra BD. The relations of the sciatic nerve to the piriformis in Indian cadavers. J Anat Soc India.1954; 3:28–33.
20. Moore KL, Dalley AF II, Agur Anne M. R. Clinically Oriented Anatomy (7th ed.). Lippincott Williams & Wilkins, a Wolters Kluwer business,Philadelphia 2014: 532-69.
21. Natsis K, Totlis T, Konstantinidis GA, et al. Anatomical variations between the sciatic nerve and the piriformis muscle: A contribution to surgical anatomy in piriformis syndrome. Surg Radiol Anat 2014; 36(3):273-280, doi: 10.1007/s00276-013-1180-7, index in Pubmed: 23900507.
22. Navarro RA, Schmalzried TP, Amstutz HC et al. Surgical approach and nerve palsy in total hip arthroplasty. J Arthroplasty. 1995; 10(1):1-5, doi:10.1016/s0883-5403(05)80093-2, index in Pubmed: 7730818.
23. Nizankowski C, Slociak J, Szybejko J. Variations in the anatomy of the sciatic nerve in man. Folia Morphol (Warsz).1972; 31(4):507–513, index in Pubmed: 4539117
24. Parsons FG, Keith A. Sixth annual report of the committee of collective investigation of the anatomical society of Great Britain and Ireland, 1895–96. J Anat Physiol.1896; 31(Pt 1):31–44, index in Pubmed: 17232229.
25. Pecina M. Contribution to the etiological explanation of the piriformis syndrome. Actaanat (Basel) 1979; 105(2):181-187, doi:10.1159/000145121, Index in Pubmed:532546.
26. Pokorny D, Sosna A, Veigl D, et al. Anatomical variability of the relation of pelvitrochanteric muscles and sciatic nerve. Acta Chir Orthop Traumatol Cech. 1998; 65(6):336–339, index in Pubmed: 20492810.
27. Pokorný D, Jahoda D, Veigl D, et al. Topographic variations of the relationship of the sciatic nerve and the piriformis muscle and its relevance to palsy after total hip arthroplasty. SurgRadiol Anat. 2006; 28(1):88-91, doi:10.1007/s00276-005-0056-x, index in Pubmed: 16311716.
28. Purnindhu D. Relation of Sciatic Nerve to Piriformis muscle in Thais. SirirajHosp Gaz. 1983; 35:379-382.
29. Robertson WJ, Kelly BT. The safe zone for hip arthroscopy: a cadaveric assessment of central, peripheral, and lateral compartment portal placement. Arthroscopy.2008; 24(9):1019-1026, doi: 10.1016/j.arthro.2008.05.008, index in Pubmed: 18760209.
30. Selkirk GD, Mclaughlin AC, Mirjalili SA. Revisiting the surface anatomy of the sciatic nerve in the gluteal region in children using computed tomography. Clin Anat. 2016; 29(2):211-216, doi: 10.1002/ca.22628, index in Pubmed:26379096.
31. Smoll NR. Variations of the piriformis and sciatic nerve with clinical consequence: A review. Clin Anat. 2010; 23(1):8-17, doi: 10.1002/ca.20893, index in Pubmed: 19998490.
32. Tomaszewski KA, Graves MJ, Henry BM et al. Surgical anatomy of the sciatic nerve: a meta-analysis. J Orthop Res. 2016; 1820-1827, doi: 10.1002/jor.23186, index in Pubmed: 26856540.
33. Ugrenovic S, Jovanovic I, Krstic V, et al. The level of the sciatic nerve division and its relations to the piriform muscle. Vojnosanit Pregl. 2005;62(1):45-9. doi: 10.2298/vsp0501045u, index in Pubmed: 15715349.
34. Vicente EJD, Viotto MJS, Barbosa CAA, et al. Study on anatomical relationships and variations between the sciatic nerve and piriformis muscle. Rev Bras Fisioter.2007; 11:197-202, doi: 10.1590/S1413-35552007000300009.

Table 1. Prevalence of type a, b, and c of SN-PM relationship

Type	Male			Female			Total n (%)
	Left n (%)	Right n (%)	Total n (%)	Left n (%)	Right n (%)	Total n (%)	
a	41(20.10)	41(20.10)	82 (40.20)	34(16.67)	35(17.16)	69 (33.83)	151 (74.02)
b	11(5.39)	13(6.37)	24 (11.76)	13(6.37)	9(4.41)	22 (10.78)	46 (22.55)
c	3 (1.47)	1(0.49)	4 (1.96)	0(0.00)	3 (1.47)	3 (1.47)	7 (3.43)
Total	55(29.96)	55(29.96)	110 (53.92)	47(23.04)	47(23.04)	94 (46.08)	204(100.00)

Table 2. Prevalence of symmetrical SN-PM relationship

Types	Male n (%)	Female n (%)	Total n (%)
Symmetry			
a	35(34.32)	30(29.41)	65 (63.73)
b	5(4.90)	6(5.88)	11 (10.78)
c	1(0.98)	0(0.00)	1 (0.98)
total	41(40.20)	36(35.29)	77 (75.49)
Asymmetry			
a & b	12(11.76)	8(7.84)	20 (19.61)
a & c	0(0.00)	1(0.98)	1(0.98)
b & c	2(1.96)	2(1.96)	4(3.92)
total	14(13.72)	11(10.79)	25(24.51)
Total	55(53.92)	47(46.08)	102(100.00)

Table 3. Lengths of PSIS-IT, PSIS- GT, IT-GT, S_1-R, S_1-Q lines, and the distances of PSIS-Q (S_1), PSIS-R and IT- S_2

Parameters	Mean± SD(range) mm			
	Type a	Type b	Type c	All types

PSIS-IT	128.01±11.22 (102.86-157.20)	133.64 ±13.24(95.88-163.94)	138.12 ±6.58(129.36-148.67)	129.63±11.89(95.88-163.94)
PSIS-GT	150.77±15.09 (111.72-189.34)	153.15±14.2 (114.06-188.11)	151.46 ±12.35 (139.38-172.51)	151.34±14.78 (111.72-189.34)
IT-GT	73.20±10.58 (48.83-106.55)	72.08±8.65(51.37-87.74)	75.36 ±11.96(56.07-89.45)	73.02±10.20(48.83-106.55)
PSIS-Q (S_1)	76.60±9.97 (54.43-110.26)	81.40 ±12.74 (55.65-113.59)	81.97±6.81(72.48-92.56)	77.86±10.74 (54.43-113.59)
PSIS-R	82.12±12.97 (54.80-116.10)	83.25 ±13.86 (57.35-109.45)	75.13±6.70 (67.10-84.05)	82.11±13.04 (54.80-116.10)
IT-S_2	27.86±6.69 (15.46-54.54)	25.73±5.06(14.61-38.14)	30.10±5.60(21.60-37.49)	27.45±6.39(14.61-54.54)
S_1-R	29.53±8.07 (11.67-56.55)	31.47±8.53 (13.83-60.87)	32.73±11.08 (20.51-49.77)	30.07±8.30 (11.67-60.87)
S_1-Q	6.11±8.04 (0.00-30.95)	7.87±7.99(0.00-27.12)	6.96 ± 6.60(0.00-13.50)	6.54 ±7.99 (0.00-30.95)

Table 4. Prevalence of PSIS-IT line passing SN at S_1 in each type of SN-PM relationship

PSIS-IT line	**n (%)**			
	Type a	**Type b**	**Type c**	**All types**
Pass SN at S_1	89 (43.63%)	20 (9.80%)	3(1.47%)	112 (54.90%)
Not Pass SN at S_1	62 (30.39%)	26 (12.75%)	4(1.96%)	92 (45.10%)

Table 5. Position of Q (S_1), S_2 and R in terms of percentage of the mean length of PSIS-Q(S_1), IT-S_2 and PSIS-R to the length of PSIS-IT, IT-GT and PSIS-GT, respectively

Parameters	**Mean± SD(range) %**			
	Type a	**Type b**	**Type c**	**All types**
Q(S_1) on PSIS-IT	59.87±5.92 (43.17-77.00)	60.80±6.14(49.76-76.67)	59.32±3.51(53.96-65.67)	60.06±5.90 (43.17-77.00)
S_2 on IT-GT	38.37±8.81 (18.76-69.89)	35.90±6.45 (19.51-53.01)	39.94±4.83 (33.73-47.36)	37.87±8.27 (18.76-69.89)
R on PSIS-GT	54.39±6.02(39.39-73.40)	54.20±6.25(37.29-65.48)	49.90±6.17(41.96-58.62)	54.19±6.10(37.29-73.40)

Table 6 Comparison of the prevalence of SN-PM relationships in different ethnics and this study

Researchers	Number of limbs	Race	Type (n)							Total atypical limbs n (%)
			a	b	c	d	f	g	Other	
Parsons and Keith, 1896[24]	138	English	118	17	0	3	0	0	-	20 (14.5)
Bardeen, 1901[2]	246	US	220	25	1	0	0	0	-	26 (10.6)
Beaton and Anson,1937[3]	120	US	101	14	4	1	0	0	-	64 (15.8)
Ming-Tzu, 1941[18]	140	Chinese	92	46	0	2	0	0	-	48 (34.3)
Misra, 1954[19]	300	Indian	262	18	12	8	0	0	-	38 (12.7)
Nizankowski et al.,1972[23]	200	Polish	181	8	3	5	3	0	-	19 (9.5)
Lee and Tsai, 1974[16]	168	Taiwanese	118	33	7	3	2	5	-	50 (29.8)
Pecina, 1979[25]	130	Yugoslav	102	27	1	0	0	0	-	28 (21.5)
Puranindu, 1983[28]	434	Thai	325	101	8	0	0	0	-	109 (25.1)
Chiba, 1992[7]	511	Japanese	328	173	10	0	0	0	-	183 (35.8)
Pokorny et al., 1998[26]	102	Czech	82	14	4	2	0	0	-	20 (19.6)
Benzon et al., 2003[4]	66	US	65	1	0	0	0	0	-	1 (1.5)
Ugrenovic et al., 2005[33]	200	Serbian	192	5	3	0	0	0	-	8 (4.0)
Pokorny et al., 2006[27]	182	Czech	144	0	0	26	4	8	-	38 (20.9)
Guvencer et al., 2009[12]	50	Turkish	38	8	4	0	0	0	-	12 (24.0)
Natsis et al., 2013[21]	294	Caucasian (Greek)	275	12	1	1	0	1	4	19 (6.4)
Anbumani et al., 2015[1]	50	Indian	45	2	2	0	0	0	1	5 (10)
Budhiraja et al, 2016[6]	60	Indian	41	8	11	0	0	0	-	19 (31.66)
This study, 2019	204	Thai	151	46	7	0	0	0	-	53 (25.98)

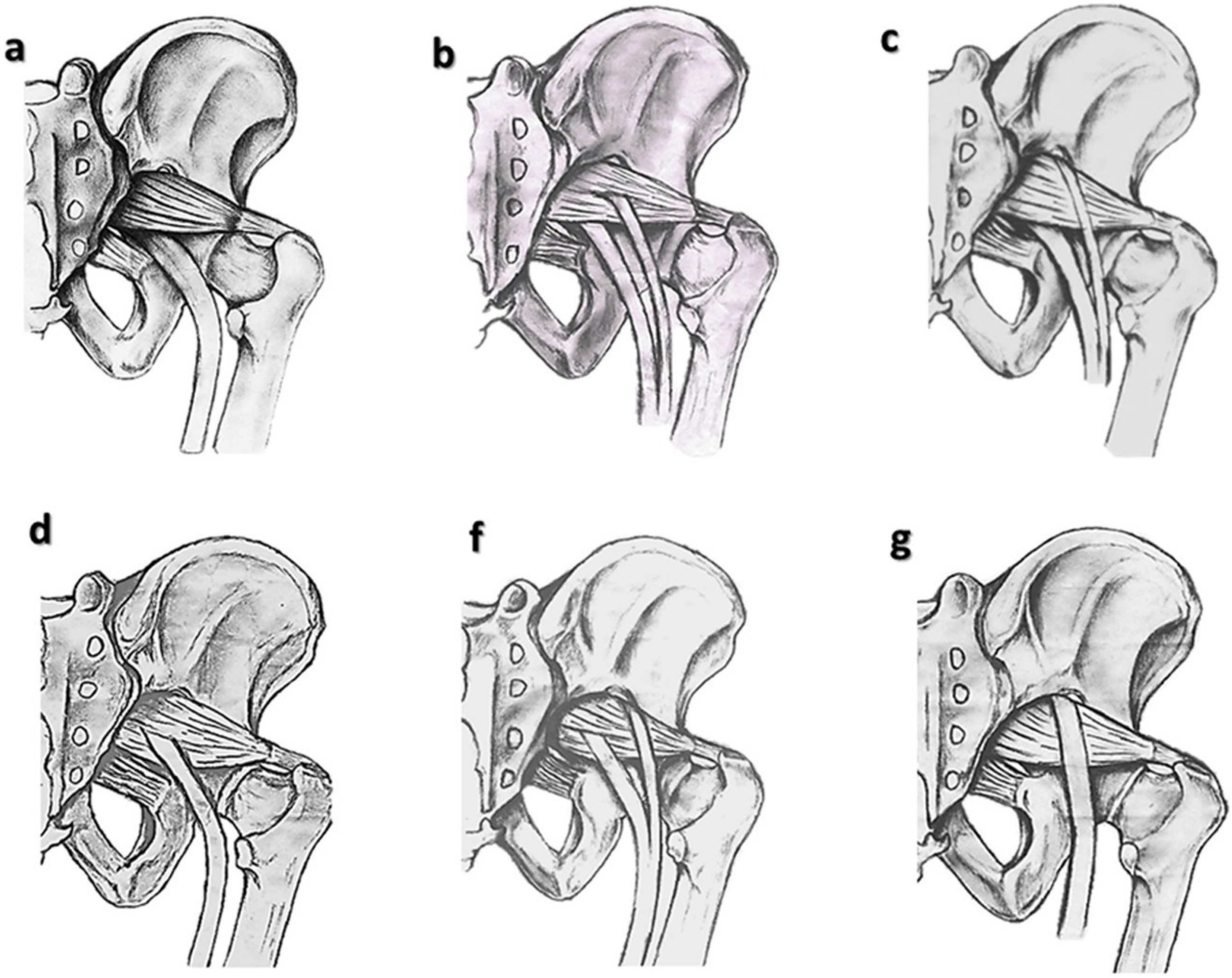
Figure 1. Schematic diagram of six types of the anatomical relationship between the SN and the PM according to Beaton and Anson [3]: a) undivided nerve passes below the muscle; b) divisions of nerve pass between and below muscle; c) divisions of nerve pass above and below the muscle; d) undivided nerve passes between the divided heads of the muscle; f) divisions of nerve pass between and above the divided muscle; g) undivided nerve passes above the muscle.

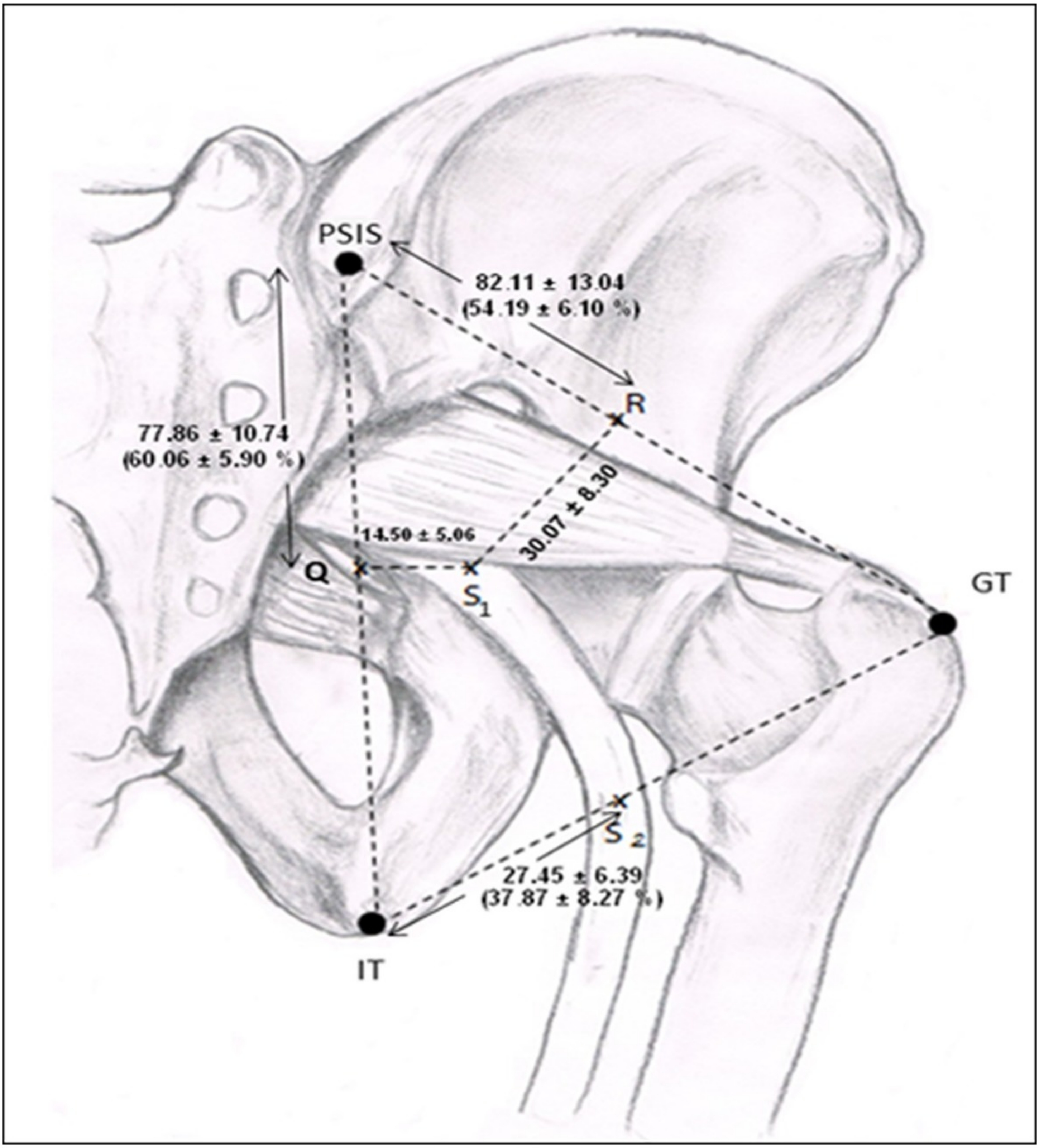
Figure 2. Schematic diagram illustrating the lines joining the three bony landmarks, the perpendicular lines from the midpoint of the SN (S1) to PSIS-GT line (S1-R), PSIS-IT line (S1-Q) and surface localization of SN
GT = greater trochanter, IT = Ischial tuberosity, PSIS = Posterior superior iliac spine, SN =sciatic nerve

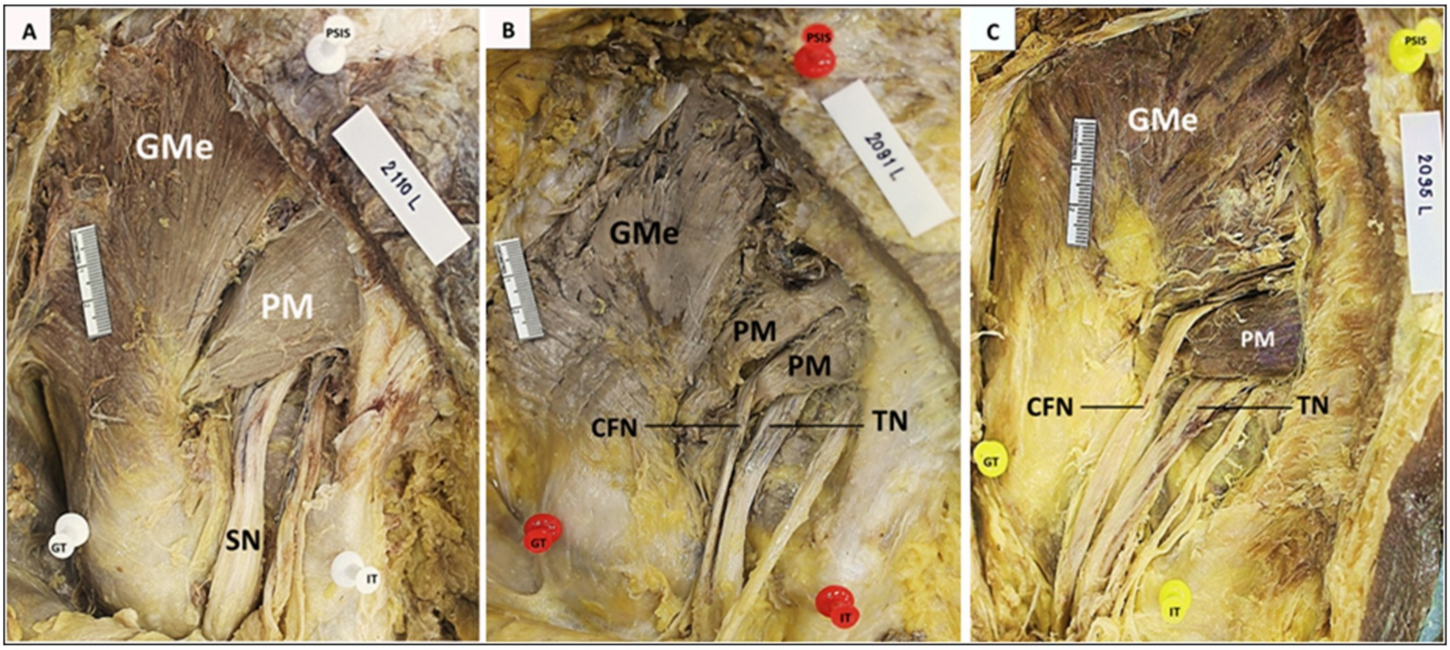
Figure 3. Specimens of left gluteal region showing 3 types of SN-PM relationship: A) Type a: undivided SN passed under PM; B) Type b: CFN pierced PM; C) Type c: CFN emerged from the upper edge of PM and TN emerged from the lower edge of PM
(CFN = common fibular nerve, GMe = gluteus medius muscle, GT = greater trochanter, IT =Ischial tuberosity, PM = piriformis muscle, PSIS = Posterior superior iliac spine, SN = sciaticnerve, TN = tibial nerve)

Figure 4. Specimen of right (A) and left (B) gluteal regions showing type c SN-PM relationship with special formation of the CFN: A) CFN formed by the joining of one branch passing the upper edge of PM and the other passing the lower edge of PM (black arrows); B) CFN formed by two branches passing through the upper edge of PM and one branch passing through the lower edge of PM (black arrows).
(CFN = common fibular nerve, GMe = gluteus medius muscle, GT = greater trochanter, IT = Ischial tuberosity, PM = piriformis muscle, PSIS =posterior superior iliac spine, SN = sciaticnerve, TN = tibial nerve)

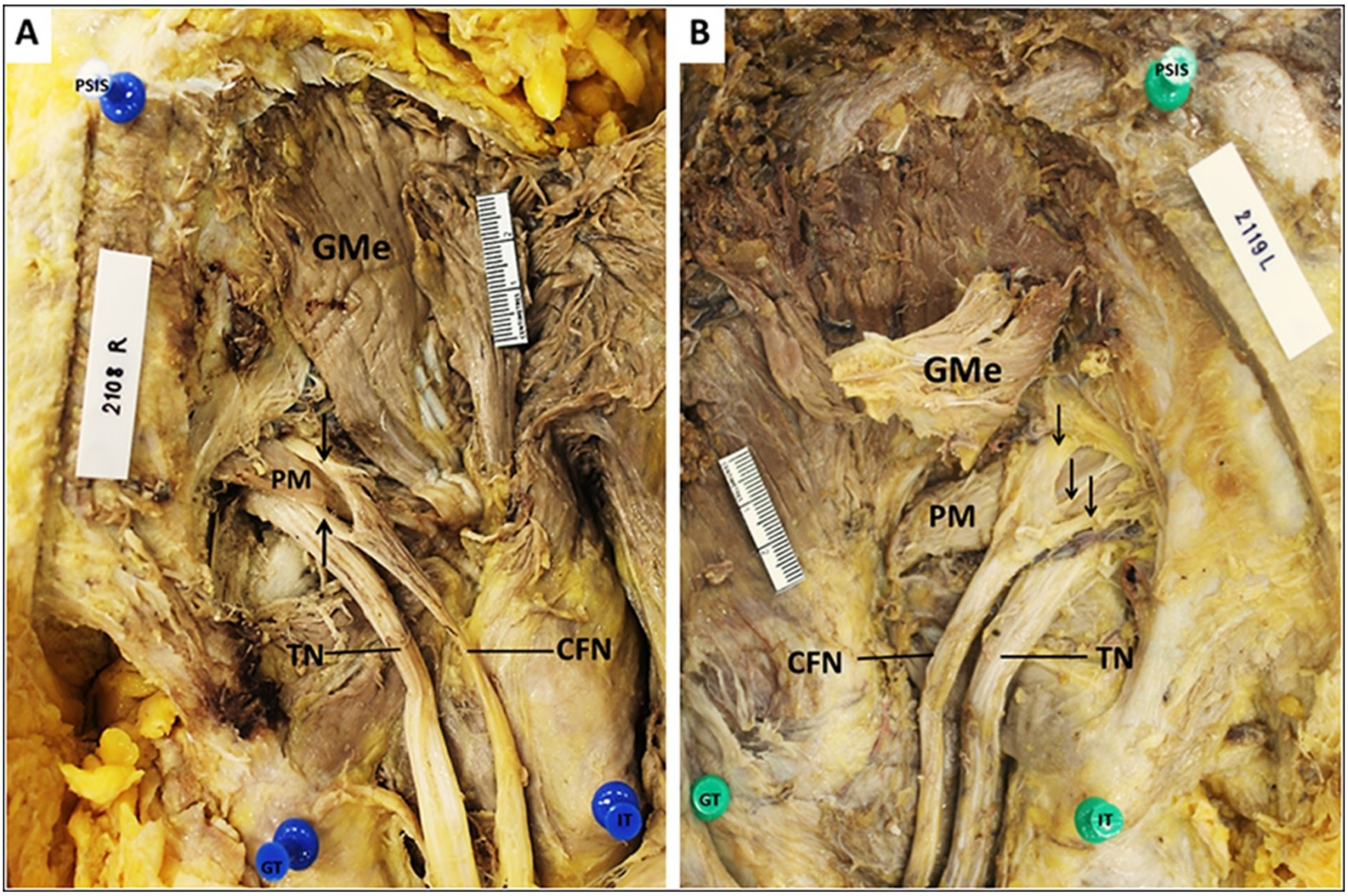
Figure 5. Specimens of right (A) and left (B) gluteal regions showing the relation of PSIS-IT line and SN: A) PSIS-IT line passed SN; B) PSIS-IT line did not pass SN
GT = greater trochanter, IT = Ischial tuberosity, PM = piriformis muscle, PSIS = posterior superior iliac spine, SN = sciatic nerve

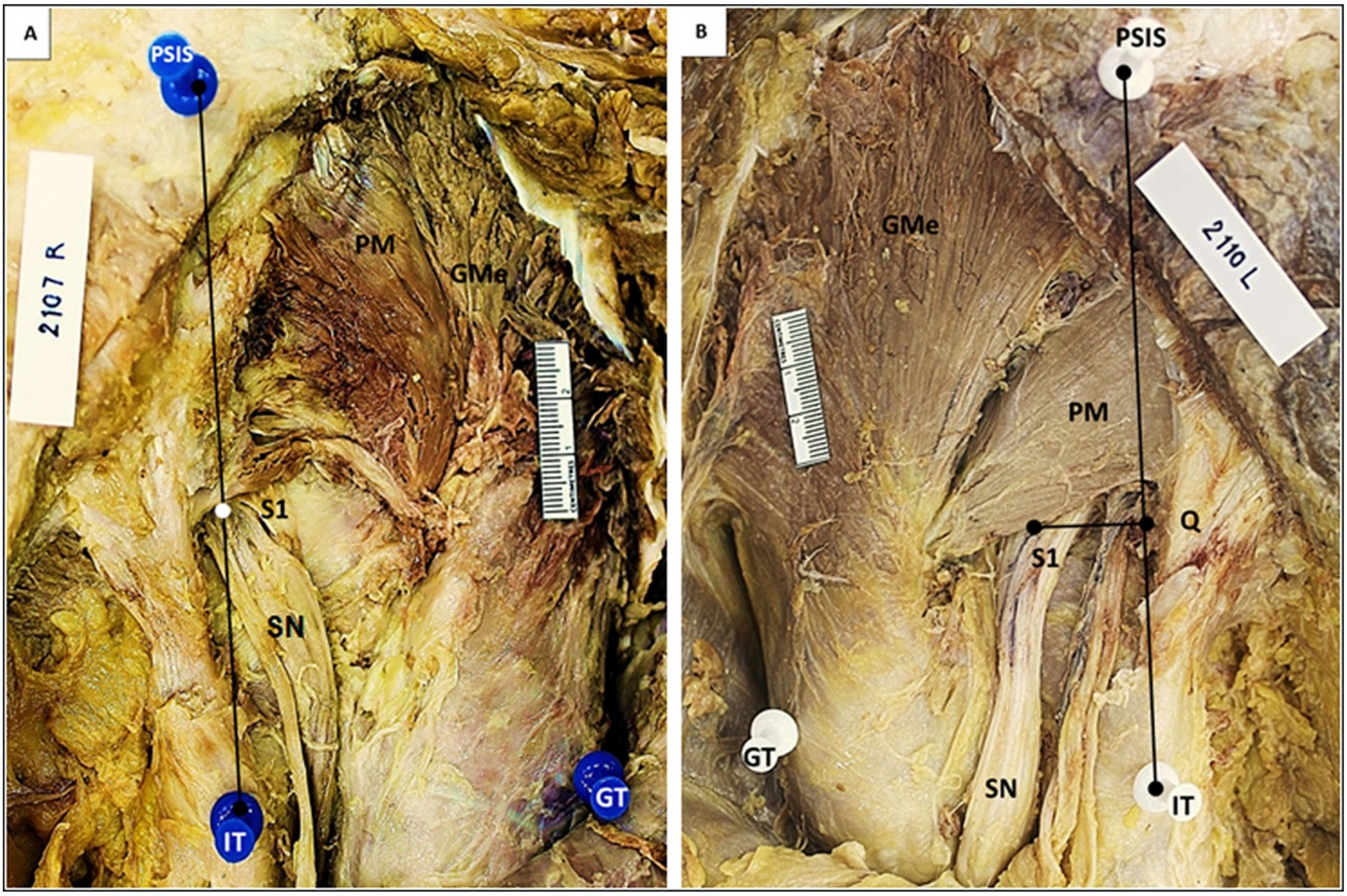

a
b
c
d
f
g


PSIS
82.11 ± 13.04
(54.19 ± 6.10 %)
R
77.86 ± 10.74
(60.06 ± 5.90 %)
30.07 ± 8.30
14.50 ± 5.06
Q
S1
GT
S2
27.45 ± 6.39
(37.87 ± 8.27 %)
IT



A
GMe
PM
SN
PSIS
GT
IT
2110 L
B
GMe
PM
PM
CFN
TN
PSIS
GT
IT
2081 L
C
GMe
PM
CFN
TN
PSIS
GT
IT
2095 L


A
PSIS
GMe
2108 R
PM
TN
CFN
GT
IT
B
PSIS
2119L
GMe
PM
CFN
TN
GT
IT


A
PSIS
2107 R
PM
GMe
S1
SN
IT
GT
B
PSIS
GMe
2110 L
PM
S1
Q
SN
GT
IT