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Variations in the Course and Branching Pattern of Sciatic Nerve in the Gluteal region with Surgical Implications.

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ABSTRACT

Sciatic nerve is vulnerable to iatrogenic injuries during intramuscular injections in the gluteal region because of its course and relations in the gluteal region. It originates from sacral plexus, usually in the pelvic cavity and enters the gluteal region through the greater sciatic foramen below the piriformis. The level of its termination by dividing into tibial and common peroneal nerves varies. The present study is undertaken to measure the width and thickness of sciatic nerve in the gluteal region as well as to measure the length of sciatic nerve till its terminal division in 46 lower limbs. Among the 46 lower limbs studied the SN was below the piriformis in 40 specimens (87%), between the fibres of piriformis in 2 specimens (4%), above and below the superior gemellus in 3 limbs (7%) and it divided before entering the gluteal region in 1 (2%) lower limb. Since lower limb surgeries frequently involve sciatic nerve block, time to time documentation of usual and unusual course of sciatic nerve in the gluteal region becomes worthwhile.

Keywords: sciatic nerve; anatomic variation; gluteal region; piriformis

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INTRODUCTION

Sciatic nerve originates from the sacral plexus in the pelvic cavity usually anterior to piriformis [1]. It enters the gluteal region through the greater sciatic foramen along the lower border of piriformis. Its terminal branches (tibial and common peroneal) are given off classically at the upper angle of popliteal fossa. There are several reports of variations of sciatic nerve, both in its course and its level of termination [2 - 4]. Sciatica is a well-known condition caused by compression or irritation of the sciatic nerve [5]. The symptoms of sciatica include radiating pain, numbness, tingling and weakness along its sensory distribution. It may also include postural disturbances depending upon the severity and site of compression. Additionally, sciatic nerve is prone for iatrogenic injuries during intramuscular injections in the gluteal region. Therefore the awareness of topographic relations of sciatic nerve in the gluteal region becomes clinically beneficial. The present study is undertaken to measure the width and thickness of sciatic nerve in the gluteal region as well as to measure the length of sciatic nerve till its terminal division.

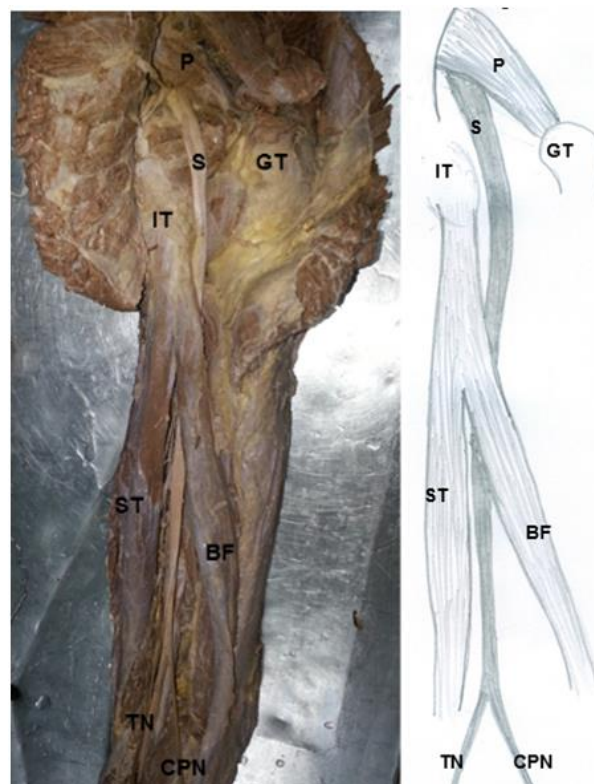
MATERIALS AND METHODS

Forty three formalin fixed lower limbs (27 left and 16 right) were dissected in the department of Anatomy. After reflecting the gluteus maximus, and muscles of the back of thigh, the location of the SN and its exit from pelvis and the level of the SN division were noted. The distance of sciatic nerve from greater trochanter (GT) and ischial tuberosity (IT) were taken using the measuring scale. The dimensions of sciatic nerve and piriformis were measured using vernier caliper and measuring scale. The maximum and minimum values for all measurements are calculated and tabulated.

RESULTS

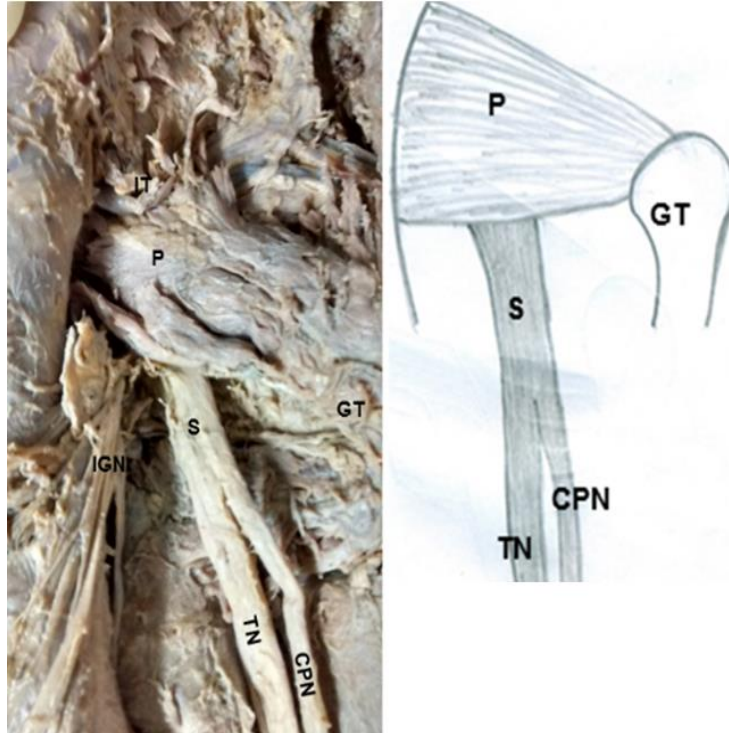
Among the 46 lower limbs studied the SN was below the piriformis in 40 specimens (87%), between the fibres of piriformis in 2 specimens (4%), above and below the superior gemellus in 3 limbs (7%) and it divided before entering the gluteal region in 1 (2%) lower limb.

Figure 1: Right gluteal and femoral region showing longest sciatic nerve



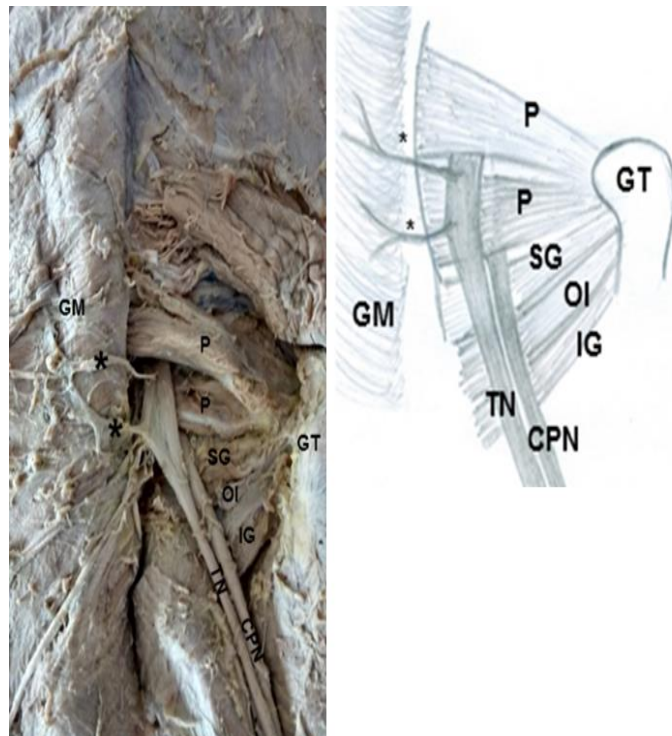
P-piriformis; GT-greater trochanter; IT-ischial tuberosity; S-sciatic nerve; ST-semitendinosus; BF-biceps femoris; TN-tibial nerve; CPN-common peroneal nerve

Figure 2: Right gluteal region showing shortest SN



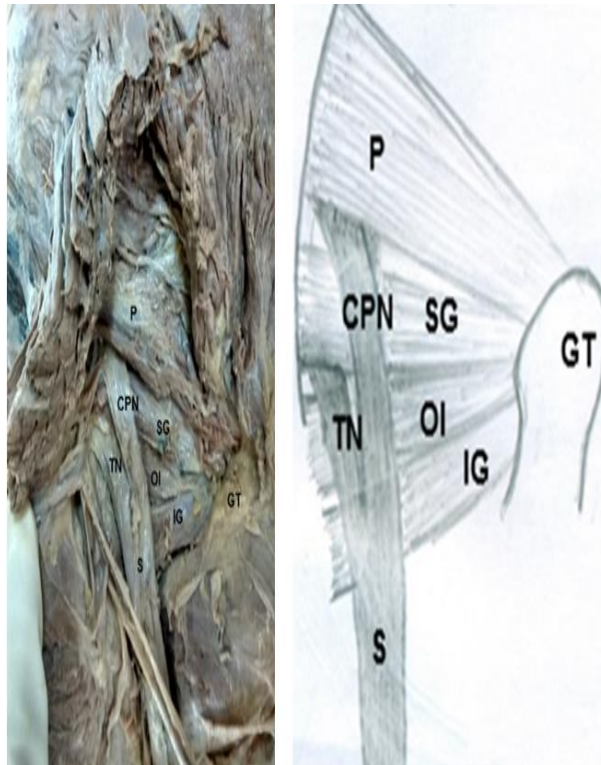
P-piriformis; GT-greater trochanter; S-sciatic nerve; TN-tibial nerve; CPN-common peroneal nerve; IGNI-inferior gluteal nerve

Figure 3: Right gluteal region showing SN divisions between piriformis and providing twigs (*) to gluteus maximus



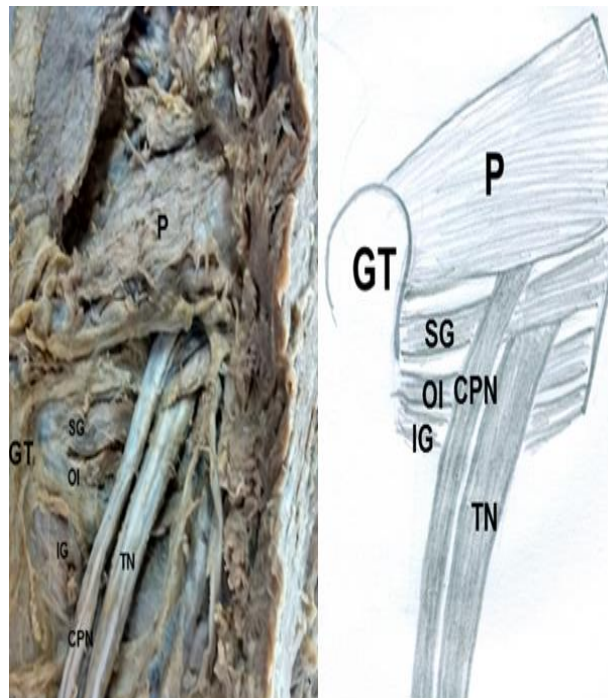
P-piriformis; GT-greater trochanter; TN-tibial nerve; CPN-common peroneal nerve; SG-superior gamellus; IG-inferior gamellus; OI-obturator internus; GM-gluteus maximus; ** - twigs to gluteus maximus

Figure 4: Right gluteal region showing CPN above & TN below superior gamellus and then united



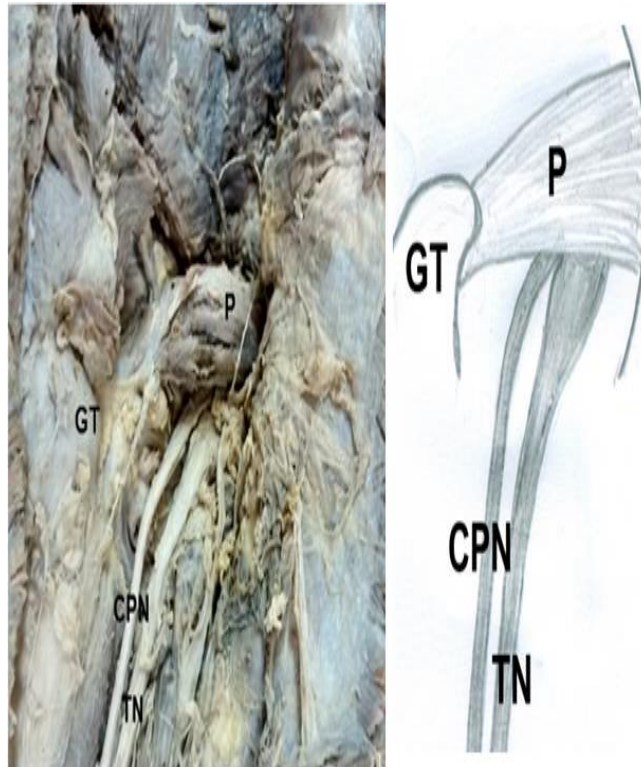
P-piriformis; GT-greater trochanter; TN-tibial nerve; CPN-common peroneal nerve; SG-superior gamellus; IG-inferior gamellus; OI-obturator internus; S-sciatic nerve

Figure 5: Left gluteal and femoral region showing CPN above & TN below superior gamellus and remain separate



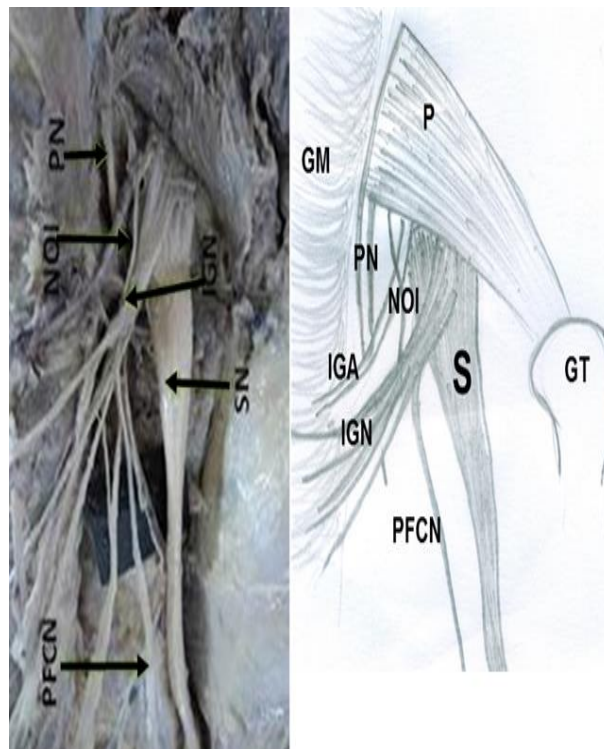
P-piriformis; GT-greater trochanter; TN-tibial nerve; CPN-common peroneal nerve; SG-superior gamellus; IG-inferior gamellus; OI-obturator internus

Fig 6: Left gluteal region showing intrapelvic division of SN



P-piriformis; GT-greater trochanter; TN-tibial nerve; CPN-common peroneal nerve

Figure 7: Right gluteal region showing branches of sacral plexus from SN



P-piriformis; GT-greater trochanter; PN-pudendal nerve; NOI-nerve to obturator internus; S-sciatic nerve; PFCN-posterior femoral cutaneous nerve; IGN-inferior gluteal nerve; IGA-inferior gluteal artery; GM-gluteus maximus

Table 1: Measurements taken for different parameters of sciatic nerve in both right and left lower limb

Measurements	Right lower limb (n=16)		Left lower limb (n=27)	
	Max	Min	Max	Min
Distance between GT and IT (cm)	6.6	4.2	6.2	4.2
Distance between medial border of SN and lateral border of IT (cm)	3.3	1.1	1.8	0.8
Distance between lateral border of SN and medial border of GT (cm)	3.7	1.8	3.4	1.6
Width of SN (mm)	14.1	9	12.9	7.84
Thickness of SN at the level of between IT and GT (mm)	3.45	1.37	2.53	1.3
Length of SN from the lower border of PM till its division (cm)	36.5	10.1	39	2.5

Table 2: maximum and minimum values for length & thickness of piriformis in the gluteal region

S No.	Piriformis	MAX(cm)	MIN(cm)	AVERAGE(cm)
1.	length	9.5	6.4	7.764
2.	Thickness - Maximum	3.6	2	2.656
3.	Thickness - Middle	2.2	1.5	1.858
4.	Thickness – at Insertion	0.9	0.5	0.719

The nerve divided into common peroneal and tibial nerve at different levels as seen in Figures 2 - 8. Both highest and lowest division of sciatic nerve was observed on the left side only. Maximum length of SN was 39cm (Figure 1) and minimum was 2.5cm (Figure 2). Widest SN was also observed on the right side (3.45mm) as depicted in table 2. It was observed that the distance between medial border of SN and lateral border of IT was less on left side with the minimum distance being 0.8cm. Whereas the distance between lateral border of SN and medial border of GT was almost same on both the side as shown in Table 1. In one of the lower limb on the right side the tibial branch SN was giving two twigs to the gluteus maximus (Figure 3). In two specimens tibial and common peroneal components emerged above and below the superior gamellus (Figure 4 & 5). Among these two in one the two divisions united below the superior gamellus (Figure 4).

In one case the major branches except pudendal nerve (PN) of sacral plexus were given from sciatic nerve in the gluteal region (Figure 7). The length and thickness of piriformis muscle in the gluteal region is also tabulated with minimum and maximum values as shown in table 3.

DISCUSSION

Sciatic nerve block (SNB) is often preferred for most of the lower limb surgery. There are several procedures or approaches for SNB and for that a thorough knowledge about the course and relations of the sciatic nerve to the surrounding tissues is essential. Therefore time to time documentation of the dimensions and course of SN in the gluteal region, its level of division as well as any other novel variations becomes vital. Karmaker et al, have recommended the injection of local anaesthetic into the subgluteal space under ultrasound guidance for effective SNB [6]. Classical course of the SN in the gluteal region is midway between the greater trochanter and ischial tuberosity deep to the gluteus maximus, and divides at the superior angle of the popliteal fossa into tibial and common peroneal nerves[1]. These two components represent two portions of sciatic nerve during early embryonic life which preserve their individuality throughout their path [7]. This separation at the early embryonic life may persist in the adult, thereby manipulating the topographic relationships between the sciatic nerve and the piriformis. The high division of sciatic nerve may lead to sciatica, nerve damage during deep intramuscular injections in gluteal region or posterior hip operations, and sometimes failed sciatic nerve block [8]. In the present study the SN was emerging below the piriformis in 38 lower limbs (88.4%). Usual emergence of the sciatic nerve below the piriformis is reported by several authors [9 - 12]. Variations like two divisions of SN between and below PM was found by Beaton and Anson [13] in 17%, Beaton [14] in 7.1%, Pecinain 6.15% [15], Moore and Dalley in 12.2% [16], Pokorny et al. in 14.3% [17] of the specimens they studied. Undivided sciatic nerve between two heads of PM was found in few studies like Beaton and Anson in 0.8% [13], Beaton in 0.8% [14], Porky et al, in 2.2% [17] of specimens. In the present

study the sciatic nerve was below the piriformis in 88.4%, between the fibres of piriformis in 4.6% and it was divided before entering the gluteal region in 2.3% of lower limbs. In piriformis syndrome one of the divisions of sciatic nerve pierces the piriformis and gets compressed and irritated resulting in specific entrapment symptoms [18]. Usually common peroneal division gets compressed in piriformis syndrome but in the present study tibial nerve pierces the piriformis (Fig 3). Prevalence of piriformis syndrome is six times more frequent in females as reported by Papadopoulos et al., [19]. On the contrary, in our study occurrence of divided piriformis was seen in two male lower limbs exclusively. Machado et al. [20] and Ugrenovic et al. [21] did not find even a single divided piriformis in their study series. In the present study another rare variation is the emergence of two divisions of sciatic nerve above and below the superior gemellus as shown in Fig 4 & 5. Similar type of course of sciatic nerve in relation to superior gemellus was observed by Babinski et al, [22]. In the present study it was observed in 4.6% of specimens studied. In Fig 4 the two divisions united below the superior gemellus which may irritate the nerve during the contraction of the superior gemellus. Additionally in one of the lower limb a branch was given to the gluteus maximus from the medial border of SN (Fig 3).

In the present study, the average length of SN was 24.3 cm with the maximum length being 39cm and minimum 2.5cm and both were recorded on the left side. Vicente and co-authors have reported the width of SN at the level of inferior border of PM as 18.85mm on the right side and 22.32 mm on the left side [12]. However, Williams et al. endorsed a width of 20.0 mm to the sciatic nerve at its origin [1]. However, we have observed maximum width of SN as 14.1cm on the right side and 12.5cm on the left side. In the present study, the mean distances between the medial margin of the SN and the lateral border of the IT were 2cm and 1.4cm on the right and left sides respectively. And the mean distance between lateral border of SN and medial border of GT were 3cm and 2.8cm respectively on right and left sides. However Vicente et al, observed the mean distance between the medial margin of the sciatic nerve and the lateral border of the sacro- tuberos ligament as 1.7 cm and 1.8 cm in the right and left lower limbs respectively [12]. The nerve's lateral border was located at a 3.3cm distance from the apex of the greater trochanter, on the right side, and at a 3.3cm distance, on the left side. Knowledge of level of high division of the sciatic nerve as well as its course is important for surgical approaches, and also in cases of lesions affecting the medial or lateral portions [23]. In the present study on both sides the sciatic nerve was descending with an inclination towards the medial side because the distance between IT and sciatic nerve was lesser on the medial side.

Another important variation in the present study is majority of the branches of sacral plexus coming from the sciatic nerve in the gluteal region as seen in Figure 7. During reconstructive surgeries involving inferior gluteal flap perforators [24] if the posterior femoral cutaneous nerve which is also coming from SN in close relation to inferior gluteal nerve, gets avulsed or injured may become the cause for loss of sensation in the posterior aspect of thigh and such people are at increased risk of developing ulcers with prolonged rest. Since the branches are given off in the gluteal region hypertrophy of piriformis may compress these nerves easily and may produce nerve compression symptoms also.

CONCLUSION

The data documented from the present study confirmed the previous reports as well as added some new observations like the two components of the sciatic nerve passing between superior gemellus muscle, sciatic nerve providing a branch to gluteus maximus and branches of sacral plexus given off from sciatic nerve in the gluteal region. The knowledge of this unique information may minimize the risk of injuries during various surgical interventions in this region.

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Conference presentation: this work is presented as poster in the IIER international conference which was held in Dubai. Anatomical study of width and thickness of sciatic nerve in the gluteal region

Conference Name: ISERD-The IIER-International Conference

REFERENCES

- [1] Williams A et al., Gray's Anatomy, 39th edition. Churchill Livingstone New York,2005.

- [2] Vloka JD et al., The division of the sciatic nerve in the popliteal fossa: anatomical implications for popliteal nerve blockade. *Anesth. Analg.* 2001;92:215-217.
- [3] Guvencer, M et al. Variations in the high division of the sciatic nerve and relationship between the sciatic nerve and the piriformis. *Turk. Neurosurg*2009;19:139-144.
- [4] Saleh HA et al. Anatomical variation of sciatic nerve division in the popliteal fossa and its implication in popliteal nerve blockade. *Folia Morphol*2009;68:256-259.
- [5] Saritha S et al. Anatomical Variations in the Bifurcation of the Sciatic Nerve, a Cadaveric Study and its Clinical Implications. *Anat. Physiol* 2012;2:111. doi:10.4172/2161-0940.1000111.
- [6] Karmaker MK et al. Ultrasound-guided sciatic nerve block: description of a new approach at the subgluteal space. *Br J Anaesth* 2007;98(3):390-395.
- [7] Bardeen CR, Elting AW. A statistical study of the variations in the formation and position the lumbosacral plexus in man. *AnatAnz* 1901;19:209-239.
- [8] Patel S et al. *Natl J Med Res*2011;1(2):27-30.
- [9] Nizankowski C et al. Varieties of the course of the sciatic nerve in man. *Folia Morph* 1972;31: 507-13.
- [10] Hollinshead WH. *Anatomy for Surgeons: Volume 3 - The back and limbs*, 2nd edition, Harper & Row, New York, 1969.
- [11] Gabrielli C et al. Relações topográficas entre o nervo ciático e o músculo piriforme. *Rev Bras Cienc Morfol*1994;11:8-12.
- [12] Vicente EJD et al. Study on anatomical relationships and variations between the sciatic nerve and piriformis muscle. *Rev Bras Fisioter.* 2007;11(3):197-202.
- [13] Beaton LE, Anson BJ. The relation of the sciatic nerve and its subdivisions to the piriformis muscle. *Anat Rec*1937;70: 1–5.
- [14] Beaton LE. The sciatic nerve and piriform muscle: Their interrelation possible cause of coccygodynia. *J Bone Joint Surgery Am*1938;20:686–688.
- [15] Pecina M. Contribution to the etiological explanation of the piriformis syndrome. *Acta Anat (Basel)* 1979;105:181–187.
- [16] Moore KL, Dalley AF. *Clinical Oriented Anatomy*, 4th edition. Baltimore Lippincott Williams & Wilkins, 1999, p 558.
- [17] Pokorny 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. *Surg Radiol Anat* 2006; 28(1):88-91.
- [18] Demiryurek D et al. Bilateral divided piriformis muscle together with the high division of the sciatic nerve. *Gazi Med J* 2002; 3,41–44.
- [19] Papadopoulos SM et al. Unusual cause of 'piriformis muscle syndrome'. *Arch Neurol*1990;47:1144–1146.
- [20] Machado FA et al. Anatomical variations between sciatic nerve and piriform muscle during fetal period in human. *Int J Morphol* 2003; 21: 29–35.
- [21] Ugrenovic S et al. The level of the sciatic nerve division and its relation to the piriformis muscle. *Vojnosanit Pregl*2005;62(1):45-49.
- [22] Babinski MA, Machado FA, Costa WS. A rare variation in the high division of the sciatic nerve surrounding the superior gemellus muscle. *Eur J Morphol*2003;41: 41-42.
- [23] Healey JA. *Synopsis of clinical anatomy*. Philadelphia: W B Saunders, 1969.
- [24] Boustred AM, Nahai F. Inferior gluteal free flap breast reconstruction. *Clin Plast Surg*1998;25:275-282.