

# The course of the sciatic nerve in the gluteal region and comparison of two methods used for sciatic nerve blockage

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## Abstract

**Objectives:** The aim of this study was to reevaluate the anatomy of the sciatic nerve (SN) in the gluteal region by identifying reliable landmarks in order to suggest a safe insertion point for SN blockage (SNB), and to compare two methods used for SNB.

**Methods:** Bilateral dissections of the SN were performed on ten embalmed cadavers. The course of the SN in relation to a line drawn between the posterior superior iliac spine (PSIS) and the ischial tuberosity (IT) was determined. The files of 100 patients, 50 of whom had SNB with the Labat's method (group L) and 50 with the parasacral approach (group P), were reviewed retrospectively. The results of the two methods were compared.

**Results:** The vertical distance between the PSIS to the IT was 13.1±6.5cm. The vertical distance between the intersection points of the inferior border of the piriformis with the medial and lateral margins of the SN were 7.8±0.7 and 9.1±0.6 cm, respectively. Medial and lateral margins of the SN were found to be 1.8±0.5 and 2.9±0.6 cm lateral to the IT. Insertion depth of the needle and time for the intervention were similar for both of the methods, but need for additional nerve blockages were significantly higher in group L than in group P.

**Conclusion:** We defined a safe insertion point for SNB in the gluteal region, using prominent, fixed bony and easily detectable landmarks. The clinical results of both groups were similar, but need for additional nerve blockages were significantly higher in group L.

**Keywords:** anatomical landmark; postoperative pain; regional anesthesia; sciatic blockage; gluteal region

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## Introduction

Peripheral nerve blockage has become increasingly popular for providing peri- and post-operative analgesia, due to lower complication rates in comparison with other anesthetic procedures. Successful application is limited and

depends on knowledge of the regional anatomy, as well as special skills and techniques that are required for efficient peripheral nerve blockages, especially when the nerve is deeply located. Sciatic nerve (SN) blockage (SNB) may be used to anesthetize most of the foot and the knee, as well as the posterior thigh. At the pelvic level, the SN can be

anesthetized by classical posterior (Labat's method) approach, Raj's posterior approach, anterior, lateral, or parasacral approaches.<sup>[1-5]</sup> So many approaches have emerged in SNB because there is no single method that is the most effective, safest, and has the least undesirable effects. However, all points defined by published descriptions are insufficient in determining the exact line that corresponds to the underlying nerve.

The use of ultrasound-guided peripheral nerve blockages has become increasingly popular in recent years. However, ultrasound is not always available everywhere, and its use requires certain training and expertise. In this situation, the physician who will apply the blockage should know the anatomical landmarks used to locate the nerve. For these reasons, in-depth knowledge of anatomy is a precondition for performing regional anesthesia.<sup>[6]</sup> Defining the main anatomical landmarks for regional anesthesia, detailed knowledge of the proper anatomy is required to define the sonoanatomy.<sup>[7]</sup> The SNB, guided by classical anatomy knowledge and traditional nerve stimulation, still maintains its importance recently.

The aim of this study was to reevaluate the regional anatomy of the SN for anesthetic blockage using simply accessible bony landmarks, and to compare the clinical efficacy of two methods used for SNB.

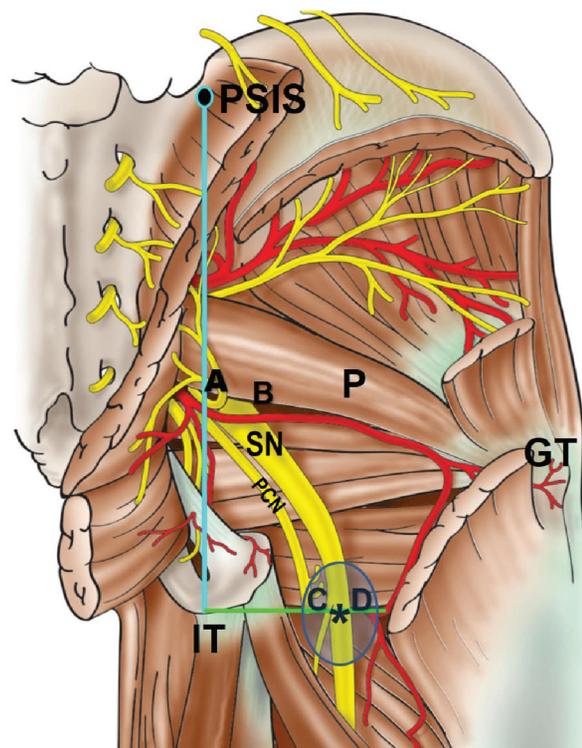
## Materials and Methods

### Cadaveric Study

Bilateral dissections of the SN were performed on 10 (6 women, 4 men) formaldehyde fixed cadavers (46 to 69 years at death). The use of the human cadaveric material was guided according to the guidelines of the university. Dissections were performed by senior anatomists.

The location and course of the SN was assessed by identifying its relationship with a line drawn from the midpoint of the posterior superior iliac spine (PSIS) to the lowermost point of the ischial tuberosity (IT) (**Figure 1**). The safe area for accessing the SN was determined according to the branching of the regional vascular structures and nerves. The branching of the posterior femoral cutaneous nerve (PCN) was also considered.

The vertical distance between the PSIS and the lowermost point of the IT was measured. The intersection points of the inferior border of the piriformis muscle with the medial (A) and lateral (B) margins of the SN were identified and the vertical distances between the PSIS and A and B points were measured. The horizontal distances between the lateral border of the IT and the medial (C) and the lateral (D) margins of the SN at the level of the lowermost point of the IT were measured (**Figure 2**). The horizontal

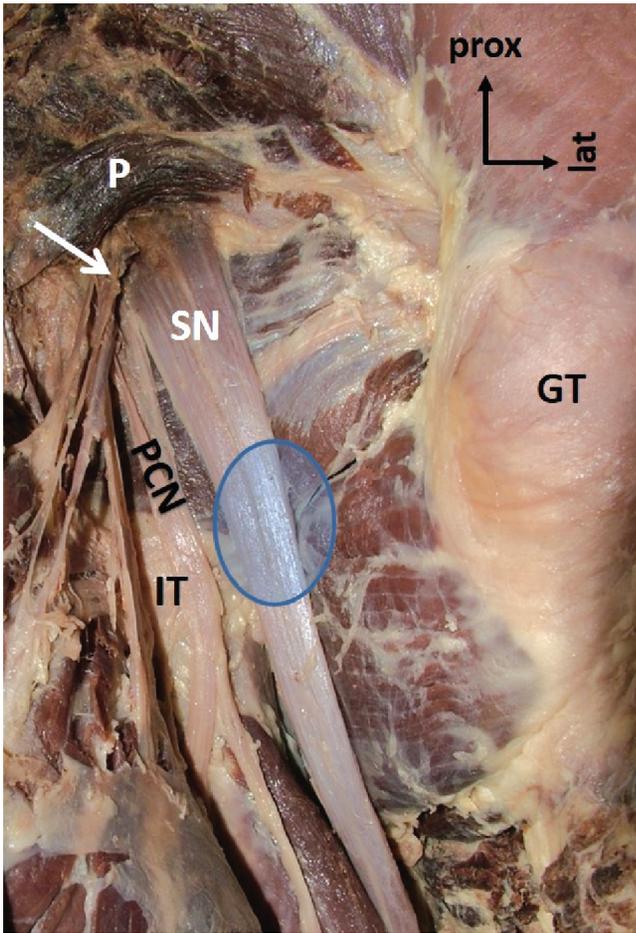


**Figure 1.** Illustration of the posterior gluteal region. The blue transparent circle is the suggested safe area relatively free from neurovascular structures with asterisk showing the ideal needle insertion point. The vertical distance between PSIS and IT is shown as the blue line. The horizontal distances between IT and the sciatic nerve is shown as the green line. A: the intersection point of the inferior border of the piriformis muscle with the medial margins of SN; B: the intersection point of the inferior border of the piriformis muscle with lateral margins of SN; C: the medial margin of the SN at the level of the lowermost point of IT; D: the lateral margin of the SN at the level of the lowermost point of IT; GT: greater trochanter; IT: ischial tuberosity; P: piriformis muscle; PCN: posterior femoral cutaneous nerve; PSIS: posterior superior iliac spine; SN: sciatic nerve.

distances between A and B points, and C and D points were measured, and considered as the widths of the SN at the level of the exit point from the infrapiriform foramen and at the level of the lowermost point of the IT, respectively. Measurements were performed with ruler and a digital caliper sensitive to one decimal. The neurovascular area was defined as the area surrounding the points A, B, C and D (**Figure 3**). The optimal injection point to reach the SN effectively without injuring any other neurovascular structures was defined according to the measurements.

### Clinical Study

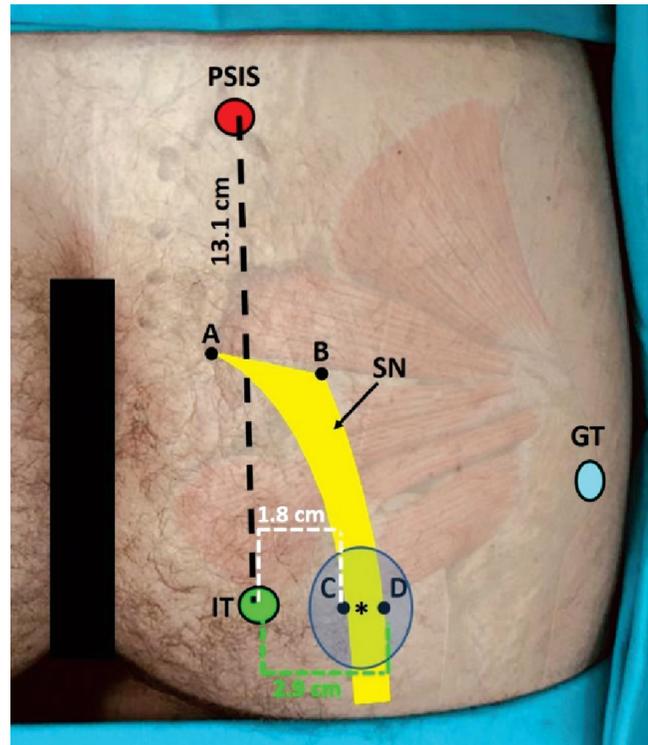
A hundred patients, aged between 18 and 69 years, who had ankle and/or foot surgery between January 2015 and January 2018 in our tertiary hospital were included in this study. Fifty of the patients had SNB with the Labat's



**Figure 2.** Anatomical dissection of the right sciatic nerve. The arrow indicates the vascular structures emerging from the infrapiriform foramen. Blue transparent circle shows the suggested safe area relatively free from neurovascular structures. GT: greater trochanter; IT: ischial tuberosity; P: piriformis muscle; PCN: posterior femoral cutaneous nerve; SN: sciatic nerve.

method (group L), and 50 of them had SNB with the parasacral approach (group P). The files of the patients were reviewed retrospectively. Patients with a history of neuropathy, neuromuscular disease, or chronic pain syndromes were excluded from the study. All the premedication procedures had been the same for both groups of patients. All patients taken to the operating rooms had been routinely monitored, and vital signs had been checked properly until the end of the operation. Demographic data (age, weight, height, sex), duration of surgery, the depth of the nerve, the number of attempts, and time for successful blockage were obtained from the files of the patients.

The skin at the needle entry site had been infiltrated with 2 mL of 2% lidocaine using a 30-gauge hypodermic needle. SNB had been performed either with Labat's approach, or parasacral approach.

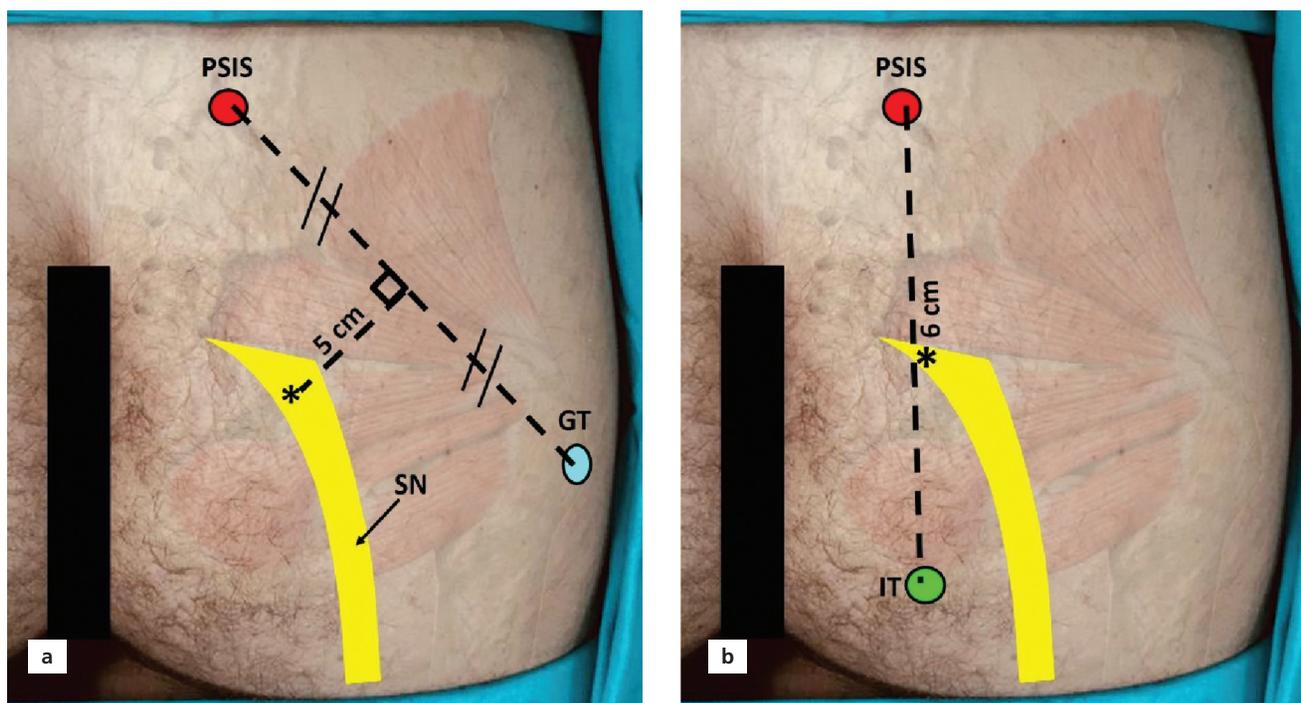


**Figure 3.** Surface projection of the sciatic nerve on a patient using anatomical landmarks. The blue transparent circle is the suggested safe area relatively free from neurovascular structures with asterisk showing the ideal needle insertion point. A: the intersection points of the inferior border of the piriformis muscle with the medial margins of SN; B: the intersection points of the inferior border of the piriformis muscle with lateral margins of SN; blue circle: the greater trochanter; C: the medial margin of the SN at the level of the lowermost point of IT (ischial tuberosity); D: the lateral margin of the SN at the level of the lowermost point of IT (ischial tuberosity); GT: greater trochanter; green circle: IT (ischial tuberosity); IT: ischial tuberosity; PSIS: posterior superior iliac spine; red circle: PSIS (posterior superior iliac spine); SN: sciatic nerve.

Labat's approach was applied as follows: The PSIS and the GT are marked and a line was drawn between the two structures. A perpendicular line from the midpoint of this line was drawn towards infero-medial. The 5th cm was used as the needle insertion point (Figure 4a).<sup>[4]</sup>

Parasacral approach was applied as follows: The PSIS and the IT are marked and a line was drawn between the two structures. The 6th cm from the PSIS was used as the needle insertion point (Figure 4b).<sup>[4]</sup>

The following procedures were the same for both methods. To block the SN, a 100-mm short, beveled, 22-gauge stimulating needle (B. Braun, Melsungen, Germany) had been used. The needle had been connected to a nerve stimulator (Stimuplex HNS11, B. Braun, Melsungen, Germany). The initial stimulus had been set at 2 mAmp intensity with 2 Hz frequency. After ankle dor-



**Figure 4.** Compared sciatic blockage techniques with asterisk showing the needle insertion point. (a) Labat's approach, (b) Parasacral approach. GT: greater trochanter; IT: ischial tuberosity; PSIS: posterior superior iliac spine; SN: sciatic nerve.

siflexion or eversion with 0.5 mAmp stimulus, gentle aspiration had been performed and 20 mL of a 0.5% solution of bupivacaine (Astra-Zeneca, Orebo, Sweden) had been administered in 5 mL increments. Block had been applied to all patients by senior anesthetists in charge of the orthopedic room. Needle insertion was considered successful if plantar flexion, eversion of the foot, and/or dorsiflexion of the foot had been observed under 0.5 mAmp stimulation. The depth of the location of the SN was measured as the length of the needle from the skin to the point that plantar flexion had been observed. The time for a successful blockage was defined as the time from insertion of the needle into the skin to the observation of muscle contraction with a 0.5 mAmp stimulus. The depth of the nerve, the number of attempts, and time for successful blockage were obtained from the patients' files and considered for this study. The quality of the SNB, which was graded as good (no supplemental anesthetic required), satisfactory (local anesthetic to the surgical site or intravenous analgesic supplementation required), or failed (general anesthesia required) had been recorded in the files and considered for the study. Additional nerve blockages (saphenous and femoral) were also considered. Pain sensation during the procedure of performing SNB had been graded using the visual analog scale (VAS) by the patients according to a scale from 0 (no pain) to 10 (worst imaginable pain). A neurological examination (assessment for paresthesia,

dysesthesia, prolonged anesthesia, or unexpected motor deficit) had been performed preoperatively and 24 hours postoperatively. Neural complications had been recorded.

First, a preliminary study was performed on the files of 20 patients. The data of the first 20 patients were used to do a power calculation, which indicated that at least 50 patients for each group were required to determine statistical significance with an alpha of 0.05 and beta of 0.2. Ordinal data were evaluated using contingency tables with  $\chi^2$  and Fisher's exact test. Student's t-test or Mann-Whitney U tests were used to compare nominal data according to data distribution. Results were documented as mean $\pm$ SD, and a p value <0.05 was considered for statistical significance. SPSS (Version 22, IBM Corp., Armonk, NY, USA) was used to run basic statistical analyses.

## Results

### Data from Cadavers

The SN showed a slightly concave course, extending from points A-B to points C-D, with its concavity facing medial (Figures 1, 2 and 3). With its concavity facing medial a slightly concave line with a width of 2 cm proximally and 1 cm distally, drawn from 8 cm below the PSIS towards 2 cm lateral to the lateral border of the IT was considered to be the surface projection of the SN (Figure 3). At the exit point from the infrapiriform foramen, it was observed that

the inferior gluteal artery accompanied the SN. The distal half of the area that the SN coursed was relatively free from neurovascular structures (Figures 1 and 2). However, the proximal PCN was in this area in 90% of cases (Figure 2). Meanwhile, we did not observe small or large variants of the SN, that is, separation in the pelvic region, in the cadavers used in the study. The results of the measurements were summarized in Table 1.

Being free from any other neurovascular structures, we determined the needle insertion point for a safe approach as the point between C and D points (Figure 3). It was 13 cm distal to the PSIS and 2–3 cm (C-D points, respectively) lateral to the lateral border of the IT.

### Clinical Data

There were no statistically significant differences between the two study groups for patients' demographic data (age, weight, height, sex), and duration of surgery (Table 2).

The results of the evaluated parameters of the two groups were summarized in Table 3. There was no statistically significant difference between the two approaches for the distance to reach to the nerve ( $p=0.315$ ), and for

**Table 1**  
Cadaveric measurements

	Mean±SD (cm)
PSIS-IT	13.1±0.6
PSIS-SN (A)	7.8±0.7
PSIS-SN (B)	9.1±0.6
IT-SN (C)	1.8±0.5
IT-SN (D)	2.9±0.6
A – B distance	2.3±0.5
C – D distance	1.2±0.3

A: the intersection point of the inferior border of the piriformis muscle with the medial margins of SN; B: the intersection point of the inferior border of the piriformis muscle with lateral margins of SN; C: the medial margin of the SN at the level of the lowermost point of IT; D: the lateral margin of the SN at the level of the lowermost point of IT; IT: ischial tuberosity; PSIS: posterior superior iliac spine; SD: standard deviation; SN: sciatic nerve.

the number of attempts to target the SN ( $p=0.062$ ). The quality of the SNB was similar ( $p=0.781$ ). Pain intensity during the blockages was equal between the two techniques. No neural complications were observed in the 24-hour follow-up period in both study groups. Need for

**Table 2**  
Patient data and duration of surgery.

	Group L (n=50)	Group P (n=50)	p-value
Age (years)	43.5±14	50.9±12.6	0.23
Weight (kg)	78.7±17.2	79.6±13.4	0.43
Height (cm)	169.5±9.2	163.4±8.9	0.48
Sex (W/M) (%)	56/4	60/40	0.09
Duration of surgery (min)	61.1±14.6	65.3±19	0.32

Data are given as mean±standard deviation and %.

**Table 3**  
Comparison of the results of the two methods (Labat's approach: Group L and parasacral approach: Group P).

		Group L	Group P	p-value
SN Depth (mm)		71.4±14	69.6±15	0.315
Number of attempts to target the SN		1.72±0.72	1.60±0.59	0.834
The time between inserting the needle into the skin to seen muscle contraction with 0.5 mAmp stimuli (seconds)		32.4±10.6	30.3±8.5	0.062
The quality of the SNB	Good	28	32	0.781
	Satisfactory	19	15	
	Failed	3	2	
Pain intensity	Moderate and severe pain (VAS ≥4)	21/50 (42%)	19/50 (38%)	0.838
Need for additional nerve blockages	Saphenous nerve blockage	26/50 (52%)	19/50 (38%)	0.017*
	Femoral nerve blockage	14/50 (28%)	9/50 (18%)	

\* $p<0.05$ .

additional nerve blockages (saphenous and femoral) were significantly higher in group L than in group P ( $p=0.017$ ).

## Discussion

The SNB is frequently used for surgery of the distal lower limb and foot. There are various limitations of SNB methods applied to date. Therefore, we compared two approaches used for SNB, and conducted a cadaveric study in order to suggest novel landmarks for a safe approach.

The SN is actually two nerves that are loosely connected together in the same connective tissue sheath. The tibial and the common fibular nerves usually diverge at the distal thigh, but in nearly 12.2% of people, the common fibular nerve passes through the piriformis, while in 0.5% it passes superior to the muscle.<sup>[8]</sup> Cuvillon et al.<sup>[9]</sup> demonstrated that single injection produces similar success rates compared with double injection. However, it is well known that the multiple injection technique for the SNB offers a higher success rate. Because the division of the SN into its components can occur at any point between the sacral plexus and the lower third of the thigh. In our study we did not observe a variation such as split SN in the cadaveric part of the study.

For the SNB procedures, clinicians usually use bony landmarks. The PSIS, the greater trochanter, and the IT are the most frequently used ones. However, identifying the greater trochanter might be difficult in some patients, e.g., obese patients. di Benedetto et al.<sup>[10]</sup> used the GT and the IT as landmarks with the hip in flexion, but the required 90° of hip flexion might be difficult in certain patients. The subgluteus parabiiceps technique is questionable for identification of soft tissues in obese patients.<sup>[11]</sup> Additionally, both of the studies mentioned above describe the SNB distal to the gluteal region rather than the posterior femoral area. Posterior approach for the SNB requires special positioning that might be difficult to obtain in some patients.<sup>[2]</sup> The anterior approach to the SN has also been described and could be performed in the supine position; however, the procedure is difficult at the level of the lesser trochanter, and reaching the nerve may require leg rotation.<sup>[12,13]</sup> Novel and easy landmarks have been developed to overcome this problem.<sup>[14]</sup> However, needle advancement under ultrasound guidance is not feasible when using the anterior approach due to acoustic shadowing by the overlying femur. Another new supine technique proposes using the GT and the anterior superior iliac spine as landmarks for reaching the SN laterally.<sup>[15]</sup> However, this study was conducted on a limited number of cadavers. Uz et al.<sup>[16]</sup> described a novel anterior approach and concluded that it could be used without damaging regional vascular structures while simultaneously blocking

the femoral nerve. In our cadaveric study, we defined a safe insertion point using the PSIS and the IT as landmarks. Also, we determined the surface projection of the SN using these landmarks (**Figure 3**). A line was drawn from the PSIS to the IT. Then, a slightly concave line was drawn from the point 8 cm distal to the PSIS on the first line to 2 cm lateral to the IT (the point described above as between points C and D) to indicate the course of the proximal part of the SN. The point between C and D was then defined as the point of puncture. The advantage of the line proposed in our study is that, it also defines the course of the SN. Therefore, it provides a better orientation for choosing the optimal site for needle entry. The line describing the course of the SN in our study also provides safety margins for both sites that were determined using cadavers. The advantage of our landmarks is using clearly defined bony prominences that can be identified even on obese patients. Furthermore, our descriptions may also facilitate ultrasound-guided SNB or other imaging studies that assess the SN in the gluteal region.

Guidance by ultrasound provides basic information about the exact location of deeply located nerves and their anatomical relationships with other structures necessary to achieve nerve blockage. However, ultrasound training is not compulsory in the anesthesiology residency curriculum.<sup>[17]</sup> In addition, insufficient knowledge about the operation of the ultrasound device, limited educational resources, the minority of teaching centers using the technique are the most important restrictions in front of the widespread use of ultrasound in the peripheral block. Therefore, the traditional method is still valid in most geographies. In the future, standard ultrasound training should be a milestone to be added to the anesthesiology specialty curriculum.

The limitation of our cadaveric study is the limited sample size. Further studies being conducted on imaging methods would be useful in order to increase the sample size.

## Conclusion

Without requiring any special positioning such as hip flexion, the insertion point for SNB suggested in our study may be a significant advantage in certain patients with restricted hip joint mobility. Also, we believe that the insertion point we determined is safe and reliable being free of neurovascular structures. Prominent, fixed bony and easily detectable landmarks for determining the surface projection of the SN is the other advantage of our study.

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### Conflict of Interest

No conflict of interest was declared by the authors.

### Author Contributions

BIT: Dissections, data analysis, manuscript writing; ASC: Project development, collecting the clinical data, manuscript writing; LF: Data analysis, editing the manuscript; RST: Data analysis, editing the manuscript; AA: Collecting the clinical data, data analysis; AU: Project development, dissections, editing the manuscript.

### Ethics Approval

Ethical approval was taken from the Ethical Committee of Yıldırım Beyazıt University Faculty of Medicine (2022-06). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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