

Ultrasound-guided Sciatic Nerve Blocks: Higher and Popliteal Approaches

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ABSTRACT

Background and objective: In modern anaesthetic practice the classical landmark approaches for sciatic nerve blocks have been constantly modified and adjusted to the ultrasound-guided techniques. This huge variety in published ‘new’ ultrasound SNB approaches may be somewhat confusing for the anaesthetic trainee. In this article we compare most popular ultrasound approaches to the landmark techniques trying to systematize them for teaching purposes.

Materials and methods: After reviewing the current literature, publications and websites we describe the four most popular groups of ultrasound approaches for sciatic nerve blocks discussing the sonoanatomy, sonotechnique, clinical tips and complications. We start with the most superficial approach—the popliteal and end with the deepest of them—the anterior approach. We also hope that our classification will even accommodate the US approaches developed in the future.

Keywords: Sciatic nerve blocks, Ultrasound guidance, Classification.

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INTRODUCTION

In modern anaesthetic practice the classical landmark approaches for sciatic nerve blocks have been constantly modified and adjusted to the ultrasound-guided techniques. Comparing most popular ultrasound approaches to the landmark techniques, one can easily see the similarities between both groups (Table 1).

These similarities are more related to the anatomical landmarks and zone of injection rather than the direction and angle of the needle. For example, the bone structures used as landmarks for the Labat and Raj approaches—greater trochanter and ischial tuberosity—can be used as

ultrasound landmarks too, e.g. in subgluteal approaches. This makes profound anatomical knowledge as crucial now (in the ultrasound era) as it was before the use of ultrasound.

ANATOMY

The sciatic nerve is the biggest peripheral nerve in the human body. It originates from the lumbosacral plexus and is formed by the ventral rami of L4, L5, S1, S2 and S3 (Fig. 1). The sciatic nerve leaves the pelvis through the infrapiriform foramen of the greater sciatic foramen. The inferior gluteal artery, vein and nerve also pass through the infrapiriform foramen together with posterior femoral cutaneous nerve and pudendal nerve. After emerging under the piriformis muscle, sciatic nerve then descends on the gemellus superior, internal obturator and gemellus inferior muscles. Here it is covered by gluteus maximus and lies behind the acetabulum. Below the line between the greater trochanter and ischial tuberosity, it lies on quadratus femoris, adductor minimus, adductor magnus and short head of biceps femoris (Fig. 2). After exiting the infrapiriform foramen the sciatic nerve is covered by gluteus maximus and long head of biceps femoris.

The sciatic nerve supplies the following structures:

- *Below the knee:* It supplies the skin over the postero-lateral-anterior regions of the leg and foot and all muscles and bones of the leg and the foot (Fig. 3). The skin over the medial part of the leg and ankle is innervated by saphenous branch of femoral nerve.
- *Above the knee:* Sciatic nerve supplies part of the hip joint and part of femoral bone. It also innervates the following muscles—superior and inferior gemelli, internal obturator, quadratus femoris, half of adductor magnus, semitendinosus, semimembranosus and biceps femoris. The branch to the hip joint can separate from sciatic nerve before the infrapiriform foramen.

Table 1: Relation between classical and ultrasound-guided approaches

<i>Ultrasound-guided approaches</i>	<i>Classical landmark approaches</i>
<ul style="list-style-type: none"> • Anterior approach • Subgluteal proximal approaches • Subgluteal distal approaches 	Anterior (Beck) approach Posterior (Labat) approach Inferior (Raj) approach Lateral high femoral approach Lateral midfemoral approach Lateral popliteal approach Prone popliteal approach Supine popliteal approach
<ul style="list-style-type: none"> • Midfemoral approach • Popliteal approaches 	

Next we describe the four most popular groups of ultrasound approaches for sciatic nerve blocks discussing the sonoanatomy, sonotechnique, clinical tips and complications. We start with the most superficial approach—the popliteal and end with the deepest of them—the anterior approach:

POPLITEAL APPROACHES

Sonoanatomy: Ultrasound images obtained in the popliteal fossa reflect the anatomical relations of the sciatic nerve in this region (Figs 4 and 5). Here the nerve is usually divides to its common peroneal and tibial branches. However, in some patients this division can take place as high as gluteal region or as low as the most distal border of the popliteal fossa.

With a high frequency linear transducer, sciatic nerve is visualised as a hyperechoic oval structure. In the proximal part of popliteal fossa it runs lateral to the popliteal artery and vein but more distally its tibial branch can be found immediately above the vessels. With the same transducer and

machine settings, tibial and peroneal branches are less echogenic than the main nerve. Anatomical variations are possible.

Sonotechnique

- *Transducer:* Among 38 mm, high frequency (7.5-12 MHz) linear transducer is the best choice.
- *Position:* Three patient positions are possible for this approach—prone, lateral and supine (Fig. 6). The position choice depends on performer’s preferences, whether the block is done on awake or anaesthetised patient, whether the patient is relatively mobile or in pain, etc. The prone position is good for awake, mobile and pain free patients and is arguably the most convenient for the performer of the procedure. The lateral position can be used in patients under general anaesthesia (GA). The supine position requires pillows under the leg/ankle to create space for the probe under the popliteal fossa. It may also require better hand coordination.
- *Scanning technique:* The scanning can start either just laterally from the apex of the popliteal triangle

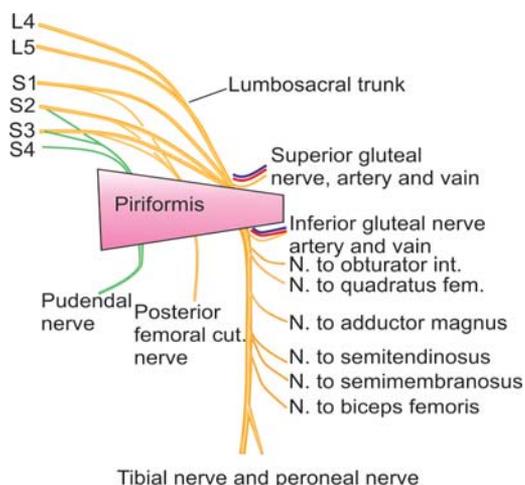


Fig. 1: Sciatic nerve: formation and branches

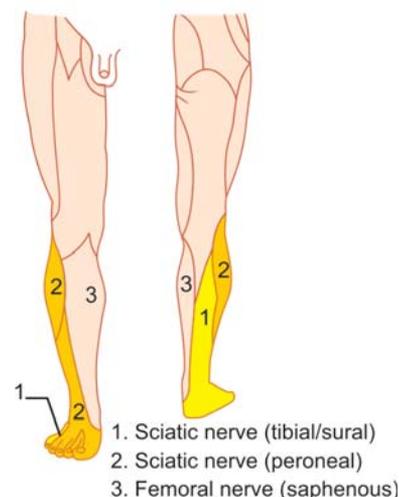


Fig. 3: Sciatic nerve—skin innervation

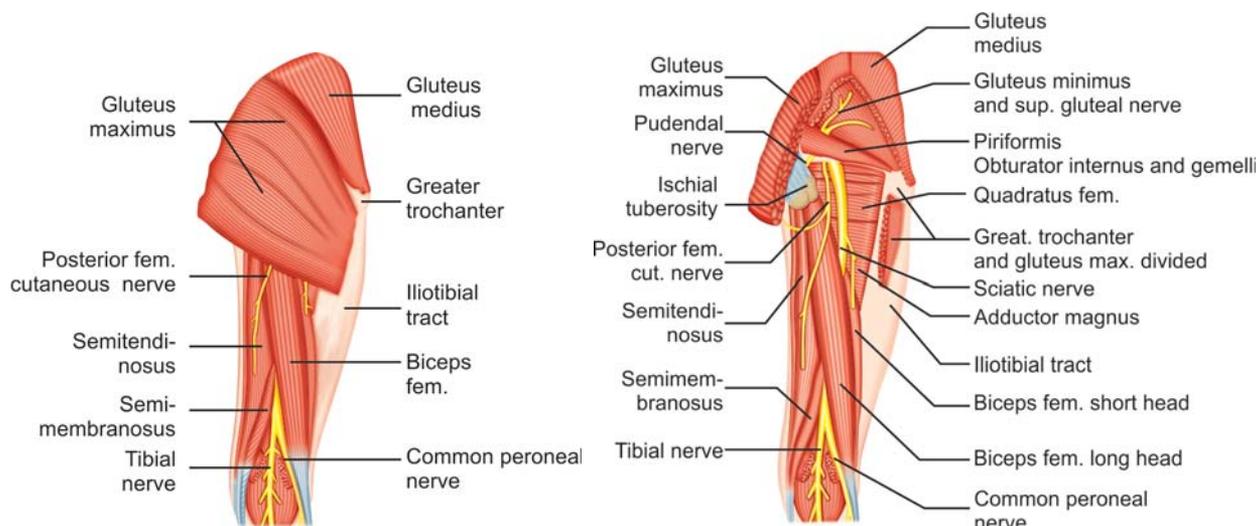


Fig. 2: Sciatic nerve—relation to the adjacent muscles

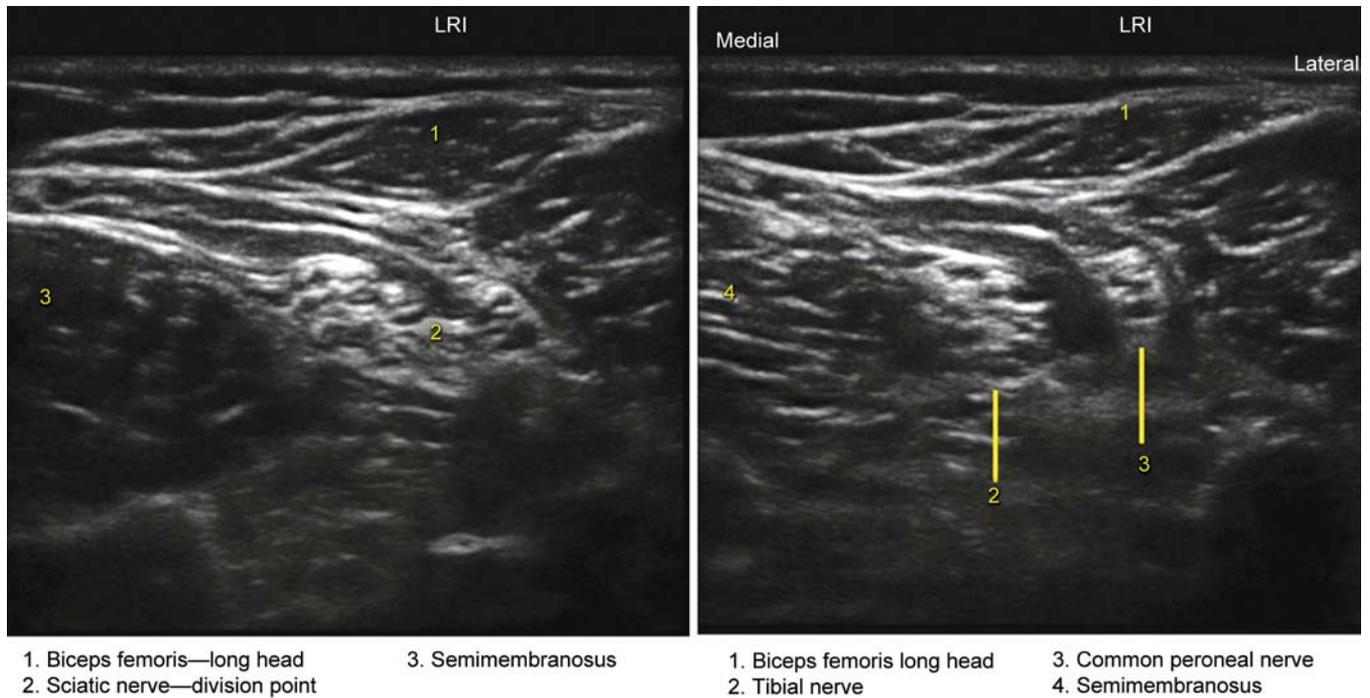
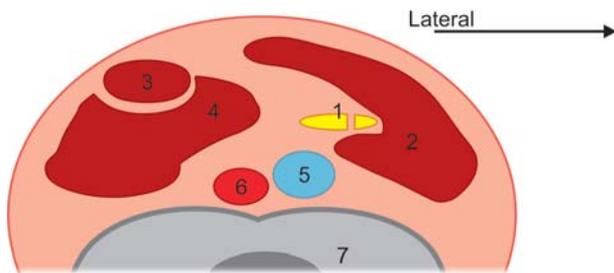


Fig. 4: Sciatic nerve—before and after its division in the popliteal area



1. Sciatic nerve (tibial and common peroneal)
2. Biceps femoris
3. Semitendinosus
4. Semimembranosus
5. Popliteal vein
6. Popliteal artery
7. Femur

Fig. 5: Popliteal area—patient prone

- (identifying biceps femoris and the nerve beneath it) or with a probe placed at and parallel to the popliteal crease (identifying the popliteal vessels and tibial/peroneal nerves superficial and lateral to them). Scan the whole length of the popliteal fossa in order to visualise the main nerve and division to tibial and common peroneal branches.
- *Needles and technique:* A 50 to 100 mm ‘peripheral nerve block’ needles; both in-plane and out-of-plane techniques⁴ can be used but we recommend the in-plane technique. Insert the needle at the lateral aspect of the transducer. For better results the local anaesthetic should be injected just above and below the nerve. Among 15 to 20 ml (maximum 30 ml) of local anaesthetic should be enough.⁴ For catheter insertion 100 mm insulated 18G

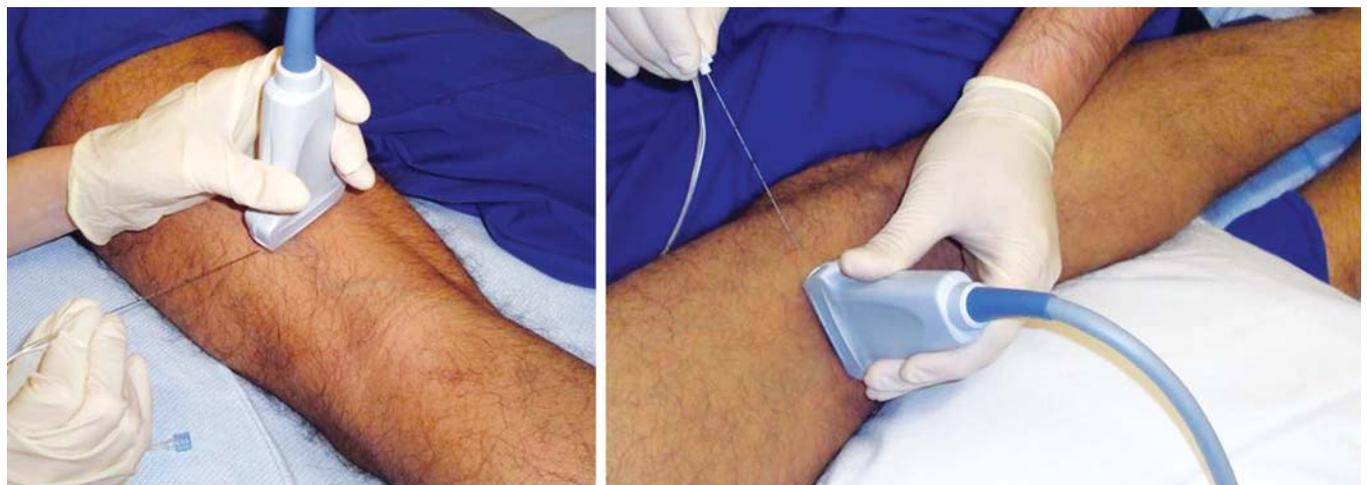


Fig. 6 Prone and lateral patient position for popliteal blocks (the two pictures shown are only for teaching purposes—hence no aseptic precautions)

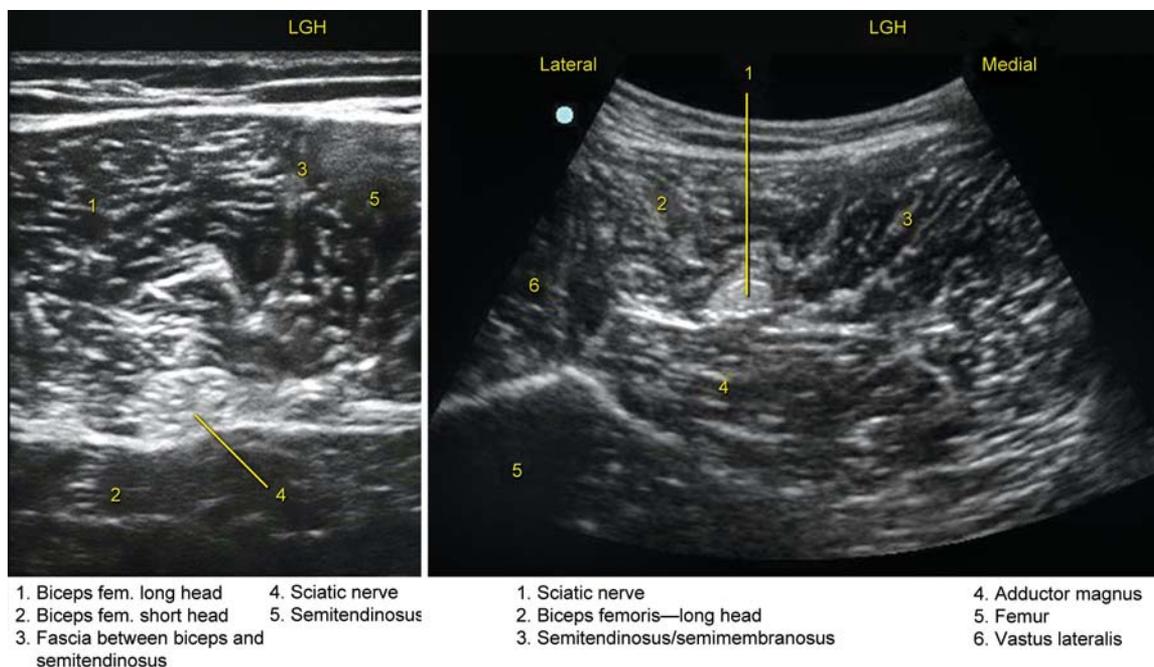


Fig. 7: High frequency linear and low frequency curvilinear midfemoral scans

Tuohy needle is used and the catheter is inserted 3 to 4 cm beyond the tip.

Clinical Tips

- The block should be performed proximal to the division unless specific tibial or peroneal block is desired.
- If lost try to identify the key anatomical structures – the biceps muscle or the popliteal vessels and then keeping the probe at 90° to skin try slight proximal or distal tilt in order to visualise the nerve.
- For a complete block below the knee the saphenous nerve must also be blocked.

Complications: Intravascular injection, bleeding and haematoma, nerve injury.

MIDFEMORAL APPROACH

Sonoanatomy: In the midfemoral region, sciatic nerve lies between the two heads of the biceps muscle (under the long head) with semitendinosus/semimembranosus medially (Fig. 7).

Here it appears as hyperechoic oval structure under the long head of biceps femoris.^{7,8}

Sonotechnique

- *Transducer:* High frequency linear or low frequency curvilinear (for obese patients).
- *Position:* Prone, lateral and supine positions have been described for this approach. The lateral is better for anaesthetised patient.
- *Scanning technique:* The scan should start with identifying the bulk of bicep's long head and semitendinosus and the fascia layers between them and

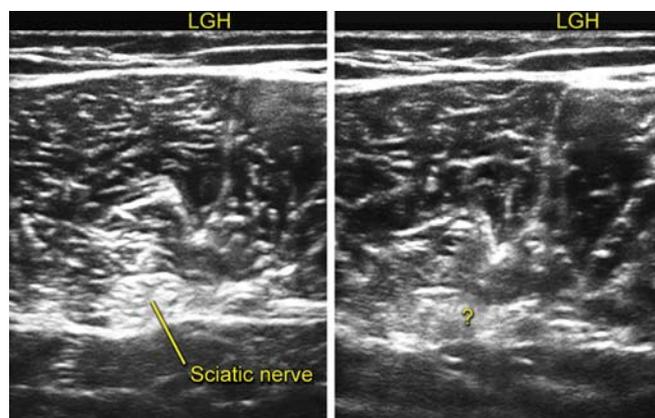


Fig. 8: Anisotropy—only 3 and 4° tilt of the probe makes the nerve almost invisible

the deeper muscle group. Then careful tilt of the transducer should display the oval hyperechoic shape of the nerve. Careful probe tilting is important because the sciatic nerve is remarkably anisotropic in this region (Fig. 8).

- *Needles and technique:* Among 50 to 100 mm 'peripheral nerve block' needle. Both in-plane and out-of-plane techniques are possible (Figs 8 and 9). Among 10 to 15 ml local anaesthetic (LA) should be enough. It is also possible to visualise the nerve in longitudinal view and to perform needle in plane technique (also suitable for catheter insertion and continuous block) (Figs 10A and B).

Clinical Tips

- Inject the local anaesthetic medially and laterally to the nerve for better results. The characteristic 'bull's eye' appearance after the LA injection should be displayed.

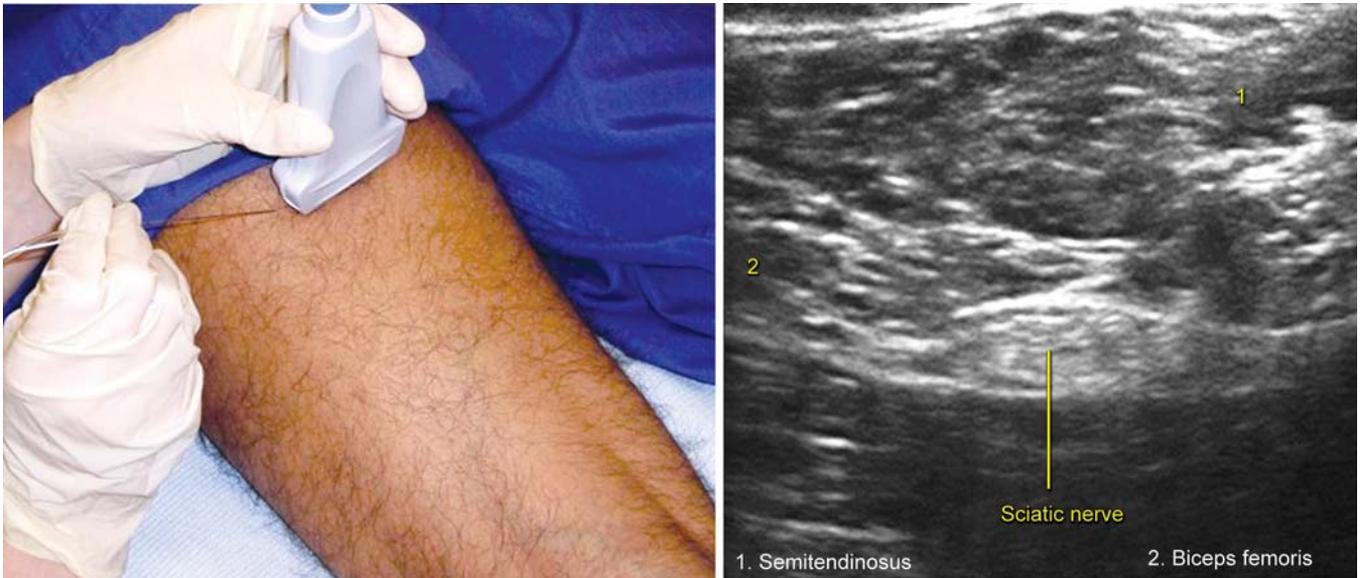


Fig. 9: Needle-in-plane technique for midfemoral approach

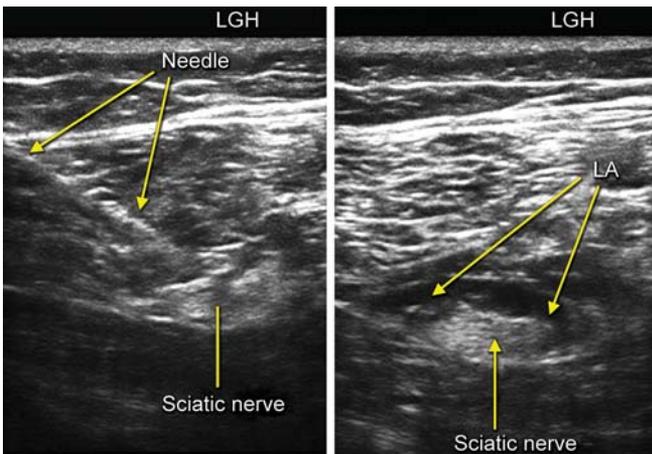


Fig. 10A: Needle-in-plane midfemoral approach and the local anaesthetic (LA) spread

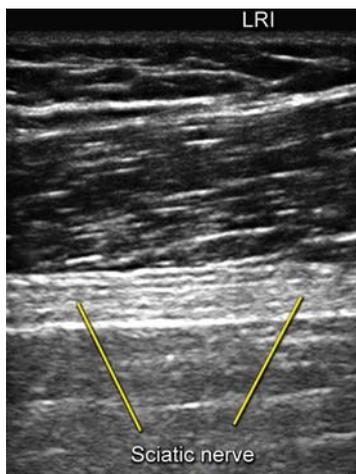


Fig. 10B: Sciatic nerve—midfemoral longitudinal view

- Beware the division of the nerve—it could take place in the gluteal region in which case both tibial and common peroneal nerves should be visualised and blocked.

Complications

Nerve injury is very rare. Infection, intravascular injection or haematoma are very unlikely for this approach.

SUBGLUTEAL APPROACHES

Before we describe the different subgluteal approaches we would like to explain our classification. First, the term ‘subgluteal’ refers to the space where the LA should be injected, namely the space confined between piriformis muscle proximally with a floor consisting of gemelli, internus obturator and quadratus femoris muscles and a roof being the gluteus maximus. We then divide the relevant approaches described in the current literature into two groups (Fig. 11):

- Proximal subgluteal approaches in which the probe is placed and the sciatic nerve is visualised around the line between the greater trochanter and the sacral hiatus/ coccyx—for example, the gluteal region approach of Chan et al or the transgluteal one of Marhofer.
- Distal subgluteal approaches in which the probe is placed and the nerve is visualised around the line between the greater trochanter and ischial tuberosity—for example, the Chan’s infragluteal approach,² the Marhofer’s ‘subgluteal’ one³ or the ‘subgluteal’ approach described by Karmakar et al.¹

We realise that there are no well-defined borders between the proximal subgluteal, distal subgluteal and midfemoral approaches, e.g. the gluteus maximus stretches caudally beyond the subgluteal crease and anaesthetic solution deposited in subgluteal space may spread distally between the biceps femoris and adductor magnus.⁵ Nevertheless, a simple classification that is

easy to grasp can be useful for the beginner in the ultrasound guided blocks.

Sonoanatomy

In the subgluteal space, the sciatic nerve can be visualised immediately beneath the gluteus maximus as a narrow ellipsoid (proximal) or oval (distal approach) hyperechoic structure. Proximally it lies on superior gemellus and ischial bone and distally on quadratus femoris between the greater trochanter and ischial tuberosity (Figs 12 and 13).

Sonotechnique

- *Transducer:* Low frequency curvilinear or high frequency linear probes can be used for the subgluteal approaches, depending on the patient's BMI.
- *Position:* Lateral with hip and knee slightly flexed for both approaches; prone and supine (with 90° flexed of hip and knee) are also possible for the distal one but require more assistance.
- *Scanning technique:*
 - *Proximal subgluteal approaches:* After drawing a line between the greater trochanter (GT) and sacral

hiatus, position the curvilinear probe in the middle of the line, parallel to it [Fig. 11 (left)]. The ischial bone and spine should be easily visible. Then with



Fig. 11: The suggested initial positions of the probe (the red lines) for the proximal (line 1) and distal (line 2) subgluteal approaches. Line 3 connects PSIS and the greater trochanter (GT) and line 4 is the subgluteal crease. SH—sacral hiatus and IT is ischial tuberosity. The initial position of the transducer for the proximal subgluteal approach is around the needle insertion point used in the classical Labat approach (marked with green arrow)

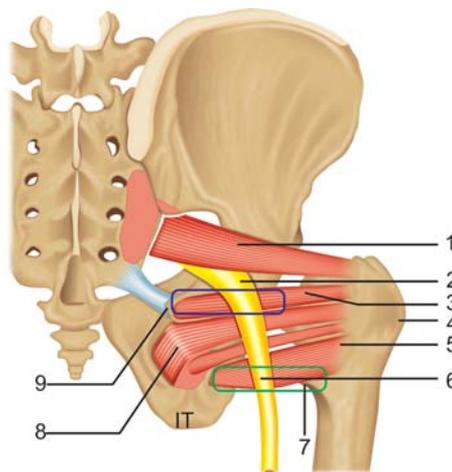
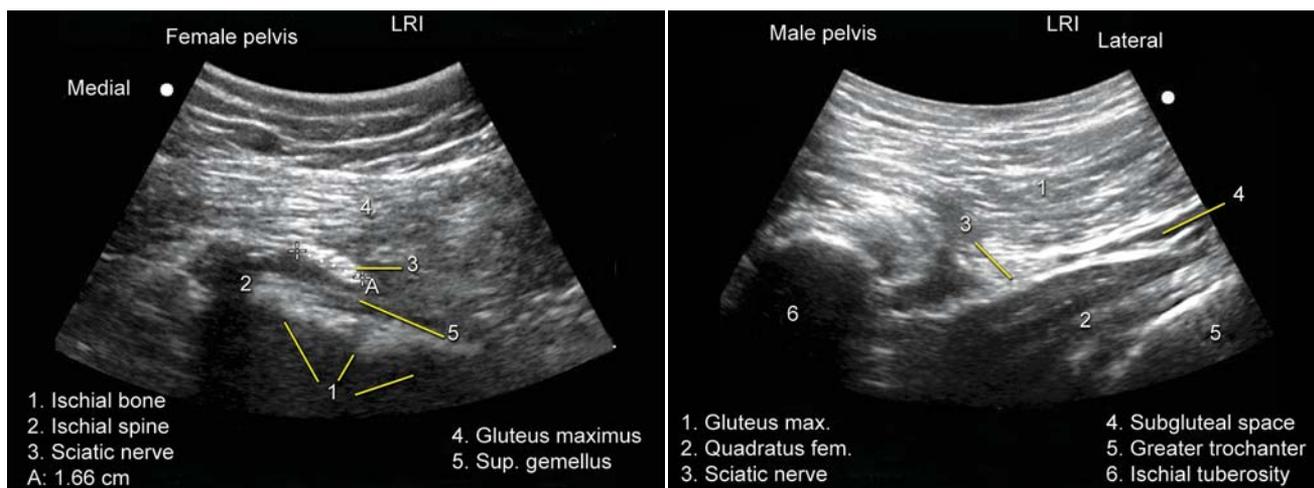


Fig. 12: Proximal and distal subgluteal scans and the relation of the bone structures to the position of the transducer (right)—purple for the proximal and green for distal approach: (1) piriformis muscle, (2) sciatic nerve, (3) sup. gemellus, (4) greater trochanter, (5) quadratus femoris, (6) sciatic nerve, (7) lesser trochanter, (8) int. obturator muscle and (9) ischial spine

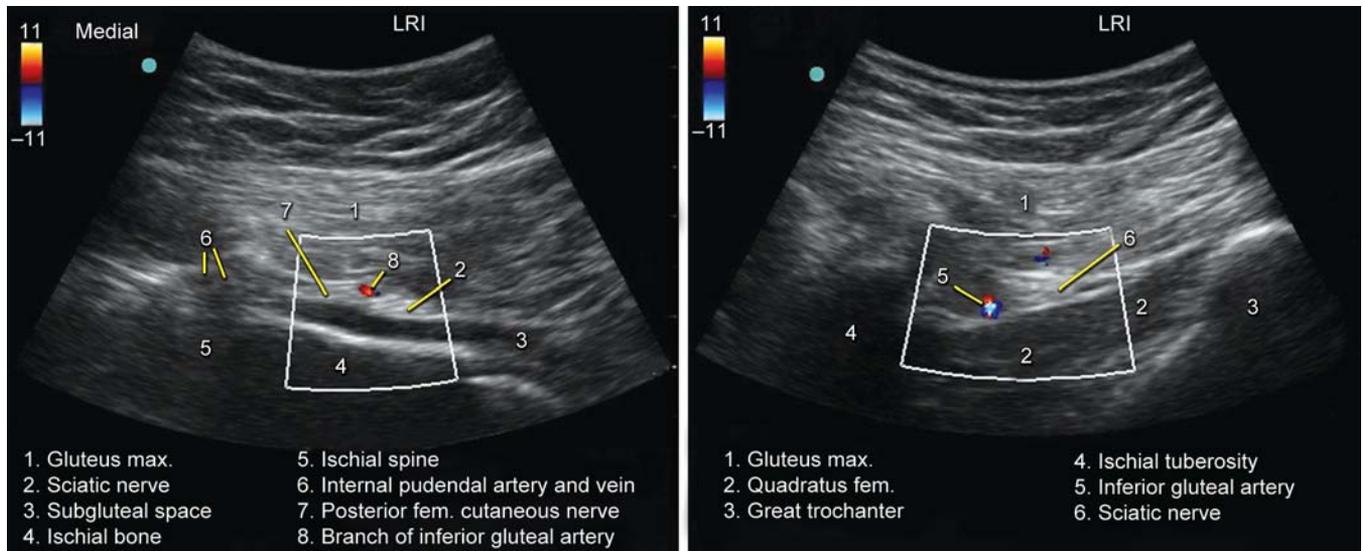


Fig. 13: The proximity of inferior gluteal artery branches in the proximal and distal approaches

slight tilt of the transducer try obtain the best image of the nerve. If necessary slide the probe slightly medial or lateral.

- *Distal subgluteal approaches:* Draw a line between the ischial tuberosity (IT) and the greater trochanter and then position the curvilinear probe vertical to skin, parallel to and approximately at the midpoint of that line. The GT and IT should be easily identifiable; some probe tilting and sliding in lateral or medial direction may be needed to visualise the nerve in the subgluteal space. Around the gluteal crease the high frequency transducer can provide better images of the nerve and sometimes the posterior femoral cutaneous nerve can be identified.
- *Needles and insertion:* Use a 100 mm ‘peripheral nerve block’ needles. Both in-plane and out-of-plane techniques are possible but we recommend the needle in-plane one especially for single shot blocks. If in-plane technique is used, the needle should be inserted from the lateral side. Among 10 to 15 ml of LA should be enough if injected in the right space. Continuous catheter technique is also an option with these approaches.⁶

Clinical Tips

- If lost, try to identify the hyperechoic perimysium of the gluteus maximus and the quadratus femoris—sciatic nerve must be between them [see Figs 12 and 13 (left)].
- If trying to block the branches supplying the hip joint, the injection should be made as proximal as possible so the proximal approaches are the logical choice.

Complications

Be aware that sciatic nerve is very close to the inferior gluteal artery and its branches and also to internal pudendal artery

and vein for the proximal approaches (see Fig. 12), so intravascular injection, vascular damage and haematoma are possible.

Block of the pudendal nerve causing urinary retention is uncommon. As with all blocks nerve damage is a possibility.

ANTERIOR APPROACH

Sonoanatomy: For the anterior approach the sciatic nerve can be visualised posterior and slightly medial to the femur (lesser trochanter). The nerve is situated between the adductor magnus and the bulk of the gluteus maximus/biceps/semitendinosus muscles (Fig. 14).

Sonotechnique

- *Transducer:* Among 2 to 5 MHz curvilinear transducer is necessary for this approach.

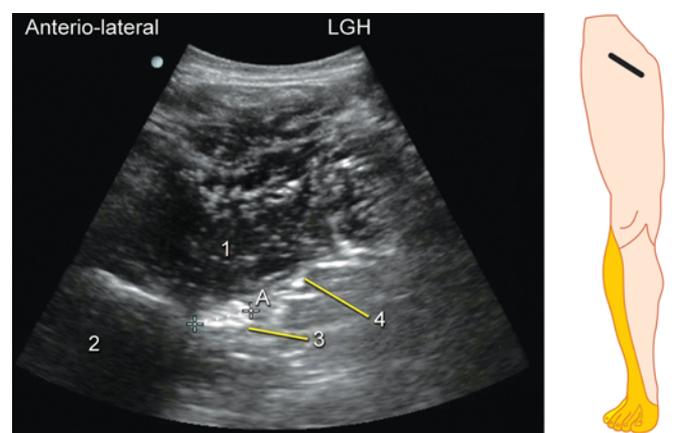


Fig. 14: Ultrasound scan and position of the thigh for the anterior approach: On the right: suggested initial position of the transducer (red line). (1) adductor magnus, (2) femur/lesser trochanter, (3) sciatic nerve, (4) the fascia between adductor magnus and the bulk of gluteus maximus, semitendinosus and biceps femoris

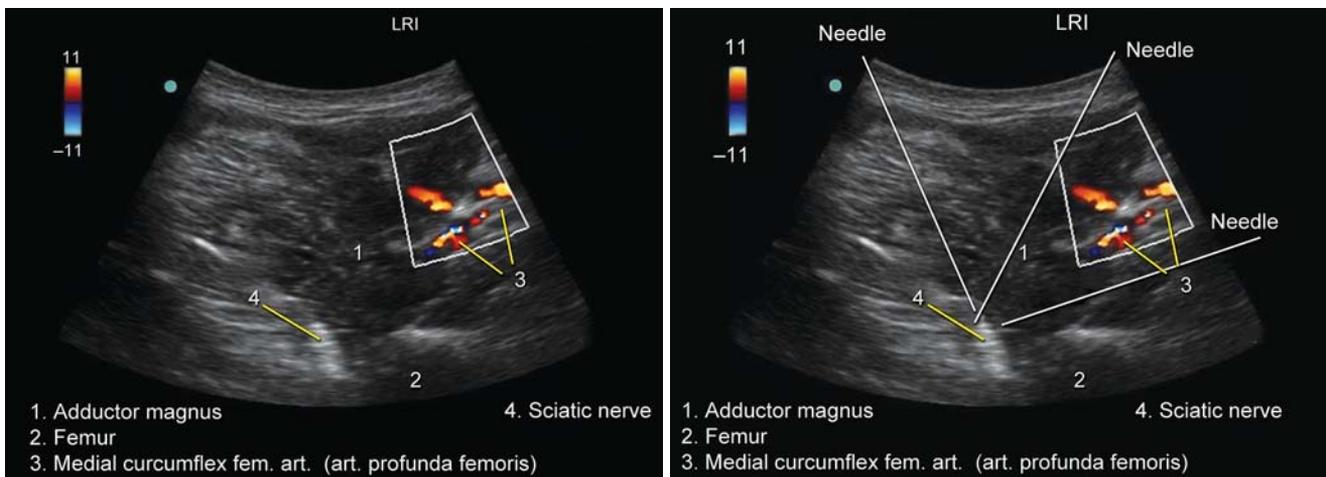


Fig. 15: The deep femoral artery branches and the possible needle trajectories for the anterior approach

- **Position:** Supine, with the hip and knee slightly flexed and the leg externally rotated to about 45°.
- **Scanning technique:** Place the transducer at a line parallel to and about 8 cm distal to the inguinal crease with the thigh in the position described above. Identify the femoral bone (lesser trochanter) and the try to identify the adductor muscles—it is often possible to identify the adductor longus, brevis and magnus. The sciatic nerve should lie just below the adductor magnus. One can also obtain a good longitudinal view of the nerve especially after the LA injection.
- **Needles and insertion:** Among 10 mm insulated needle is usually long enough. Needle in-plane technique should be used. We recommend the new ‘hyperechoic’ peripheral nerve block needles for better visualisation of the needle insertion. Nerve stimulator (if used) set at 0.5 to 0.7 mA and switched on when the needle tip is closed to the nerve. 10 to 15 ml of local anaesthetic is more than enough but many clinician still use 20 ml.

Clinical Tips

- Do not try to visualise the sciatic nerve with leg in neutral position and transducer placed rather anterior over the femoral vessels—the nerve may be behind and obscured by the femoral bone. Position the probe more medially over the adductor group of muscles for the best images.
- This is the only approach for which we strongly recommend (for the beginners) simultaneous use of nerve stimulator and ultrasound, otherwise the local anaesthetic could be injected in the adductor muscle.

Complications

Blood vessels injury and haematoma are could occur with this approach. The branches of the deep femoral artery are

very close to the insertion trajectory of the needle (Fig. 15). Accidental intravascular injection and nerve damage are also possible.

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