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ORIGINAL ARTICLE

# Ultrasound-guided supra-inguinal fascia iliaca block: a cadaveric evaluation of a novel approach

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## Summary

Existing descriptions of ultrasound-guided fascia iliaca block focus on injection of local anaesthetic inferior to the inguinal ligament, relying on supra-inguinal spread to block the lateral femoral cutaneous nerve in the iliac fossa. In this study, we explored injectate spread and nerve involvement in a cadaveric dye-injection model, using a supra-inguinal ultrasound-guided technique that places local anaesthetic directly into the iliac fossa. Bilateral injections of 20 ml 0.25% aniline blue dye were made in six unembalmed cadavers. The femoral nerve was stained by the dye in all twelve injections. The lateral femoral cutaneous nerve was stained bilaterally in five cadavers, but the nerve was absent on both sides in the sixth cadaver. The ilio-inguinal nerve passed into the iliac fossa over the iliacus muscle in eight of the hemi-pelvi and was stained in seven of these occasions. We have performed more than 150 blocks in patients using this approach without complications. Injection using this technique in cadavers leads to extensive fluid spread throughout the iliac fossa. In patients this approach may allow a lower volume block of the femoral nerve and lateral femoral cutaneous nerve while still injecting at a distance from the femoral nerve.

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Fascia iliaca block places local anaesthetic in the plane containing the femoral nerve and lateral femoral cutaneous nerve (LFCN) between the fascia iliaca and the underlying iliacus muscle. It is used for anaesthesia and analgesia of the hip, knee and thigh [1, 2]. Success rates vary between 67% in junior trainee anaesthetists [2], to over 90% for experienced anaesthetists [3–5]. Fascia iliaca block does not directly target the femoral nerve, thereby reducing the risk of needle injury, and it has a higher rate of simultaneous block of the femoral and LFCN than perivascular femoral nerve block [3, 5].

Dalens et al. first described a landmark approach to fascia iliaca block in 1989 [4] using a skin entry point in the thigh. A '2-pop' technique identifies the fascia lata and fascia iliaca. Early investigators using the landmark technique demonstrated radio-opaque dye spread into the iliac fossa, which is the target area for the block [3, 4]. Ultrasound-guided fascia iliaca block in the infra-inguinal area has been described previously [5, 6].

We have used a supra-inguinal approach to the fascia iliaca block under ultrasound guidance over a period of three years in over 150 patients. Local anaesthetic is placed directly into the iliac fossa by advancing a needle beneath the fascia iliaca from below the inguinal ligament, so that the needle tip lies superior to the ligament. This may be advantageous as the LFCN leaves the fascia iliaca plane at the inguinal ligament, and branches of the femoral nerve to the iliacus muscle and acetabulum leave the nerve proximal to the inguinal ligament [7]. An infra-inguinal local anaesthetic injection must pass superiorly from the thigh to block these nerves and may therefore require a greater volume of injectate. In addition, the proximal LFCN and femoral nerve lie close together in the iliac fossa and may be blocked simultaneously by a smaller volume injection. A previously described landmark approach to supra-inguinal fascia iliaca block involves insertion of the needle inferiorly to the inguinal ligament and then advancing it superiorly [8] and utilising a '2-pop' approach similar to the infra-inguinal, landmark-based fascia iliaca block [4]. Unfortunately, bladder perforation has now been described using this (superior needle advancement) technique [9]. Ultrasound may reduce the risk of unintended puncture of the bladder and other structures in this area, including the deep circumflex iliac artery, inferior epigastric artery, external iliac artery, spermatic cord and hernia contents.

Herein we describe an ultrasound-guided supra-inguinal approach to the fascia iliaca block in a series of dye injections in cadavers, in order to explore the extent of nerve involvement and injectate spread as a prelude to further clinical investigation.

## Methods

This block is performed with a high frequency linear ultrasound transducer (probe) imaging to approximately 4 cm depth, or a lower frequency curvi-linear probe (allowing deeper penetration in obese patients). A sterile cover is applied to the probe, the hip is extended by laying the patient flat and the anterior superior iliac spine palpated. The probe is placed over the inguinal ligament, close to the anterior superior iliac spine, and orientated in the para-sagittal plane (Fig. 1). In obese patients, an assistant may retract the abdominal wall. Initially, the thick white line of the ilium and then the more superficial, dark (echolucent) iliacus muscle with the fascia iliaca covering its surface are identified (Fig. 2). Imaging of the fascia iliaca can be enhanced by tilting the transducer so that the beam is directed more laterally to orientate the fascia more perpendicular to the beam. The probe is then moved infero-medially, along the line of the inguinal ligament, until the femoral artery is imaged. Moving supero-laterally back along the inguinal ligament the anterior inferior iliac spine is imaged. The anterior inferior iliac spine forms the attachment of the rectus femoris muscle and is identified by the sudden rising of the ilium towards the transducer as the probe is moved laterally. In this position the probe is found lateral to the femoral nerve and this is the recommended starting point for the block. If the fascia iliaca is not well imaged at this point the probe may be moved more laterally to obtain a clearer image. The deep circumflex iliac artery should be identified superficial to the fascia iliaca 1–2 cm superior to the inguinal ligament, as it forms a landmark for the needle placement.

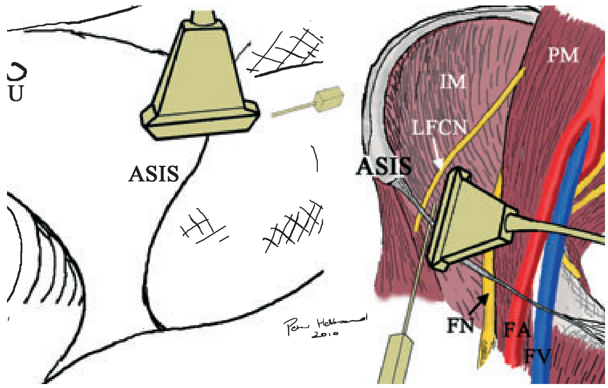


**Figure 1** Probe and needle position and diagram of dissected iliac fossa showing anatomy for the supra-inguinal fascia iliaca block. Iliacus muscle (IM), psoas muscle (PM), femoral nerve (FN), femoral artery (FA), femoral vein (FV), anterior superior iliac spine (ASIS), umbilicus (U).

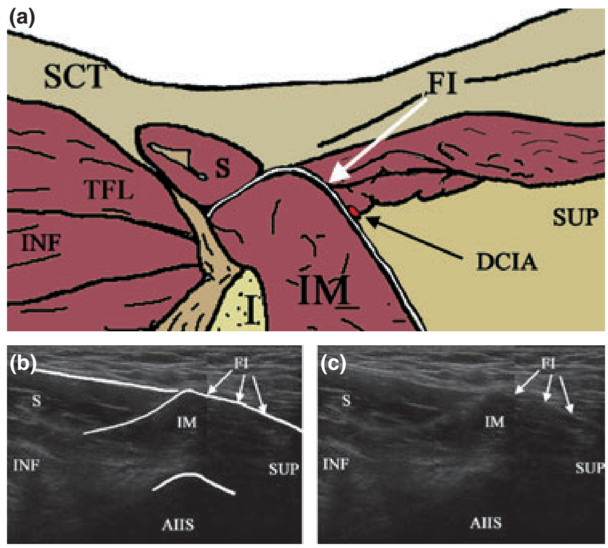


**Figure 2** Diagram of anatomical section in the parasagittal plane of the supra-inguinal fascia iliaca block (a) and composite sonograms (b) and (c). Iliacus muscle (IM), fascia iliaca (FI), psoas muscle (PM), sartorius muscle (S), tensor fascia lata muscle (TFL), ilium (I), deep circumflex iliac artery (DCIA), subcutaneous tissue (SCT). Inferior (INF), superior (SUP). The fascia iliaca, anterior inferior iliac spine (AIIS) and fascia over sartorius are highlighted in sonogram (b).

The needle is introduced through the skin, parallel to the probe, in-plane (with respect to the ultrasound beam), approximately 2–4 cm inferior to the inguinal ligament, and is advanced through the fascia iliaca at the level of the inguinal ligament. The depth of the tip of the needle relative to the skin entry point is approximately 2–4 cm.

There is usually a 'pop' as the needle passes through the fascia iliaca and into the iliacus muscle. The needle is withdrawn to the fascia and the position confirmed by an injection of 1 ml of local anaesthetic, which, if correctly placed, forms a lens deep to the fascia (Fig. 3). There is no distinct fascial line between the local anaesthetic lens and the dark iliacus muscle in this position. The needle is advanced into the lens and further local anaesthetic is injected. Through this process of hydro-dissection the needle is passed superiorly, deep to the fascia iliaca and into the iliac fossa, moving only into the space created by the distending fluid. The fluid must spread freely across the surface of the muscle, separated from the deep circumflex iliac artery by the fascia iliaca. The end-point is reached when the local anaesthetic passes freely superiorly, over the iliacus muscle and into the iliac fossa. A total of 20 ml ropivacaine 0.5–0.75% is injected slowly at this position. Imaging during the entire injection is recommended to confirm that the local anaesthetic is not being injected intravascularly. The probe may be rotated to the transverse position to image the distribution of fluid that usually passes medially, deep to fascia iliaca and superficial to the femoral nerve (Fig. 4). The needle alignment is suitable for a catheter placement.

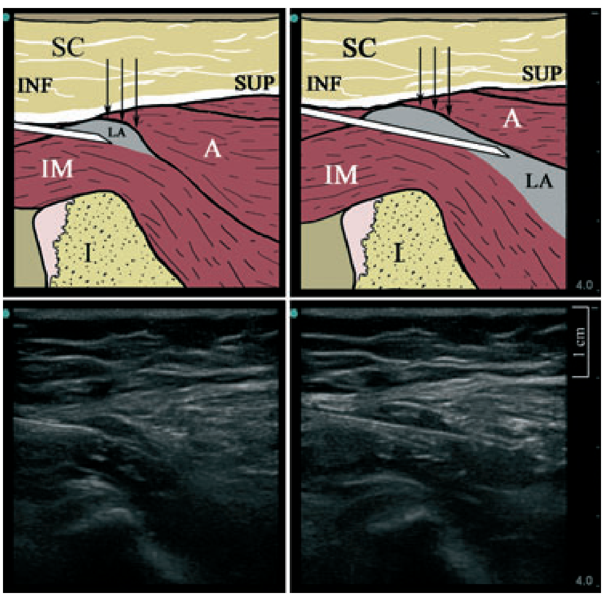


**Figure 3** Sonograms during hydro-dissection (left image) and towards conclusion of block (right image) showing the lens of local anaesthetic (LA) beneath the fascia iliaca (black arrows) with the needle advanced through it. Iliacus muscle (IM), ilium (I) subcutaneous tissue (SC), abdominal muscles (A). Inferior (INF), superior (SUP).

In the present study, we report a series of cadaveric dye-injections to simulate this ultrasound-guided supra-inguinal fascia iliaca block and subsequent dissections to explore the extent of dye spread and nerve involvement. The cadaver dye injections were performed in the Department of Anatomy at the University of Melbourne following institutional review committee approval.

We used six unembalmed, frozen/thawed cadavers. We performed bilateral ultrasound-guided supra-inguinal injections (as described above) of 20 ml aniline blue dye (0.25% in water), giving a total of 12 injections. We could not determine the position of the femoral artery as readily as in the living due to the absence of arterial flow and we gave precedence in the injection to finding a site with good imaging of the fascia iliaca. We used a 19-G 100-mm facet tip needle and 20-G catheter set (PlexoLong Nanoline facet; Pajunk GmbH Medizintechnologie, Geisingen Germany). After the dye injection we introduced the catheter through the needle, to pass 2–3 cm beyond the tip of the needle.

We commenced the dissection by reflecting the skin of the upper thigh and abdominal wall, taking care not to disturb the catheter. We performed deep dissection

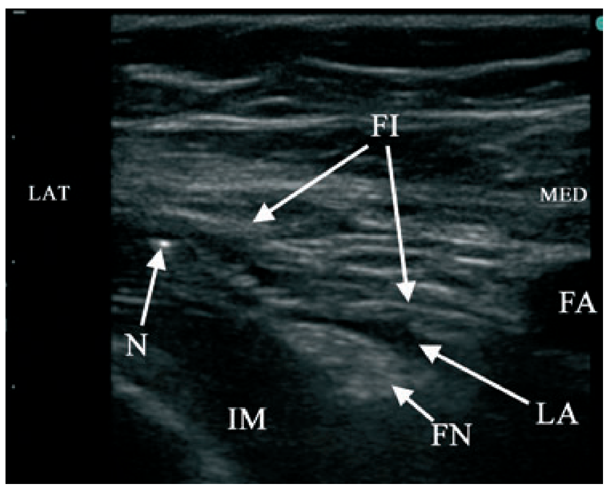


**Figure 4** Transverse scan at the conclusion of supra-inguinal fascia iliaca block. The needle (N) is lateral to the femoral nerve (FN) which has local anaesthetic (LA) passing over the superficial surface deep to the fascia iliaca (FI). Femoral artery (FA), iliacus muscle (IM). Medial (MED), lateral (LAT).

near the anterior superior iliac spine to identify the LFCN emerging through the inguinal ligament and passing superficially to the sartorius muscle. We identified the femoral nerve and femoral artery medially, deep to the inguinal ligament. We traced both the femoral and LFCNs proximally, to their emergence from the lateral edge of the psoas muscle. We identified the ilio-inguinal nerve either at the iliac crest, or just medial to it in the iliac fossa. The identity of the nerves was confirmed independently by the two dissectors (PH and JI). We measured the extent of dye spread in the superior-inferior and medial–lateral directions and we then noted the proximity of the dye to the anterior superior iliac spine and the femoral artery. We documented the nerves stained by the dye and then determined the distance from the catheter to the femoral nerve and LFCN at the levels of the catheter tip and the inguinal ligament.

## Results

There was extensive dye spread within the iliac fossa, and in 10 of the 12 injections dye also spread into the thigh along the femoral nerve, the superior to inferior spread (mean (SD)) measured 183 (36) mm and medial to lateral spread 75 (46) mm. The spread inferior to the inguinal ligament, along the course of the femoral nerve, was for a mean (SD) distance of 70 (46) mm. The dye also spread laterally to reach the anterior superior iliac spine in nine specimens and within 15 mm of it in the other three specimens. Medially, the dye spread deep to the femoral artery to a distance of 3 (8 mm) and a maximum of 25 mm medial to the lateral wall of the femoral artery. In one specimen the dye stopped 8 mm lateral to the femoral artery. There was no spread of dye superior to the iliac crest.

We identified the femoral nerve bilaterally in all six cadavers and noted it was surrounded by dye in all cases. We identified the LFCN bilaterally in five cadavers, but noted it was absent bilaterally in one cadaver. The LFCN was surrounded by dye in all cases it was present (Fig. 5), but in the one cadaver where we failed to identify the nerve in the iliac fossa, there was staining in its normal location. We identified the ilio-inguinal nerve bilaterally in all six cadavers. In eight hemi-pelvi it passed over the iliac crest onto the iliacus muscle and re-emerged into the muscular abdominal wall anteriorly. In the other four hemi-pelvi the nerve remained in the muscular abdominal wall. The ilio-inguinal nerve was stained in seven of the eight specimens when it passed over the iliac crest,

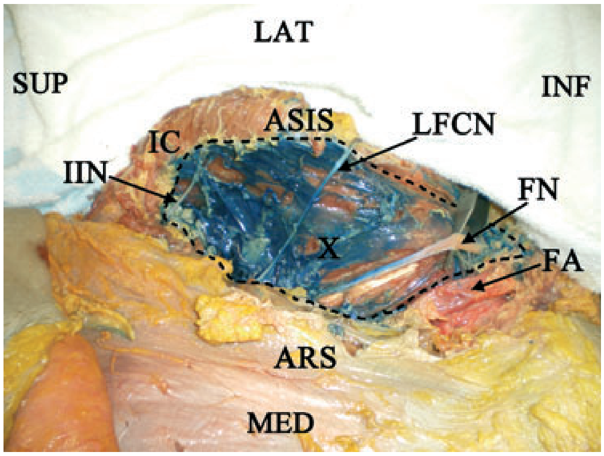


**Figure 5** Photograph of right-sided dissection specimen. The dye (outline by dashed line) fills the iliac fossa (X). The femoral nerve (FN) (lifted by forceps), lateral femoral cutaneous nerve (LFCN) and ilio-inguinal nerve (IIN) all pass through the dye. Note that the LFCN and femoral nerve are in close proximity deep in the iliac fossa. Femoral artery (FA), iliac crest (IC), anterior rectus sheath (ARS). Inferior (INF), superior (SUP), medial (MED), lateral (LAT).

but remained unstained when it did not pass into the iliac fossa.

Three of the catheters were displaced during the dissection; the position of the remaining nine catheters was assessed. At the inguinal ligament the catheter entered the fascia iliaca at a mean (SD) of 27 (14) mm lateral to the femoral artery, 17 (13) mm lateral to the femoral nerve and 25 (19) mm medial to the LFCN. The catheter tip was found to be a mean (SD) of 14 (14) mm lateral to the femoral nerve and 9 (15) mm medial to the LFCN.

## Discussion

Our cadaveric dye-injection study confirms that the ultrasound-guided supra-inguinal approach results in significant spread of injectate with simultaneous involvement of both the femoral nerve and LFCN, in the iliac fossa, in all the cadavers in which we identified these nerves by dissection. The extent of femoral nerve involvement was particularly significant, and extended between 50 and 140 mm into the thigh in ten of the twelve injections. Our clinical experience, in over 150 cases of reliable simultaneous block of the femoral nerve and LFCN using 20 ml of local anaesthetic, is consistent with these findings. In addition, we have placed catheters without difficulty in over fifty patients, using either the same catheter system as in these cadavers or alternatively 10.8-cm arterial catheters (Arrow International Inc., Reading, PA, USA). No short-term complications have been noted in any patient. Three previous reports by Capdevila et al., Dolan et al. and Morau et al. [3, 5, 10] have found a high rate of combined LFCN and femoral nerve blockade with fascia iliaca block although they used larger volumes, either 30 ml of an equal volume mix of lidocaine 2% and bupivacaine 0.5% or an average of 36 ml (0.5 $ml.kg^{-1}$) ropivacaine 0.5%. Notably, Lopez et al. used 20 ml lidocaine 1.5% and found only a 50% rate of simultaneous block of the two nerves using a landmark infra-inguinal technique [11].

The bilateral absence of the LFCN in one cadaver was an unexpected finding. This variation has been described previously (7.3% of 200 cadavers) [12] and it is suggested that when the LFCN is absent, the skin over the lateral aspect of the thigh is supplied by the femoral or iliohypogastric nerves instead. In most cases the intra-abdominal course of the LFCN is relatively constant and the variation is in its distal course through or inferior to the inguinal ligament [13].

The ilio-inguinal nerve was also involved in the injectate in seven of the eight specimens in which it passed through the iliac fossa. The passage of the ilio-inguinal nerve across the iliac crest and deep to fascia iliaca is well recognised although the incidence is not well described. Some investigators describe the nerve as remaining above the iliac crest [14, 15], whereas others have found the incidence of the ilio-inguinal nerves passing below the iliac crest to be 25–32% [16, 17], while Gray's Anatomy [7] simply describes it passing on to the iliacus muscle, as we observed in four of our six cadavers. Recognition of block of the ilio-inguinal nerve is unlikely to be clinically important when performing fascia iliaca block; however, staining of this nerve with dye in our cadaveric study suggests that it passes through the same plane as the LFCN, deep to fascia iliaca, when it passes through the iliac fossa.

The cadaveric injections and our clinical experience confirm the feasibility of ultrasound-guided supra-inguinal approach to the fascia iliaca block; however, a number of technical considerations warrant discussion. Positioning of the patient with extension of the hip is desirable as hip flexion may make the approach difficult. Other difficulties that we have encountered include poor imaging of the fascia iliaca (usually corrected by medial to lateral angulation of the probe) and associated imprecision identifying the endpoint (fluid spreading under the fascia iliaca). Free spread of fluid in the correct plane is important to allow adequate spread to the target nerves, and if local anaesthetic is deposited within the iliacus muscle it is usually apparent on ultrasound imaging and accompanied by some reflux of fluid back to the correct plane. Fluid injected within the abdominal musculature or into the fat between the fascia iliaca and peritoneum does not flow into the correct compartment along the iliacus muscle, deep to the deep circumflex iliac artery and into the iliac fossa.

During performance of the block the abdominal wall is compressed on to the fascia iliaca by the ultrasound probe, thereby excluding any intra-peritoneal organs. The peritoneum can potentially lie between the abdominal wall and the fascia iliaca, although it does not stand out on the ultrasound image. Needle misplacement into the extraperitoneal fat superficial to the fascia iliaca, the abdominal wall or the peritoneum is possible. However, the technique we described involves piercing the fascia iliaca in the proximal thigh superficial to the anterior inferior iliac spine, with subsequent advancement into the hydrodissected space deep to the fascia iliaca. We have experienced cases where the needle needs to be advanced a few millimetres beyond the hydrodissection before the local anaesthetic passes freely into the iliac fossa. In these instances the operator must be confident that the needle is deep to the fascia iliaca before advancing. The deep circumflex iliac artery should be specifically sought, as it provides a landmark superficial to the correct plane and could be damaged by incorrect needle advancement. Rotation of the probe to a transverse alignment after the injection, and the imaging of the local anaesthetic passing superficial or deep to the femoral nerve, confirms correct placement.

One catheter in the cadaver study entered the fascia iliaca very close to the femoral nerve, passing superficial to it to lie in a medial position. One catheter entered the fascia iliaca lateral to the LFCN and remained in this position after advancement. In this case, the injected dye still spread extensively along the femoral nerve in the iliac fossa, passing 60 mm along the nerve into the thigh. A medial entry point or a medial direction of the needle will make positioning close to the femoral nerve more likely. To reduce the chance of puncturing the femoral nerve we recommend imaging the femoral artery and then moving several centimetres laterally until the anterior inferior iliac spine is imaged.

Our description of ultrasound-guided supra-inguinal fascia iliaca block has the advantage of placing the local anaesthetic more directly into the target area for fascia iliaca block than existing described techniques, as well as facilitating convenient catheter placement. The role of ultrasound-guided supra-inguinal fascia iliaca block compared to other approaches to femoral nerve block and fascia iliaca block requires further study, particularly to determine if this approach offers advantages of lesser local anaesthetic dose requirement or improved reliability.

## Competing interests

No external funding and no competing interests declared.

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