Ultrasound-Guided Suprainguinal Fascia Iliaca Technique Provides Benefit as an Analgesic Adjunct for Patients Undergoing Total Hip Arthroplasty

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Analgesia after total hip arthroplasty is often accomplished by the fascia iliaca compartment block, traditionally performed below the inguinal ligament, to anesthetize both femoral and lateral femoral cutaneous nerves. The course of the lateral femoral cutaneous nerve below the inguinal ligament is variable as opposed to consistent above the inguinal ligament in the pelvis. In this case series including 5 patients, we demonstrate that an ultrasound-guided suprainguinal fascia iliaca approach would consistently anesthetize the lateral femoral cutaneous nerve along with anterior cutaneous femoral nerve branches and provide cutaneous analgesia after total hip arthroplasty, as shown by decreased opioid consumption.

Key Words—fascia iliaca; lateral femoral cutaneous nerve; musculoskeletal ultrasound; sonography; suprainguinal; ultrasound; total hip arthroplasty

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Abbreviations
IV, intravenous; SIFI, suprainguinal fascia iliaca

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Several regional anesthesia techniques have been implemented to decrease postoperative pain after total hip arthroplasty, all with varying success.[1,2] Of these, the fascia iliaca block is a commonly used compartment block for cutaneous analgesia for hip surgery. This block anesthetizes the lateral femoral cutaneous nerve but has reported failure rates of 10% to 37%.[3–5] To reduce failure, the femoral nerve and the lateral femoral cutaneous nerve have been blocked individually by using ultrasound guidance. As such, the lateral femoral cutaneous nerve has traditionally been approached below the inguinal ligament,[3–8] and anesthetizing this nerve has shown to provide analgesia in patients with chronic pain/meralgia paresthetica by achieving an appropriate sensory block while avoiding a motor block.

Anterior approaches for total hip arthroplasty have led to careful cadaveric examination of the course of the lateral femoral cutaneous nerve[9–11] after reports of nerve damage.[8,9] This nerve has an inconsistent course, with variable branching below the inguinal ligament. The branching is variable such that one or more branches may course superficial to, through, or deep to the inguinal ligament and may cross the sartorius laterally anywhere from 0 to 9 cm below the inguinal crease.[9–11] In contrast, the lateral femoral cutaneous nerve has a more consistent course above the inguinal ligament superficial to iliacus muscle and immediately deep to the fascia iliaca in the pelvis.[8]

In this case series, a novel ultrasound-guided out-of-plane suprainguinal fascia iliaca (SIFI) plane block is described. The approach described requires new transducer positioning and new sonographic landmarks for a combined lateral femoral cutaneous nerve and femoral nerve analgesic block. This technique is simple to perform and provides successful postoperative adjunctive analgesia after total hip arthroplasty.

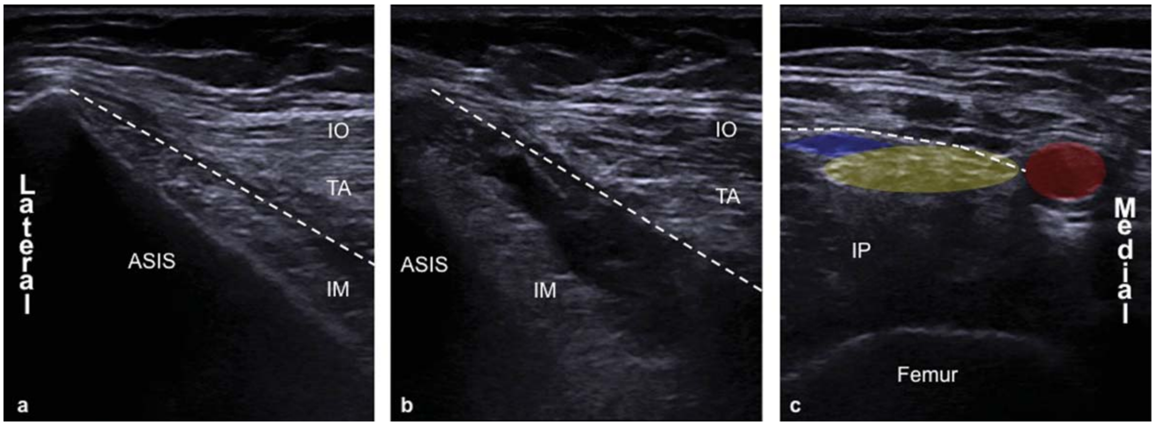
Materials and Methods

This case series, which was approved by the Duke University Institutional Review Board, comprised 5 patients receiving an ultrasound guided suprainguinal fascia iliaca nerve block as an analgesic adjunct for total hip arthroplasty. In accordance with our departmental policies, separate informed consent for anesthesia was obtained from all patients, encompassing both general and regional anesthesia. The procedure was explained to the patients, who agreed to receive the suprainguinal fascia iliaca technique as a novel analgesic adjunct, after which informed consent to participate in the case series was obtained. Additionally, they agreed to inclusion in the case series for future publication.

All patients received preoperative analgesics, unless medically contraindicated, including 10 mg of oxycontin, 100 mg of pregabalin, 975 mg of acetaminophen, and 400 mg of celecoxib. The patients received either spinal or general anesthesia as the primary anesthetic at the discretion of the attending anesthesiologist. All blocks were performed preoperatively by 1 of 2 authors (W.M.B. or S.A.G.) using ultrasound with a 10–15-MHz linear transducer (SonoSite, Inc, Bothell, WA) in the supine position. Initially, the anterior superior iliac spine was palpated. The transducer was placed in the inguinal crease to identify the femoral artery in the short axis. From the femoral artery, the transducer was translated laterally to identify the sartorius muscle. The sartorius was traced cephalad to its insertion on the anterior superior iliac spine. The hypoechoic shadow of the anterior superior iliac spine is easily identifiable just cephalad to the insertion of the sartorius. Medial to the shadow of the anterior superior iliac spine lies the iliacus muscle. With the anterior superior iliac spine and iliacus identified, the medial end of the transducer was rotated to point at the umbilicus, which was the final transducer position.

With the transducer in the final position, sonographic anatomy was identified, from superficial to deep, consisting of subcutaneous fat, the internal oblique muscle, the transverse abdominus muscle, the fascia iliaca overlying the iliacus muscle, and the iliacus muscle itself (Figures 1a and 2). A 21-gauge, 100-mm block needle (Stimuplex; B. Braun, Bethlehem, PA) was advanced in an out-of-plane fashion to puncture the fascia iliaca. With the needle tip just below the fascia iliaca, 2 mL of a local anesthetic was injected to confirm the tip location. Once the proper position was confirmed, 30 mL of 0.2% ropivacaine with 1:400,000 epinephrine was incrementally injected superficial to the iliacus muscle and deep to the fascia iliaca (Figure 1). After completion of the injection, the transducer was translated medially toward the

Figure 1. Ultrasound imaging of preinjection anatomy (**a**), postinjection spread of local anesthetic below the fascia iliaca (**b**), and spread of the local anesthetic from the injection site to the femoral nerve (**c**). Dashed line indicates the fascia iliaca; blue, local anesthetic; red, artery; yellow, femoral nerve; ASIS, anterior superior iliac spine; IM, iliacus muscle; IO, internal oblique; IP, iliopsoas muscle; and TA, transverse abdominus.

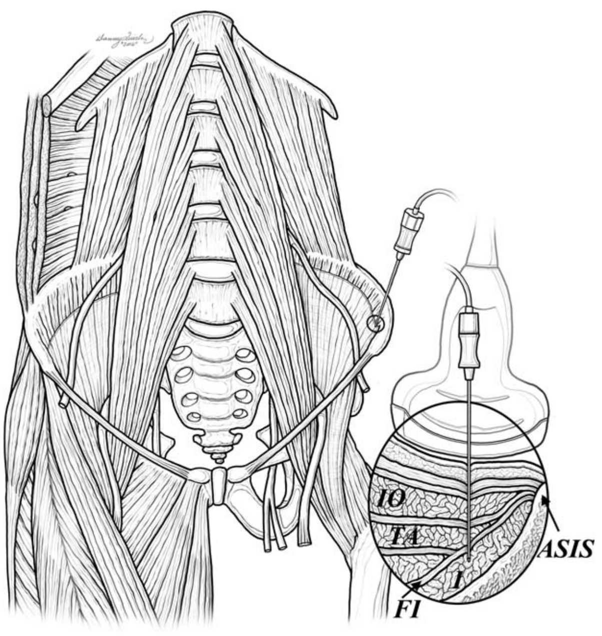


femoral nerve, where caudomedial spreading of the local anesthetic was easily identified.

After resolution of the primary anesthetic, sensory testing was performed on both limbs for light touch, pain (using a needle), and sensation to cold temperature in the distribution of the lateral femoral cutaneous nerve and anterior cutaneous femoral nerve, spanning from the level of the greater trochanter to the lateral tibial condyle and circumferentially around the leg. Patients were then asked to contract their quadriceps on both legs to crudely assess the motor block. Values for resting pain scores and opioid consumption were recorded in the electronic medical record by bedside nurses both in the postanesthesia care unit and on the floor at 1, 4, 8, 12, and 24 hours. Opioids were converted to equivalents of intravenous (IV) morphine for normalization. Oxycodone was given postoperatively for breakthrough pain.

To determine the spread of the injectate, the suprainguinal fascia iliaca technique was performed on 2 embalmed cadavers with methylene blue. Dye was injected in the plane directly above the fascia iliaca in the first cadaver and immediately below the fascia iliaca in the second. Approximately 10 minutes after dye injection, the hip was dissected by W.M.B., and the spread of dye was determined.

Figure 2. Schematic image of the muscles and nerves of the pelvis. The magnified inset shows the tissue layers as seen by the ultrasound probe with the needle in the appropriate position for the block. I indicates iliacus muscle; other abbreviations are as in Figure 1.



Results

Patients in this case series ranged in age between 41 and 75 years with a body mass index range of 24.9 to 30.75 kg/m^2 (average, 28.69 kg/m^2). All 5 patients were successfully blocked by the suprainguinal fascia iliaca approach, which was demonstrated by a lack of sensation in the lateral femoral cutaneous nerve distribution from approximately the greater trochanter to the superolateral aspect of the knee. Additionally, all patients showed evidence of a lack of sensation in the anterior cutaneous femoral nerve distribution. The median pain score during the 12-hour duration of the block was 4 (range, 0–9) on a 11-point scale. Median opioid consumption rates were 6.67 (range, 0–8.33), 6.67 (3.33–20.30), 11.67 (3.33–27.80), 11.67 (3.75–25.83) and 34.17 (20.42–48.33) mg of IV morphine equivalents at 1, 4, 8, 12, and 24 hours, respectively (Table 1 and Figure 3).

The second cadaver, which was dissected after injection of methylene blue immediately below the fascia iliaca by the suprainguinal fascia iliaca technique, showed dye covering both the lateral femoral cutaneous nerve and the femoral nerve (Figure 4). Dye did not, however, reach the femoral nerve in the cadaver in which dye was injected in the plane between the fascia iliaca and the transverse abdominus fascia, staying above the fascia iliaca at the level of the femoral nerve. Femoral nerve coverage was also shown in patients, as the local anesthetic could be seen around the femoral nerve after the suprainguinal fascia iliaca block (Figure 1c). As the local anesthetic migrated to the femoral nerve, anterior femoral cutaneous nerves were anesthetized; however, quadriceps motor function remained grossly intact, as assessed in the postanesthesia care unit.

Discussion

Innervation of the hip is complex, receiving nerve fibers from the femoral, obturator, and sciatic nerves. Cutaneous analgesia for most hip incisions, however, is supplied by the lateral femoral cutaneous nerve. In our case series, the suprainguinal fascia iliaca approach to anesthetize the lateral femoral cutaneous nerve attenuated postoperative pain after total hip arthroplasty. The choice of technique for analgesia perioperatively will vary depending on practitioner preference, available equipment, and patient body habitus. In this case series, we demonstrated that the suprainguinal fascia iliaca technique is feasible in most patients, including overweight patients.

Other techniques have been described that differ from the suprainguinal fascia iliaca approach for various reasons. Swenson et al[12] described injection of a local anesthetic under the fascia iliaca at the level of the inguinal ligament, with subsequent distal compression to advance the local anesthetic in a retrocaudal direction, with magnetic resonance imaging confirmation of the distribution using dye. A sensory deficit in the distribution of the lateral femoral cutaneous nerve was shown in all patients, although the local anesthetic was up to 2.2 cm laterally from the anterior superior iliac spine in 40% of their patients. This technique, however, causes a substantial motor block, since the local anesthetic is injected near the femoral nerve.

Hebbard et al[13] described an infrainguinal approach for suprainguinal needle placement in cadavers and showed dye surrounding the lateral femoral cutaneous nerve in the pelvis by advancing the needle in a cephalad direction underneath the inguinal ligament. Despite the

Figure 3. Total cumulative opioid requirements in IV morphine equivalents as measured at 1, 4, 8, 12, and 24 hours for the 5 patients analyzed.

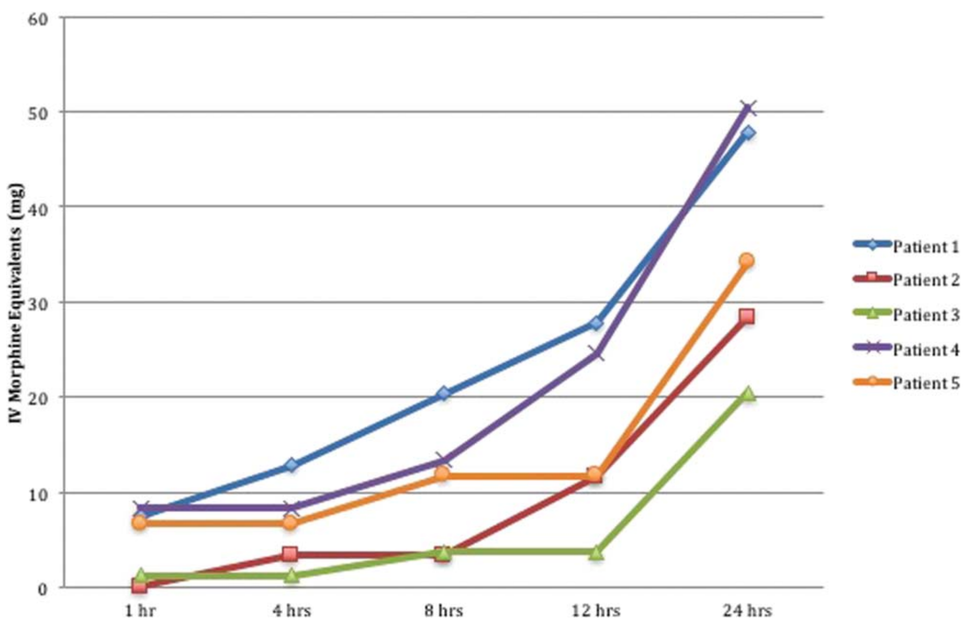


Table 1. Total Opioid Consumption and Numeric Pain Scores per Patient as Measured at 1, 4, 8, 12, and 24 Hours

Patient	Anesthesia Type	Opioids, mg IV Morphine Equivalent					Pain				
		1 h	4 h	8 h	12 h	24 h	1 h	4 h	8 h	12 h	24 h
1	Subarachnoid	7.50	12.80	20.30	27.80	47.80	4	9	8	5	5
2	General	0.00	3.33	3.33	11.66	28.33	2	2	0	6	5
3	Subarachnoid	1.25	1.25	3.75	3.75	20.42	2	NA	4	1	0
4	General	8.33	8.33	13.33	25.83	48.33	6	5	4	5	5
5	General	6.67	6.67	11.67	11.67	34.17	5	4	4	2	9
Median (range)		6.67 (0.00–8.33)	6.67 (3.33–20.30	11.67 (3.33–27.8)	11.67 (3.75–25.83)	34.17 (20.42–48.33)					

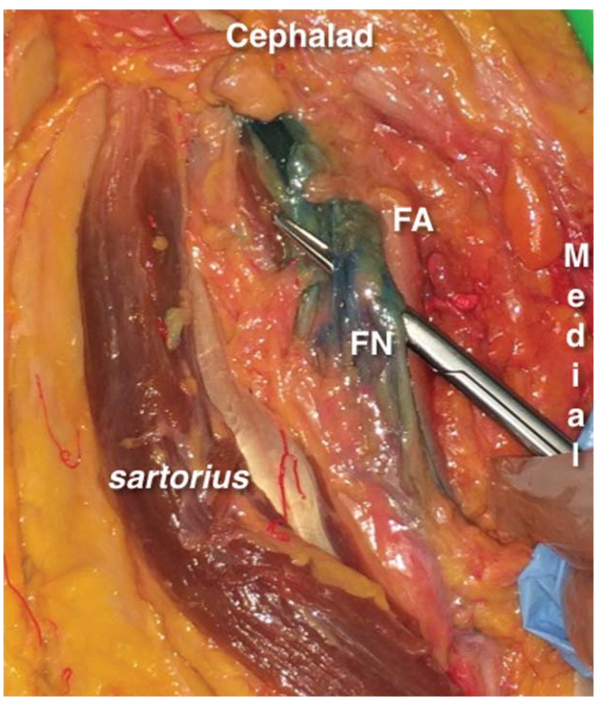
NA indicates not applicable.

potential advantages of the suprainguinal needle placement, the long needle entry path and difficulty imaging the correct fascial plane, particularly in obese patients, can make this approach challenging. As such, this approach has not been widely studied in the several years since its description.

In our case series of 5 patients, the suprainguinal fascia iliaca approach was 100% successful in blocking the lateral femoral cutaneous nerve. This finding is not surprising, given that Hebbard et al[13] showed that a suprainguinal needle position with parasagittal transducer orientation was effective in analgesia for hip surgery in more than 150 patients. The semitransverse position of the transducer in the suprainguinal fascia iliaca technique with an out-of-plane needle approach was simple to perform in this case series. We do acknowledge, however, given the distribution of patient body mass indices in our series, that morbid obesity or a large pannus may make any nerve blocks in this area more challenging.

Additionally, our data show that anterior femoral cutaneous nerves also received effective analgesia while the motor components of the femoral nerve were grossly spared. Maintaining motor function is essential, as more patients are required to participate in physical therapy earlier in their postoperative courses. The early initiation of postoperative physical therapy may lead to expedited discharge. Unfortunately, no quantitative measurement of motor strength was taken. As such, more investigation is needed to objectively quantify the motor-sparing aspect of the block versus that of other approaches.

Figure 4. Cadaver dissection showing the femoral nerve covered in dye after injection using the suprainguinal fascia iliaca technique. FA indicates femoral artery; and FN, femoral nerve.



As would be expected with a block using ropivacaine, postoperative opioid consumption was decreased for the duration of the block ($\approx$10–12 hours), with a subsequent increase after block resolution. Opioid consumption, which is a more objective measure of pain compared to subjective numeric pain scores, suggests that the block was functional. Pain scores, however, were likely unchanged because of the complex innervation of the hip joint. Although both pain scores and opioid use should be taken into account, a decrease in opioid consumption was seen during the duration of the block.

Cadaver dissection showed dye spreading to both the lateral femoral cutaneous nerve and the femoral nerve when injected immediately below the fascia iliaca by the suprainguinal fascia iliaca technique (Figure 4). This finding confirmed the real-time ultrasound-detectable spread of the local anesthetic seen in the patients (Figure 1c). When dye was injected above the fascia iliaca, spreading was not seen near the lateral femoral cutaneous nerve or the femoral nerve, highlighting the importance of subfascial injection of local anesthesia.

The purpose of this series was to report the suprainguinal fascia iliaca block technique and its efficacy in a small initial cohort of patients. However, many limitations exist. Case series, by design, are not blinded, adding an element of potential bias. Also, whereas an overall subjective measure of quadriceps motor function was made, no objective measures such as dynamometry were undertaken. Also, the time to first physical therapy and distance walked were not examined to determine the presence of a clinically important motor block.

The suprainguinal fascia iliaca technique may be beneficial to aid in postoperative recovery by improving analgesia and decreasing opioid consumption in patients presenting for total hip arthroplasty. To our knowledge, this work is the first reported case series using the newly described suprainguinal fascia iliaca approach as a successful adjunctive analgesic technique for total hip

arthroplasty. As there are limitations to case series, we are planning prospective studies to further examine the validity of this technique.

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