A Case Series of Deep Subgluteal Block: A New Block Targeting the Missed Portion of the Hip for Analgesia After Total Hip Replacement

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The study aimed to evaluate the effectiveness of deep subgluteal block (DSGB) for pain relief after posterolateral-approached total hip replacement. The cadaver study and observational case series assessed the spread and outcomes of ultrasound-guided DSGB. Results showed low postoperative pain scores, minimal opioid requirements, and no complications related to DSGB. Anatomical dissection revealed effective spread of the injected substance. These findings suggest that DSGB could be a promising regional analgesic technique for postoperative pain management after posterolateral-approached total hip replacement. (A&A Practice. 2024;18:e01848.)

Total hip replacement (THR) often results in postoperative pain, necessitating effective pain management for recovery. Regional anesthesia techniques are known to offer better pain control and reduce opioid use.[1] Current regional block techniques predominantly target the nerves supplying the anterior hip capsule, leaving a significant gap in addressing the posterior region of the hip. Recognizing the increasing importance of focusing on the posterior articular nerve supply to alleviate persistent hip pain after anterior regional anesthesia procedures, there is a growing need to reevaluate the impact of anterior versus posterior approaches in managing posttraumatic and postsurgical hip pain. This underscores the necessity for the development of advanced regional anesthesia techniques that specifically target the posterior articular nerve supply.[2] In response to this gap, a cutting-edge technique known as the deep subgluteal block (DSGB) has emerged as a promising method to deliver effective analgesia for the posterior hip region during total hip arthroplasty. This technique was evaluated in a cadaver study and applied to 10 patients undergoing posterolateral approach hip arthroplasty. The study protocol was granted ethical approval from the Ethics and Research Committee of our university (Turkiye), and written informed consent was obtained from 10 patients scheduled for hip replacement surgery.

CASE DESCRIPTION

The cadaver study was performed at the anatomy laboratory of our university utilizing a single fresh-frozen cadaver. The injection was administered after the cadaver had been allowed to equilibrate to room temperature for 4 hours. All procedures used an 80-mm 22-Gauge block needle (Braun 360°) and a low-frequency curvilinear ultrasound probe (B-Braun, Philips, Xperius). The cadaver was positioned laterally with the hip flexed 20° to 30° for ultrasound evaluation of the lateral hip region. The transducer was placed in a transverse plane parallel to the lateral midfemur to visualize the greater trochanter's anterior facet and the gluteus minimus muscle. The block needle was inserted in-plane until it reached the greater trochanter, and 15 mL of methylene blue was injected beneath the gluteus minimus muscle. The probe was then moved posteriorly to visualize the hyperechoic line of the lateral facet and identify the attachment of the gluteus medius muscle.[3] The needle was then advanced toward the greater trochanter, withdrawn slightly on contact with the bone, and another 15 mL of methylene blue was injected under the gluteus medius muscle (Figures 1, 2). The injection solution, consisting of 50 mg of methylene blue in 500 mL of isotonic solution, was used. An anatomical dissection was performed 20 minutes after the injection to evaluate the spread of the injectate.

The cadaver was positioned on its side, and an incision along the crista iliaca was made to lift the front-back skin flap. Another incision connecting the thigh's midpoint from the medial to the lateral epicondyle was made, and the skin on the thigh's side was raised to remove fat. Opening the thigh's fascia lata revealed the rectus femoris muscle. Methylene blue staining was observed on the posterior surface of the rectus femoris and sartorius muscles, and the tensor fascia lata muscle was dissected alongside the iliotibial tract. By inwardly turning the iliopsoas muscle, we accessed the front of the hip joint. A small part of the iliofemoral ligament's front section was stained blue, suggesting that the nerves innervating the anterior joint capsule were unaffected. The cadaver was rotated to expose the gluteus maximus, trochanter major, and other muscles, revealing blue staining on their back surfaces (Figure 3).

Patients received the DSGB in the lateral decubitus position before surgery, after the same procedure as the cadaver study, but using 0.25% bupivacaine instead of methylene blue. No additional nerve blocks were administered.

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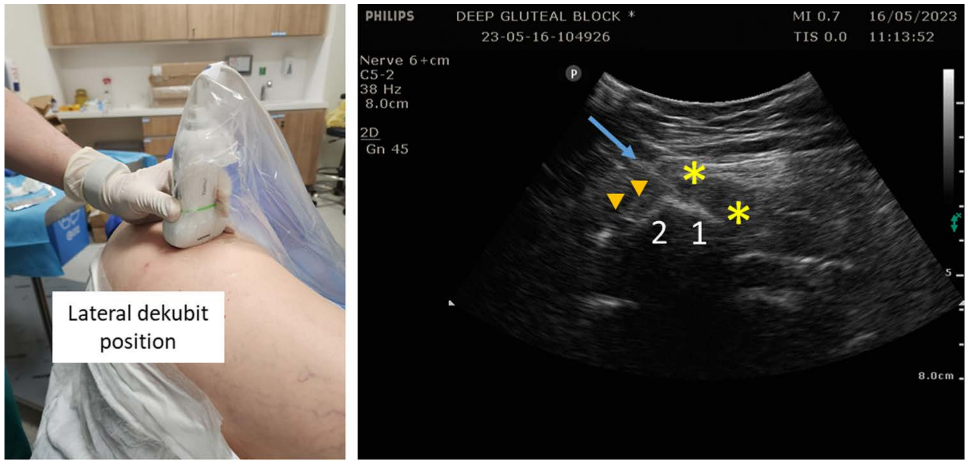

Figure 1. Ultrasound-guided deep subgluteal block. 1: trochanter major-anterior facet; 2: trochanter major-lateral facet; yellow star: m. gluteus minimus; yellow arrow head: m. gluteus medius; blue arrow: needle.

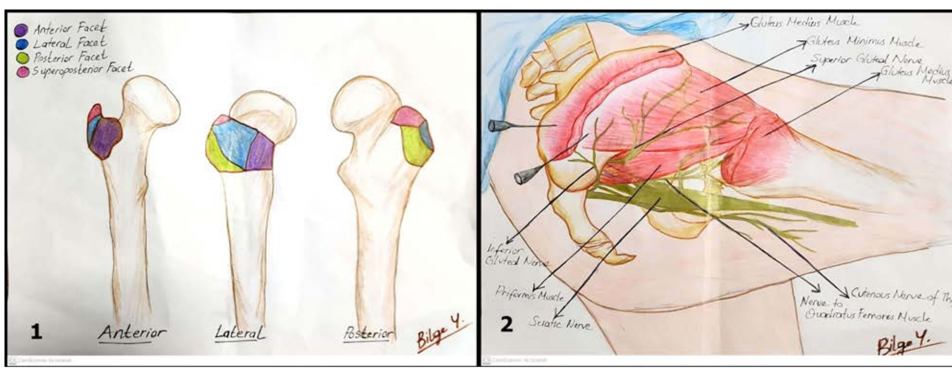

Figure 2. Anatomic illustration of the deep subgluteal block (the anatomic illustration hand-drawn by author Bilge Yilmaz.)

In 1 patient, the anesthetic was combined with a gadolinium-based magnetic resonance imaging (MRI) contrast agent for an MRI scan to examine the local anesthetic's hip distribution. The dermatomal spread, the intensity of postoperative pain, and the presence or absence of motor block were evaluated. Quadriceps strength (knee extension and hip adduction) was quantified using the Oxford Muscle Strength Rating. A multimodal pain management plan was used, including non-steroidal anti-inflammatory drugs (NSAIDs), paracetamol, and tramadol as rescue analgesia if the patient's pain exceeded a numeric rating scale (NRS) score of 4. Pain assessments were conducted at rest and during movement at various time points. The block's effectiveness was evaluated based on the need for rescue analgesia, opioid consumption, presence of motor block, and any associated complications.

The study included 10 patients (male-to-female ratio of 1:1, mean age of 67.2 years). The American Society of Anesthesiologists (ASA) physical status classification varied, with 5 patients as ASA physical status II, 3 as ASA physical status III, and 2 as ASA physical status I. Half received general or spinal anesthesia. Postoperatively, mean NRS scores were 1.1 at rest and 1.9 with movement (Table), with no need for additional opioids, motor block, or block-related complications. During an MRI scan of a patient, fluid signals corresponding to the needle trajectory were detected in the adipose tissue of the gluteal muscles on the fat-suppressed T2-weighted image, along with the presence of contrast agent on the T1-weighted image. Additionally, hyper-intense fluid signals related to the contrast agent were observed in the anterior and posterior compartments of the right hip joint (Figure 4). Dermatomal distribution of L4–L5 and S1 was also observed (Figure 5).

DISCUSSION

Understanding hip joint innervation is crucial for clinical practices, especially for surgical and anesthesia techniques. The nerve to quadratus femoris and obturator nerve are the main sources of innervation, but variations in patterns and distribution may occur. Additionally, sensory information to the hip joint is provided by articular branches from muscular branches of the lumbosacral plexus.[4] According to Hilton's law, the nerve supplying a muscle passing over a joint also provides innervation to the joint's internal aspects.[5] The anterosuperior capsule is innervated by the femoral, obturator, and accessory obturator nerves, while the posterior capsule is supplied by the sciatic nerve, superior gluteal nerve, inferior gluteal nerve, and the nerve to the quadratus femoris muscle.[4,6]

The rich innervation of the anterior hip capsule is an important target for interventional pain management, but the pericapsular nerve group (PENG) block or iliopsoas

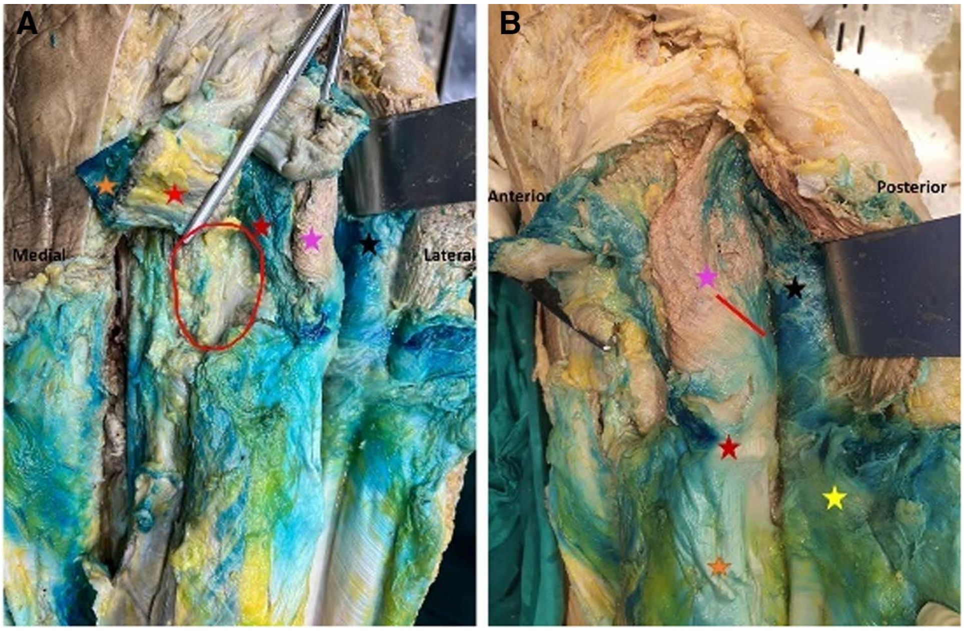

Figure 3. Methylene blue dye distribution following deep subgluteal block in cadaveric specimens. A, Supine Position: Anatomical spread of the dye with key muscle landmarks identified by colored stars. Orange star: M. Sartorius; red star: M. rectus femoris; burgundy star: M. gluteus minimus; pink star: M. gluteus medius; black star: M. gluteus maximus; yellow star: iliotibial tract; red circle: joint. B, Lateral Position: Dye distribution with emphasis on the posterior aspect of the joint and surrounding muscles.Orange star: M. vastus lateralis; burgundy star: trochanter major; pink star: M. gluteus medius; black star: M. gluteus maximus; yellow star: iliotibial tract; red arrow: posterior aspect of the joint.

Table. Patient Characteristics, Type of Anesthesia, and Pain Assessment Data

Patient	Age	Sex	ASA	Type of anesthesia	NRS score (rest) 0–2–4–6–12–24 h (mean)	NRS score (movement) 4–6–12–24 h (mean)	Opioid consumption
1	68	F	II	General	2–1–1–1–1–1 (1.2)	1–2–2–3 (2)	-
2	72	F	II	General	0–0–1–1–2–2 (1)	1–1–2–2 (1.5)	-
3	73	M	III	General	0–0–1–1–1–2 (0.8)	2–2–2–2 (2)	-
4	61	F	I	General	1–1–0–1–2–2 (1.2)	1–2–2–2 (1.8)	-
5	68	F	II	General	1–1–1–1–1–2 (1.2)	1–1–1–2 (1.3)	-
6	78	M	III	Spinal	0–1–2–2–2–2 (1.5)	1–2–2–2 (1.8)	-
7	63	M	I	Spinal	0–1–1–2–2–2 (1.2)	1–2–2–3 (2)	-
8	70	M	II	Spinal	0–0–1–2–2–2 (1.2)	2–2–3–3 (2.5)	-
9	52	F	III	Spinal	0–0–1–2–2–2 (1.2)	2–2–3–3 (2.5)	-
10	67	M	II	Spinal	0–1–1–1–1–1 (0.8)	1–2–2–2 (1.8)	-
Mean	67.2				1.1	1.9	-

Abbreviations: ASA, American Society of Anesthesiologists; NRS, numeric rating scale.

plane block may not effectively address posterior hip pain. Instead, a posterior ultrasound-guided infiltration could be advantageous for blocking the posterior articular branches.[7] Ultrasound-guided techniques, such as blocking the superior gluteal nerve, have proven effective for providing analgesia and anesthesia for orthopedic procedures, particularly for patients with risk factors for neuraxial techniques and deep peripheral nerve blocks.[8] Additionally, ultrasound-guided gluteal facial plane block has been used to treat chronic refractory greater trochanteric pain syndrome by blocking the superior gluteal nerve. The authors' findings were correlated with an anatomical study, which noted adequate staining of the superior gluteal nerve in cadavers but found no spread to the piriformis muscle belly, sciatic nerve, or inferior gluteal nerve. This highlights the need to consider other nerves for comprehensive coverage of the posterior hip capsule.[9] These studies emphasize the complexity of hip joint innervation and the importance of considering diverse anatomical factors in developing effective pain management interventions.

In their study, Vermeylen et al described an ultrasound-guided technique called deep gluteal compartment block, aimed at addressing posterior hip pain by targeting the nerves supplying the posterior hip capsule. This block was evaluated in cadavers and applied to 2 patients, resulting in substantial pain reduction. The injection site was close to the posterior acetabular rim, near the attachment of the ischiofemoral ligament, and a total of 20 mL of local anesthetic solution was injected under the piriformis muscle. The study presented the spread of the injected dye to specific anatomical structures, including the deep fascia and muscles of the gluteal region, the posterior capsule, the periacetabular rim of the hip joint, and the course of the sciatic nerve under the piriformis muscle and greater sciatic foramen. These findings particularly affected the posterior hip

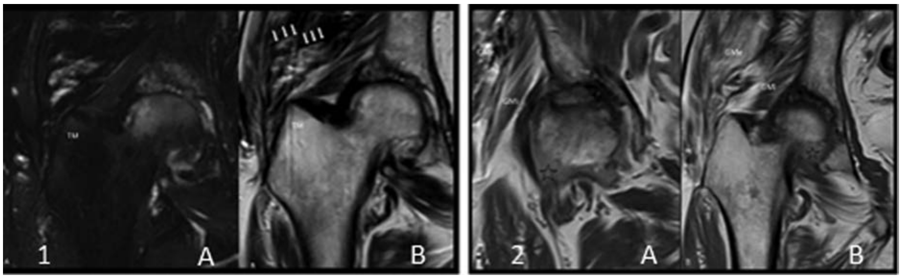

Figure 4. Imaging of contrast material distribution in the right hip joint. 1: Fat-suppressed T_2-weighted image of the right hip reveals fluid signals corresponding to the needle passage trajectory between the gluteal muscles (A). T_1-weighted image shows a high signal (arrows) associated with the contrast material 2: Coronal T_1-weighted image displays hyperintense fluid signals (stars) linked to the contrast material in the anterior (A) and posterior (B) compartments of the right hip joint. Gme indicates gluteus medius; Gmi, gluteus minimus; TM, trochanter major.

Figure 5. Dermatomal distribution of L4–L5 and S1.

structures and associated nerves.[2] In our study, the injection site targeted the attachment site of the gluteus medius and minimus to the trochanter major in 10 patients undergoing a posterolateral approach for THR. Staining was observed on the anterior and posterior surfaces of various muscles indicating a possible influence on the nerves innervating these areas.

Our cadaver study found no staining in the iliofemoral ligament's anterior portion, suggesting that the nerves responsible for innervating the anterior joint capsule may have remained unaffected. However, complete staining of the hip joint's posterior surface indicates a possible influence on the nerves innervating this area. Furthermore, MRI results showed local anesthetic spread in both anterior and posterior capsules, differing from the cadaver findings, possibly due to tissue property variations. The dermatomal distribution supports the spread to the anterior hip capsule, suggesting a more complex innervation pattern than previously thought. These findings underscore the importance of considering anatomical and physiological variations from cadaveric studies in clinical practice, especially in pain management interventions. Both studies provided valuable insights into the spread of injected dye and its implications for nerve innervation and associated structures in the hip joint. While the first study primarily focused on the posterior structures and nerves, our study included findings related to both anterior and posterior aspects of the hip joint anatomy.[2] Further research and clinical validation are needed to understand the implications of targeted pain management strategies in the hip joint.

In conclusion, our initial findings show that DSGB, a newly identified posterior PENG block, shows promise as an analgesic option for patients undergoing posterolateral-approached THR. Further comprehensive studies, including randomized controlled trials, are necessary to validate its utility as a regional analgesic technique for various approaches to THR and other hip surgeries.

DISCLOSURES

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