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Overview of Postoperative Analgesia in Patients Undergoing Total Hip Arthroplasty Using Ultrasound Pericapsular Nerve Group Block

Lotfy Adel Lotfty Hassan*, Maha Ibrahim El desouky, Akmal Abdel Samad Abdou, Mohamed Ali Abd El Aziz

Anesthesia, Intensive Care and Pain Management Department, Faculty of Medicine, Zagazig University, Egypt.

Abstract

Osteoarthritis (OA) represents a major burden as it exerts an extreme effect on patients' quality of life. The majority of total hip arthroplasty (THA) patients experience postoperative pain, with varying degrees of severity ranging from mild to severe pain**.** Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage. Assessment of postoperative pain is crucial in patients undergoing to ensure adequate pain management. The severity of postoperative pain after THA can vary depending on several factors, including patient-related and surgical factors. The perioperative pain management techniques employed, including the use of local anesthetics, opioids, and regional nerve blocks, can influence the occurrence and intensity of postoperative pain. There is a wide range of regional anesthetic techniques. The most used techniques in this anatomical area are lumbar plexus block, femoral nerve block, and fascia iliaca block. Other techniques, such as selective obturator nerve infiltration and lateral femoral cutaneous nerve blocks, represent alternatives. Various methods can be utilized to assess pain in postoperative patients. Therefore, this study aimed to review the assessment and management of postoperative analgesia in patients undergoing THA.

Keywords: Postoperative Analgesia, Total Hip Arthroplasty, Management.

Full length article **Corresponding Author*, e-mail*:* lotfyadel444@gmail.com

1. Introduction

The International Association for the Study of Pain defines pain as an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage [1]. Appropriate management of acute perioperative pain using multimodal or balanced analgesia is crucial. The American Society of Anesthesiologists developed treatment guidelines for acute postoperative pain, which have been updated and amended as of 2012 [2]. The inadequate relief of postoperative pain has adverse physiologic effects that can contribute to significant morbidity and mortality, resulting in the delay of patient recovery and return to daily activities [3].

In addition, poor postoperative pain control contributes to patient dissatisfaction with the surgical experience and may have adverse psychological consequences [4]. Acute pain has been defined as the normal, predicted, physiological response to an adverse chemical, thermal, or mechanical stimulus [5]. Generally, acute pain resolves within 1 month. However, poorly managed acute pain that might occur following surgery can produce pathophysiologic processes in both the peripheral and central nervous systems that have the potential to produce chronicity [2]. Surgical procedures that can be associated with chronic painful conditions include amputation of a limb, lateral thoracotomy, inguinal herniorrhaphy, abdominal hysterectomy, saphenous vein stripping, open cholecystectomy, nephrectomy, and mastectomy [5]. Pain can be categorized according to several variables, including its duration (acute, convalescent, chronic), its pathophysiologic mechanisms (physiologic, nociceptive, neuropathic), and its clinical context (e.g., postsurgical, malignancy related, neuropathic, degenerative). Acute pain follows traumatic tissue injuries, is generally limited in duration, and is associated with temporal reductions in intensity. Chronic pain may be defined as discomfort persisting 3–6 months beyond the expected period of healing. In some chronic pain conditions, symptomatology, underlying disease states, and other factors may be of greater clinical importance than definitions based on duration of discomfort [1,3].

Several patient-related factors can influence the incidence and severity of postoperative pain in THA. These factors may include age, sex, body mass index (BMI), preoperative pain levels, and comorbidities such as diabetes or osteoarthritis [6]. Older age and higher BMI have been associated with increased postoperative pain after THA [7]. Female patients may also experience higher levels of postoperative pain compared to male patients [8]. Preoperative pain levels, particularly moderate to severe pain, have also been correlated with higher postoperative pain scores [9]. Surgical factors, such as the surgical approach, implant type, and perioperative pain management techniques, can also impact the incidence and severity of postoperative pain in THA. For instance, the surgical approach used in THA, such as the posterior or lateral approach, may affect the occurrence of postoperative pain [10]. Implant-related factors, such as the type of prosthesis used and the fixation method, can also impact postoperative pain [11].

2. Assessment of pain

Several methods can be utilized to assess pain in postoperative patients. The most commonly used forms are:

2.1. The category rating scale

It also termed Verbal Rating Scale (VRS). A VRS consists of a series of adjectives reflecting degrees of pain severity, arranged from "no pain" to "severe pain" or whatever word or phrase is used to designate the most extreme pain (Figure 1). A pain severity VRS may have 4 or more gradations Patients circle or put a checkmark next to the adjective that best describes how severe their pain is [12].

2.2. The visual analogue scale (VAS)

A VAS is a horizontal or vertical line, most often 10 cm long, and marked at the extremes with "no pain" and "worst pain imaginable" or similar phrases (Figure 2). The patient is asked to place a mark on the line that represents his/her pain level. A ruler is used to translate the information to a score ranging from 1 to 100 [13]. The VAS has been shown to be more sensitive to change and is therefore more widely used. These scales may also be incorporated into pain diaries [12].

2.3. Numerical Rating Scale (NRS)

The Numerical Rating Scale (NRS) is a subjective measure in which individuals rate their pain on an eleven-point numerical scale. The scale is composed of 0 (no pain at all) to 10 (worst imaginable pain) (Figure 3) [14].

3. Acute and chronic effects of postoperative pain

Postoperative pain is a common consequence of total hip arthroplasty (THA) and can have both acute and chronic effects on patients. Acute pain refers to the immediate pain experienced after surgery, while chronic pain persists beyond the expected healing time of the surgical incision. Acute postoperative pain can have several adverse effects on patients, including increased stress response, delayed recovery, decreased mobility, impaired wound healing, and prolonged hospital stay [15]. Uncontrolled acute pain can also lead to negative emotional outcomes, such as anxiety, depression, and decreased overall satisfaction with the surgical experience [16]. In addition to the acute effects, postoperative pain can also have long-term or chronic effects. Persistent postoperative pain, defined as pain that persists beyond 3-6 months after surgery, can occur in a significant proportion of patients undergoing THA, with reported rates ranging from 5% to 50% [17]. Chronic pain after THA can significantly impact patients' quality of life, physical function, and psychological well-being. It can result in long-term disability, reduced mobility, and limitations in activities of daily living [18]. Furthermore, chronic pain after THA is associated with increased healthcare utilization, including increased outpatient visits, emergency room visits, and use of healthcare resources, which can further impact healthcare costs and burden the healthcare system [19]. Chronic pain can also have a significant psychological impact, leading to increased levels of anxiety, depression, and decreased quality of life [20].

4. Management of postoperative pain

Many options are available for the treatment of postoperative pain, including systemic (i.e., opioid and non-opioid) analgesics and regional (neuraxial and peripheral) analgesic techniques. The clinician can optimize the postoperative analgesic regimen for each patient [21].

4.1. Systemic analgesic techniques

4.1.1. Opioids

Opioid analgesics are one of the cornerstone options for the treatment of postoperative pain. They generally exert their analgesic effects through μ-receptors in the CNS, although opioids may also act at peripheral opioid receptors. Realistically, the analgesic efficacy of opioids is typically limited by the development of tolerance or opioid-related side effects such as nausea, vomiting, sedation, or respiratory depression. Opioids may be administered by the subcutaneous, transcutaneous, transmucosal, or intramuscular route, but the most common routes of postoperative systemic opioid analgesic administration are oral and intravenous. Opioids may also be administered at specific anatomic sites such as the intrathecal or epidural space [22].

4.1.2. Nonsteroidal Anti-inflammatory Agents (NSAIDs)

The primary mechanism by which NSAIDs exert their analgesic effect is through inhibition of cyclooxygenase (COX) and synthesis of prostaglandins, which are important mediators of peripheral sensitization and hyperalgesia. NSAIDs given alone generally provide effective analgesia for mild to moderate pain. NSAIDs are also traditionally considered a useful adjunct to opioids for the treatment of moderate to severe pain. NSAIDs may be administered orally or parenterally and are particularly useful as components of a multimodal analgesic regimen by producing analgesia through a different mechanism than that of opioids or local anesthetics. Several meta-analyses have examined the analgesic efficacy of NSAIDs (including COX-2 inhibitors) and acetaminophen when added to intravenous PCA with opioids. Surprisingly, NSAIDs, not acetaminophen, resulted in a statistically significant (but probably not clinically meaningful) reduction in pain scores.

Although all regimens significantly decreased morphine consumption, only NSAIDs reduced the risk for the opioid-related side effects of nausea, vomiting, and sedation [23-24]. Perioperative use of NSAIDs may be associated with several side effects, including decreased hemostasis, renal dysfunction, and gastrointestinal hemorrhage. Inhibition of COX and the formation of prostaglandins cause many of the side effects, which mediate many diverse processes throughout the body. Decreased hemostasis from NSAID use is from platelet dysfunction and inhibition of thromboxane A2 (generated by COX-1), an important mediator of platelet aggregation and vasoconstriction [25].

4.2. Regional analgesic techniques

A variety of neuraxial and peripheral regional analgesic techniques may be used for the effective treatment of postoperative pain. In general, the analgesia provided by epidural and peripheral techniques (particularly when local anesthetics are used) is superior to that with systemic opioids, and use of these techniques may even reduce morbidity and mortality [26].

4.2.1. Femoral nerve block (FNB) technique

Femoral Nerve Block (FNB) is a regional anesthesia technique commonly used for postoperative pain management in hip joint surgeries. It involves the targeted administration of local anesthetic near the femoral nerve to provide analgesia to the anterior thigh and knee, which are innervated by the nerve [27]. The FNB technique can be performed using various approaches, including the landmark-based technique and the ultrasound-guided technique. In the landmark-based technique, the femoral nerve is located using anatomical landmarks, such as the femoral artery and the inguinal ligament. The local anesthetic is then injected near the nerve to achieve nerve blockade [28]. Ultrasound guidance has become increasingly popular for performing FNB due to its ability to provide real-time visualization of the femoral nerve and surrounding structures (Figure 4). This technique allows for precise needle placement and reduces the risk of complications [29]. FNB provides effective analgesia by blocking the sensory fibers of the femoral nerve, thereby reducing pain sensation from the anterior thigh and knee. It can be used as a standalone technique or as part of a multimodal analgesic regimen to improve pain control and reduce the need for systemic opioids [30]. Several studies have demonstrated the efficacy of FNB in improving postoperative pain management and patient satisfaction following hip joint surgeries. Furthermore, FNB has been shown to have a favorable safety profile, with a low incidence of major complications. Commonly reported adverse events include transient quadriceps weakness, numbness, hematoma formation, and infection, but these are generally self-limiting and resolve spontaneously [29-31].

4.2.2. Lumbar Plexus Block (LPB)

Lumbar Plexus Block (LPB) is a regional anesthesia technique that targets the lumbar plexus, a network of nerves originating from the ventral rami of the lumbar spinal nerves**.** LPB provides analgesia to the lower abdomen, anterior thigh, and medial leg by blocking the sensory and motor innervation of the lumbar plexus [32]. LPB can be performed using various approaches, including the landmark-based technique and the ultrasound-guided technique. In the landmark-based technique, the block is administered based on anatomical landmarks, such as the iliac crest, inguinal ligament, and transverse processes of the lumbar vertebrae**.** The local anesthetic is injected around the nerves of the lumbar plexus to achieve nerve blockade [33]. Ultrasound guidance has become increasingly popular for performing LPB due to its ability to provide real-time visualization of the nerves and surrounding structures (Figure 5). This technique allows for precise needle placement and reduces the risk of complications [33-34]. LPB provides effective analgesia for various surgical procedures involving the lower abdomen, hip, and thigh. It can be used as a primary anesthetic technique or as part of a multimodal analgesic regimen. LPB is particularly beneficial for patients undergoing hip surgeries, as it can provide excellent pain control and reduce the need for systemic opioids [32]. LPB can be associated with potential complications, including vascular puncture, intravascular injection, nerve injury, infection, and local anesthetic systemic toxicity. However, with proper technique, meticulous needle placement, and adequate patient monitoring, the risk of complications can be minimized [34].

4.2.3. Fascia iliaca block technique

Two approaches for ultrasound guided fascia iliaca block.

4.2.3.1. Infrainguinal approach

In the supine position, a linear high frequency probe (8-13 MHz) is placed along the inguinal crease to identify the femoral artery, femoral nerve and iliacus fascia. The needle is advanced using an in-plane technique from lateral to medial side and local anesthetic is deposited under the fascia iliaca (Figure 6). Twenty milliliters of 0.25% bupivacaine is administered under US guidance following careful intermittent aspiration [35].

4.2.3.2. Suprainguinal approach

In the supine position, the high-frequency linear transducer is placed in the sagittal plane to identify the anterior superior iliac spine, and the transducer is moved medially to identify the fascia iliaca, iliopsoas, sartorius, and internal oblique muscles. Using an in-plane approach, 21-G block needle tip is positioned deep in the fascia iliaca and above the iliacus muscle (Figure 7). After negative aspiration, 30 mL of 0.25% bupivacaine is injected incrementally under the fascial plane, aspirating every 5 mL [36]. Although, FICB resulted in reduced opioid consumption and pain scores following THA [37]. Failure of blockage of obturator nerve and accessory obturator nerve gives moderate pain control postoperatively. As well decreasing of the strength of quadriceps muscle which hinders early ambulation [38].

4.2.4. Transmuscular quadratus lumborum block technique

The Transmuscular Quadratus Lumborum (TQL) block is a regional anesthesia technique that targets the nerves in the quadratus lumborum muscle plane. It provides effective analgesia for various abdominal and lower extremity surgeries by blocking the sensory innervation of the anterior abdominal wall, flank, and thigh [37].

The TQL block can be performed using different approaches, including the posterior approach and the lateral approach. In the posterior approach, the local anesthetic is injected deep to the quadratus lumborum muscle, between the quadratus lumborum and the psoas major muscle. This results in blockade of the ventral rami of the lumbar spinal nerves and their branches [38]. The lateral approach involves injecting the local anesthetic between the quadratus lumborum and the transversus abdominis muscles. This allows for spread of the local anesthetic along the thoracolumbar fascia and provides analgesia to the paravertebral, lumbar plexus, and sympathetic chain [39]. The TQL block can be performed under ultrasound guidance to improve accuracy and reduce complications. Furthermore, the TQL block has been utilized in hip surgeries to improve postoperative pain management. TQL block combined with general anesthesia provided superior pain control and reduced opioid consumption compared to general anesthesia alone in patients undergoing total hip arthroplasty [40]. Potential complications of the TQL block include inadvertent vascular puncture, local anesthetic systemic toxicity, and injury to nearby structures. However, with proper technique, meticulous needle placement, and appropriate patient monitoring, the risk of complications can be minimized [41].

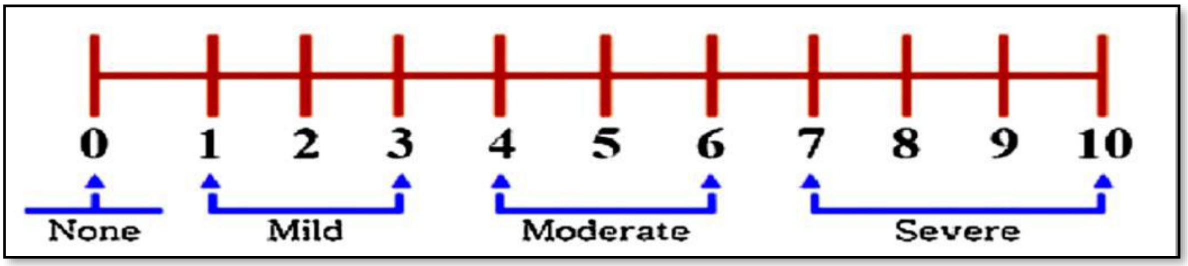

Figure 1: The category rating scale [12].

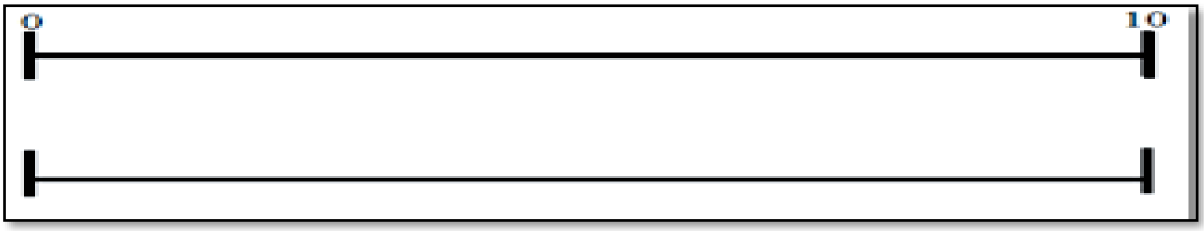

Figure 2: Visual analogue scale (VAS) [12].

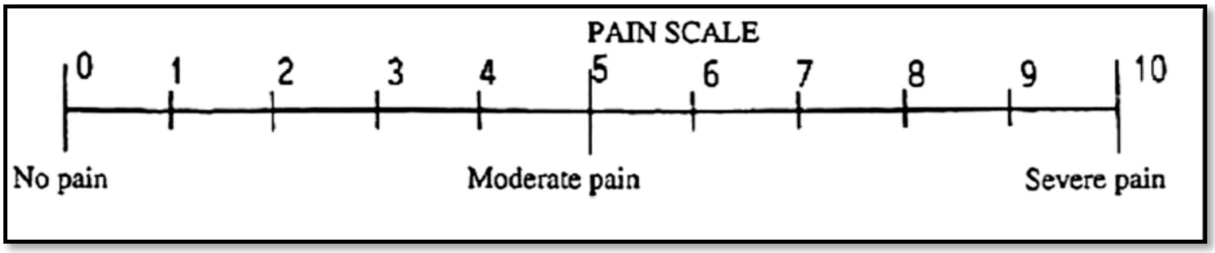

Figure 3: The numeric rating scale (NRS) [12].

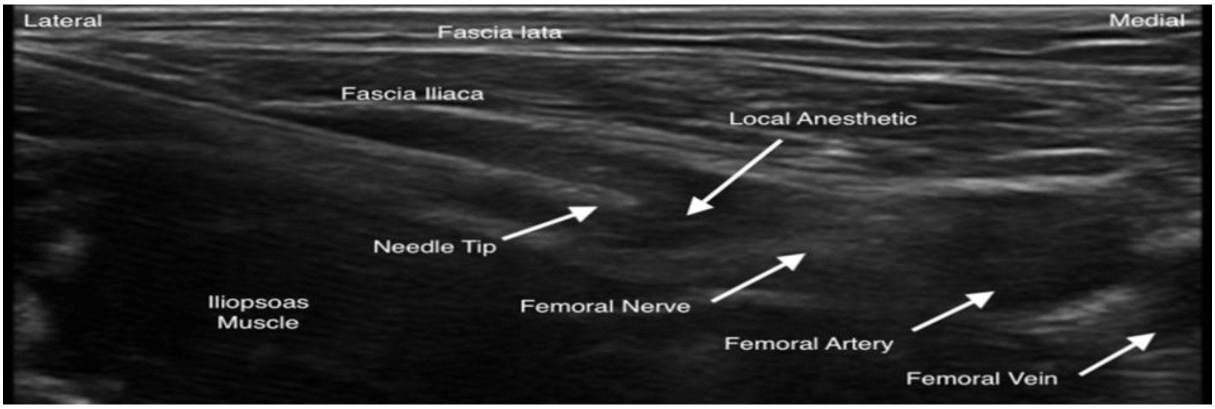

Figure 4: Femoral nerve block [30].

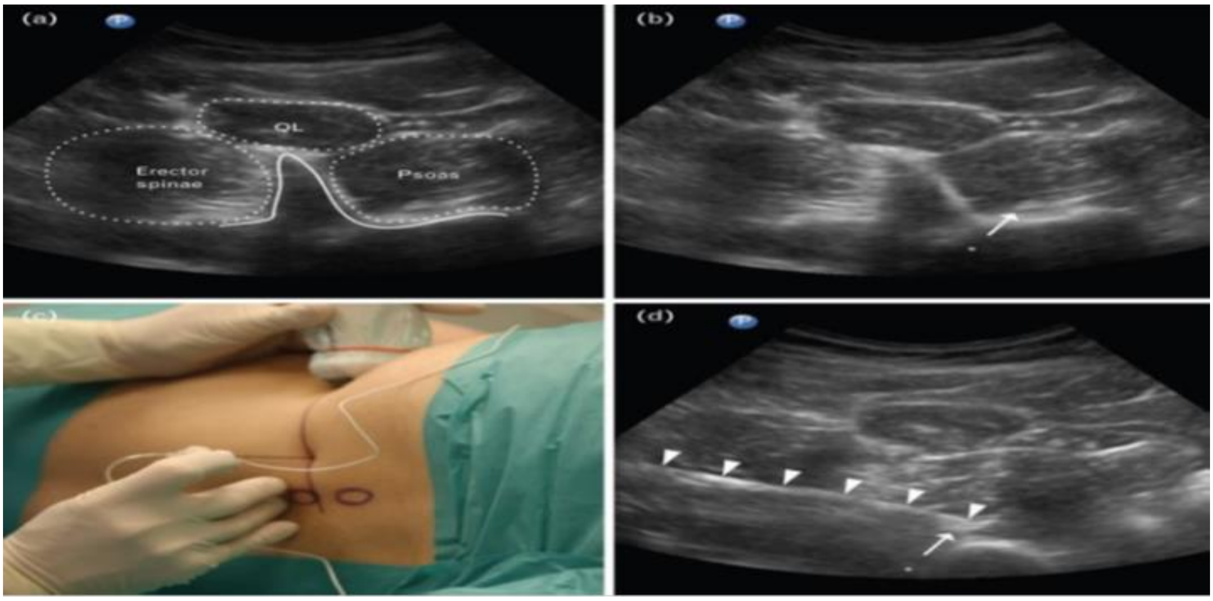

Figure 5: Lumbar plexus block techniques [33].

Figure 6: Infra inguinal fascia iliaca block [35].

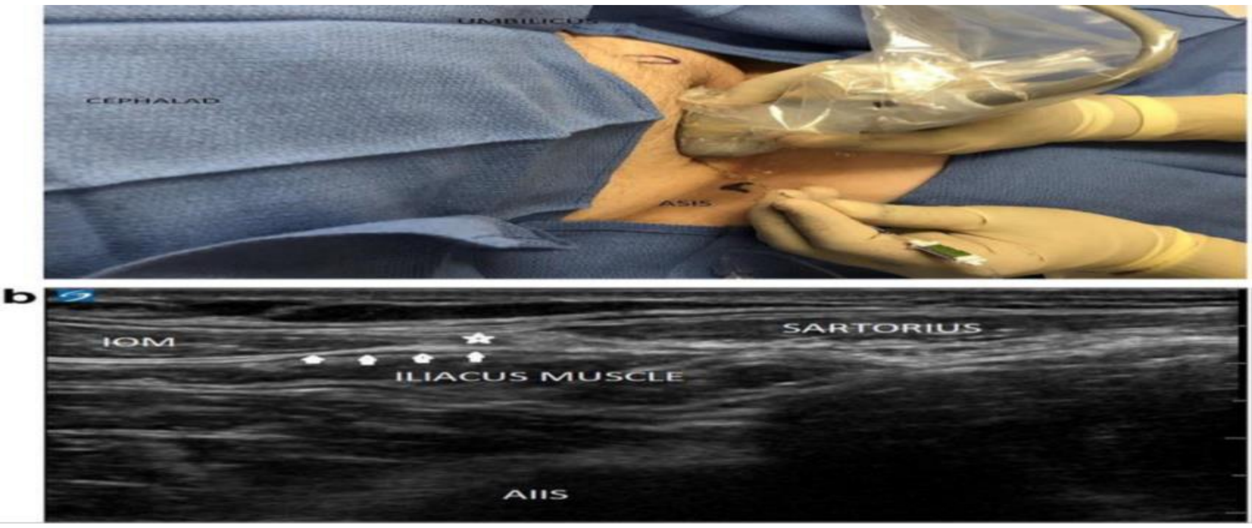

Figure 7: Supra inguinal fascia iliaca block [36].

5. Conclusions

THA is one of the most commonly performed surgical procedures that accompanied by excessive pain, especially during the first days following the surgery. Multimodal analgesia seems to play a major role in the perioperative care of patients undergoing THA. Femoral Nerve Block (FNB) is an effective technique for providing postoperative analgesia in hip joint surgeries. FNB offers improved pain control, reduced opioid consumption, and enhanced early mobilization. Lumbar Plexus Block (LPB) is an effective technique for providing regional anesthesia. It offers improved pain control, reduced opioid consumption, and enhanced patient satisfaction. Although LPB carries potential risks, with appropriate training and adherence to safety guidelines, it is considered a safe and valuable technique in the management of postoperative pain. Transmuscular Quadratus Lumborum (TQL) block offers several advantages, including ease of performance, reliable analgesia, and potential sparing of motor function. It can improve postoperative pain management in hip surgeries. Nevertheless, more research including orthopaedic surgeons, anaesthetists, and rehabilitation specialists is required to fully assess the method's advantages.

Conflict of interest

The authors declare no conflict of interest.

Author contribution

Authors contributed equally in the study.

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