# POST- OPERATIVE ANALGESIA AND OPIOID- SPARING EFFICACY OF ULTRASOUND- GUIDED PERICAPSULAR NERVE GROUP (PENG) BLOCK VERSUS QUADRATUS LUMBORUM BLOCK (QLB) IN PROXIMAL FEMUR FRACTURE PATIENTS: A COMPARATIVE STUDY

by

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Dissertation Submitted to

B.L.D.E(DEEMED TO BE) UNIVERSITY,

VIJAYAPURA, KARNATAKA

In partial fulfilment of the requirements for the degree of

**DOCTOR OF MEDICINE**

**IN**

**ANAESTHESIOLOGY**

Under the guidance of

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I declare that this dissertation entitled **"**POST- OPERATIVE ANALGESIA AND OPIOID- SPARING EFFICACY OF ULTRASOUND- GUIDED PERICAPSULAR NERVE GROUP (PENG) BLOCK VERSUS QUADRATUS LUMBORUM BLOCK (QLB) IN PROXIMAL FEMUR FRACTURE PATIENTS: A COMPARATIVE STUDY**",** is a bonafide and genuine research work carried out by me under the guidance of DR. K NIRMALA DEVI, Associate professor, Department of Anaesthesiology, Shri B. M. Patil Medical College, Hospital and Research Centre, Vijayapura.

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# ABBREVIATIONS

NHFD's - National Hip Fracture Database

FNB- Femoral nerve block

FICB - fascia iliaca compartment block

PENG- Pericapsular nerve group

QL – Qadratus lumborum

QLB - Quadratus Lumborum Block

TAP - Transversus Abdominis Plane

THA - Total hip arthroplasty

VAS - Visual Analog Scale

PACU – Post anaesthesia care unit

N.R.S - Numeric rating scale

ASIS - Anterior superior iliac spine

AIIS - Anterior inferior iliac spine

PT- Pubic tubercle

IA – Intra articular

IPE - Iliopubic eminence

LIFT - Lumbar inter fascial triangle

EO - External oblique

IO - Internal oblique

TA - Transversus abdominis

ES= erector spinae muscle

PM= psoas muscle

IASP - International Association for the Study of Pain

GRs- glucocorticoid receptors

GREs- glucocorticoid response elements

COX-2- cyclooxygenase-2

iNOS- inducible nitric oxide synthase

IL- interleukin

TNF-α- tumor necrosis factor α

ARDS - acute respiratory distress syndrome

CBG- Corticosteroid-Binding Globulin

Vd - Volume of Distribution

CNS- central nervous system

RDS- respiratory distress syndrome

IVH- intraventricular haemorrhage

CINV- chemotherapy-induced nausea and vomiting

LA- local anaesthetics

IV- Intravenous

IM – Intramuscular

PONV – Post operative nausea and vomiting

ACLS- advanced cardiac life support

S.D- standard deviation

## ABSTRACT

BACKGROUND AND AIMS:

Hip arthroplasty is frequently associated with significant postoperative pain, which can delay mobilization and recovery. Effective pain management is essential for early rehabilitation, improved functional outcomes, and reduced complications in proximal femur fracture surgeries. Regional anaesthesia techniques, such as the Pericapsular Nerve Group (PENG) block and Quadratus Lumborum Block (QLB), have gained prominence for their ability to provide targeted analgesia while minimizing opioid use. The PENG block selectively targets articular branches of the lumbar plexus, preserving quadriceps strength and enabling early mobilization, whereas the QLB offers broader analgesia with variable motor involvement. Despite their growing use, comparative data on these techniques in hip arthroplasty are limited. This study aimed to evaluate and compare the analgesic efficacy, opioid-sparing effects, quadriceps strength preservation, and safety of the PENG and QLB techniques to optimize postoperative pain management strategies.

METHODOLOGY:

- Written informed consent obtained.
- Nil by mouth status confirmed.
- IV access was secured 20 Gauge cannula.
- Patients underwent thorough pre anaesthetic evaluation with detailed history, airway examination, systemic examination. Patient was explained about the study procedure and sensitized about Visual analogue scale. Routine blood investigations were done.
- PENG block was given in group P with 20 ml of 0.25% bupivacaine and

dexamethasone, QL block with 20 ml of 0.25% bupivacaine and dexamethasone in group Q and no block given in group C followed by spinal anaesthesia was given using 2 mL of 0.5% Bupivacaine combined with 25 mcg Fentanyl.

RESULTS: -

- The demographic parameters, including age and gender, were comparable across all groups, showing no significant differences.
- Pain scores (VAS) were significantly lower in the PENG group compared to the QLB and control groups, particularly during the early postoperative period.
- The time to first rescue analgesia was significantly longer in the PENG group, and opioid consumption was lower in both block groups compared to the control group, with the PENG group showing the greatest opioid-sparing effect.
- Quadriceps strength was better preserved in the PENG group, while the QLB group showed moderate preservation, and the control group had the least preservation.

CONCLUSION: -

In conclusion, the PENG block demonstrated superior efficacy in postoperative pain relief, opioid-sparing effects, and preservation of quadriceps strength compared to the QLB and control groups, facilitating early mobilization and faster recovery. The QLB provided effective pain relief and moderate preservation of quadriceps strength, though less consistent than the PENG block. Both regional techniques were safe, with no significant adverse events observed, emphasizing their utility in optimizing pain management for proximal femur fracture surgeries.

Keywords: - PENG block, QL block, bupivacaine, post-operative pain.

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# INTRODUCTION

Hip fractures are a significant global health concern, particularly in the elderly population. Around 70% of patients with hip fractures are aged 80 years or older. These patients often have frail preoperative status and multiple comorbidities, complicating their care. Approximately 1.5 million hip fractures occur worldwide each year. Due to the increasing and ageing global population, this number is projected to rise dramatically to 7–21 million annually by 2050.[1,2] Hip fractures lead to prolonged hospital stays, rehabilitation costs, and loss of independence in patients, resulting in substantial healthcare expenditure. The U.K.'s National Hip Fracture Database (NHFD's) performance indicators emphasize timely, patient-centered, and multidisciplinary care. Focusing on early mobilization and prompt surgery improves functional recovery, reduces complications, and supports long-term quality of life in this high-risk population. By adhering to these benchmarks, healthcare systems can ensure better outcomes and more efficient resource utilization. [3] Anaesthesiologists play a crucial role in managing perioperative pain for patients with hip fractures. Adequate pain control not only improves patient comfort but also reduces complications and facilitates early postoperative mobilization. Regional analgesia techniques such as the femoral nerve block (FNB), fascia iliaca compartment block (FICB), and epidural analgesia are indispensable tools for anesthesiologists managing hip fracture patients. These techniques not only enhance perioperative pain relief but also contribute to better functional outcomes and reduced postoperative complications, underscoring their value in the multidisciplinary care of this vulnerable population.[4]

Infrainguinal blocks like FNB and FICB are effective for pain relief, their associated motor weakness can delay postoperative mobilization.[5] Techniques such as the PENG block and QL block are emerging as promising alternatives, offering effective analgesia with minimal impact on mobility. These approaches align with the goal of high pain score reduction promoting early mobilization and discharge, particularly in elderly and frail hip fracture patients.

The Pericapsular Nerve Group (PENG) block, introduced in 2018 by Girón-Arango et al., is a promising regional anaesthesia technique specifically designed for hip analgesia. Its unique characteristics make it an attractive alternative to traditional blocks, particularly in terms of minimizing motor impairment while achieving significant pain relief. The PENG block represents a major advancement in regional analgesia for hip-related pain.[6] By delivering effective sensory blockade without motor impairment, it addresses a key limitation of infrainguinal techniques like the femoral nerve block. This innovation supports early mobilization and improves postoperative recovery, making it a valuable tool in the management of hip fracture patients, particularly in frail or elderly populations.

Similar to the PENG block, the Quadratus Lumborum Block (QLB) is another innovative interfacial plane block technique. Initially described in 2007 as an extension of the posterior Transversus Abdominis Plane (TAP) block, the QLB was first utilized to deliver effective analgesia for patients undergoing abdominoplasties. Over time, this technique has gained prominence for its ability to provide prolonged and targeted pain relief, making it a versatile option for managing postoperative pain in various abdominal and pelvic surgeries.[7] Since its initial description, the Quadratus

Lumborum Block (QLB) has been widely adopted for postoperative analgesia in a variety of abdominal surgeries, including cesarean sections, inguinal hernia repairs, and laparotomies.[8-10] Furthermore, case reports have highlighted its effectiveness in providing satisfactory pain relief following total hip arthroplasty (THA), demonstrating its versatility beyond abdominal procedures. [11-14]

For patients undergoing hemiarthroplasty for femoral neck fractures, the lateral Quadratus Lumborum Block (QLB) has been associated with lower Visual Analog Scale (VAS) pain scores and reduced opioid consumption compared to the femoral nerve block. The potential mechanism behind the effectiveness of the QLB in providing hip analgesia may be the direct spread of local anesthetic to the nerve roots and branches of the lumbar plexus, targeting the pain pathways more effectively.[19]

As there were no existing studies in the literature comparing these blocks, this study was conducted to evaluate and compare the efficacy of the PENG Block and the Quadratus Lumborum Block (QLB) in proximal femur fracture surgeries. The results of this study provided valuable insights into the optimal regional analgesia techniques for managing pain in this patient population.

## AIM AND OBJECTIVES OF THE STUDY

### AIM:

The study aimed to compare the effectiveness of ultrasound-guided Pericapsular Nerve Group (PENG) block and Quadratus Lumborum Block (QLB) in providing postoperative analgesia and opioid-sparing benefits for patients undergoing surgery for proximal femur fractures. The goal was to determine which technique offers better pain control while minimizing opioid use in this patient population.

### PRIMARY OBJECTIVE:

The study aimed to compare Visual Analogue Scale (VAS) pain scores across the three groups at various time points: 30 minutes post-procedure, during spinal positioning, upon admission to the PACU, at discharge from PACU, and at 12, 24, and 48 hours post-surgery.

**SECONDARY OBJECTIVE:**

1) Time of first rescue analgesia.
2) To compare the total consumption of opioids (Tramadol) for first 24hrs and 25-48hrs post-surgery.
3) To access Quadriceps strength at 12, 24, and 48hrs post-surgery
4) Time of first standing
5) Discharge time post-surgery
6) Satisfactory score at time of discharge
6) The side effects of drugs used in the study, like nausea & vomiting, pruritus, sedation.
7) Complications of blocks such as hematoma, local anesthetic toxicity.

# REVIEW OF LITERATURE

1) In 2018, Laura giron arango et al. developed a novel ultrasound-guided approach for the blockade of articular branches of the femoral nerve, obturator and accessory obturator nerve to the hip known as pericapsular nerve group (PENG) block. They applied this technique on five consecutive hip fracture patients. Out of 5 hip fracture patients on 4 patients they performed a single-injection block using 20 mL of 0.25% bupivacaine mixed with 1:400,000 epinephrine. In one case they gave peng block using 20 ml. of 0.5% ropivacaine with epinephrine 1:200,000 plus dexamethasone 4mg. They assessed all patients after thirty minutes of performing peng block by asking them to perform a straight leg raise of the affected limb to 15 degrees flexing their hip. They noted that all patients were able to do leg raise and there was significant reduce in pain scores when compared with baseline. They reported a numeric rating scale (N.R.S) pain score reduction of 7 points out of 10 postoperatively compared with a baseline of intravenous opiates only for analgesia. They also noted purely sensory blockade without motor impairment.[6]

2) Faramarz mosafa et al., in 2018 -2019 compared pericapsular nerve group block (PENG) with Fascia iliaca compartment block (F.I.C.B.) in hip fractures surgeries. It's a double-blind prospective randomised controlled clinical trial. They divided 52 patients randomly into two groups (Group

A(FICB), n = 22; Group B(PENG), n = 30) aged between 40–80 years with ASA class I and II. They performed both blocks in block room 15min before patient shifts to operating room and used ropivacaine 0.5% at a rate of 3 ml/kg (max of 40 ml). If patient had VAS > 3 in the sitting position for spinal, they received 1mcg/kg of intravenous fentanyl which was repeated every 5 minutes as needed and used injection morphine as a rescue analgesia postoperatively. They noticed after 12 hours of surgery, the VAS score (3.01±1.08) significantly reduced in the PENG block group (p = 0.031) compared with the F.I.C.B. group VAS score (3.91±1.48) (p = 0.021). The time of first rescue analgesia after surgery was significantly longer in the PENG block when compared to the FCIB (p = 0.007) and total dose of morphine given in 24hours drastically reduced in the PENG block when compared to FICB group (p = 0.008). They concluded that compared with F.I.C.B., PENG block is suited for complete hip analgesia.[15]

3) In 2020 D-Yin Lin et al. compared PENG block and femoral nerve block in hip fracture surgeries. They conducted double-blinded, randomized comparative trial and divided sixty patients into two equal groups (PENG and F.N.B). They performed allocated block 15–45 min preoperatively with ultrasound guidance using 20 mL of 0.75% ropivacaine. Postoperatively the PENG group had less pain compared with the F.N.B. group. In the PENG group, 63% had no pain, 27% had mild pain, and 10% moderate to severe pain. In comparison, 30% of the F.N.B. group had no pain, 27% mild pain,

and 36% moderate to severe pain. This was assessed using an 11-point Likert N.R.S. And also they noted that Quadriceps strength (assessed using Oxford muscle strength grading) was better preserved in the PENG group postoperative period, 60% intact in the PENG group and not intact in the F.N.B. group.[16]

4) In 2020 Ashok Jadon et al. conducted a study for Pericapsular nerve group (PENG) block based on landmark technique. They stated that in developing countries like India ultrasound may not be available to everyone. Total 10 patients were selected scheduled for hip surgeries under spinal anaesthesia. Out of which 4 patients were given PENG block by USG guided to mark the needle entry point at skin and depth which was 3-5 cm deep and distance from ASIS to AIIS is about 3–4 cm medial was measured. Remaining 6 patients were given block by surface landmark technique using the above recorded values. After positioning the patients in supine the ASIS, pubic tubercle and femoral artery were identified by palpation and marked. Keeping two fingers of one hand on the femoral artery, by connecting nerve stimulator they introduced the block needle perpendicular to skin at 5 cm medial to ASIS on the line joining ASIS and PT. When bony contact was made about 3–5 cm deep, with repeated negative aspiration 20 ml 0.25% bupivacaine and 8 mg dexamethasone was injected. Needle was reinserted one cm laterally if quadriceps contraction noticed during needle insertion. All patients had >50% of pain relief in rest pain as well as on 15° limb elevation and comfortable during spinal positioning without any complications. They concluded that

when ultrasound is not available landmark-based technique is a viable option to give PENG block using nerve stimulator to avoid inadvertent femoral nerve injury.[17]

5) In 2021, G Pascarella et al. conducted a study – Impact of PERICAPSULAR NERVE GROUP (PENG) block on postoperative analgesia and functional recovery following total hip arthroplasty. They divided 60 patients into two equal groups (PENG group and control group), accessed the numeric rating scale pain scores at 12hr, 24hr and 48hr. They performed Peng block injecting 20 ml of ropivacaine 0.375% after giving spinal anaesthesia and before surgical incision. According to their research articles they stated that PENG block covers only peripheral fibres innervating anterior hip capsule sparing analgesia for skin incision. In other study Nielsen et al.,described most of the surgical incision in total hip arthroplasty is innervated by lateral cutaneous branches of the iliohypogastric and subcostal nerves. Based on this reason pascarela et al. at the end of surgery infiltered wound in all patients in both groups with 20 ml ropivacaine 0.375% to eliminate perception of superficial pain and to provide incision site analgesia during the first postoperative hours. Their results suggested that PENG block group had lower pain scores than the control group at all points and peng block provides optimal post-operative analgesia with fast motor recovery and reduced consumption of opioids as recommended by enhanced recovery after surgery protocols.[18]

6) Promil kukreza et al., in the year 2017, did a comparative study comparing the patients receiving Posterior quadratus lumborum block prior to primary total hip arthroplasty for postoperative analgesia with the patients undergoing same surgery without block. They assessed 238 patients and gave posterior Q.L.B. in 79 patients; the remaining 159 did not receive a block. They performed posterior QLB block with a curvilinear low frequency ultrasound probe using an in-plane technique lateral to medial approach injecting the local anesthetic 20mL 0.25% bupivacaine with 1:400 concentration epinephrine in the fascial plane lying on the posterior border of the quadratus lumborum muscle, which is located between the quadratus lumborum muscle, sacrospinalis and latissimus dorsi muscles. They concluded that preoperative posterior quadratus lumborum block in total hip arthroplasty decreased Visual Analog Scale pain (VAS) scores (1.55±2.68) (p-0.0012) up to 12 hours and shortened post-anaesthesia care unit length of stay. Their study proved that posterior quadratus lumborum block improves postoperative analgesia in total hip arthroplasty surgeries in an opioid-sparing manner.[19]

7) Christopher L McCrum et al., in 2017, did a study to evaluate immediate patient outcomes in hip arthroscopy surgeries with a preoperative, single-shot Q.L. block. They divided 56 patients into two equal groups Q.L. Block and the control group. A QL type I block was performed on QL group injecting 20–30 ml of 0.5% ropivacaine plus dexmedetomidine 20–30 mcg plus dexamethasone 4 mg. They reported that in Q.L. block, patients had significantly less pain (VAS score 4.161±3.210) ($P$ = 0.026) immediately postoperatively, as well as

at the time of discharge (VAS score 2.571±2.290) ($P$ = 0.015) when compared with the control group who did not receive a block.[20]

8) Sophia Margareta et al., in 2018 did a randomized, double-blind, placebo-controlled study of posterior QLB on patients undergoing total hip arthroplasty. One hundred patients who were scheduled for elective total hip replacement were assigned at random to receive a 30-ml injection posterior to the quadratus lumborum muscle with either normal saline (n = 50) or 0.33% ropivacaine (n = 50). To both groups, multimodal analgesia included systematic administration of acetaminophen, ketoprofen, and a morphine intravenous patient-controlled analgesia. They found that there was no significant difference in the 24-h total morphine consumption and pain scores in both the groups.[21]

9) Promil Kukreja et al., in 2020 done a retrospective case series combining PENG block with anterior QL block. In total sixteen patients undergoing revision THA 8 patients given both QL (25ml of local anesthetic 0.25% Bupivacaine) and PENG block (20 ml of local anesthetic 0.5% ropivacaine) and eight patients given only QL block. They concluded that combination block for revision THA reduced pain scores and had opioid sparing effects post operatively when compared to QL block alone.[22]

10) Tayfun Et et al., in 2021 compared the pericapsular nerve group (PENG) block, quadratus lumborum block (QLB), and intra-articular (IA) local anesthetic

injection in total 89 patients who underwent a unilateral primary THA under spinal anaesthesia were randomly divided into groups PENG 20 ml of 0.5% bupivacaine (n = 30), QLB 30 ml of 0.5% bupivacaine (n = 30), or intra articular-IA (n = 29) 30 ml of 0.5% bupivacaine and 30 ml of saline. They noted effective analgesia for up to 6h postoperatively in PENG block and QLB group and PENG block reduced opioid consumption during the first 6h when compared to IA local anesthetic injection.[23]

11) Q.-R. WANG et al., in 2021-22 compared pericapsular nerve group (PENG) block against anterior quadratus lumborum block (QLB) for pain management in primary THA. Total 90 patients were randomized into two groups PENG (20 mL of 0.5% ropivacaine containing 1:200,000 epinephrine) and anterior QLB (30 mL of 0.33% ropivacaine containing 1:200,000 epinephrine). They noted that Patients in the PENG group had significantly lower pain scores and concluded that PENG block may show greater analgesic efficacy, at least in the first several hours after the procedure.[24]

# CLINICAL ANATOMY

## PENG BLOCK RELEVANT ANATOMY

PELVIC BONE: The cup shaped pelvic acetabulum in which the rounded head of the femur sits and articulate to create the hip joint, which is a ball and socket synovial joint.[25]

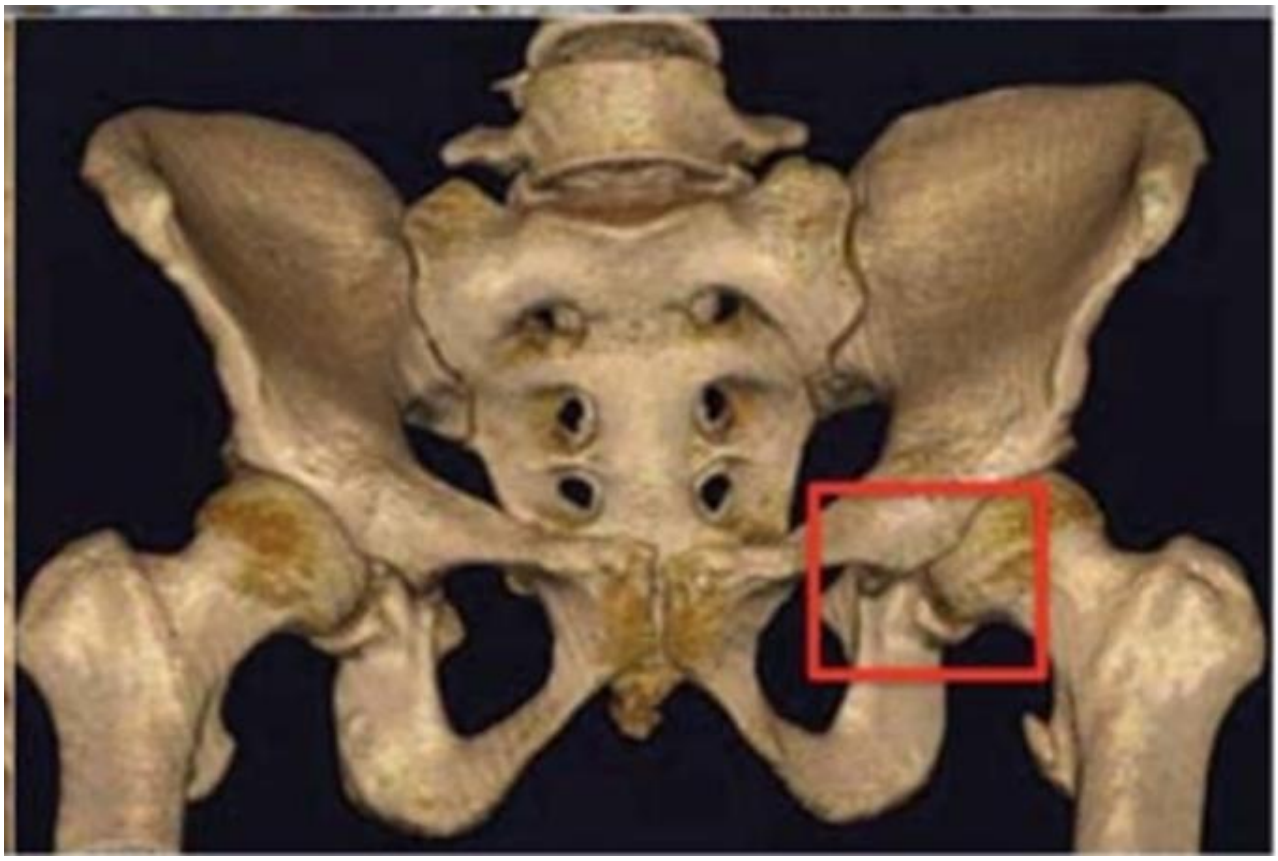


*Figure 1 PELVIC BONE*

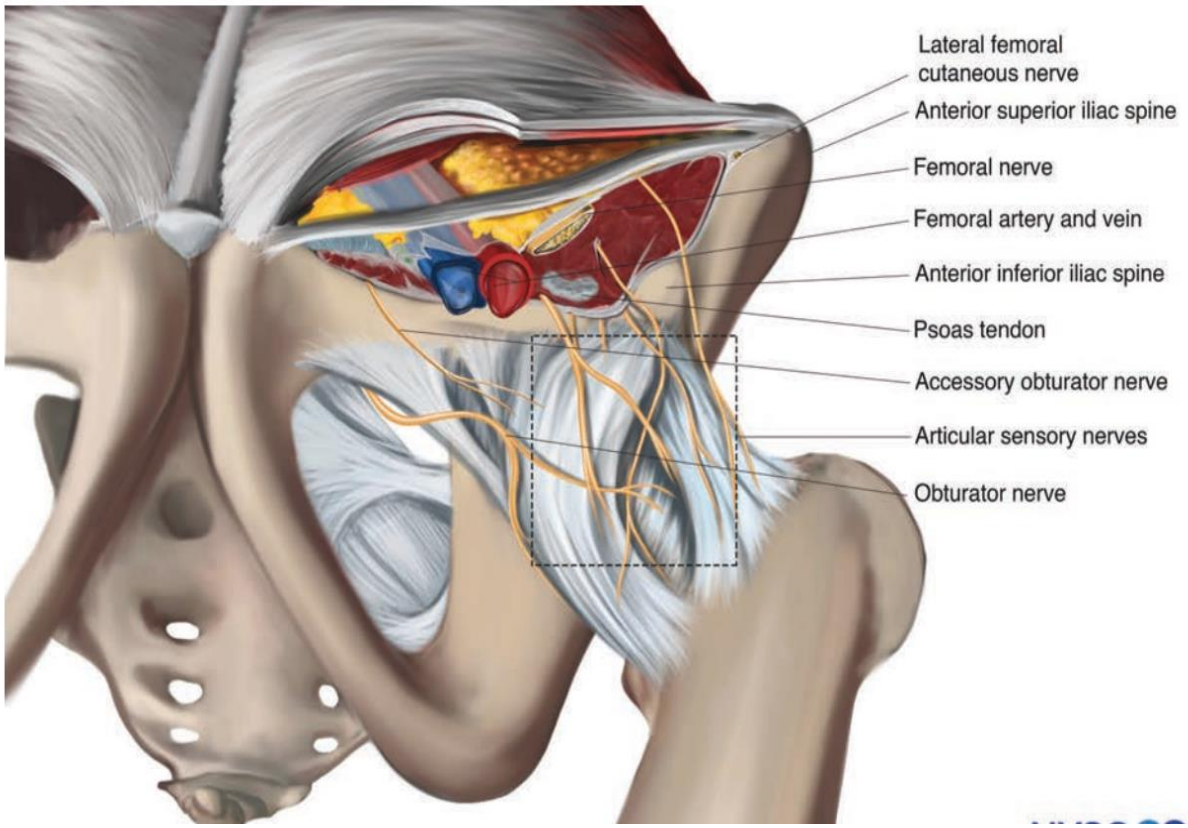



*Figure 2 Innervation of the anterior aspect of the hip capsule.*

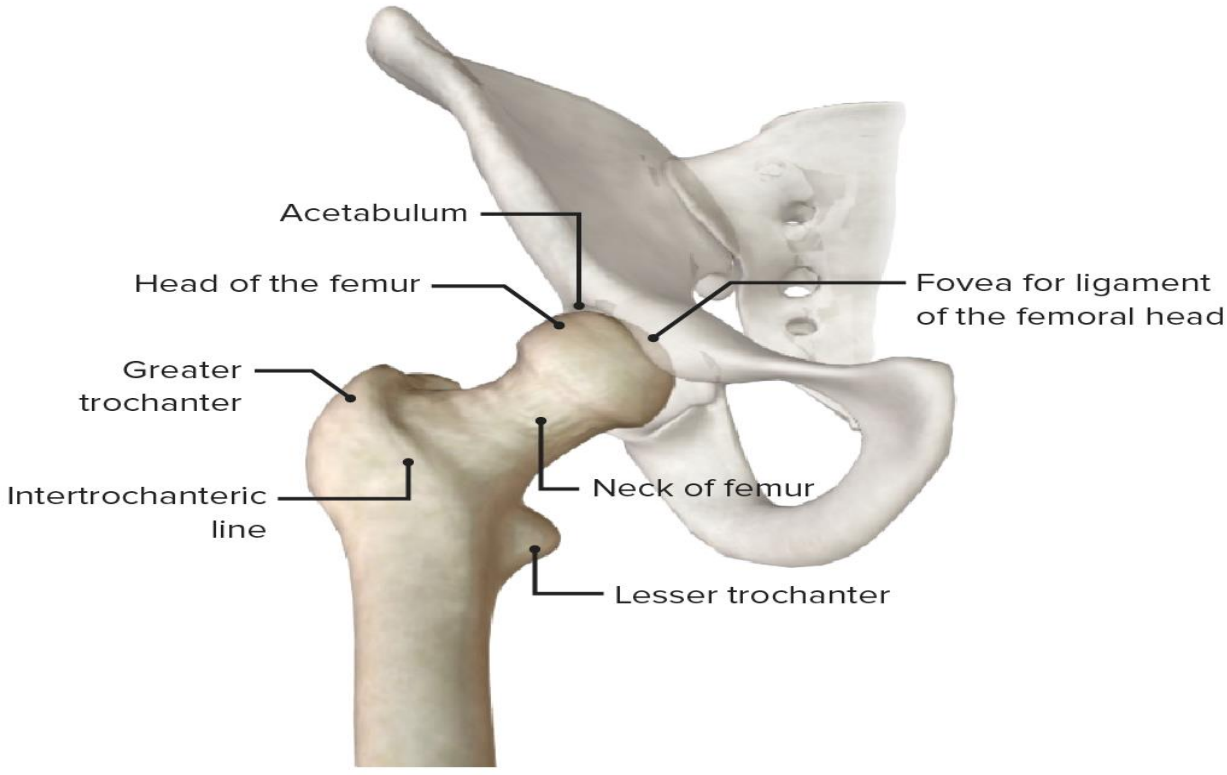



*Figure 3 HIP JOINT*

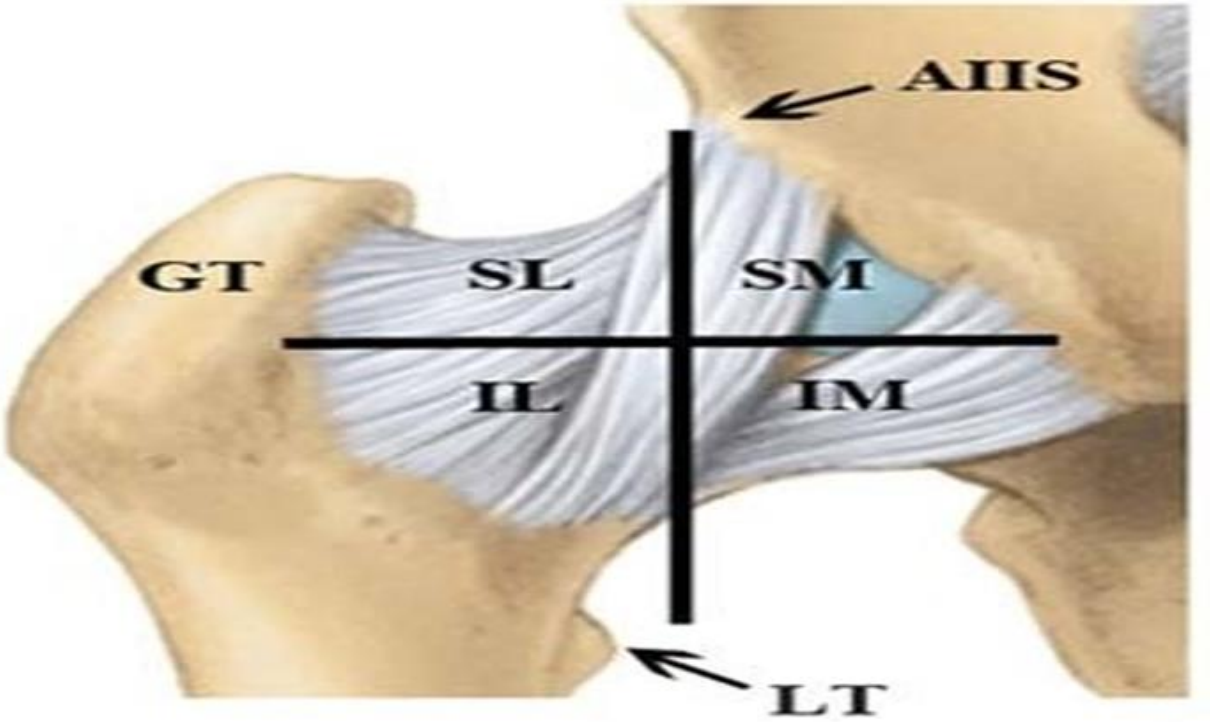



*Figure 4 Quadrants of the anterior hip capsule: superolateral (SL), superomedial (SM), inferolateral (IL), and inferomedial (IM). GT indicates greater trochanter; LT, lesser tubercle. Anterior view.*

**The capsule of hip joint :-**

- The capsule of hip joint is strong and fibrous and loose enough to accommodate wide range of movements. It attaches to acetabular labrum, transverse acetabular ligament and intertrochanteric line of femur.
- The three major ligaments iliofemoral, pubofemoral, and ischiofemoral ligaments form hip joint capsule which is thicker antero-superiorly and thinner postero-inferiorly.[26]

**Blood supply of capsule of hip joint:-**

Major contributing arteries from medial and lateral circumflex arteries which arises from femoral artery. Minor contribution from artery of head of femur. Blood supply of femoral head which is clinically very important and quite variable. The two main branches of deep femoral artery which supplies the femoral head are lateral epiphyseal

branch of medial circumflex femoral artery and ascending branch of lateral circumflex femoral artery. This leaves the femoral head vulnerable to avascular necrosis in presence of femoral neck fracture because these vessels are easily ruptured in neck of femur fractures. Another important artery ligamentum teres artery which arises from posterior branch of obturator artery and attaches at the fovea. This artery commonly disrupted with the dislocation of hip joint. It is the main blood supply to the femoral head in children.[25] In smaller portion of the patients as an anatomical variant the inferiorgluteal artery is the main blood supply to the femoral head.[27]

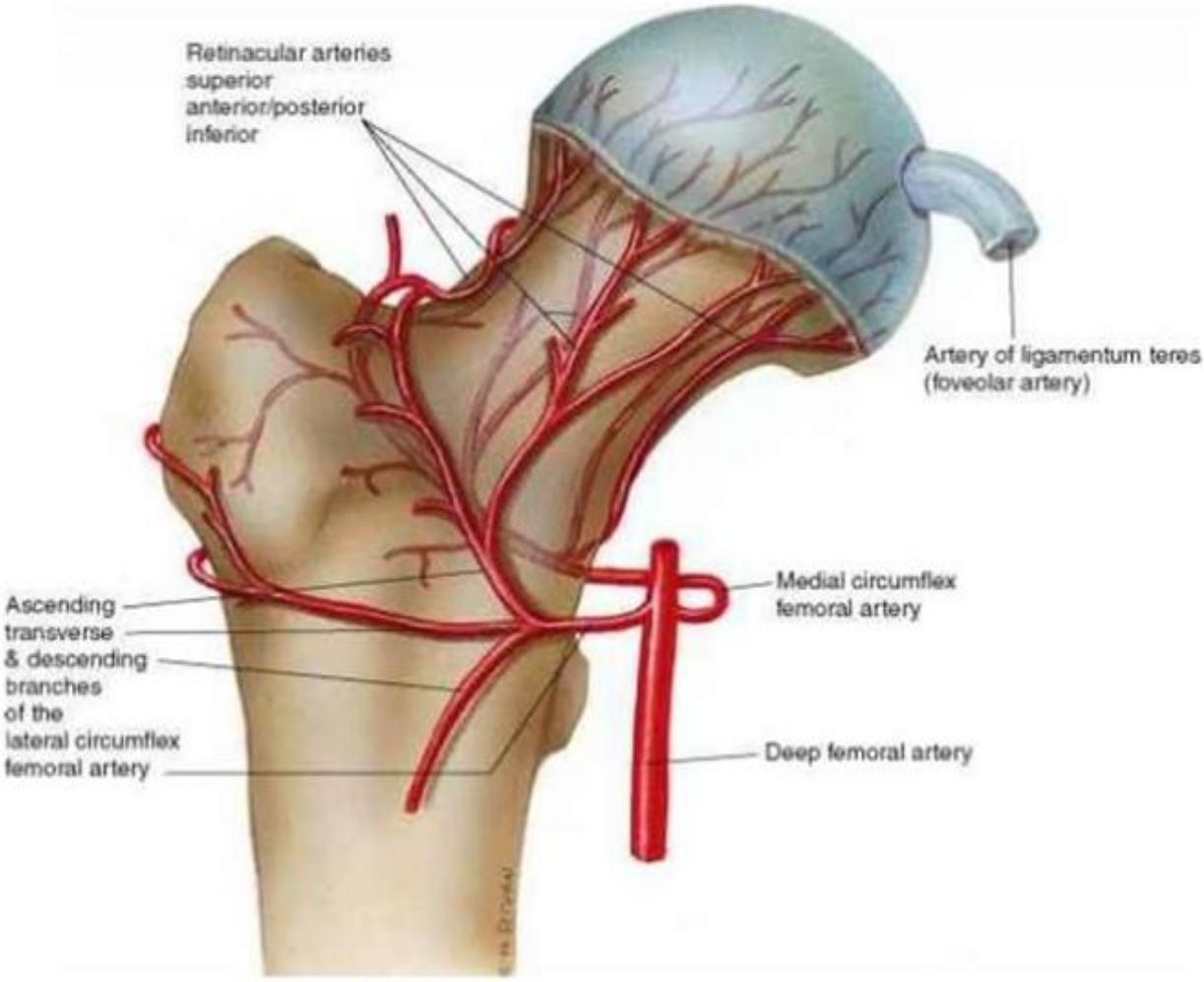



*Figure 5 PROXIMAL FEMUR VASCULAR SUPPLY*

**Nerve supply of hip joint:-**[25-29]

According to hiltons law the nerves crossing a joint supply the muscles acting on it, the skin over the joint and the joint itself. The innervation of hip joint comes anteriorly from femoral nerve which is the main nerve, inferiorly from anterior division of obturator nerve, laterally from articular branch of sciatic nerve and posteriorly from the nerve that runs to the quadratus femoris and superior gluteal nerve. Anatomically hip capsule is divided into anterior and posterior part. The anterior capsule is a nociceptive component the main cause of pain in hip related pathologies. Anterior capsule is supplied by:

1) Femoral nerve (L2-L4) which is responsible for hip flexion
2) Obturator nerve (L2-L4) which is responsible for thigh adduction
3) Accessory obturator nerve (L3-L4) which is present in 10-30% of population.

Posterior capsule is proprioceptive component for mechanoreceptors which does not contribute to nociception. Posterior capsule is supplied by:

1) Sacral plexus
2) Nerve to quadratus lumborum
3) Superior gluteal nerve
4) Musculocutaneous nerve

Anterior hip capsule further divided in four quadrants:-

1) superior lateral quadrant supplied by femoral nerve
2) Superior medial quadrant supplied by femoral nerve and accessory obturator nerve
3) Inferior medial quadrant supplied by femoral nerve, obturator nerve,

accessory obturator nerve.

4) Inferior lateral quadrant supplied by femoral nerve, obturator nerve

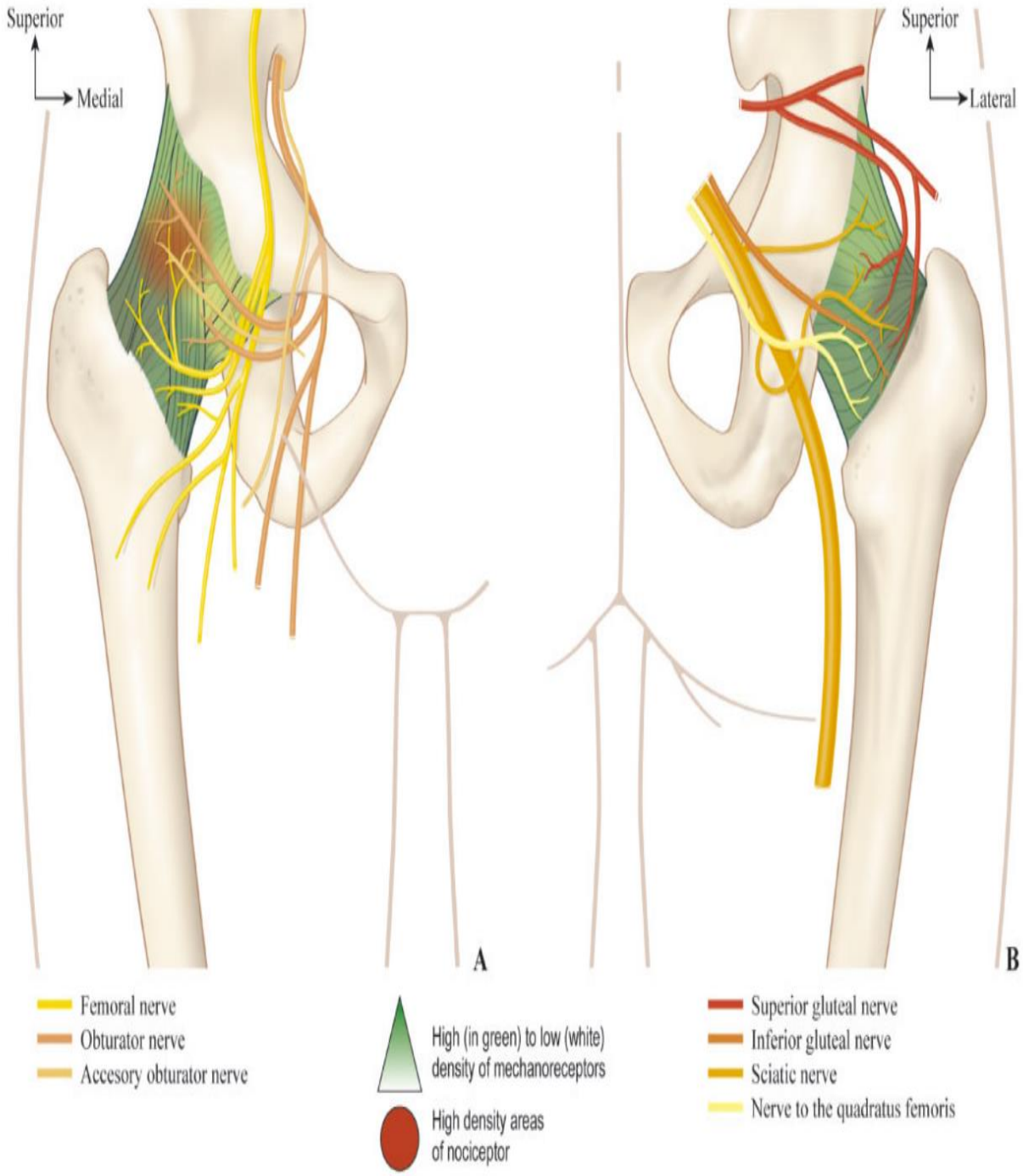



Figure 6 Summary of the sensory innervation of the hip joint based on review of the literature: (A) anterior and (B) posterior view

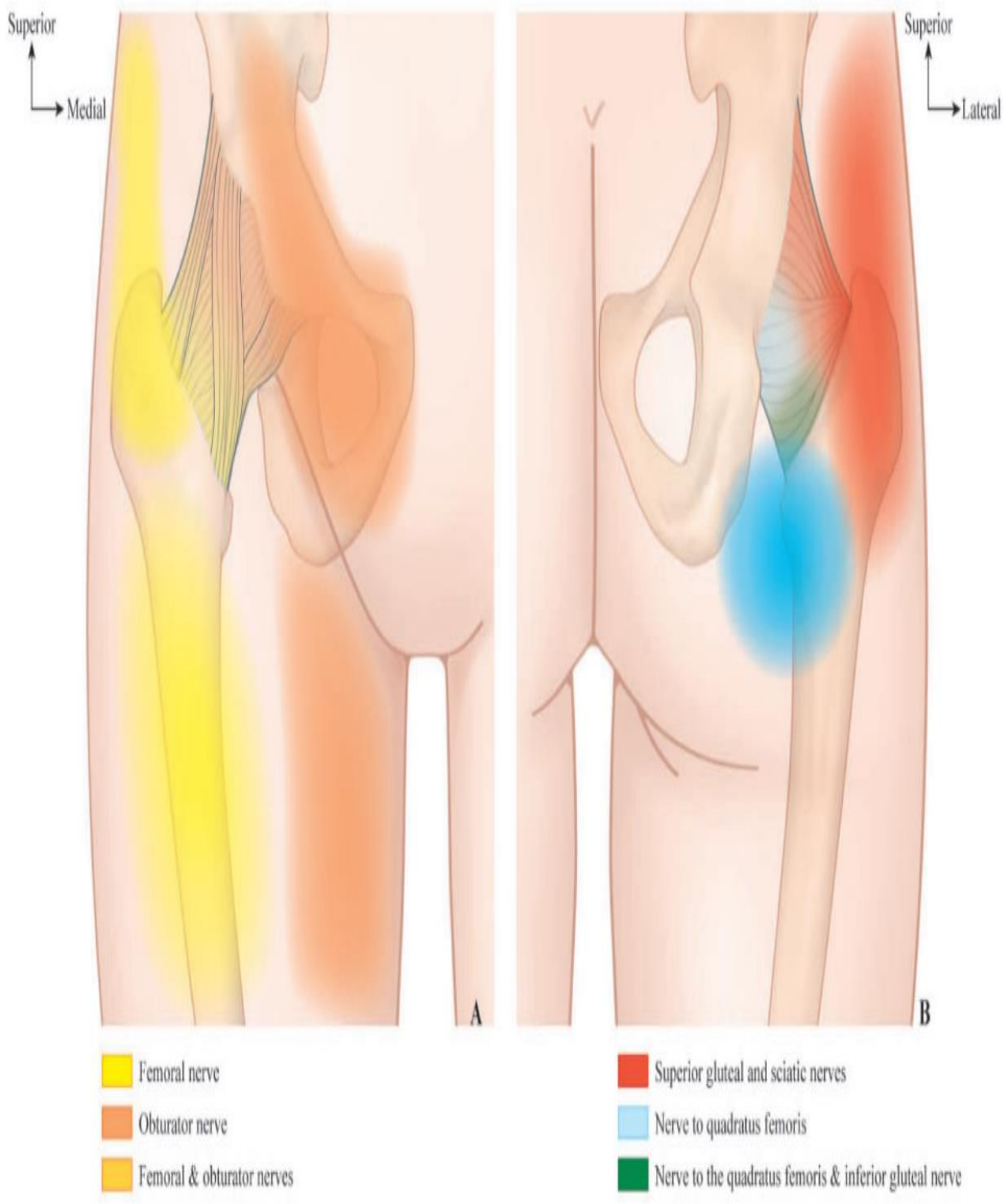



*Figure 7 Visual representation of the anatomic regions supplied by nerves, which simultaneously innervate the hip capsule. The richly innervated areas of the anterior (A) and posterior (B)*

In a cadaveric study on 13 hemipelvises (4 male and 9 female cadavers) with a mean age of 79.3 ± 11.9 years to find out the anterior hip capsule innervation and the image-guided radiofrequency denervation associated bony landmarks. They mentioned that corresponding to their origin inferior or superior to the inguinal ligament, articular branches of Femoral nerve were classified as either high or low femoral. High branches branched from the FN distal to the lateral border of the psoas. The branches at that point traveled intramuscularly through iliacus muscle, profound to the inguinal tendon, earlier to innervating the anterior hip capsule. High femoral branches most frequently supplied the superolateral, inferolateral, and superomedial quadrants of anterior capsule. Low branches penetrated the iliopsoas muscle to provide direct supply to the anterior capsule or travelled downward before coming back up to supply the joint capsule. All quadrants of anterior hip capsule were supplied by low femoral branches, with the inferolateral quadrant having the highest occurrence rate. The Obturator nerve supplied branches for the joint, which were classified as high or low depending on where they originated. High branches started near or inside the obturator canal and low branches came from the posterior branch of the Obturator nerve.[31]

Most high branches from Obturator nerve recurved to feed exclusively the inferomedial quadrant of anterior hip capsule after descending inferiorly from the obturator canal, just distal to the inferior aspect of the hip joint. When found, the low branches were more abundant and either went directly to the hip joint or created a little plexus that supplied innervation to the anterior hip capsule. These low branches of obturator nerve supplied both the inferomedial and the inferolateral aspects of the anterior hip capsule.

The accessory obturator nerve when found formed by branches from the lumbar plexus (L2–L5) and travelled deep to the psoas muscle along the medial border passing across the iliopubic eminence before ending on the capsule. [30-32]

So it is the anterior part of hip capsule and the nerves supplying to the anterior part of hip capsule which we have to block to get adequate analgesia for any hip related procedures. The articular branches from the three major nerves ie., femoral nerve, obturator nerve and accessory obturator nerve leave the major nerve branches at a proximal level that is in the supra inguinal region.

According to a anatomical study the articular branches from the FN to the hip joint enter the iliacus muscle at the level of L4–L5 vertebrae, travel deep to the psoas muscle and tendon between the AIIS and IPE, and then innervate the hip capsule. Approximately at the level of L5 vertebrae, the AON travels deeply to the medial aspect of the psoas muscle. After that, it enters the anteromedial joint capsule by traveling deeply to the psoas around IPE.[33]

So, if we are giving a classic femoral nerve block or classic infra inguinal block, they are very distal and it will not block the articular branches and we will not get the adequate analgesia. The blocks involving the proximal part where the articular branches are with the major nerves we get adequate analgesia but along with the articular branches there is a chance of blocking major nerves as well and that can lead to femoral nerve block, associated quadriceps weakness and further hindering of the post-operative ambulation of patient. So that's why the PENG block comes into importance because it is exactly where we are going to block the articular branches of femoral nerve, obturator nerve and accessory obturator nerve without much involvement of major nerves itself.

So, we can escape from the complications like post-operative motor weakness and difficulty in ambulation of patient and at same time we can get adequate analgesia for hip related procedures.

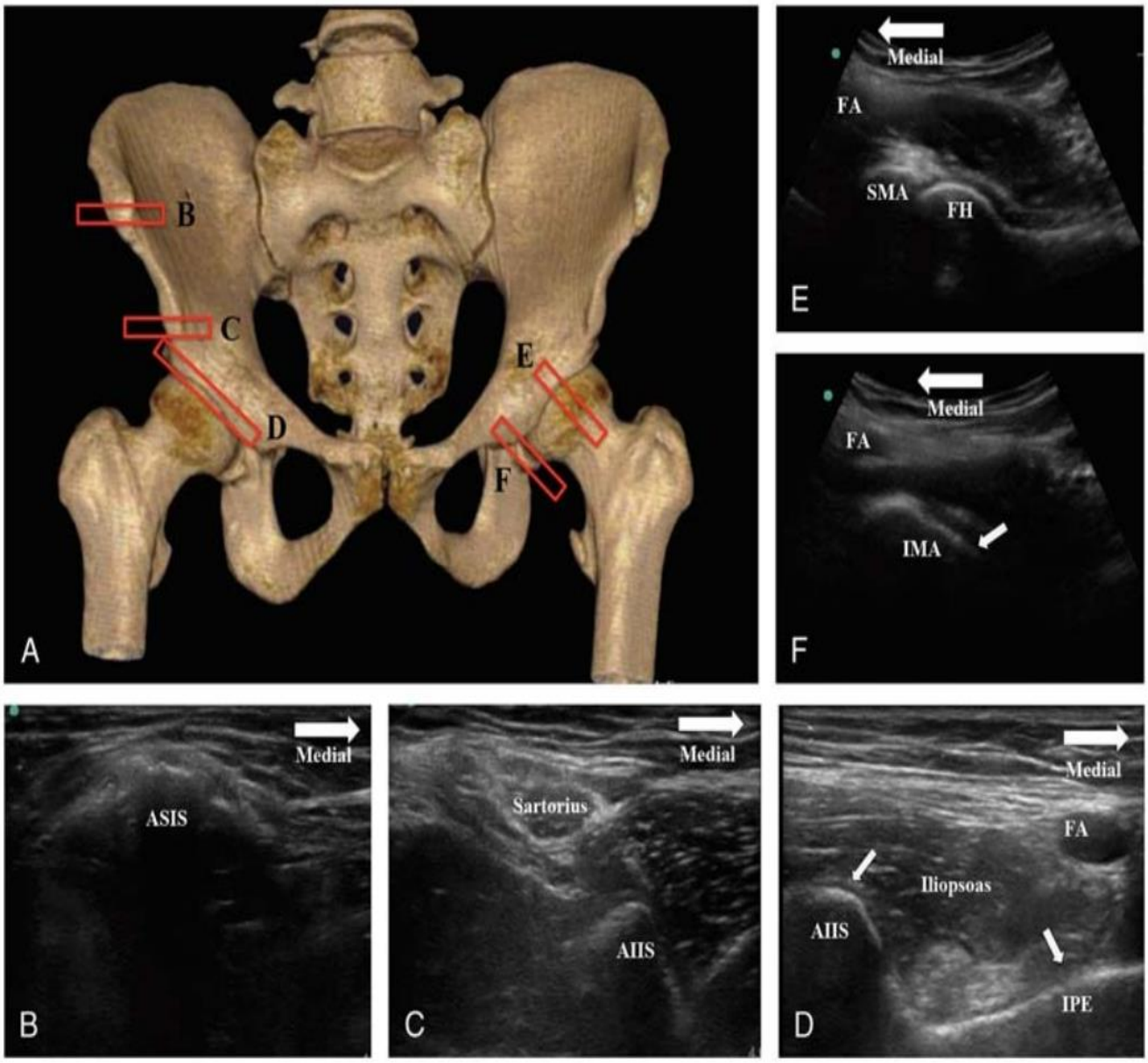



*Figure 8 Ultrasound landmarks for image-guided injections of articular branches innervating the anterior hip capsule. A, Skeletal model showing US probe positions (red rectangles). B, Ultrasound image at the level of anterior superior iliac spine (ASIS). C, Ultrasound image at the level of AIIS. D, Ultrasound image aligning the AIIS and iliopubic eminence (IPE). The tendon of iliopsoas muscle is shown as hyperechoic structure at the deep end of the muscle. Femoral artery (FA) is on the medial side of the muscle. E, Ultrasound image aligning the femoral head (FH) and neck with superomedial acetabulum (SMA). F, Moving the US probe medially reveals the inferomedial acetabulum (IMA).*[31]

**Indications of PENG block :-**

PENG block a novel regional analgesia technique typically used to provide analgesia following injuries or surgeries of the hip or thigh, such as acetabular fractures, neck or midshaft fractures of femur, hip arthroplasty, hip arthroscopy and knee surgery.[34] Some recent studies demonstrated PENG block as effective surgical anesthesia for a medial thigh lesion, vascular operations, such as stripping to target several dermatomes.[35,36]

**Contraindications for PENG block include :**

- Patient refusal for block
- Injection site infection
- Local anaesthetics toxicity
- Systemic anticoagulants (INR >1.5 or inadequate time since cessation of anticoagulant)

**PENG BLOCK TECHNIQUE:**

• The patient was placed in the supine position on a clean and comfortable surface to allow easy access to the groin area. This position ensures optimal exposure of the target site and enhances the operator's ability to perform the procedure with precision.

• The groin region was cleaned thoroughly with an appropriate antiseptic solution (e.g., chlorhexidine or povidone-iodine) to minimize the risk of infection. The

cleaned area was then covered with sterile drapes, ensuring that only the procedural site was exposed. This maintains a sterile field throughout the procedure.

- A local anaesthetic, specifically 0.2% lignocaine, was drawn into a sterile syringe. Using a fine needle (e.g., 26 or 27 gauge), 2 ml of lignocaine was injected subcutaneously around the procedural site. This numbed the skin and underlying tissue, ensuring patient comfort during the procedure. Care was taken to inject slowly while aspirating intermittently to avoid inadvertent intravascular injection.

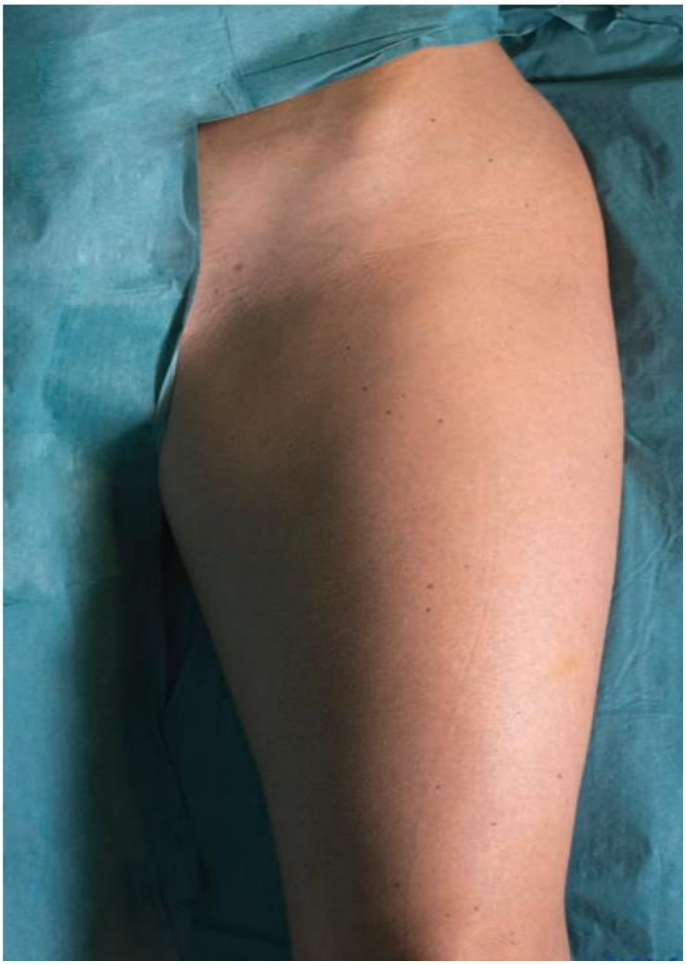


*Figure 9 Patient position to perform a PENG block.*

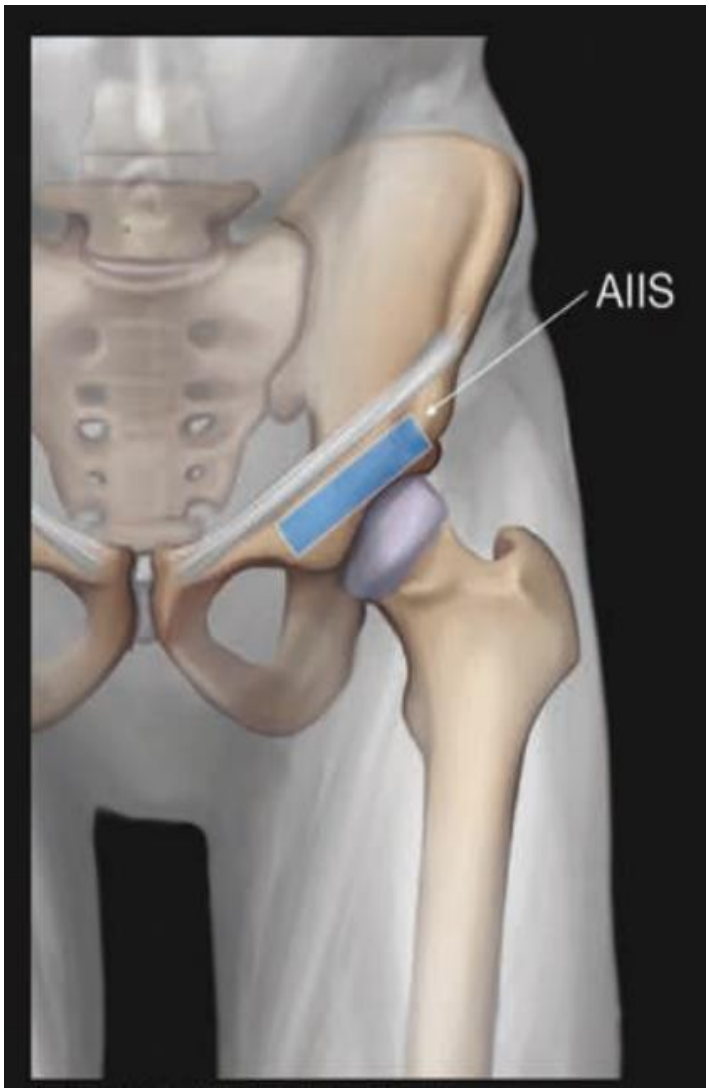



*Figure 10 Transducer positions to perform a PENG block.*

• A linear ultrasound probe (2–5 MHz, Sonosite M-Turbo, U.S.A.) was used to visualize the anatomical structures and guide the needle placement. The in-plane needle approach was utilized for precise needle visualization and control.

• The ultrasound probe was initially placed in the transverse plane over the anterior inferior iliac spine (AIIS) and adjusted by moving laterally, medially, or back and forth until a clear and high-quality image of the target anatomical structures was obtained.

• The orientation mark on the probe was consistently positioned on the lateral side to maintain proper image orientation.

• This orientation allowed the identification of the pubic ramus and the iliopubic eminence.

• The ultrasound gain, depth, and focal points were optimized to clearly visualize the relevant anatomy, including the anterior inferior iliac spine (AIIS) and adjacent structures.

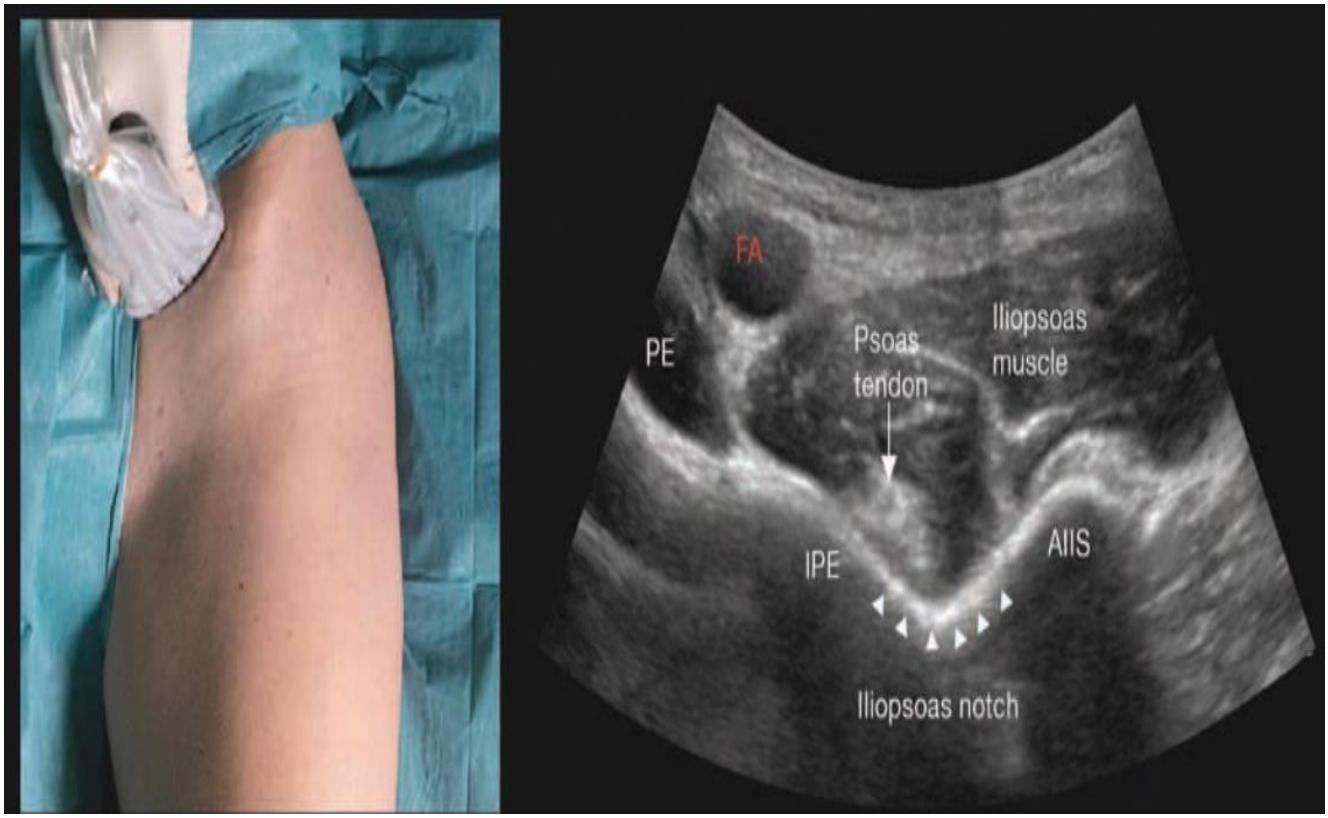



*Figure 11 Transducer position to perform Pericapsular nerve group block*

• The probe was then rotated counter-clockwise by 45 degrees, aligning it with the pubic ramus. This adjustment ensured optimal visualization of the ilio-psoas plane, femoral artery, and the target nerves (e.g., articular branches of the obturator and femoral nerves, accessory obturator nerve).

• In this view the iliopubic eminence (IPE), iliopsoas muscle and tendon, femoral artery, and pectineus muscle were visualized under ultrasound.

• Slight sliding, rotating, tilting, and pushing motions of the ultrasound transducer were performed to:

-Enhance visibility of the hyperechoic iliopsoas notch between the anterior inferior iliac spine (AIIS) and the iliopubic eminence.

-Clearly identify the hypoechoic iliopsoas muscle and the hyperechoic oval psoas tendon.


*Figure 12 PENG block; reverse ultrasound anatomy with needle insertion in-plane. FV, femoral vein; FA, femoral artery; FN, femoral nerve; PE, pectineus muscle; IPE, iliopubic eminence; AIIS, anterior inferior iliac spine.*

- The femoral artery and femoral nerve, located superficial to the iliopsoas muscle, were identified to prevent inadvertent injury during needle advancement.
- A 22-gauge, 80-mm needle connected to an extension tube was inserted using an in-plane lateral-to-medial approach.
- The needle tip was positioned in the musculofascial plane between the psoas tendon (anterior) and the pubic ramus (posterior).
- Before injecting, negative aspiration was performed to rule out inadvertent intravascular placement of the needle.
- A total of 20 mL of 0.25% bupivacaine mixed with 8 mg of dexamethasone was administered. The solution was injected in 5 mL increments while continuously monitoring under ultrasound for proper spread.
- The fluid spread in the musculofascial plane was observed in real time, ensuring correct placement.
- Proper injection caused the psoas tendon to visibly lift from the pubic ramus, confirming the desired distribution of the solution.
- If high resistance was encountered during injection, the needle was slightly withdrawn to reposition it.
- If the solution appeared to be injected into the iliopsoas muscle, the needle was advanced further to reach the correct plane.

## LUMBAR PLEXUS ANATOMY

Lumbar plexus is the nerve fibres network which supplies the skin and musculature of lower limb. These nerve fibres located in lumbar region within the posterior portion of the psoas major muscle and anterior to the lumbar vertebrae transverse processes.[37] The lumbar plexus originates from the anterior rami of spinal nerves L1-L4 and anterior ramus of spinal nerve T12 contributes to the formation of the lumbar plexus via the dorsolumbar nerve, which joins the anterior ramus of spinal nerve L1.[38] These plexus are enclosed within two muscles-Quadratus lumborum and psoas muscles.[39]

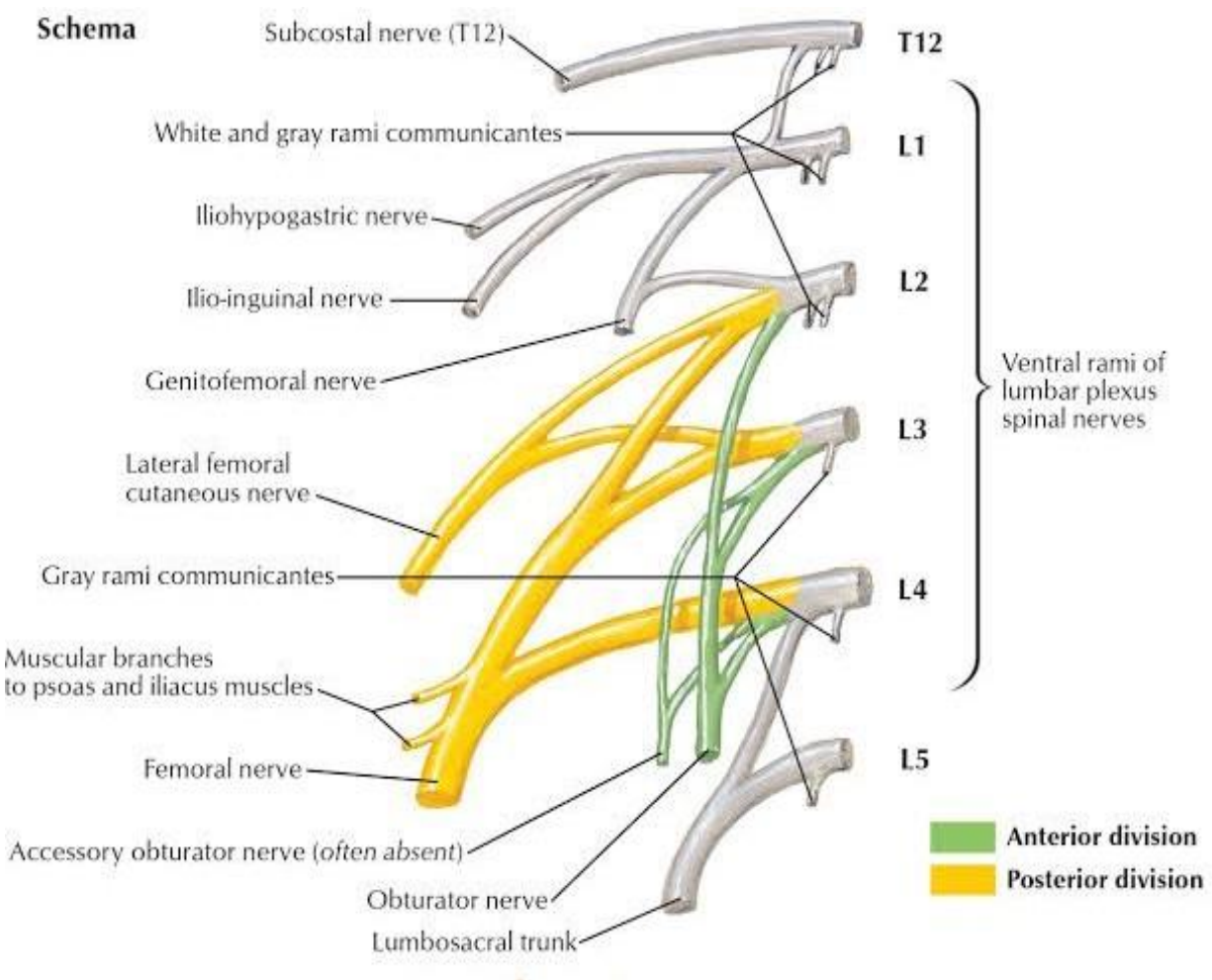



Figure 13 lumbar plexus

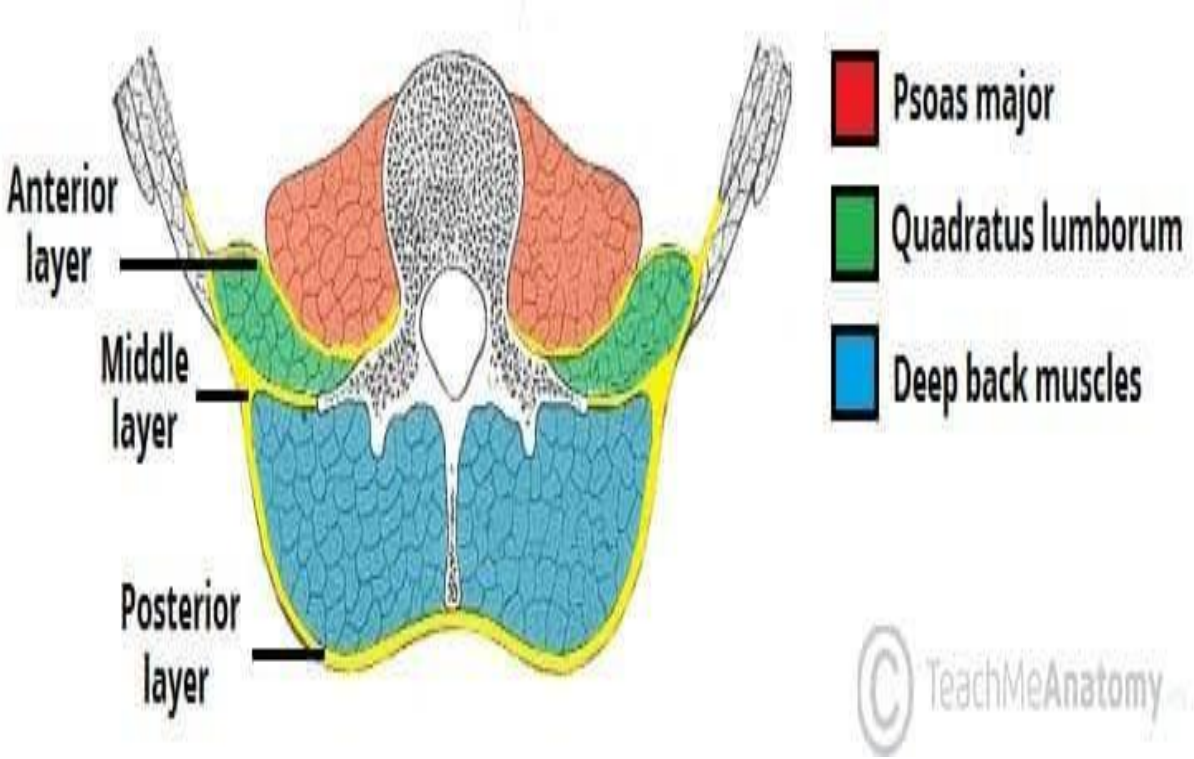



*Figure 14 Thoracolumbar fascia*

**QUADRATUS LUMBORUM ANATOMY:**[40]

**Muscles :** The iliac crest gives rise to the quadratus lumborum muscle, which inserts into the transverse processes of the first through fourth lumbar vertebrae and the medial border of the twelfth rib. An angled lateral free boundary extending from craniomedial to caudolateral forms the quadratus lumborum. The diaphragm's lateral and medial arcuate ligaments are posterior to the quadratus lumborum and psoas major muscles, respectively. The quadratus lumborum muscle is situated posterior to the erector spinae muscular group, which also comprises the multifidus, longissimus, and iliocostalis muscles.

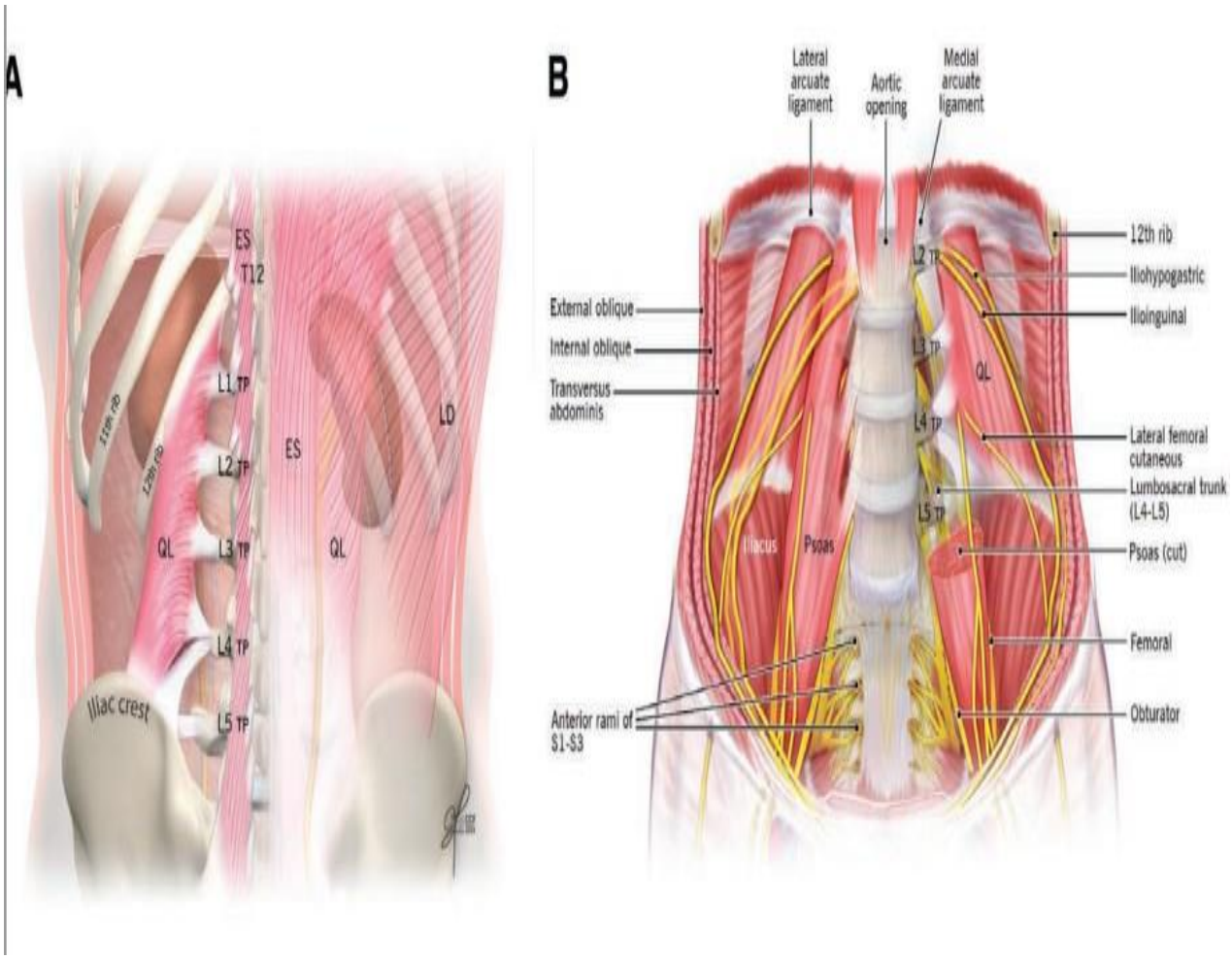



*Figure 15 Musculature of the posterior abdominal wall*

**Fascia :** The quadratus lumborum muscle is surrounded by fibrous aponeurotic and fascial tissue known as thoracolumbar fascia. The myofascial girdle that encircles the lower torso, known as the thoracolumbar fascia, is essential for maintaining proper posture, transferring weight, and stabilizing the lumbar spine. The thoracolumbar fascia is made up of two possible kinds of aponeuroses and multilayered fascia. The model is composed of two layers: an anterior layer that lies between the quadratus lumborum muscles and the erector spinae muscles, and a posterior layer that encloses them. The anterior fascia of the quadratus lumborum in the two-layered model is the transversalis fascia, which differs from the thoracolumbar fascia in terms of embryology. The anterior portion of the investing

fascia (epimysium) of the quadratus lumborum and psoas muscles, as well as the peritoneal side of the transversus abdominis muscle, are covered by the transversalis fascia.

**Neural Structures:**

After leaving the psoas major muscle, the iliohypogastric and ilioinguinal nerves (ventral ramus of L1, with sporadic contributions from T12, L2, and L3) cross the ventral side of the quadratus lumborum. The psoas major muscle is the caudal departure point for the lateral femoral cutaneous, obturator, and femoral nerves. The ilioinguinal, subcostal, and iliohypogastric nerves all pass anteriorly through the quadratus lumborum.

## QUADRATUS LUMBORUM (QL) BLOCK

Rafael Blanco,in the year 2007,explained the USG guided QL block. depositing the drug over the anterolateral side of the muscle which blocks the similar dermatomes as TAP block. Visceral analgesia can also be achieved from this block.[7]

Dr Jens Borglum in the year 2013, described about the transmuscular QL block. He explained about the ‘Shamrock sign’ for the site of local anaesthetic placement.[41]

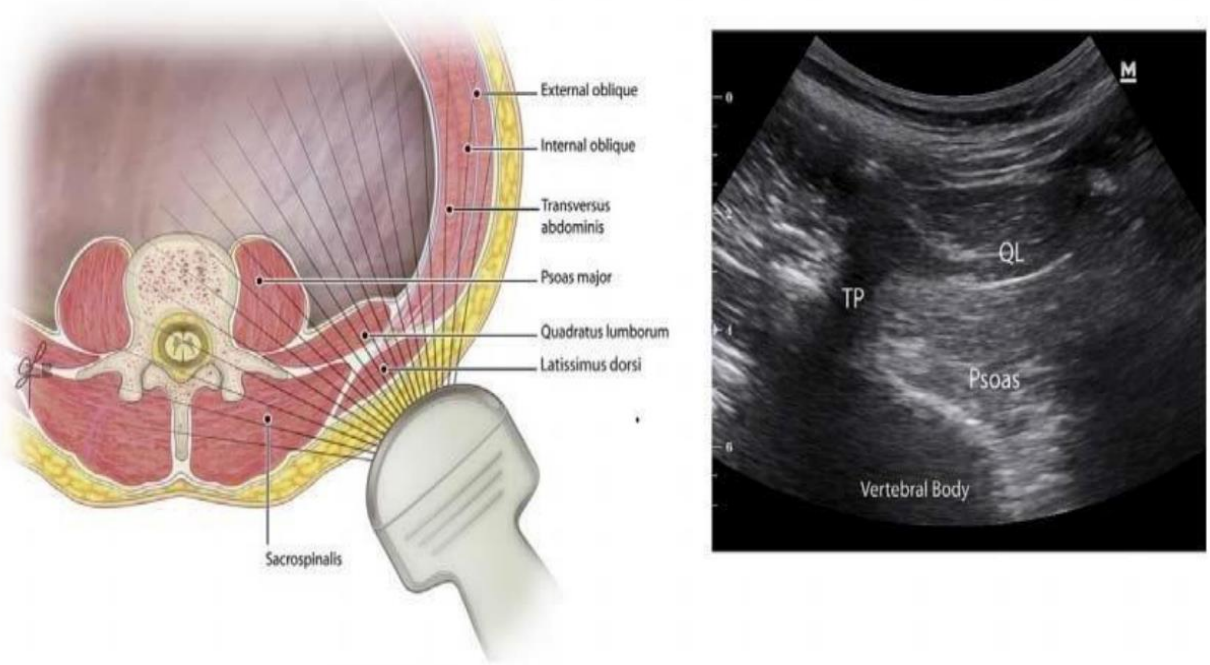



*Figure 16 QL BLOCK (ULTRASOUND IMAGE)*

Approaches to quadratus lumborum block include:

1. The quadratus lumborum 1 (QL1) anterolateral
2. The quadratus lumborum 2 (QL2) block posterolateral
3. The quadratus lumborum transmuscular (QL-TM)

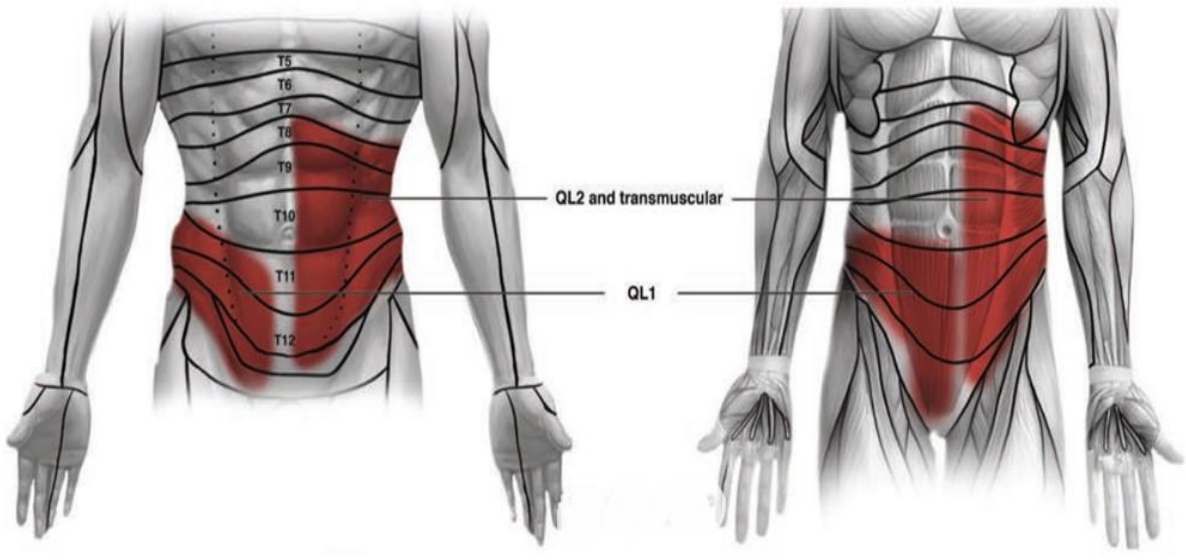



*Figure 17 Sensory distribution after the performance of different QL blocks.*

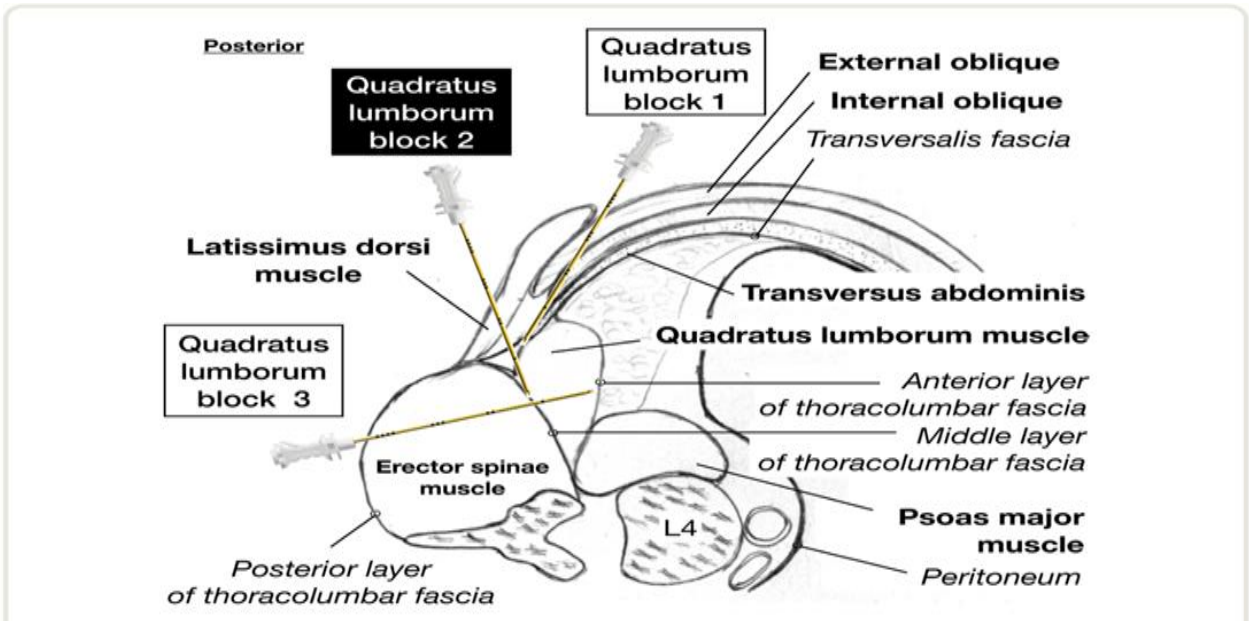



*Figure 18*

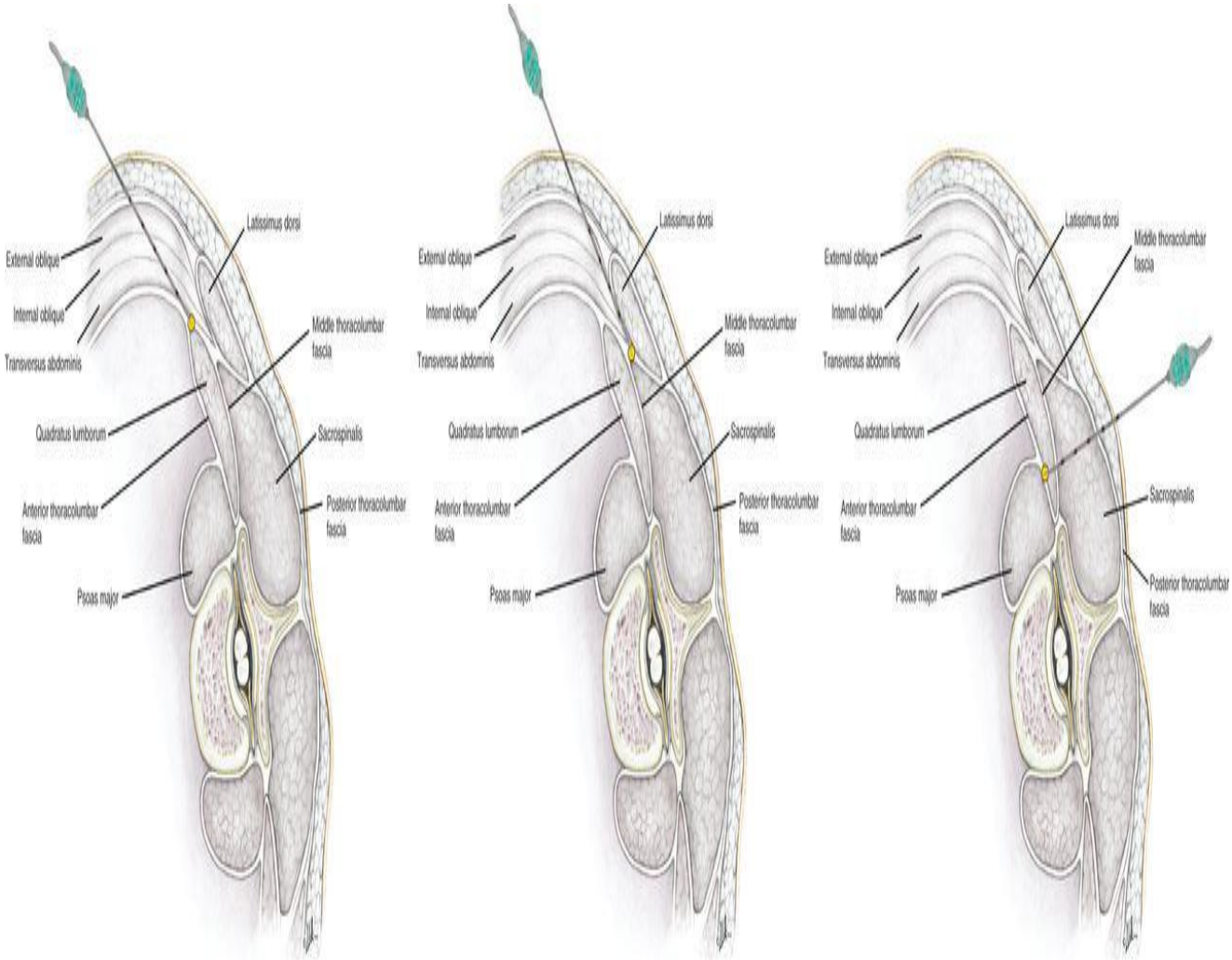



*Figure 19 Schematic diagrams of quadratus lumborum 1 block (left), quadratus lumborum 2 block (centre), and transmuscular quadratus lumborum block. The yellow dot represents the needle tip position during injection*

TYPE 1 :-

In this technique the three abdominal muscles are visualized until they taper and QL muscle appear clearly. The drug is deposited anterolaterally over the muscle.

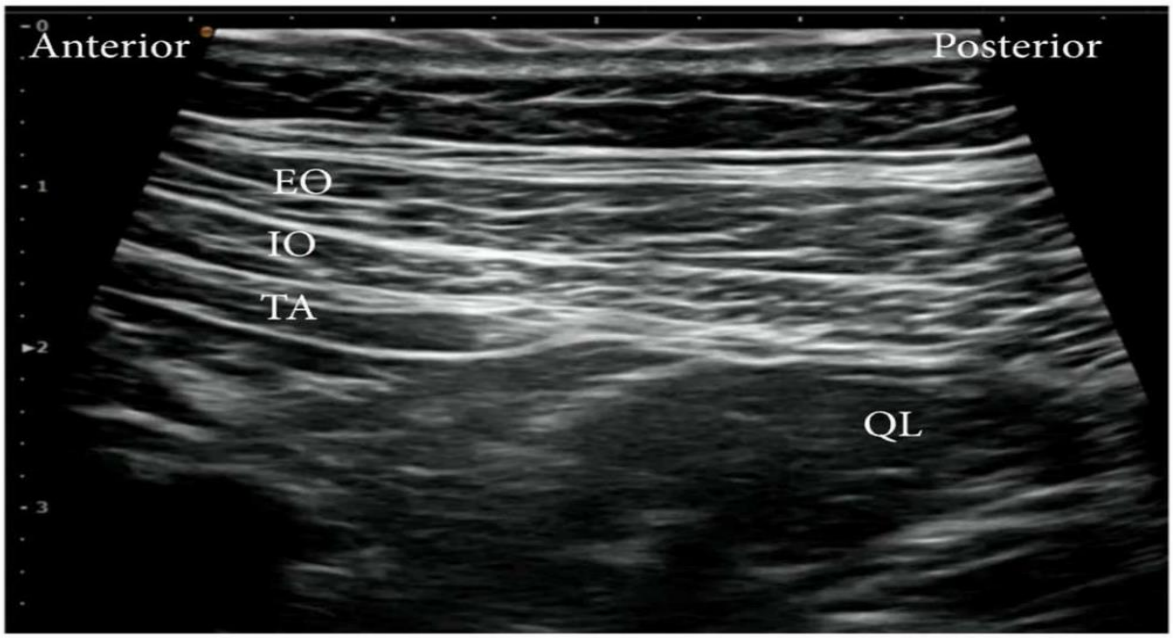



*Figure 20*

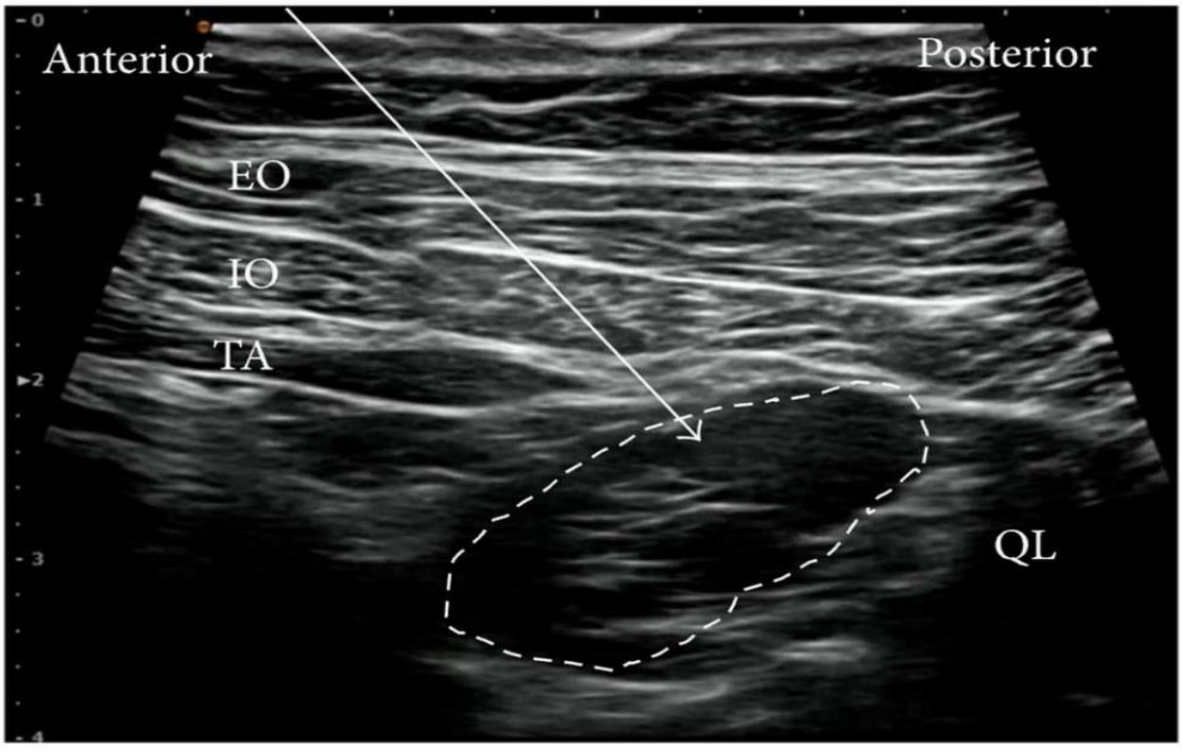



*Figure 21 QL BLOCK (TYPE 1)*

TYPE 2 :-

The needle is directed antero-posteriorly. The drug is placed posterior to the QL muscle in between the layers of thoracolumbar fascia. This site is called as the lumbar inter fascial triangle (LIFT).[42]

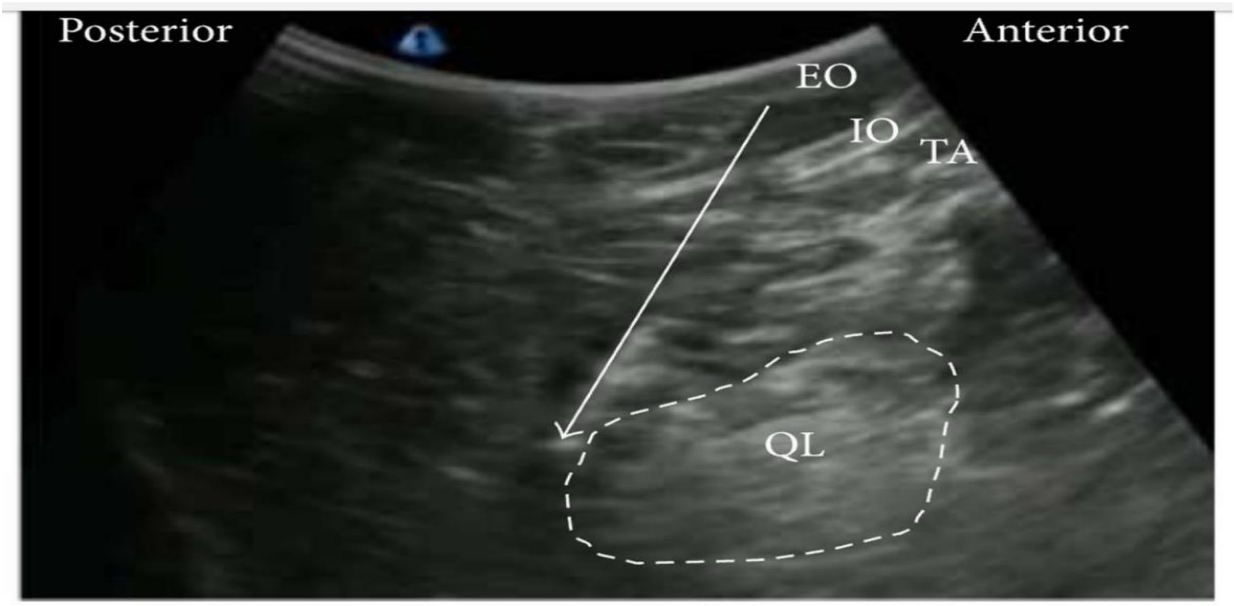



*Figure 22*

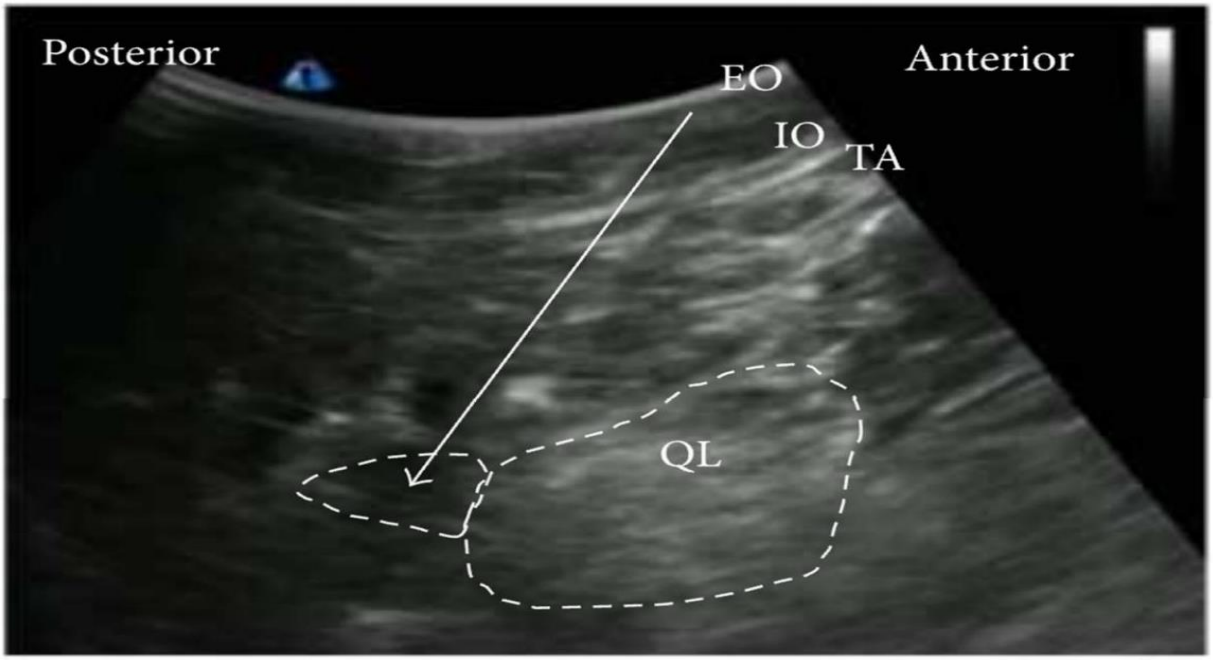
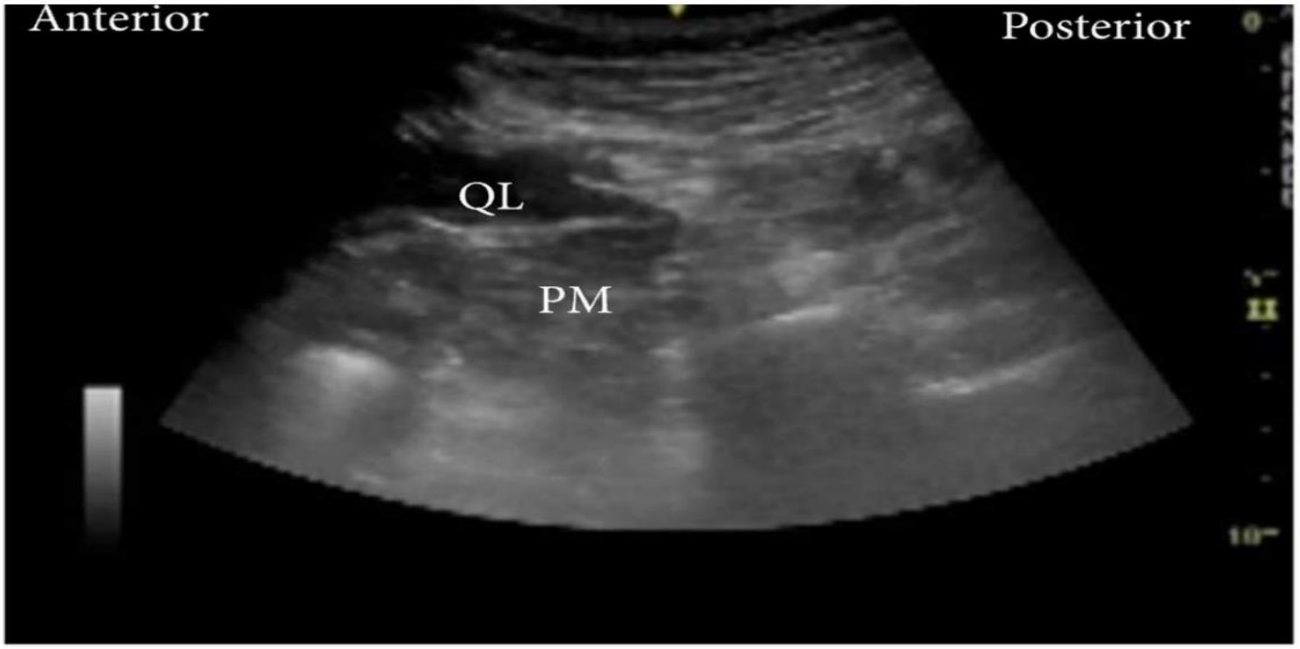



*Figure 23 QL BLOCK (TYPE 2)*

TYPE 3 (TRANSMUSCULAR APPROACH) :-

Here the drug placement is between the two muscles namely, Quadratus Lumborum and Psoas Major. By advancing the needle more towards intervertebral foramen, lumbar plexus can also be blocked.

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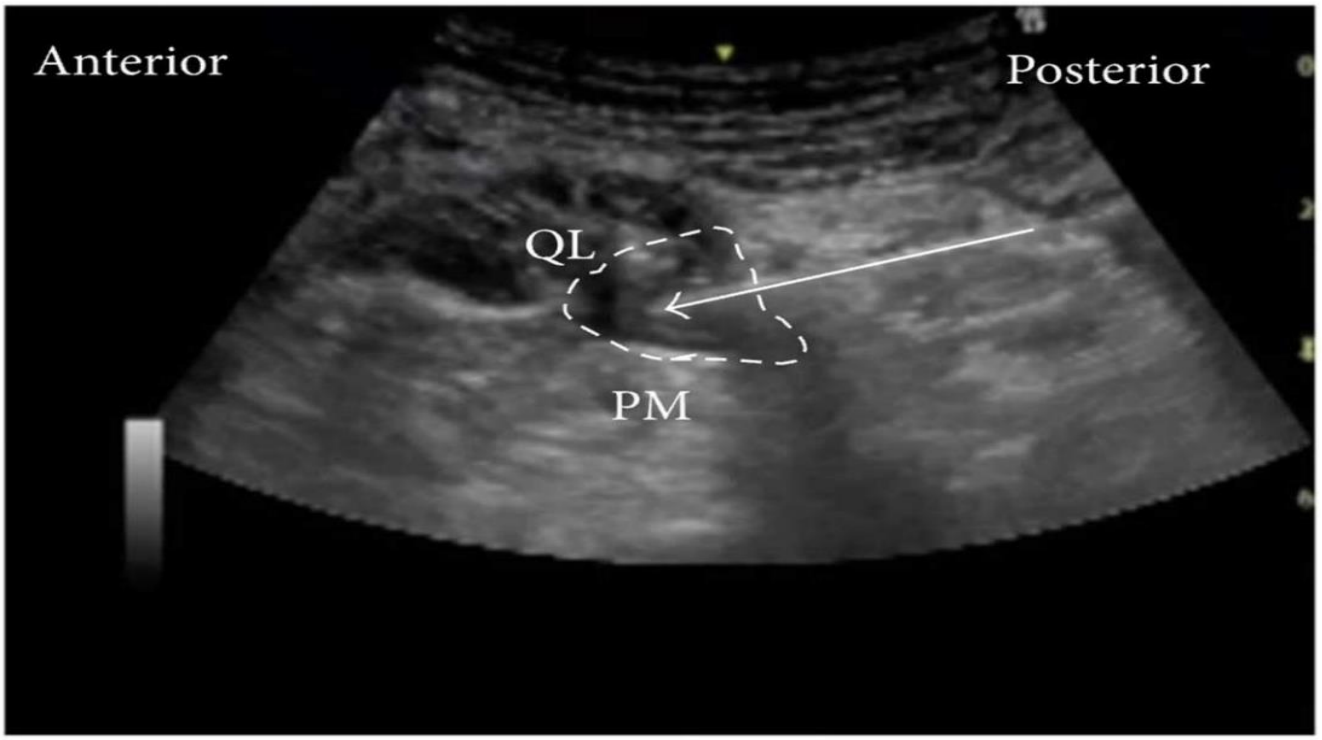



*Figure 25 QL BLOCK (TYPE 3)*

In QL block, the drug spreads into the paravertebral space lumbar nerve roots within the psoas major and quadratus lumborum muscle which contributes to the visceral and somatic analgesia.[43] Also the sympathetic fibers and mechanoreceptors over the thoracolumbar fascia, contribute in providing analgesia.[44] The mechanism of action of QL is guided by the anatomy, based on the close proximity of anterior border of QL muscle to lumbar plexus and paravertebral space. Due to potential spread of local anaesthetic to the paravertebral space quadratus lumborum block provided effective analgesia for total hip arthroplasty and decreasing opioid requirements for up to 48 hours postoperatively.[19] In cadaveric studies of QL blocks it was noted that QL blocks provided an extensive sensory blockade from T7–L4.[45]

**Inications for QL block: -**

QL block provide postoperative analgesia for abdominal, pelvic regions and can be used in the treatment of pain after abdominal, obstetric, gynecologic, and urologic surgeries since the spread of local anesthetic resulting in a large area of sensory inhibition of T7 to L4 in most of the cases. Also there are some case reports of QLBs successfully being used in the hip, femur, lumbar vertebrae surgeries and femoral-femoral bypass graft placement.[(46-48)]

**QL block is contraindicated if there is-[49]**

- No consent from the patient
- Allergy to the drug
- Infection at the site
- Bleeding diathesis

**The complications are-**

- Injury to the abdominal organs
- Nerve injury
- Sympatholysis
- Local infection

**TECHNIQUE OF QUADRATUS LUMBORUM BLOCK:**

• Iliac crest, costal margin, and posterior/midaxillary lines were identified as anatomical reference points.

• The patient was placed in the lateral decubitus position surgical side facing up with both legs flexed to provide better ergonomics for the operator and improve ultrasound imaging of relevant structures and the neuraxis.

• While the supine position may be suitable for lateral QL blocks (QL1 and QL2), it complicates visualization of neuraxial and paravertebral structures.

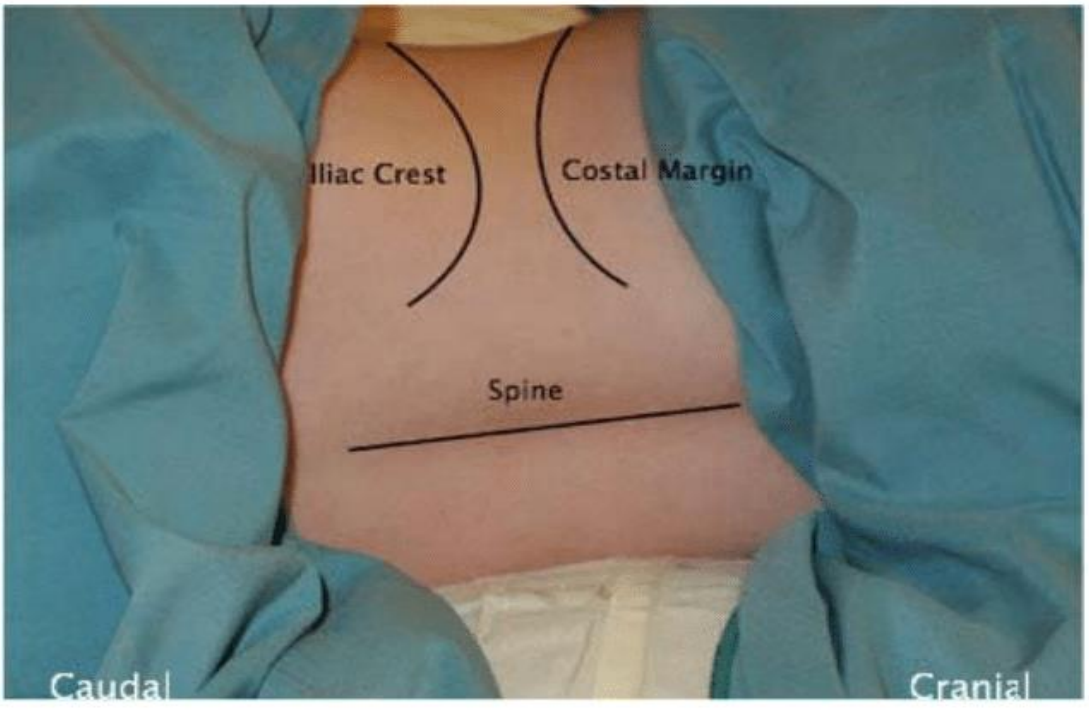



*Figure 26 patient position in right lateral decubitus*

• A 2–5 MHz low-frequency convex ultrasound probe was used. The probe was initially placed transversely along the anterior axillary line above the iliac crest to visualize the three abdominal muscle layers:

- External oblique (EO)
- Internal oblique (IO)
- Transversus abdominis (TA)

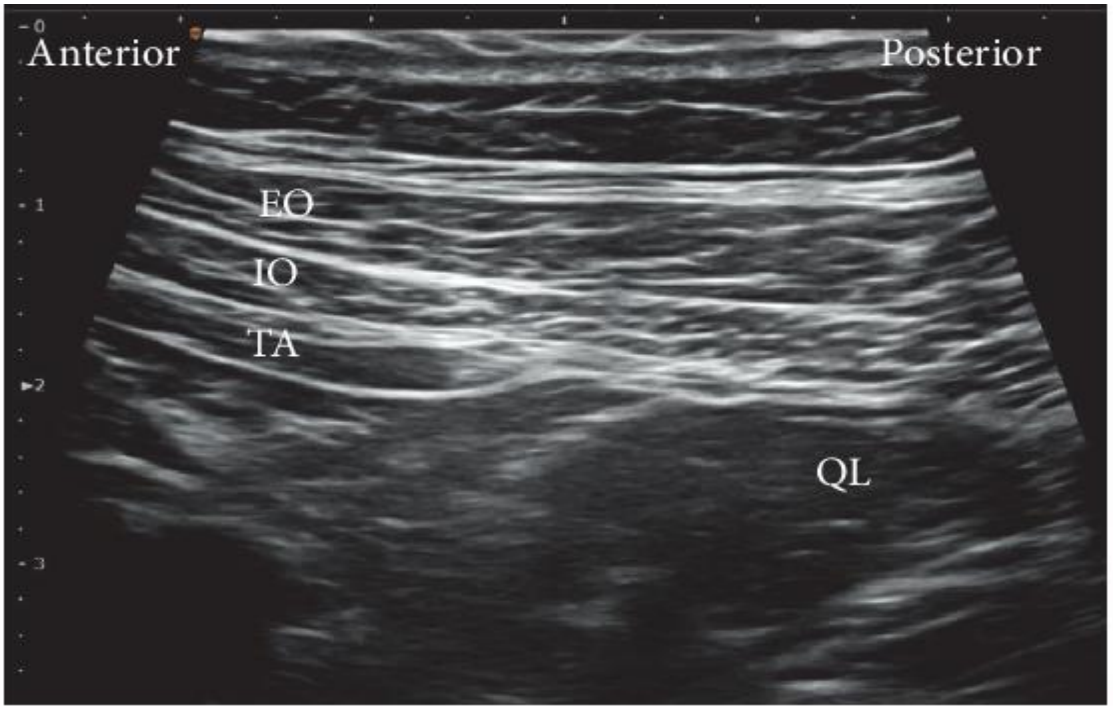



*Figure 27 USG image visualizing abdominal muscle layers (External oblique -EO, Internal oblique-IO, Transversus abdominis -TA with quadratus lumborum muscle in posterior side*

• The probe was moved posteriorly until the external oblique and internal oblique muscles transitioned into aponeurosis, and the latissimus dorsi and quadratus lumborum (QL) muscles became visible.

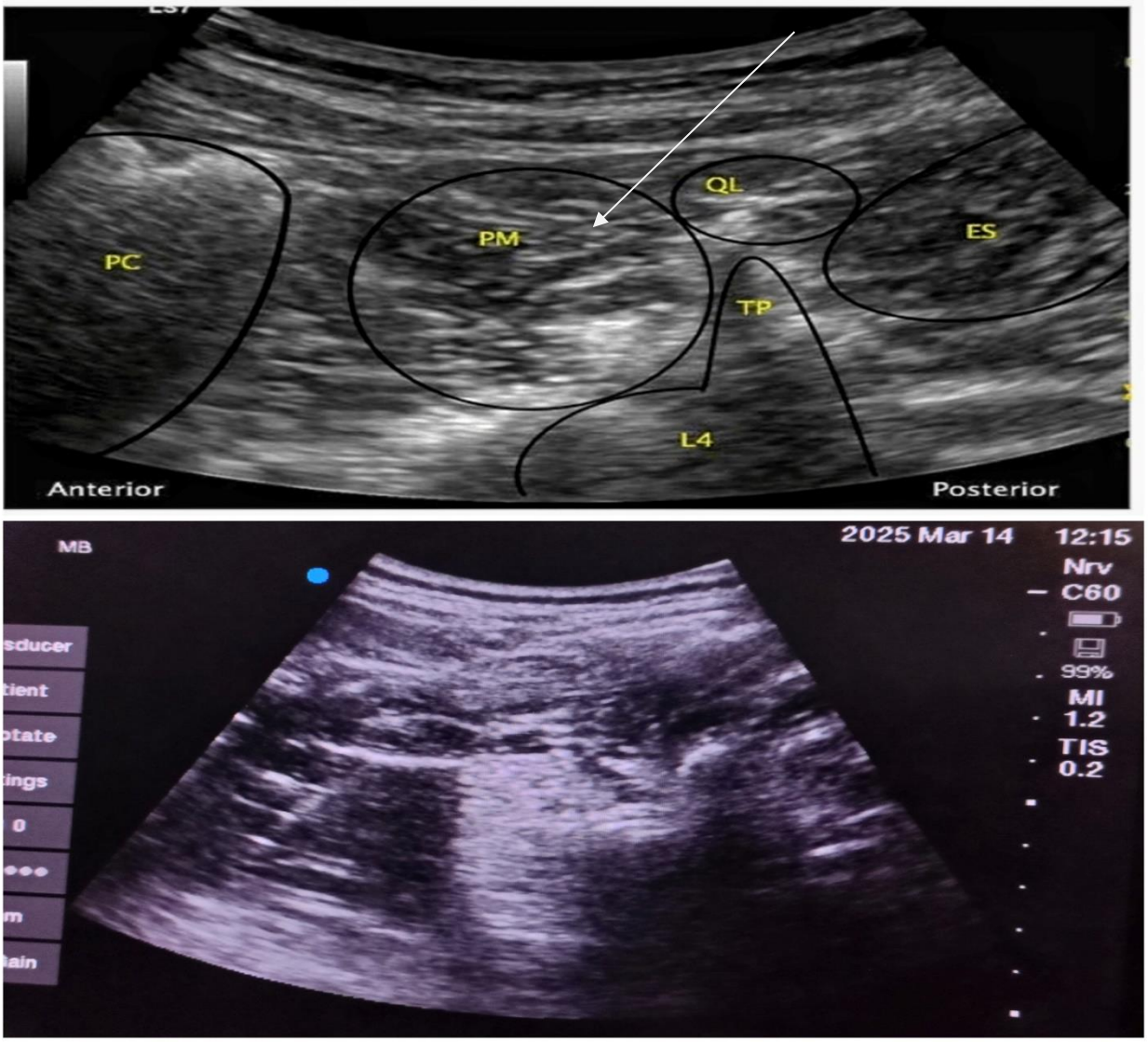



*Figure 28 The "shamrock sign" ES= erector spinae muscle, L4=fourth lumbar vertebra, TP= transverse process, PC= peritoneal cavity, PM= psoas muscle, QL= quadratus lumborum muscle, white line representing trajectory of needle*

- By moving the probe further posteriorly, the following structures were visualized, forming the shamrock sign:

  - Transverse process of the lumbar vertebra (stem of the shamrock)
  - Quadratus lumborum muscle (anterior leaf)
  - Psoas major muscle (posterior leaf)
  - Erector spinae muscle (posterior leaf)

- A 22-gauge needle, 80mm in length, is appropriate for deeper targets like the quadratus lumborum (QL) muscle, especially when approaching from a posterior-to-anterior direction.
- The needle connected to a 10cm extension is inserted in-plane (i.e., the entire needle is visible along the line of insertion) into the skin and directed towards the QL muscle. The needle is advanced posterior to anterior—this means that the needle is inserted from the back towards the front (anterior) part of the body, which is often used for better visualization of deeper structures and targeting the correct anatomical area.
- The needle tip should be placed between the psoas muscle and the fascial space of the quadratus lumborum muscle. This is a key point, as the QL block involves injecting local anesthetic into the fascial plane between the QL and psoas muscles, aiming to block the thoracolumbar fascia and associated nerves.
- After confirming the needle position with negative aspiration, local anaesthetic solution was injected: - Volume: 25ml of 0.25% bupivacaine, mixed with 8 mg of dexamethasone. Injection was performed in 5 mL increments while observing for the posterior spread of the local anaesthetic on ultrasound.
- The success of the Quadratus Lumborum (QL) block was confirmed by observing the ultrasound visualization of the fascial plane opening up between the quadratus lumborum (QL) muscle and the psoas major muscle after local anaesthetic injected.
- The injected fluid creates a clear separation of the fascial layers, ensuring the local anesthetic is deposited accurately between the two muscles in the intended space.

## PHYSIOLOGY OF PAIN[50-55]

- Pain is a subjective experience characterized by two complementary aspects. Firstly, it manifests as a localized sensation felt in a specific area of the body. Secondly, it embodies an unpleasant quality that varies in intensity, often compelling individuals to engage in behaviors aimed at alleviating or escaping the discomfort.
- The nerve endings present in most body tissues, are specific pain receptors respond only to damaging or potentially damaging stimuli. The messages generated by these painful stimuli are delivered to the spinal cord via unique, identifiable nerves. These nerve endings with the nerve attached to it together in tissue form a unit called the primary afferent nociceptor which communicates with second order pain transmission neurons in the spinal cord. Second-order cells communicate with higher centres such as the brain stem reticular formation, thalamus, somatosensory cortex, and limbic system via well-defined pathways. It is assumed that the thalamus and cortex play a primary role in pain perception.[50]
- Pain travels along three-neuron pathways that carry noxious stimuli from the periphery to the cerebral cortex.

**First-Order Neurons:**

At each cervical, thoracic, and sacral level, the majority of first-order neurons use the dorsal (sensory) spinal root to transmit the proximal end of their axons into the spinal cord. Axons of first-order neurons may form synapses with interneurons, sympathetic neurons, ventral horn motor neurons, and second-order neurons once they are in the dorsal horn.

**Second-Order Neurons:**

a) Afferent fibers enter the spinal cord in two sizes: large myelinated axons and small unmyelinated fibres. The first six laminae of the dorsal horn receive all afferent neuronal activity and serve as the principal site for pain modulation via ascending and descending neural pathways.

b) The Spinothalamic Tract.

c) Alternate Pain Pathways: Pain fibers rise with difficulty, both ipsilaterally and contralaterally, as with epicritic sensation; as a result, some individuals continue to experience pain after the contralateral spinothalamic tract is ablate. The spinomesencephalic tract, which projects to the periaqueductal grey, may play an important role in activating anti-nociceptive descending pathways.

d) Integration with the sympathetic and motor systems: Somatic and visceral afferents in the spinal cord, brainstem, and higher centers are completely integrated with the skeletal motor and sympathetic systems.

**Third-Order Neurons:**

Fibers from third-order neurons in the thalamus are sent to somatosensory regions I and II in the superior wall of the sylvian fissure and the postcentral gyrus of the parietal cortex, respectively.

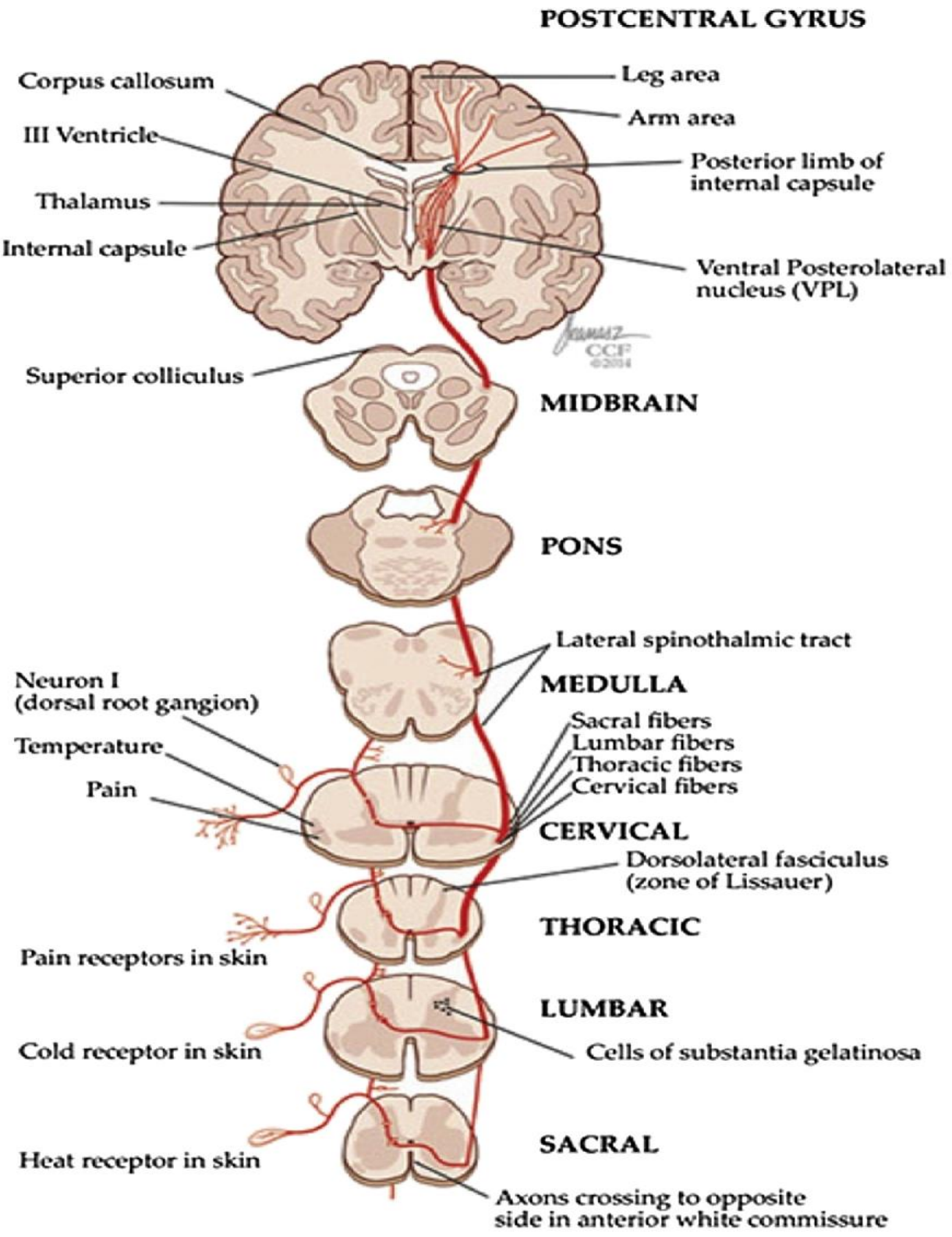



*Figure 29 physiology of pain*

• Pain and temperature signals from skin receptors go up the spinal cord to the postcentral gyrus via the lateral spinothalamic tract. First-order neurons convey sensory information via pseudounipolar neurons that enter the spinal cord through the Lissauer tract and synapse

in the Rexed lamina. Second-order neurons from the dorsal horn decussate at the ventral commissure and climb along the lateral spinothalamic tract before terminating in the ventral posterolateral nuclei of the thalamus. Third-order neurons then communicate with the postcentral gyrus.

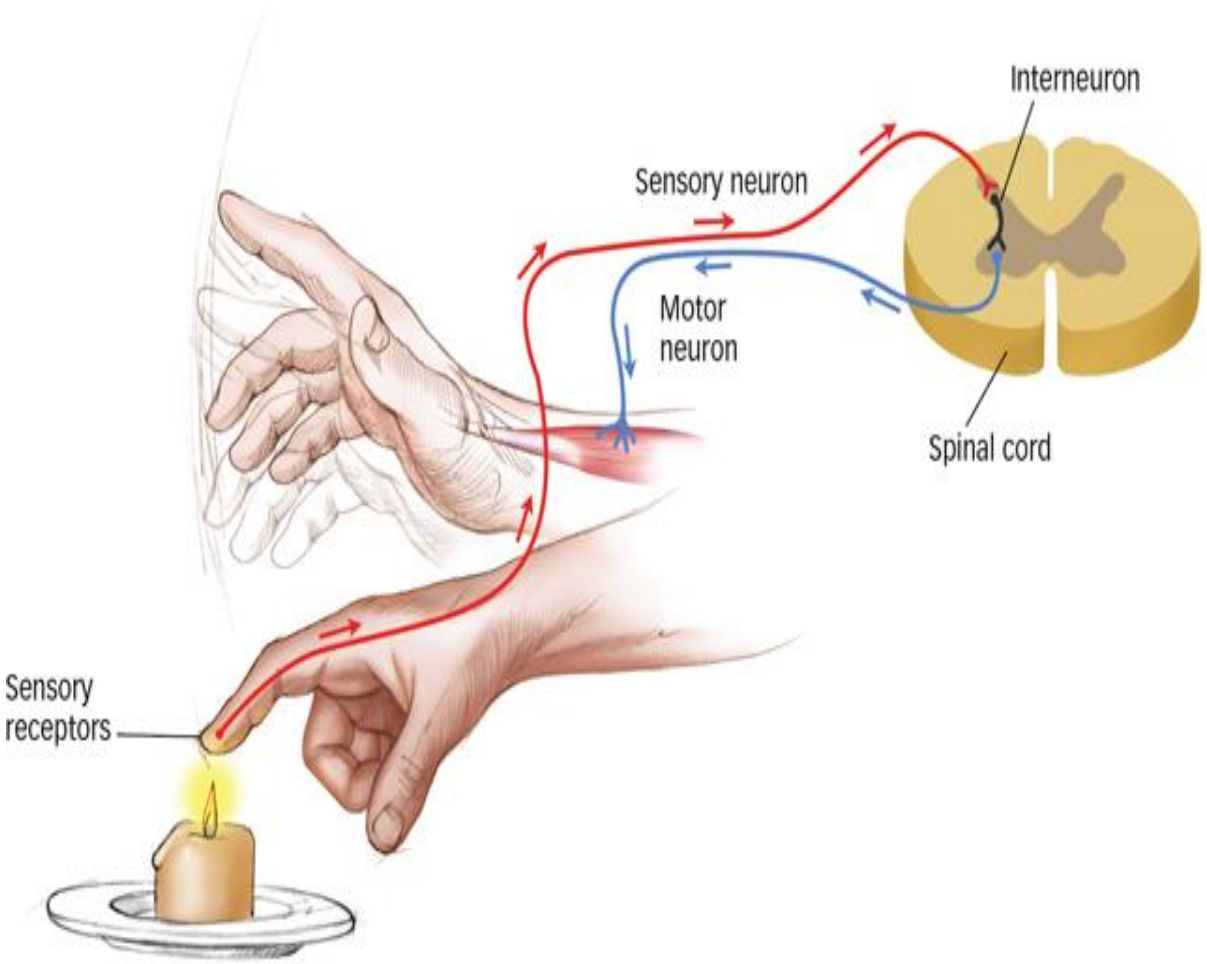



*Figure 30* ***The Pain Withdrawal Reflex***

- Pain has four components-
    1. Sensory-conscious perception
    2. Motor- withdrawal reflex
    3. Autonomic-tachycardia, perspiration
    4. Affective-anger

## GATE CONTROL THEORY OF PAIN: [56-57]

The Gate Control Theory of Pain, introduced in 1965 by Ronald Melzack and Charles Patrick (Pat) Wall, will completely change the field of pain research. Melzack and Wall state that cells in the substantia gelatinosa and "transmission" cells are the two separate areas of the spinal cord's dorsal horn where nociceptors, or pain fibers, and touch fibers synapse. Three regions of the spinal cord receive signals from primary afferent skin stimulation: 1. the substantia gelatinosa; 2. the dorsal column; and 3. a collection of cells referred to as transmission cells. They argued that the substantia gelatinosa in the dorsal horn modulates the flow of sensory information from primary afferent neurons to transmission cells, acting as a gate in the spinal cord. The big and small fibers' activities regulate this gating mechanism. The gate is inhibited (or closed) by large-fiber activity and facilitated (or opened) by small-fiber activity. Activity in descending fibers that extend to the dorsal horn from supraspinal locations may have an impact on this gate. Nociceptive input "opens the gate" and activates the pathways that result in pain

experience and pain-related behaviour’s when it surpasses the inhibition generated. The pain stimulus is not experienced if there is simultaneous stimulation by inhibitory impulses as well. Pain is delivered by A-delta and C fibers. A-beta fibres can override the pain stimulus by delivering information about touch and pressure simultaneously. Brain can decrease the pain intensity by activating endogenous pain suppression pathways. Neurotransmitters involved are serotonin and enkephalin.

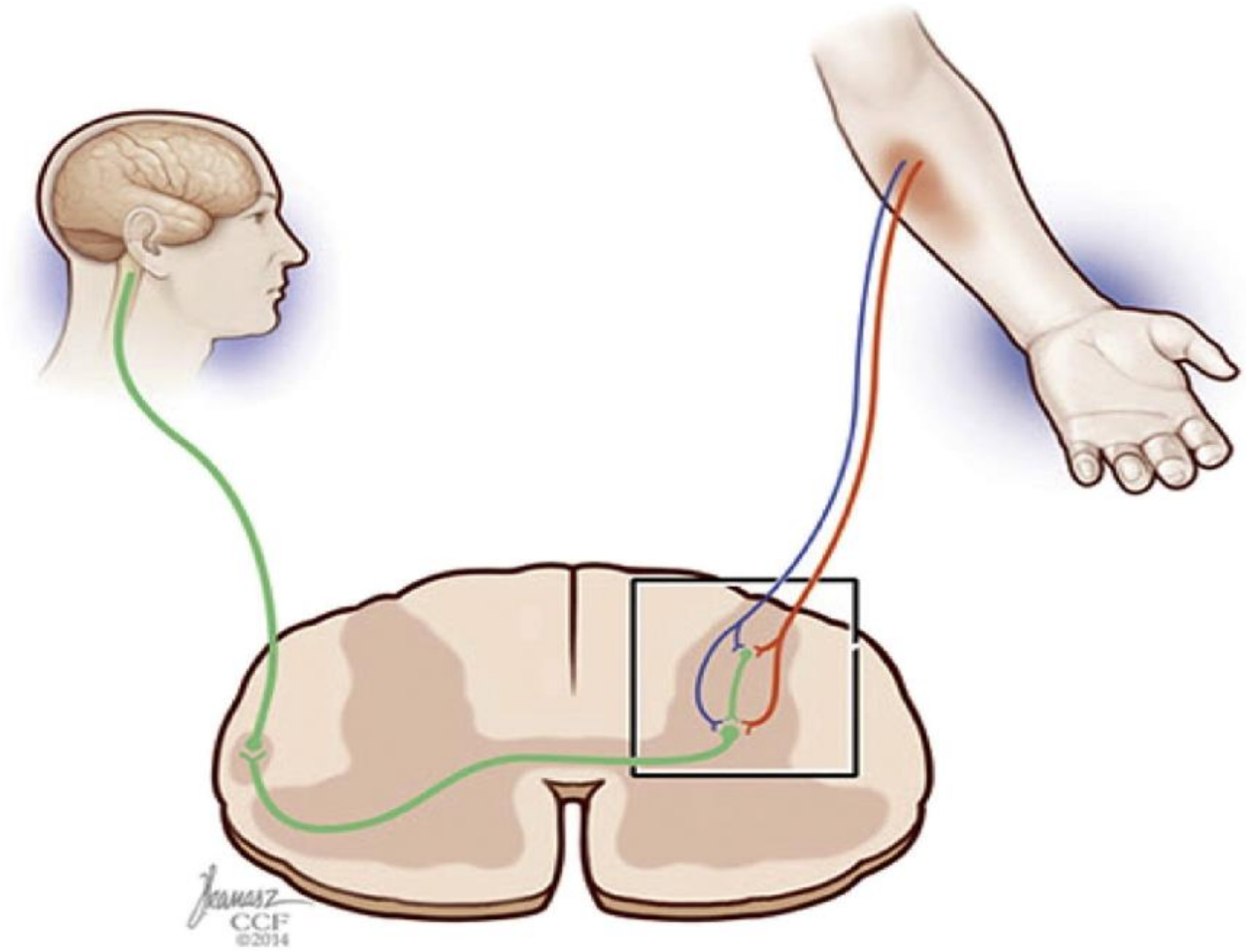



*Figure 31 Illustration of the gate control theory of pain.*

**Changes in each organ system due to pain are-**

- Heart-tachycardia, hypertension, arrhythmias
- Lungs-oxygen consumption is increased, increase in respiratory rate
- Blood-thrombosis
- Gut-decreased gut motility, ulceration, urinary retention
- Endocrine-increased catecholamines
- Immunology-increased total count
- Psychology-anger, anxiety, decreased sleep

## METHODS OF PAIN MEASUREMENT: [58-60]

The definition of pain, according to Merskey of the International Association for the Study of Pain (IASP), is "the sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage." Undimensional Pain Assessment Tools Visual analogue scales (VAS), categorical verbal rating scales (VRS), and categorical numerical rating scales (NRS) are three forms of unidimensional pain measuring instruments that were taken into consideration. These techniques are all frequently employed to gauge the degree of discomfort. Multidimensional Pain Measurement Devices, The McGill Pain Questionnaire, the Brief Pain Inventory, and the Memorial Pain Assessment Card were the three multidimensional scales that were taken into consideration. To accurately evaluate the subjective nature of pain, we must rely on the patient's expression because it is impossible to ascertain the exact amount of nociception that arises in response to tissue injury for each particular patient. A thorough model was put forth by the multimodal pain center's loser at the University of Washington. Suffering causes pain, and pain causes painful behaviours, which can be seen as –

• Withdrawing

• Grimacing

• Crying

• Asking for analgesics

Thus, based on the patient's report of pain, one can measure pain intensity and response to analgesic medications.

**Introspective Method:**

Patient or trained attender attempts to assess pain.

**Behavioural Method:**

Certain physiological markers that alter when pain is present, such tachycardia, tachypnoea, and high blood pressure, can be assessed objectively and connected to pain severity.

Visual Analog Scale (VAS): In 1966, Attken wrote about what is now the most popular method: the visual analogue scale (VAS). A 10 centimeter horizontal or vertical line is drawn, with the words "no pain" at one end and "the worst pain one can imagine" at the other. The subject's level of pain is indicated by the mark's location on the line.

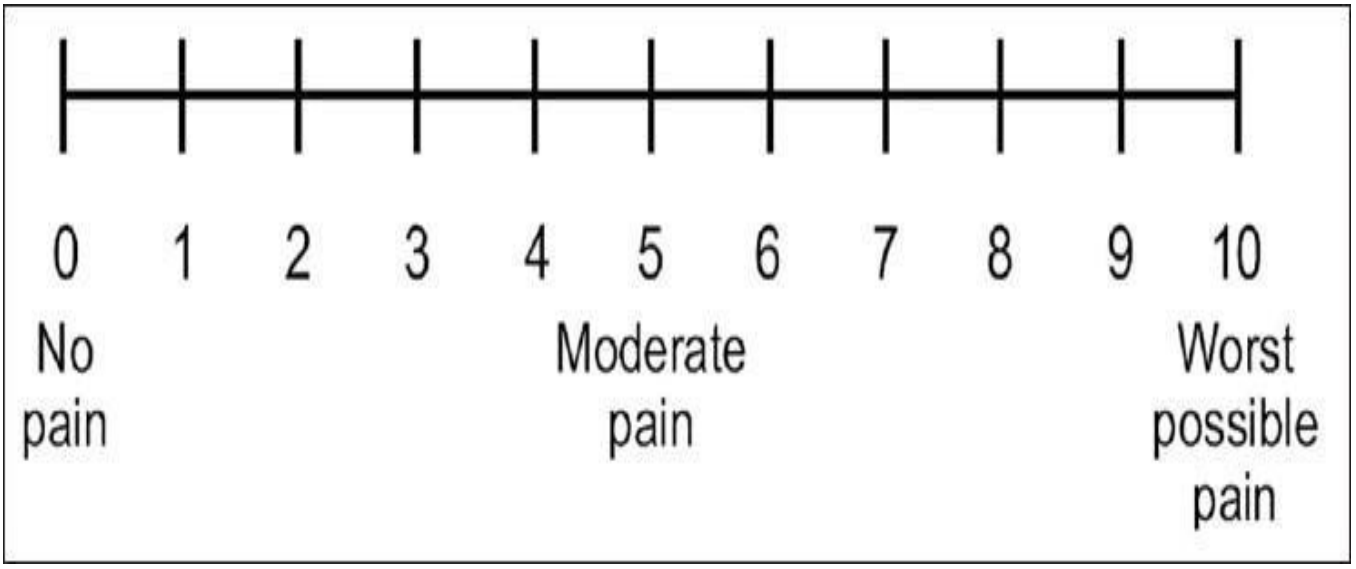



*Figure 32 Visual analogue scale*

Precise assessment of pain is essential for evaluating patient progress and therapy effectiveness. A dependable and consistent method for determining the intensity of pain is the visual analogue scale (VAS). A common interpretation of the VAS is that it measures pain linearly. The VAS measures the degree or reduction of pain in order to evaluate analgesic therapy.

The Visual Analogue Scale (VAS) has been used to measure intangible values such as concern, pain, and quality of life since the 1920s. In terms of pain, it consists of a line, typically 100 mm long, with anchor descriptions like "no pain" and "worst pain imaginable." A mark representing the patient's perception is made, and the millimetres between the mark and the left endpoint are measured. The VAS was first used in psychology to assess mood disorders, but starting in the middle of the 1960s, it was also used to assess pain. The scale could be vertical or horizontal. The Verbal Rating Scale (VRS), which employs intermediate adjectives (such as "mild," "moderate," and "severe"), is an alternative to the VAS.

Millimetres are measured, and the result is translated into pain, from the left end of the scale to the patient's marks. The findings can be used to track a patient's pain development or to assess how much pain a patient is experiencing in relation to other patients who may have comparable conditions. The scale was used to evaluate ambulation, mood, hunger, asthma, dyspepsia, and pain in addition to other conditions. Despite conflicting evidence about the advantages of the VAS over alternative pain measurement techniques, it remains a commonly used tool in both professional and domestic contexts.

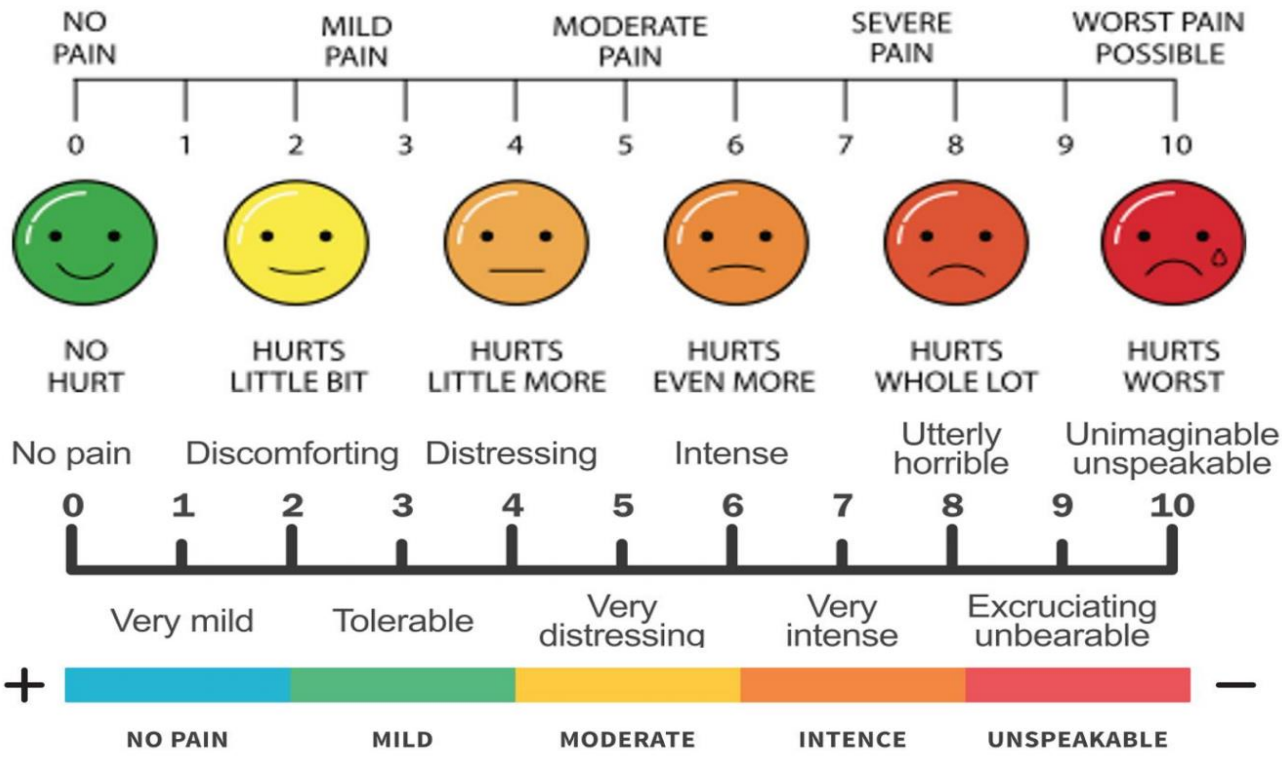



*Figure 33 Visual Analogue Scale facial expressions*

The WONG-BAKER pain rating scale and Visual Analogue Scale facial expressions: It is a pictorial self-assessment tool which includes six faces. Each face conveys different emotions which range from a face with a cheerful smile to a face with a crying one. It is popular among the population such as younger patients, elderly patients or patients with disorientation or even in patients who cannot comprehend local language or any sort of difficulty in communication.

## ULTRASONOGRAPHY:

Sound waves having a frequency more than 20,000 cycles every second are referred to be ultrasound.

### HISTORY OF ULTRASOUND GUIDANCE FOR NERVE BLOCKS:

Ting and Sivagnana Ratnam is the first to conduct blocks using ultrasonography in 1989.[61] They continuously observed the nerves around the subclavian artery, the needle point, and the distribution of local anaesthesia and had a 100% success rate with axillary nerve blocks. Kapral et al[62] Ultrasound guiding during supraclavicular blocks was found to be both safer and more efficient than axillary nerve blocks in 1994. In 1997, they demonstrated that "three-in-one" ultrasound-assisted hip joint and lower limb blocks were more effective than nerve stimulation.[63] Under ultrasound guidance, the amount of local anaesthesia required to execute an efficient nerve block also became reduced.[64] The greater brachial plexus pictures produced by ultrasound-based research in Toronto have enhanced the use of ultrasonography for nerve location.[65]

### PRINCIPLE OF ULTRASONOGRAPHY:

Sound waves are used in ultrasonography to produce pictures of the objects they pass through. Ultrasonic waves are created by piezoelectric crystals inside the ultrasound transducer probe. When these crystals are exposed to an electric current, they rapidly change form, vibrate, and generate ultrasonic waves. The piezoelectric effect transfers electrical energy into mechanical energy. These waves move at varying speeds through tissues of varying densities, transducer return the signal. The piezoelectric effect occurs when the mechanical energy of returning echoes is converted by the crystals into an electric

current, this is then converted into a two-dimensional grayscale display. As a result, the same crystals are employed to send and receive sound waves.

**Basic Principles of Ultrasound-Guided Nerve Blocks:**[79]

- Real-time Imaging: Ultrasonography allows visualization of nerves, blood vessels, muscles, and other structures during the procedure.
- Needle Visualization: It helps in accurately guiding the needle to the target nerve, reducing the risk of complications like inadvertent vascular puncture or nerve damage.
- Local Anaesthetic Spread: The technique allows real-time observation of the spread of local anaesthetic (LA) around the nerve, ensuring optimal block and avoiding overdose.

**Ultrasonography Techniques Used in Nerve Blocks:**

1. In-Plane Technique (Long Axis View):
    - Needle Insertion: The needle is introduced in parallel to the ultrasound probe, allowing visualization of the entire needle from tip to hub as it moves toward the target nerve.
    - Advantages: Continuous real-time visualization of the entire needle path, reducing the risk of accidental puncture of adjacent structures like blood vessels.
    - Commonly Used For: Blocks like brachial plexus, femoral nerve, and popliteal nerve blocks.
2. Out-of-Plane Technique (Short Axis View):

- Needle Insertion: The needle is inserted perpendicular to the ultrasound probe. The tip of the needle is visualized as a "dot" or "line" crossing the view.
- Advantages: Easier to perform in some anatomical sites (e.g., lumbar plexus block), especially in patients with difficult anatomy or in deep locations.
- Disadvantages: Risk of losing sight of the needle tip if not carefully monitored.
- Commonly Used For: Sciatic nerve, spinal anaesthesia, and certain paravertebral blocks.

3. Dynamic Needle Guidance:
    - Continuous Monitoring: In this technique, the needle is visualized and advanced in real-time on the ultrasound screen, allowing the operator to adjust the needle position dynamically.
    - Advantages: Ensures accurate placement of the needle at the target site and monitoring of LA spread.
    - Commonly Used For: Blocks like interscalene, supraclavicular brachial plexus, and lumbar plexus blocks.
4. "Pop Technique" (Ultrasound-Directed Injection):
    - Needle Advancement: As the needle advances into the correct plane near the nerve, the local anaesthetic is injected slowly under real-time visualization.
    - Pop Sensation: A sudden increase in resistance ("pop") is often felt when the needle tip enters the epineural space (e.g., in interscalene block).
    - Advantages: Provides direct visualization of LA injection and nerve separation. The "pop" sensation is a sign of proper needle placement.

**Benefits of Ultrasonography in Nerve Blocks:**

- Increased Accuracy: Provides precise needle placement, ensuring optimal LA spread around the nerve.
- Reduced Complications: Minimizes the risk of intravascular injection, nerve injury, or pneumothorax.
- Faster Onset of Block: Direct visualization of the LA injection helps in ensuring faster and more reliable block onset.
- Better Patient Safety: Real-time imaging of surrounding structures like blood vessels and other nerves reduces complications.
- Reduced Needle Insertion Attempts: Since the needle tip and target nerve are visualized, the number of needle insertions can be reduced.

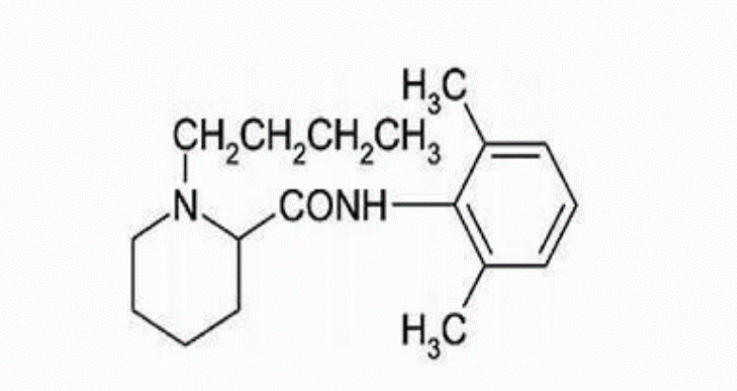
**Challenges and Limitations:**

- Obese Patients: The increased thickness of subcutaneous tissue can reduce the quality of ultrasound imaging.
- Operator Skill: The accuracy of ultrasound-guided nerve blocks depends on the skill of the operator in both imaging interpretation and needle placement.
- Inadequate Visualization: In some patients, especially those with complex or atypical anatomy, finding the nerve can be challenging.
- Depth of Nerve: Deep nerves may require high-frequency probes or longer needles, and in some cases, ultrasound may not provide adequate resolution.

**BUPIVACAINE:**


Figure 34 The Bupivacaine 0.25%

Bupivacaine is one of the homologous series developed by Ekenstam in 1957, and LJ Telivuo was the first to use it. the first to employ it in clinical practice in 1963. Bupivacaine is a tertiary amine that is separated from an aromatic ring system by a chain in the form of bupivacaine hydrochloride, which is a monohydrate of two piperidine carboxamide, one butyl N-2, and six dimethyl phenyls, a benzene ring, is. It is categorized as an aminoamide molecule since the chain has an amide bond (-NHCO-). The amide bond improves the anaesthetic substance's potency. [66-68] Because of higher lipophilicity, the safe dosage for bupivacaine is 2-3 mg/Kg, which is more potent and produces blocks that last longer.




Chemical formula of Bupivacaine:

1-n-butyl-DL-piperidine-2-carboxy acid -2-b-dimethyl anilide hydrochloride.

*Figure 35 Bupivacaine chemical structure and formula*

**The following formulations are utilized in clinical settings:**

- For Infiltration - 0.125% to 0.25%,
- For peripheral nerve blocks- 0.25% to 0.5%,
- Surgical or obstetrical epidural- 0.125%-0.75%,
- Subarachnoid blocked- 0.5% heavy.

**Chemical properties of bupivacaine:**

Molecular weight of base: 288

Molecular weight of chloride ($cl^-$): 324

Protein binding capacity: 96%.

pKa = 8.2 at 25 degrees

specific gravity:- 1.0.35 – 1.040

**ADJUVANTS:**

Bupivacaine's duration of action is extended when adjuvants are added. α-2 agonists (Clonidine, Dexmedetomidine), dexamethasone, ketamine, fentanyl, magnesium, and sodium bicarbonate are among the medications used as adjuvants that have been shown to be beneficial.

**Pharmacodynamics:**[69-71]

1)Majority of the tissue uptake of drug is by lipophilic absorption. By inhibiting sodium channels, local anaesthetics prevent neurons from firing. To inhibit impulses, it lowers currents in voltage-activated Na + channels. Although it does diminish K+ currents, the inhibition is not specific. Bupivacaine stops voltage-gated Na+ channels from opening by binding to specific sites on the channels and preventing conformational changes. A larger percentage of sodium channels are blocked with increasing concentrations of the local anaesthetic. Excessive bupivacaine plasma levels cause toxicity and unfavourable systemic responses. Pregnancy, hypoxia, and hypercarbia enhance the risk of poisoning.

2)Axon diameter, nerve fiber myelination, and conduction velocity are factors that affect how sensitive nerve fibers are to local anesthetics.

• Smaller nerve fibers and slow conductivity are more sensitive. For example, C fibers

• Larger and faster-conducting fibers are less sensitive. For example, A-δ fiber

3)Myelinated fibers are more sensitive than unmyelinated fibers. The following is the order in which local anesthetics are administered to impede nerve function:

Autonomic → sensory (pain→temperature→touch→proprioception) → motor.

**Pharmacokinetics:** [67,68,72]

The blood concentration of bupivacaine is determined by a number of factors including the site, dose, rate of administration, distribution in tissue and biotransformation of the drug. Vasoconstrictors used sometimes along with also determine the blood concentration and so the excretion rate. Highly perfused tissues have higher concentrations of drug with lungs extracting the drug quickly and skeletal muscles containing highest percentage of local anaesthetic dose injected. Enzymatic degradation of bupivacaine is done by liver however,

excretion is by kidneys. After conversion into its metabolites, 95% of the drug is eliminated in urine, and the leftover drug is excreted unchanged. Protein binding capability and urine pH determine the drug's renal clearance.

**Side effects**: [73,74]

Although there is little chance of adverse effects at the proper dosage, it is significantly more cardiotoxic than lignocaine and is exacerbated by hypoxia, pregnancy, and hypercarbia. The central nervous system is more prone to toxicity with Lightheadedness and dizziness are the first symptoms, followed by hearing and vision issues. Muscle twitches, perioral numbness, and shivering are seen in certain cases. Respiratory and cardiac arrest are risks associated with elevated blood concentrations. Bupivacaine inhibits the rapid phase of depolarization in purkinje fibers and ventricular muscles more than lignocaine does, and it also causes a shorter recovery from dependent block. Bupivacaine has an antiarrhythmic effect, but lignocaine has an arrhythmogenic effect because of the restricted restoration of V-max during high-rate nerve impulses. Bupivacaine decreases ventricular tachycardia, but lignocaine increases it. Sometimes reaching a high plasma level might cause respiratory depression, which can lead to depression of the medullary respiratory center. Because preganglionic beta fibers transmit impulses more quickly, they are more susceptible to local anaesthetics. Significant vasodilation and ensuing hypotension are caused by preganglionic sympathetic fibers participating in central neuraxial blocking. When administered for conduction block, bupevacaine produces sensory block more quickly than motor block.

**Management of bupivacaine toxicity:** [68,75]

A variety of strategies should be taken into account to avoid toxicity. A few things to think about are slowly injecting, limiting medication dose, using ultrasound-guided procedures, and aspiration technique prior to injection.

**Treatment:**

- To begin with, injecting local anaesthetic should be stopped immediately.
- Maintaining oxygenation, giving 100% oxygen, and securing the airway if necessary are all part of the initial care to avoid hypoxia, hypercapnia, and acidosis.
- Benzodiazepines are the primary line of therapy for convulsions.
- Low doses of muscle relaxants might be given if the convulsions continue.
- Lipid emulsion therapy- Lipid emulsion administered intravenously works by moving bupivacaine from blood-rich organs like the heart to storage or metabolic sites like the liver and muscles. The suggested dosage is a fast bolus of 100 ml of 20% lipid emulsion for an adult weighing 70 kg, followed by 200–250 ml over the following 15–20 minutes. A 1.5 ml/kg bolus followed by 0.25 ml/kg/min is advised for patients weighing less than 70 kg.
- ACLS algorithms should be followed for resuscitation in case of a cardiac arrest.

## DEXAMETHASONE:[76-78]

Synthetic adreno-cortical steroids like dexamethasone have anti-inflammatory properties. In 1958, it was first described. It has 30–40 times the potency of hydrocortisone and 16 times the potency of prednisone.

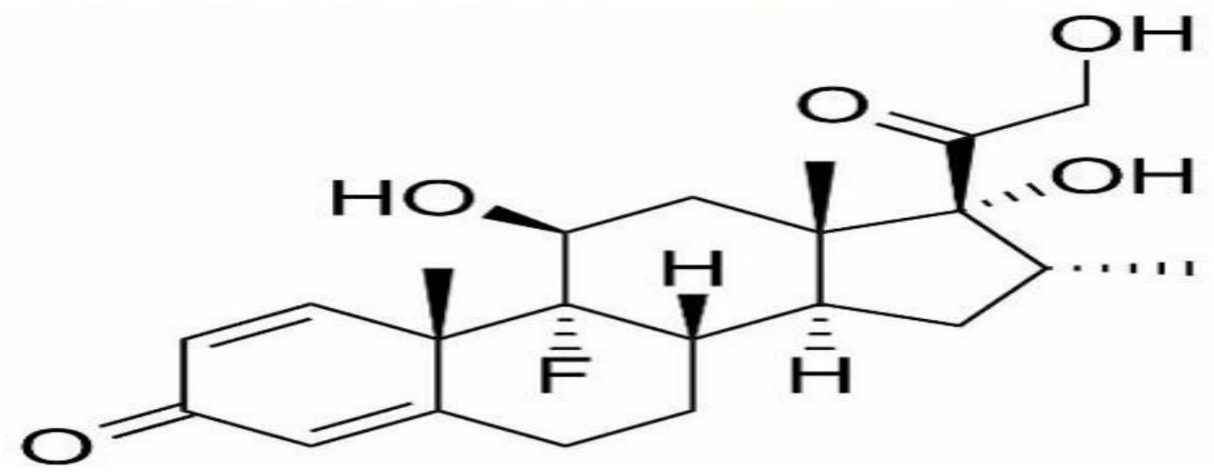



*Figure 36 CHEMICAL STRUCTURE OF DEXAMETHASONE*

Chemical formula: - 9-FLURO-11β, 17, 21-TRIHYDROXY-16α-METHYLPREGNA-1,4-DIENE- 3,20-DIONE, 21- (DIHYDROGEN PHOSPHATE)

The mechanism of action of dexamethasone is centered on its interaction with glucocorticoid receptors (GRs) and subsequent downstream effects, leading to its anti-inflammatory, immunosuppressive, and metabolic effects. Here's a structured explanation:

1. Interaction with Glucocorticoid Receptors (GRs):

- Intracellular Receptors: Glucocorticoid receptors (GRs) are primarily located in the cytoplasm in an inactive state, bound to chaperone proteins (e.g., heat shock proteins).

- Activation: Dexamethasone binds to the GR, causing conformational changes that dissociate it from the chaperone proteins.
- Translocation: The activated GR-dexamethasone complex translocates to the nucleus, where it interacts with specific DNA sequences known as glucocorticoid response elements (GREs).

2. Gene Transcription and Modulation:

- Positive Regulation: The GR complex binds to GREs, leading to the induction of transcription of genes that have anti-inflammatory and immunosuppressive effects.
    - For example, lipocortin-1 (annexin-1) inhibits phospholipase A2, reducing prostaglandin and leukotriene synthesis.
- Negative Regulation: GRs suppress transcription of genes responsible for pro-inflammatory mediators.
    - Suppression of genes encoding cyclooxygenase-2 (COX-2), inducible nitric oxide synthase (iNOS), and inflammatory cytokines (e.g., IL-1, IL-2, IL-6, TNF-α).

3. Key Biological Effects:

- Anti-inflammatory Effects:
    - Reduces the production of prostaglandins, leukotrienes, bradykinin, and collagenase.
    - Inhibits migration and activation of neutrophils and reduces lymphocyte proliferation.

- Immunosuppressive Effects:
    - Suppresses cytokine production and decreases the number of circulating lymphocytes.
- Vascular Effects:
    - Reduces capillary permeability, thereby controlling edema.
- Pulmonary Effects:
    - Enhances surfactant production and improves pulmonary circulation, aiding in respiratory conditions.

4. Clinical Relevance:

- The anti-inflammatory and immunosuppressive actions of dexamethasone make it effective in treating:
    - Autoimmune disorders
    - Allergic reactions
    - Pulmonary conditions like ARDS (acute respiratory distress syndrome)
    - Cancer-related inflammation and edema (e.g., in brain tumors).

**Pharmacokinetics of Dexamethasone:**

1. Absorption

- Oral Administration:
    - Dexamethasone is well-absorbed from the gastrointestinal tract with high oral bioavailability (~70-90%).

    - Its lipid-soluble structure facilitates easy passage across cell membranes, enhancing absorption.
- Intravenous (IV) Administration:
    - Administering dexamethasone via IV rapidly achieves high plasma concentrations.
    - This route is often used in emergencies (e.g., cerebral edema, anaphylaxis) due to the immediate onset of action.
- Intramuscular (IM) Administration:
    - IM injections provide a depot effect, releasing dexamethasone slowly into the systemic circulation, resulting in a prolonged duration of action compared to IV administration.
- Topical or Local Administration:
    - When applied locally (e.g., intra-articular injections for joint inflammation or inhalation for respiratory conditions), dexamethasone is absorbed into systemic circulation in small amounts.
- Bioavailability from Other Sites:
    - Dexamethasone absorption has been demonstrated in synovial spaces (joints), the respiratory tract (inhaled forms), and through the skin in specific topical preparations.

2. Distribution

- Plasma Protein Binding:
    - Dexamethasone binds reversibly to plasma proteins (~77-90%), primarily:

        - Corticosteroid-Binding Globulin (CBG), also known as transcortin, a high-affinity, low-capacity protein.
        - Albumin, a low-affinity, high-capacity protein.
    - Protein binding reduces free (active) drug concentration, but the equilibrium ensures a steady release of the active drug when bound proteins dissociate.
- Volume of Distribution (Vd):
    - Dexamethasone has a moderate volume of distribution (Vd ~1.3 L/kg), allowing it to penetrate tissues, including the central nervous system (CNS).
- CNS Penetration:
    - Due to its lipid solubility and ability to cross the blood-brain barrier, dexamethasone is effective in reducing CNS inflammation, such as cerebral edema.
- Placental Transfer:
    - Dexamethasone crosses the placenta and is sometimes used in obstetric settings, such as promoting fetal lung maturation in preterm labor.

3. Metabolism:

- Site: Primarily metabolized in the liver by hepatic enzymes.
- Pathways:
    - Phase I Metabolism:
        - Reduction of the steroid molecule to dihydro- and tetrahydro-derivatives by hepatic cytochrome P450 enzymes.
        - For example, cortisol is reduced to tetrahydrocortisol.

    - Phase II Metabolism:
        - Conjugation of these derivatives with glucuronic acid or sulfate in the liver via enzymatic processes.
        - These conjugated metabolites are more water-soluble, facilitating excretion.
- Impact of Liver Function:
    - Impaired liver function (e.g., cirrhosis) may delay dexamethasone metabolism, prolonging its half-life.

4. Excretion:

- Primary Route: Renal (kidneys).
    - Conjugated metabolites (water-soluble forms) are excreted in the urine.
- Half-Life:
    - Plasma half-life: 36-54 hours, which is significantly longer than endogenous glucocorticoids like cortisol.
    - Biological half-life (duration of action): ~24-72 hours, making it suitable for once-daily dosing in many conditions.
- Factors Affecting Excretion:
    - Conditions like renal impairment may reduce the rate of excretion, leading to prolonged drug effects.

**Comparison with Other Glucocorticoids:**

- Potency:
    - Dexamethasone is 25-30 times more potent than cortisol and has a longer duration of action.
- Mineralocorticoid Activity:
    - Dexamethasone has minimal mineralocorticoid activity, reducing its effect on sodium retention and blood pressure compared to other glucocorticoids like hydrocortisone.

**Clinical uses:**

1) Used as replacement therapy in adrenal insufficiency (e.g., Addison's disease).
2) Aids in the diagnosis of hypercortisolism via the dexamethasone suppression test (DST).
3) Treats autoimmune and rheumatic diseases such as systemic lupus erythematosus (SLE), rheumatoid arthritis, polyarteritis nodosa, and Wegener's granulomatosis.
4) Administered as local injections for osteoarthritis, tendinitis, and bursitis.
5) Effective in renal diseases like nephrotic syndrome, membranous glomerulonephritis, and lupus nephritis.
6) Acts as a supplement in treating allergic diseases like anaphylaxis, hypersensitivity reactions, and serum sickness.
7) Reduces airway inflammation in pulmonary conditions, including asthma and COPD exacerbations.

8) Prevents respiratory distress syndrome (RDS) and intraventricular hemorrhage (IVH) in preterm neonates by promoting fetal lung maturity.
9) Used as adjunctive therapy for infections, including Pneumocystis jirovecii pneumonia, Haemophilus influenzae meningitis, and severe COVID-19.

10)Applied topically for ocular diseases like uveitis and allergic conjunctivitis, and for skin conditions like eczema and psoriasis.

11)Included in oncology regimens to treat leukemia and lymphomas, manage cerebral edema, and prevent chemotherapy-induced nausea and vomiting (CINV).

12)Administered in high doses to reduce cerebral edema caused by brain tumors, trauma, or infections.

13)Prevents post-operative nausea and vomiting (PONV) in surgical patients.

14)Treats autoimmune hematological disorders, such as immune thrombocytopenic purpura (ITP) and hemolytic anemia.

**Adverse effects:**

Adverse effects include increased susceptibility to infections owing to immunosuppression, myopathy, which is the weakness of the muscles in the proximal limbs, cataracts, osteoporosis, osteopenia, osteonecrosis, reduced glucose tolerance, and adrenal suppression upon withdrawal.

## ROLE OF DEXAMETHASONE IN ANAESTHESIA:

1. Prevention of Post-Operative Nausea and Vomiting (PONV):
    - Dexamethasone is widely used to prevent PONV, a common issue after general anaesthesia, reducing patient discomfort and promoting a smoother recovery process. It works by inhibiting inflammation in the gastrointestinal tract and central nervous system.
2. Post-Operative Pain Relief:
    - Dexamethasone aids in pain relief post-surgery by inhibiting cyclooxygenase (COX) and lipoxygenase, enzymes involved in the inflammatory response.
    - It suppresses inflammatory, metabolic, and immune responses to surgical stimuli, helping to reduce pain and swelling.
    - When administered intravenously, it decreases post-operative pain, extends sensory block duration when used with spinal anaesthesia, and enhances peripheral nerve block duration.
    - Epidural dexamethasone works by stabilizing nerve membranes and acting on transcription factors like NFKB, prolonging post-operative anaesthesia and analgesia.
    - When administered perineurally, it causes vasoconstriction, which slows the absorption of local anaesthetics (LA) and reduces rebound pain.
    - Optimal Dose and Timing: A dose of 0.1–0.2 mg/kg, given 60 minutes before the surgical incision, provides significant pain relief and has an opioid-sparing effect.
3. Effect on Neuromuscular Blockade:

- Dexamethasone can reduce the duration of neuromuscular blockade induced by rocuronium and cis-atracurium by 15–20% when administered 2–3 hours before surgery.
- This effect can help speed up recovery from muscle relaxation, improving the post-operative recovery process.

4. Prevention of Post-Operative Shivering:
    - Shivering increases sympathetic activity, oxygen consumption, and can delay post-operative recovery.
    - Dexamethasone reduces shivering by decreasing the temperature gradient between the skin and core body, improving thermoregulation.
    - Studies show that it is more effective than pethidine in preventing post-operative shivering, enhancing patient comfort after anaesthesia.
5. Improved Postoperative Recovery:
    - At a dose of 0.1 mg/kg, dexamethasone enhances the quality of recovery following surgery by reducing inflammation, minimizing opioid requirements, and facilitating faster mobilization and return to baseline function.
6. Prevention of Postoperative Sore Throat:
    - Postoperative sore throat is a common and distressing complication following general anaesthesia, especially with the use of endotracheal tubes.
    - Dexamethasone reduces the incidence of postoperative sore throat when administered via IV, topical application, or nebulization, with nebulization being the most effective technique for prevention.

## TRAMADOL [77,80,81]

Tramadol is a centrally acting synthetic opioid analgesic, often used for moderate to severe pain management. Its pharmacological effects are due to its dual mechanism of action, involving both opioid receptor binding and the inhibition of norepinephrine and serotonin reuptake.

Chemical formula - $C_{16}H_{25}NO_2$

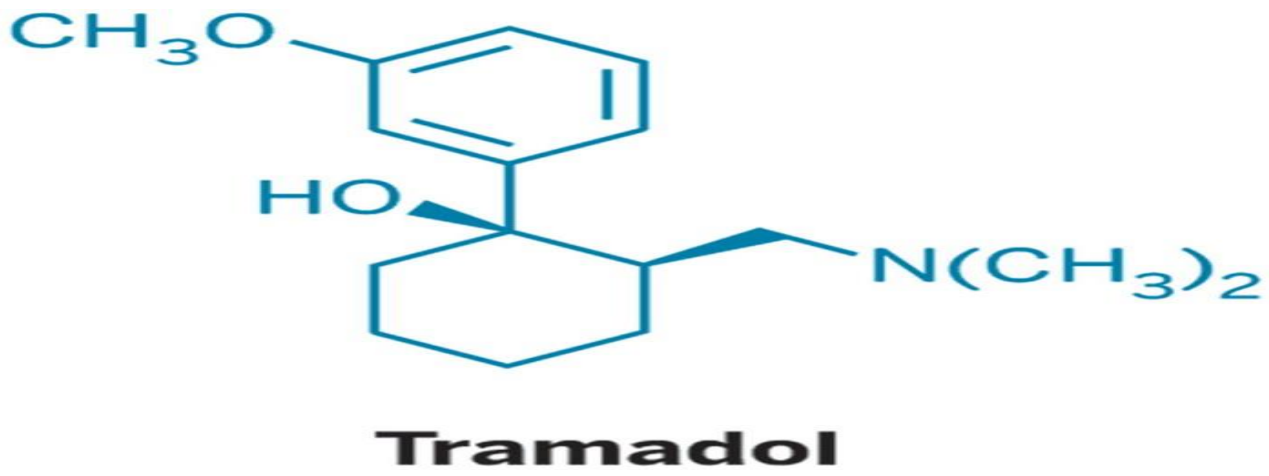



*Figure 37 chemical structure of tramadol*

**Mechanism of Action:**

- Opioid Receptor Agonist (MOR): Tramadol acts as a weak agonist at the μ-opioid receptor (MOR), which is responsible for mediating its analgesic effects. While tramadol is less potent than other opioids like morphine, it still provides significant pain relief.
- Norepinephrine and Serotonin Reuptake Inhibition: Tramadol also inhibits the reuptake of norepinephrine and serotonin, which contributes to its analgesic effects, especially in neuropathic pain. This action enhances the descending inhibitory

pathways of pain and is similar to the action of antidepressants like SSRIs and SNRIs.

**Pharmacokinetics:**

- Absorption: Tramadol is well absorbed from the gastrointestinal tract after oral administration. Its bioavailability is around 70%, but it is subject to significant first-pass metabolism in the liver.
- Metabolism: Tramadol undergoes hepatic metabolism via the CYP450 enzyme system, primarily CYP2D6 and CYP3A4. The CYP2D6 enzyme is responsible for converting tramadol to its active metabolite, O-desmethyltramadol, which has a higher affinity for opioid receptors and contributes significantly to its analgesic effect.
- Elimination: Tramadol and its metabolites are primarily excreted through the kidneys. The elimination half-life of tramadol is around 6-7 hours, while its active metabolite has a slightly longer half-life.

**Pharmacodynamics:**

- Pain Relief: Tramadol's dual mechanism of action, involving both opioid receptor activation and neurotransmitter reuptake inhibition, provides effective analgesia for both nociceptive and neuropathic pain.
- CNS Effects: As a central analgesic, tramadol can cause sedation, dizziness, and in some cases, seizures, especially at high doses or in combination with other drugs that lower the seizure threshold.

- Respiratory Depression: Unlike stronger opioids, tramadol has a lower risk of respiratory depression, though it can still occur at higher doses or with co-administration of other CNS depressants.
- Addiction Potential: Tramadol has a lower abuse potential compared to classic opioids, but dependence and addiction can still occur, particularly with long-term use.

**Dosage:**

- Adult Dose: For moderate pain, tramadol is commonly prescribed at 50-100 mg every 4-6 hours as needed. The maximum dose is usually 400 mg/day.
- Renal/Hepatic Impairment: Dose adjustments may be needed in patients with renal or hepatic dysfunction.

**Side Effects:**

- Common Side Effects:
    - Nausea, vomiting, constipation
    - Dizziness, headache, drowsiness
    - Sweating, dry mouth
- Serious Side Effects:
    - Seizures: Tramadol lowers the seizure threshold, and its use should be cautious in patients with a history of seizures or those on drugs that can lower seizure threshold.

- Serotonin Syndrome: Tramadol can increase serotonin levels, potentially leading to serotonin syndrome when combined with other serotonergic drugs (e.g., SSRIs, SNRIs, MAOIs).

**Clinical use in anaesthesia:**

- Perioperative Analgesia (Multimodal Analgesia):
  - Preoperative: Tramadol is used preoperatively as part of a multimodal analgesia strategy to reduce opioid consumption postoperatively. Administering tramadol before surgery can provide effective pain relief and reduce the need for stronger opioids like morphine or fentanyl.
  - Postoperative: Tramadol is often used for postoperative pain management in patients undergoing minor to moderate surgical procedures. Its opioid action helps manage pain, while its serotonin and norepinephrine reuptake inhibition enhances analgesia, especially for neuropathic pain.
- Opioid-Sparing Effect: Tramadol has a lower abuse potential and causes less respiratory depression than stronger opioids, making it a useful opioid-sparing agent. In multimodal analgesia, tramadol reduces the total opioid dose required, minimizing side effects like nausea, vomiting, constipation, and sedation.
- Adjunct to Local Anaesthesia: Tramadol can be used in combination with local anaesthetics in epidural and nerve block techniques to provide longer-lasting analgesia. It enhances the effect of local anaesthetics by providing central analgesic action, thus reducing the need for higher doses of opioids or local anaesthetics.

- Chronic Pain Management (Pre-Existing Conditions): In patients with pre-existing chronic pain conditions (e.g., neuropathic pain or fibromyalgia), tramadol can be continued perioperatively to provide consistent pain relief and reduce the likelihood of post-operative pain exacerbations.
- Preemptive Analgesia: Tramadol can be given preemptively to prevent the sensitization of pain pathways before surgery. This may reduce the severity of post-surgical pain and help in faster recovery by providing effective early pain relief.
- Adjunct in Nerve Blocks and Regional Anaesthesia: Tramadol is sometimes used as an adjuvant in nerve blocks (e.g., brachial plexus block, femoral block) and epidural anaesthesia to prolong the duration of analgesia and reduce opioid consumption. When administered with local anaesthetics, it enhances pain relief due to its dual mechanism of action.
- Management of Postoperative Shivering: Tramadol has been shown to be effective in reducing postoperative shivering, which is common after anaesthesia. By decreasing the temperature gradient between the skin and the core body temperature, tramadol helps reduce the sympathetic response and improves patient comfort.
- Reduction of Narcotic Side Effects: As part of a multimodal approach, tramadol helps in reducing narcotic-related side effects (such as nausea, vomiting, respiratory depression) while still providing effective pain relief.
- Epidural and Perineural Administration: Tramadol can be used epidurally or perineurally to provide extended pain relief, particularly after orthopaedic or abdominal surgeries. Its analgesic effect is enhanced in combination with local anaesthetics.

# MATERIALS AND METHOD

## SOURCE OF DATA:

This study was conducted in the Department of Anesthesiology, B.L.D.E. (Deemed to be University) Shri B. M. Patil Medical College, Hospital and Research Centre, Vijayapura.

METHOD OF COLLECTION OF DATA:

**Study Design:** Prospective randomized, double-blind control Study.

**Study Period:** One-and-a-half-year

**Sample Size:** 84 patients of both genders are randomly divided into three groups of 28 each.

# STATISTICAL DATA

## SAMPLE SIZE

The anticipated VAS score mean ±SD of PENG block 3.01±1.08, in quadratus lumborum block 1.55±2.68 andcontrol group 3.095±2.53 respectively at 12 hrs. (ref) the required minimum sample size is 25 per group (total of 75) to achieve a power of 80% and a significance level of 5% (two-sided) for detecting an actual difference in means of VAS scores between the groups using one-way ANOVA. Considering 10% attrition sample size rounded to 28 in each group (total 84).

(Software used is g* power 3.1 f tests - ANOVA: fixed effects, omnibus, one-way)

- Statistical Analysis
- The data obtained was entered into a Microsoft Excel sheet, and statistical analysis was performed using the statistical package for the social sciences (version20).
- Results were presented as Mean±SD, counts and percentages and diagrams.
- For normally distributed continuous variables between three groups was compared using the ANOVA test. For not normally distributed variables Kruskal walli's test was used.
- Categorical variables between the two groups was compared using the Chi-square test.
- $P < 0.05$ was considered statistically significant. All statistical tests was performed in two-tailed.

## INCLUSION CRITERIA

- Patients aged between 20- 70 years.
- Patients of either sex.
- Patients with A.S.A. Grade I & II.
- Patients posted for elective proximal femur fractures such as intertrochantericfracture, fracture neck of the femur, hemi arthroplasty and hip surgeries.

## EXCLUSION CRITERIA

- Patient refusal
- Pregnant women.
- Infection at the site of block.
- Patients with H/o Cardio-Respiratory disorders
- Patients with Hepatic and Renal diseases.
- Patients with H/o convulsions & neurological deficits.
- Patients with Spinal deformities.
- Patients on anticoagulants or coagulation disorders.
- Patients with cognitive impairment.

# METHODOLOGY:

**Pre-anaesthetic evaluation:** Patients participated in the study after a thorough preoperative evaluation, which includes the following:

- **History:**

  History of underlying medical illness, previous history of surgery, previous anaesthetic exposure, and hospitalization was obtained.

- **Physical examination:**

1. The patient's overall condition, including vital signs (heart rate, blood pressure, respiratory rate), height and weight, as well as an examination of the cardiovascular system, respiratory system, central nervous system, and vertebral system. Additionally, an airway assessment was conducted using Mallampati grading which helped to predict the ease of intubation based on the visibility of the patient's oropharyngeal structures. This thorough preoperative assessment is crucial for determining the appropriate anesthetic plan and ensuring patient safety throughout the surgical process.
2. After explaining the procedure and its potential complications, informed written consent was obtained from the willing patients.

**PROCEDURE :**

- Patients were assigned to groups using a computer-generated randomization table. The randomization process was conducted by a statistician, and the allocation of each patient was concealed until the patient was transferred to the pre-anesthetic room.

- This prospective study was conducted in our institute on 84 patients undergoing proximal femur fracture surgery.
- The patients were randomly separated into three equal groups (n=28).

1) Group P –Pericapsular nerve group (PENG) block group
2) Group Q- Quadratus Lumborum (Q.L.) block group
3) Group C- Control group (No block given).

- Once the patient was transferred to the preoperative holding area, the standard monitoring equipment was set up, which included a pulse oximeter, sphygmomanometer cuff, and ECG leads. Baseline readings for heart rate, blood pressure, and oxygen saturation were recorded to ensure the patient's stability before proceeding. Following this, intravenous access was established, and a 10 mL/kg infusion of lactated Ringer's solution was administered to maintain adequate hydration and support circulation.
- The patient was premedicated with 0.01 mg/kg of intravenous Midazolam for anxiolysis and 0.15 mg/kg of intravenous Ondansetron to prevent postoperative nausea and vomiting.
- Oxygen was supplied at a rate of 5lit/min to ensure adequate oxygenation throughout the procedure.
- All necessary equipment for general anaesthesia, resuscitation, and the nerve block was prepared and organized by an experienced anaesthesiologist, who was not involved in the study. This comprehensive preparation ensured that all protocols for patient safety were adhered to and that the anesthetic team was fully equipped to manage any potential complications during the procedure.
- As this study was a procedure-based blinding was not possible during the technique, but blinding was maintained during data collection and analysis. The

principal investigator was revealed about the group allotment just before the procedure. Group-A patients PENG block and Group-B patients anterior Q.L. block received respectively. Control group patients received 1000mg inj paracetamol in ward itself as conventional multimodal analgesia without block.

- For the PENG Block, the patient was positioned supine, and the groin area was prepared and draped under aseptic conditions. Cutaneous anaesthesia was achieved with 2 mL of 2% lignocaine. A curvilinear 2-5 MHz ultrasound probe (Sonosite M-Turbo), was placed transversely over the anterior inferior iliac spine (AIIS) and rotated 45 degrees counter-clockwise to align with the pubic ramus. Key anatomical structures, including the iliopsoas muscle, femoral artery, and pectineus muscle, were visualized. A 22-gauge, 80-mm needle was inserted in an in-plane approach from lateral to medial into the musculofascial plane between the psoas tendon and pubic ramus. After negative aspiration, 20 mL of 0.25% bupivacaine with 8 mg dexamethasone was injected in 5-mL increments, observing for fluid spread and psoas tendon elevation. The needle was adjusted based on resistance or intramuscular injection.

- For the Quadratus Lumborum Block (QLB), the patient was positioned in the lateral decubitus position with both legs flexed for optimal. A 2-5 MHz convex ultrasound probe was placed transversely over the abdominal flank at the anterior axillary line above the iliac crest. The probe was moved posteriorly to visualize the external oblique, internal oblique, and latissimus dorsi, followed by the QL muscle. The SHAMROCK SIGN was identified, marking the lumbar vertebra transverse process, QL, psoas major, and erector spinae muscles. Using the in-plane technique,

the needle was inserted from the posterior end of the probe. The needle tip should be placed between the psoas muscle and the fascial space of the quadratus lumborum muscle. After negative aspiration, 25ml of 0.25% bupivacaine with 8 mg dexamethasone was injected in 5-mL increments, ensuring appropriate posterior spread.

- After the procedure, all patients were closely monitored for hypotension, bradycardia, or any signs of local anesthetic toxicity.
- Pain scores for both rest and dynamic pain (assessed during a passive 15-degree leg raise) were recorded at baseline, prior to the block, and again 30 minutes post-block by an anesthesiologist not involved in the study.
- The patient was then transferred to the operating theatre, where spinal anesthesia was administered for the surgery. The patient was positioned in lateral decubitus with the healthy side facing upwards for optimal surgical access and comfort. Pain scores were recorded during spinal positioning, and if the Visual Analog Scale (VAS) reached ≥4, an additional dose of fentanyl (1µg/kg) was given.
- Under strict aseptic conditions, the skin was infiltrated with 2 mL of 2% lidocaine at the L3-L4 or L4-L5 intervertebral space for local anesthesia. Spinal anesthesia was then administered using 4 mL of 0.5% Bupivacaine combined with 25 mcg Fentanyl, delivered via a 25-gauge Quincke spinal needle.
- The patient was kept in the supine position for 20 minutes, during which hemodynamic parameters such as heart rate and mean arterial pressure were monitored every 3 minutes. Oxygen was administered at a rate of 5L/minute.
- An adequate block was considered achieved if the sensory block reached ≥T10

and the motor block score was 1.

- If spinal anaesthesia was deemed insufficient, the patient was administered general anaesthesia and excluded from the study.
- Following this, the patient was positioned according to the requirements of the surgical procedure.
- Bradycardia (heart rate <50) was treated with 0.6 mg of Inj. Atropine, and a mean arterial pressure (MAP <65) was managed with 10 mg increments of Inj. Ephedrine.
- Thirty minutes before the end of surgery, all patients were administered 1000 mg of Inj. Paracetamol and 75 mg of Inj. Diclofenac via IV infusion.
- The patient's pulse rate, blood pressure, respiratory rate, and oxygen saturation were monitored until the termination of the surgery.
- Postoperatively all 3 group pateints received conventional multimodal analgesia inj paracetamol 1000mg 8th hrly and inj Diclofenac 75mg IV infusion 12th hrly and depending upon VAS pain scores rescue analgesia were given. Aditionally all control group patients received 100mg inj tramadol 12th hourly as first rescue analgesia irrespective of VAS scores.
- If the VAS pain score was ≥4 or upon patient request, 100 mg of Inj. Tramadol was administered as first rescue analgesia. If the VAS pain score remained ≥4, 0.5 mcg/kg of Inj. Fentanyl was given every 10 minutes, up to a total of 2 mcg/kg, as a second rescue analgesia.
- Immediately after surgery, resting VAS score were recorded and the patient was transferred to the Post-Anesthesia Care Unit (PACU). VAS score was also recorded

at the time of PACU discharge.

- The patient was then followed up in the ward, where the following parameters were documented: VAS pain score at 12, 24, and 48 hours, time of first rescue analgesia, total tramadol consumption in first 24 and 25-48 hours, quadriceps strength at 12, 24, and 48 hours, time of first standing with support, discharge time, and satisfaction score using a 3-point scale at the time of discharge.

- All patients were monitored for complications, including nausea, vomiting, pruritus, and potential block-related issues such as hematoma, myositis, and nerve injuries.

- Visual analog scale (VAS) consists of a 10cm line, marked at 1cm each on which the patient marked on the line that represents the intensity of pain he/she is experiencing. Mark '0' represents no pain, and mark '10' represents the worst possible pain. The numbers marked by the patient are taken as units of pain intensity.

**VAS Score Intensity of pain**

0 – No pain to slight pain

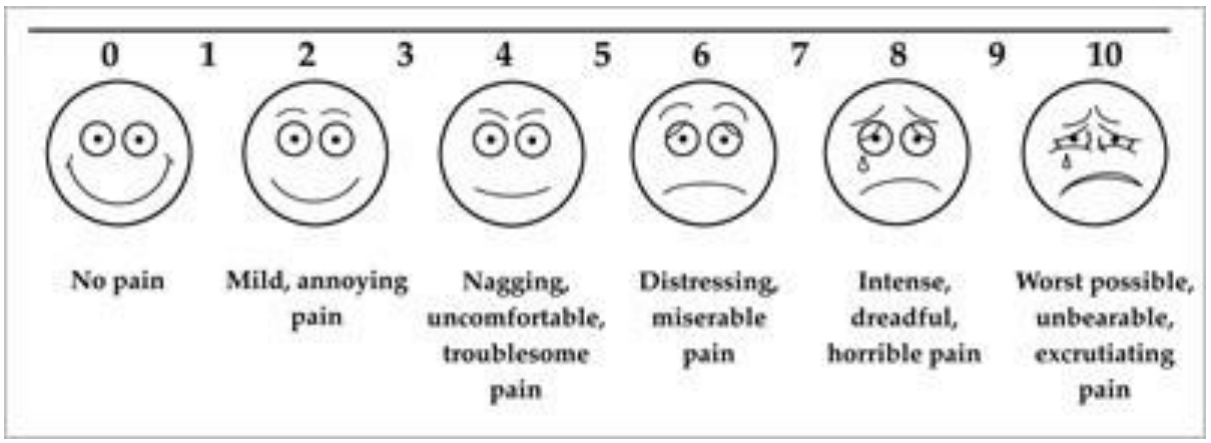
1 – 3 Mild pain.

4 – 6 Moderate pain.

7 – 9 Severe pain.

10 - Worst possible pain.

**Visual analogue scale:**




I. **<u>Satisfactory Scoring:</u>**

   i. Score 0: Ambivalent

   ii. Score 1: Unsatisfactory

   iii. Score 2: Satisfactory.

II. Side effects like Nausea, vomiting, Hypertension, respiratory depression and hematoma at the site of the block will be noted.

# RESULTS

The collected data was represented in the master chart.

Total sample size is 84 divided randomly in three groups (group P, group Q and group C containing 28 patients each group) who are undergoing surgery for proximal femur fracture.

- Group P received PENG block with 20ml bupivacaine 0.25% and 8mg dexamethasone in the block.
- Group Q received Quadratus lumborum block with 20ml bupivacaine 0.25% and 8mg dexamethasone in the block.
- Group C Control group in which no block was given.

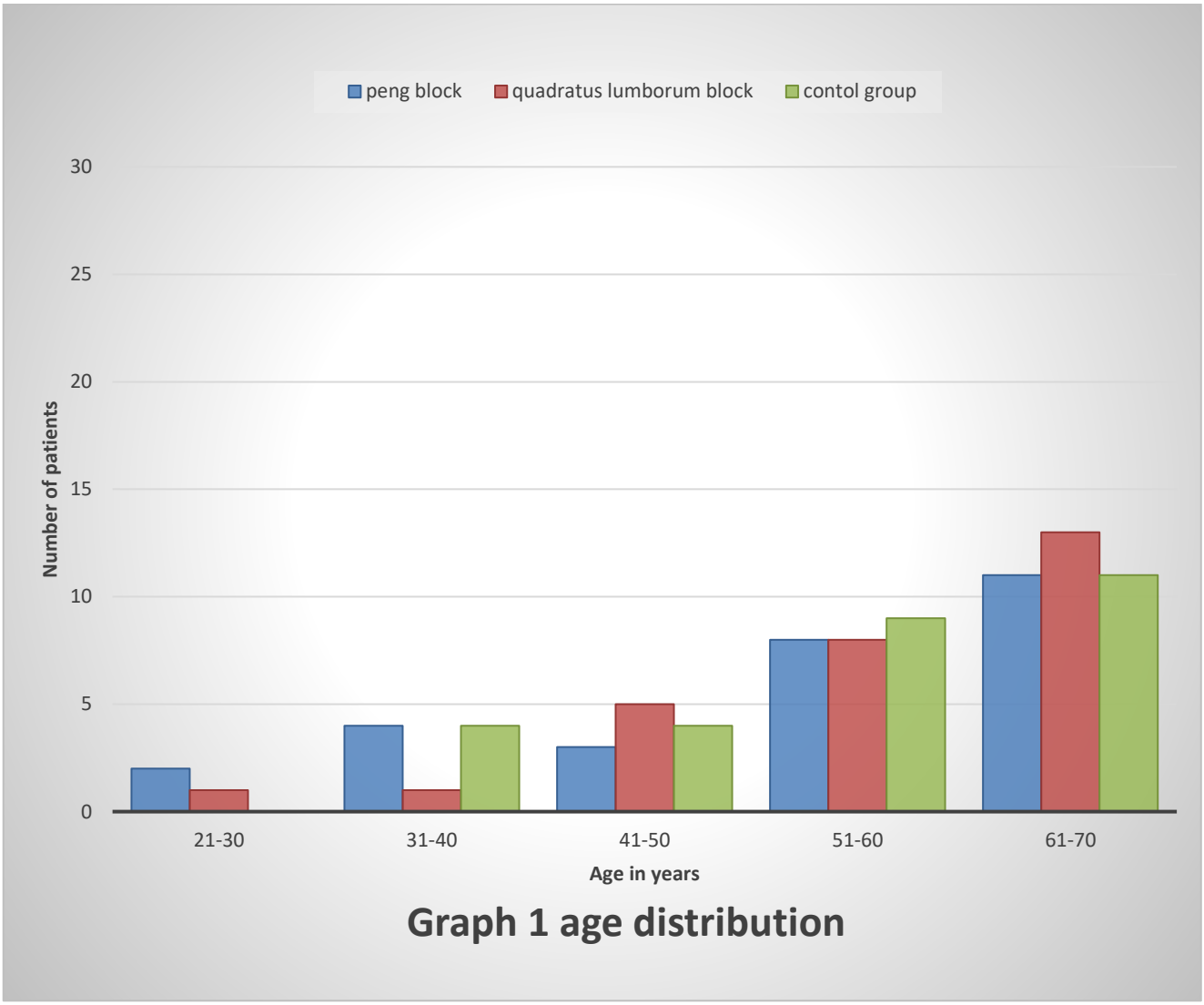
Postoperatively all 3 group pateints received conventional multimodal analgesia inj paracetamol 1000mg 8$^{th}$ hrly and inj diclofenac 75mg IV infusion 12$^{th}$ hrly and depending upon VAS pain scores rescue analgesia were given. All contol group patients received 100mg inj tramadol 12$^{th}$ hourly irrespective of VAS SCORES.

P value less than 0.05 is considered statistically significant.

**DISTRIBUTION OF AGE: -**

*Table 1 Distribution of age*

| Age in (Years) | PENG block | | Quadratus lumborum block | | Control group | |
|---|---|---|---|---|---|---|
| | Number of patients | % | Number of patients | % | Number of patients | % |
| 21-30 | 2 | 7.14 | 1 | 3.57 | 0 | 0.00 |
| 31-40 | 4 | 14.29 | 1 | 3.57 | 4 | 14.29 |
| 41-50 | 3 | 10.71 | 5 | 17.86 | 4 | 14.29 |
| 51-60 | 8 | 28.57 | 8 | 28.57 | 9 | 32.14 |
| 61-70 | 11 | 39.29 | 13 | 46.43 | 11 | 39.29 |
| Total | 28 | 100 | 28 | 100 | 28 | 100 |




Graph 1 age distribution

*Table 2 Mean age distribution*

| Age in years | Mean | SD | P value |
|---|---|---|---|
| PENG | 55.50 | ±13.489 | 0.554 |
| QLB | 59.43 | ±10.322 | |
| Control group | 59.07 | ±10.732 | |

• In our study, 3 patients were 21-30 years of age, 9 patients were in the range of 31-40 years, 12 patients were 41-50 years of age, 25 patients were of 51-60 years of age, 35 patients were of 61-70 years of age.

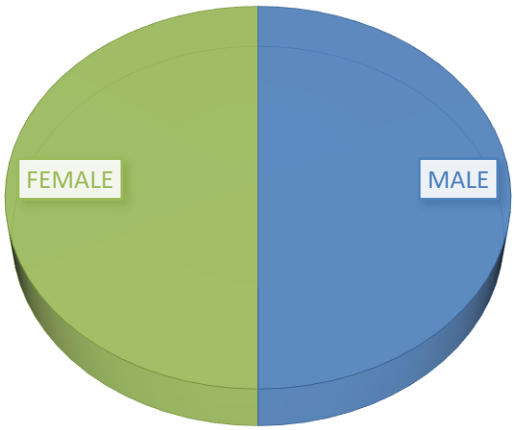
• The mean age (in years) of patients in PENG group was 55.50 ±13.489, in QLB group was 59.43 ±10.322 and in control group was 59.07 ±10.732. In terms of mean age, the groups were comparable. with a p value of 0.554.

• In this study age wise distribution of the sample in all three groups were comparable with P-value statistically insignificant.

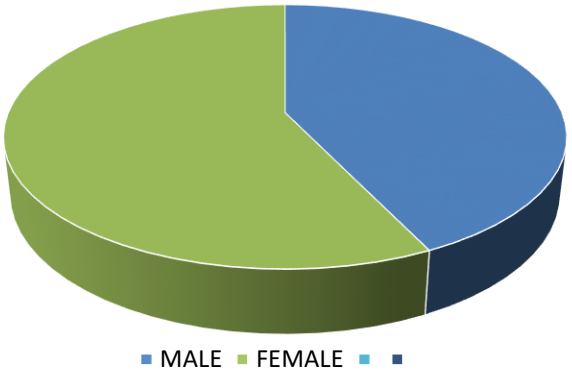
**COMPARISON OF GENDER:**

*Table 3 Gender comparison*

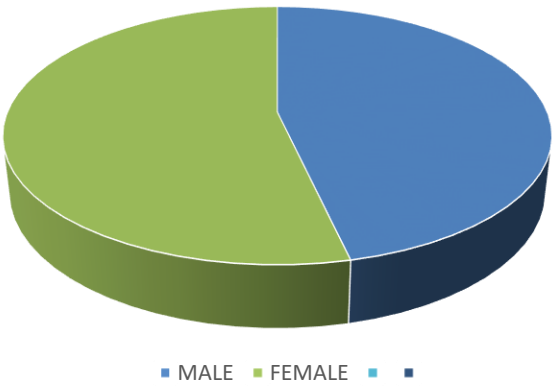
| Gender | PENG | | QLB | | Control group | |
|---|---|---|---|---|---|---|
| | No. of patients | % within group | No. of patients | % within group | No. of patients | % within group |
| Male | 14 | 50.0% | 12 | 42.9% | 13 | 46.4% |
| Female | 14 | 50.0% | 16 | 57.1% | 15 | 53.6% |
| Total | 28 | 100 | 28 | 100 | 28 | 100 |




GRAPH 2 PENG BLOCK GENDER DISTRIBUTION




GRAPH 3 QLB AGE DISTRIBUTION



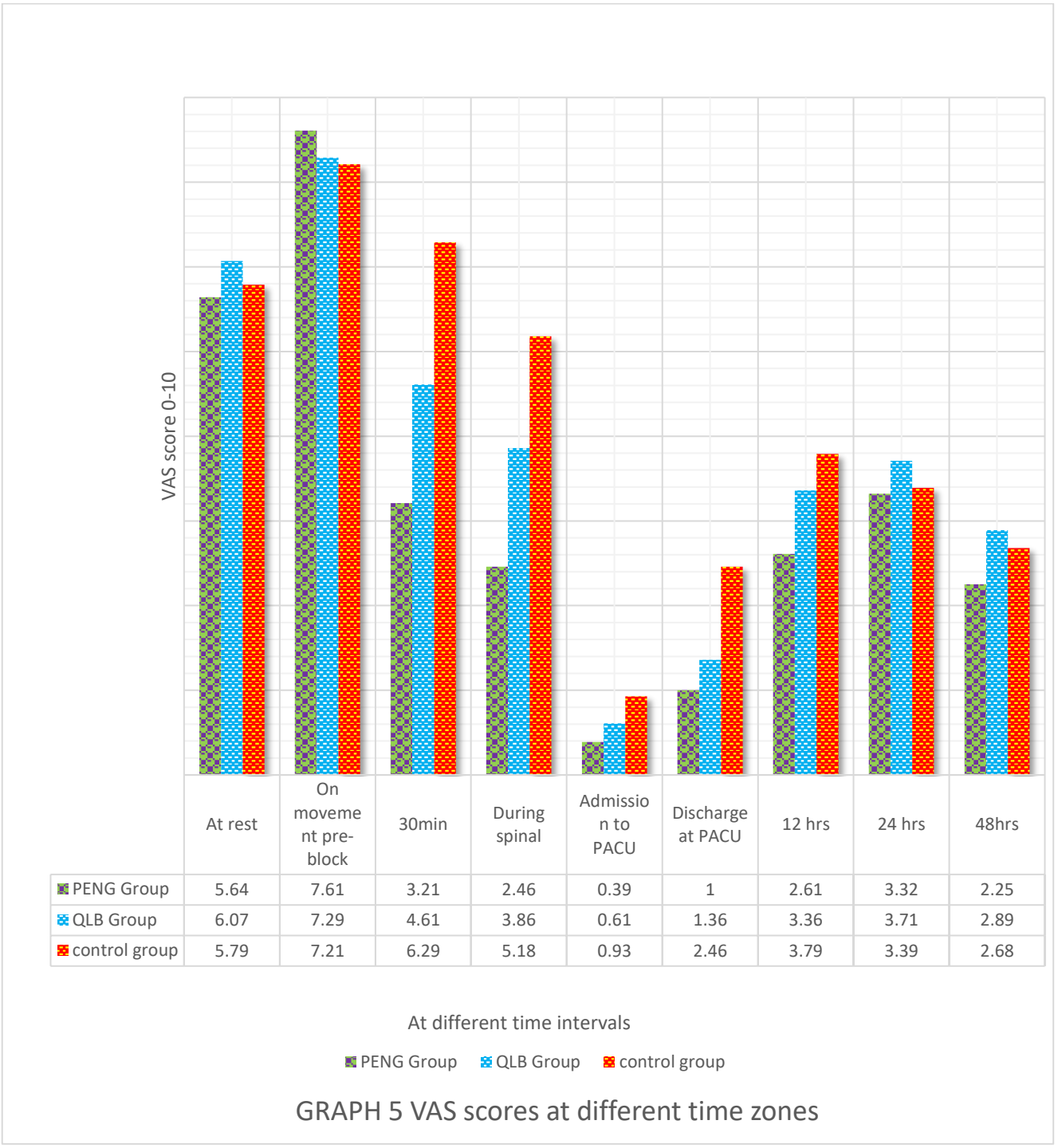

GRAPH 4 control group

When compared to the male population, the female population was more prevalent in this trial. Out of the 84 patients in our study, 39 were men and 45 were women.

***VISUAL ANALOGUE SCALE (VAS) SCORE: -***

*Table 4 VAS SCORES*

| VAS SCORES AT DIFFERENT TIME INTERVALS | PENG group | | QLB group | | Control group | | P value |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | |
| At rest | 5.64 | ±0.951 | 6.07 | ±0.979 | 5.79 | ±0.957 | 0.339 |
| On movement pre-block | 7.61 | ±0.832 | 7.29 | ±0.976 | 7.21 | ±1.031 | 0.259 |
| 30 min | 3.21 | ±0.630 | 4.61 | ±0.567 | 6.29 | ±0.763 | 0.0002 |
| During spinal | 2.46 | ±0.744 | 3.86 | ±0.705 | 5.18 | ±0.612 | 0.0001 |
| Admission to PACU | 0.39 | ±0.629 | 0.61 | ±0.737 | 0.93 | ±0.979 | 0.094 |
| Discharge at PACU | 1.00 | ±0.816 | 1.36 | ±0.731 | 2.46 | ±0.637 | 0.0001 |
| 12 hrs | 2.61 | ±0.629 | 3.36 | ±0.870 | 3.79 | ±0.876 | 0.0001 |
| 24hrs | 3.32 | ±0.863 | 3.71 | ±1.049 | 3.39 | ±0.994 | 0.302 |
| 48 hrs | 2.25 | ±0.701 | 2.89 | ±0.786 | 2.68 | ±0.670 | 0.008 |




| | At rest | On movement pre-block | 30min | During spinal | Admission to PACU | Discharge at PACU | 12 hrs | 24 hrs | 48hrs |
|---|---|---|---|---|---|---|---|---|---|
| PENG Group | 5.64 | 7.61 | 3.21 | 2.46 | 0.39 | 1 | 2.61 | 3.32 | 2.25 |
| QLB Group | 6.07 | 7.29 | 4.61 | 3.86 | 0.61 | 1.36 | 3.36 | 3.71 | 2.89 |
| control group | 5.79 | 7.21 | 6.29 | 5.18 | 0.93 | 2.46 | 3.79 | 3.39 | 2.68 |

GRAPH 5 VAS scores at different time zones

- In our study mean VAS score at rest, on movement before giving block and at 24 hrs in all three groups were comparable and was statistically insignificant as the P value is more than 0.05.
- When compared to the control group, the VAS scores of the PENG and QLB groups are significantly lower across all time intervals. Compared to the QLB group, the PENG group's VAS scores were significantly lower.

**TIME OF FIRST RESCUE ANALGESIA: -**

*Table 5 mean±SD time of first rescue analgesia*

| | Mean of first rescue analgesia in hrs | ±SD | P value |
|---|---|---|---|
| PENG group | 12.21 | 12.127 | 0.0383 |
| QLB group | 19.29 | 8.559 | |

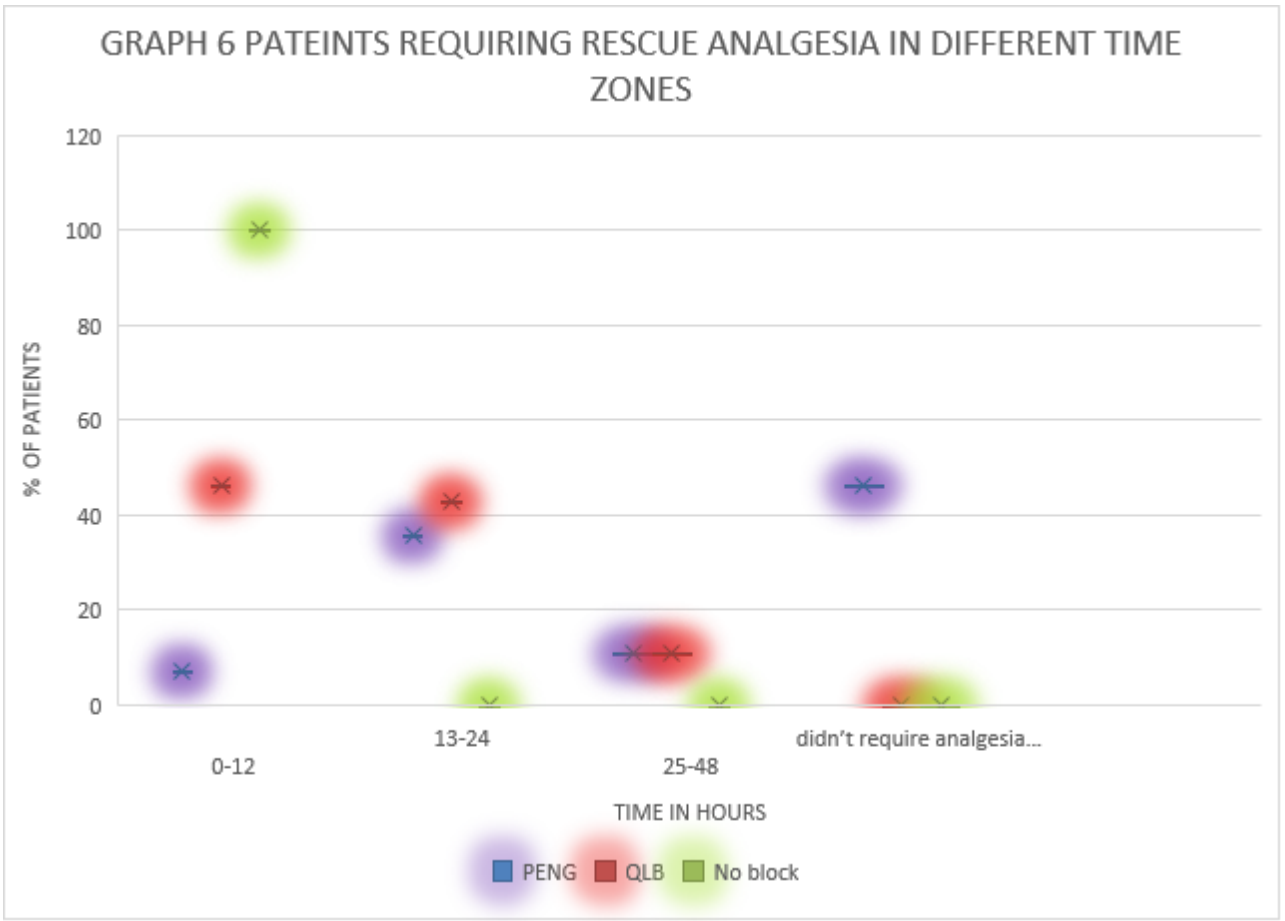
*Table 6 Timing and number of patients requiring rescue analgesia*

| Time (hrs) | PENG | | QLB | | Control group | |
|---|---|---|---|---|---|---|
| | No of patients | % | No of patients | % | No of patients | % |
| 0-12 | 2 | 7.14 | 13 | 46.42 | 28 | 100 |
| 13-24 | 10 | 35.71 | 12 | 42.85 | 0 | 0.0 |
| 25-48 | 3 | 10.71 | 3 | 10.71 | 0 | 0.0 |
| Didn't require analgesia in 48 hrs | 13 | 46.42 | 0.0 | 0.0 | 0 | 0.0 |
| Total | 28 | 100% | 28 | 100% | 28 | 100% |

- In the first 12 hours postoperatively, 7.14% of patients in the PENG group, 46.42% of patients in the QLB group, and 100% of patients in the control group required first rescue analgesia, as their VAS score exceeded 3.

• During the 13–24hour period, the need for first rescue analgesia was increased to 35.71% in the PENG group and 42.85% in the QLB group. In the subsequent 25–48 hours, 10.71% of patients in both the PENG and QLB groups required rescue analgesia.

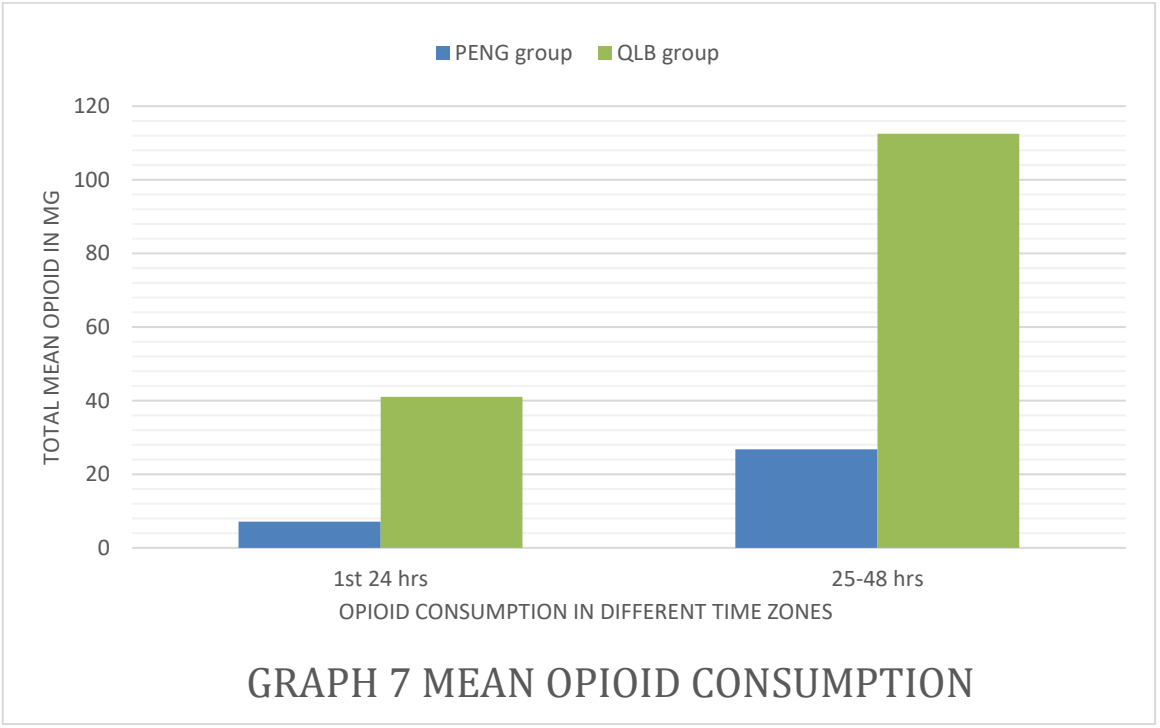
• Notably, over 46.2% of patients in the PENG group did not require any rescue analgesia throughout the entire 48-hour postoperative period, demonstrating prolonged and effective pain control compared to the other groups.



**TOTAL OPIOID CONSUMPTION IN 48 HOURS: -**

*Table 7 MEAN OPIOID CONSUMPTION*

| Study group | Total opioid consumption in mg | | | | | |
|---|---|---|---|---|---|---|
| | First 24 hrs | | | 25-48 hrs | | |
| | Mean | SD | P value | Mean | SD | P value |
| PENG group | 7.14 | 17.817 | 0.0001 | 26.79 | 25.394 | 0.0001 |
| QLB group | 41.07 | 45.243 | | 112.50 | 52.042 | |




GRAPH 7 MEAN OPIOID CONSUMPTION

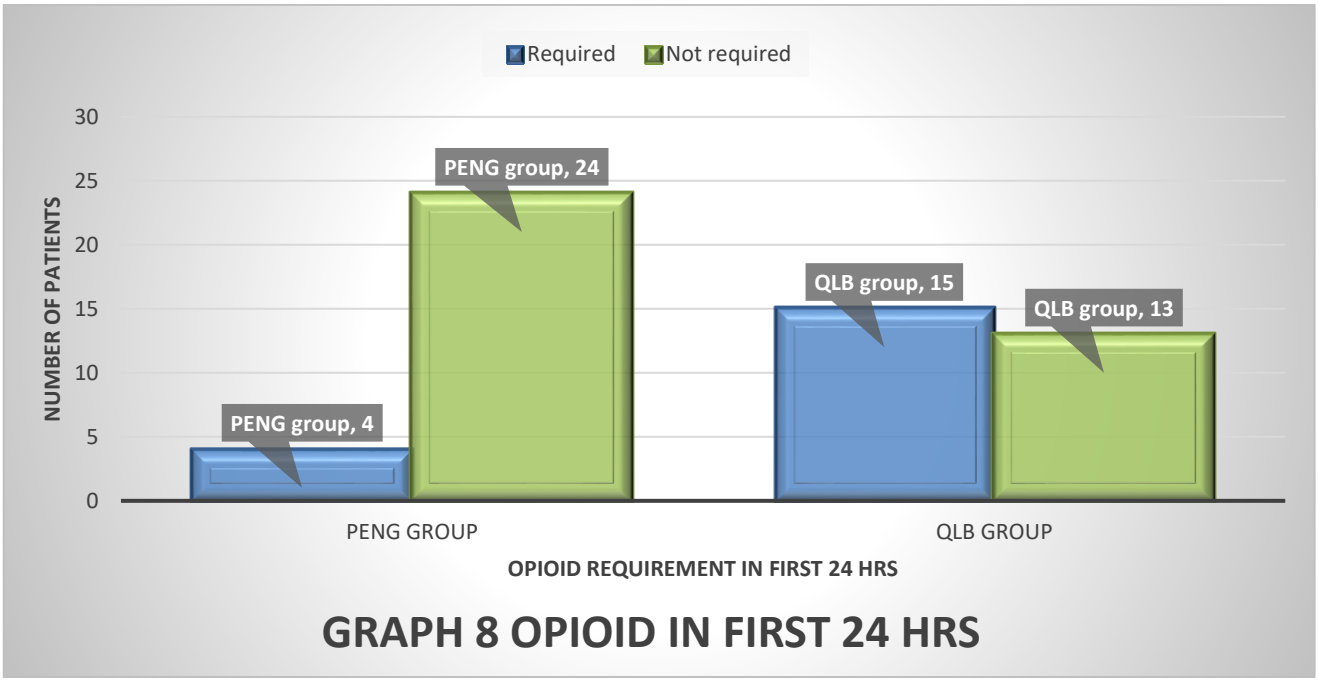
In this study, during the first 24 hours, the total opioid consumption for postoperative analgesia (tramadol in mg) in the PENG group was 7.14 ± 17.817 (mean ± SD), indicating that more than 90% of patients did not require rescue analgesia. In contrast, the QLB group required 41.07 ± 45.243 mg, indicating that almost 50% of patients require rescue analgesia which was statistically significant with a P-value < 0.05.

In the 25–48 hour period, the opioid consumption in the PENG group increased to 26.79 ± 25.394 mg, whereas it was 112.50 ± 52.042 mg in the QLB group, again showing statistical significance with a P-value < 0.05.

In the control group, all patients received 200 mg of tramadol in the first 24 hours, administered in divided doses 12 hours apart, and the same regimen was continued in the subsequent 24 hours for postoperative analgesia.

*Table 8 OPIOID IN FIRST 24 HRS*

| Opioid in first 24 hrs | PENG group (n=28) | QLB group (n=28) |
|---|---|---|
| Required | 4 | 15 |
| Not required | 24 | 13 |
| Total | 28 | 28 |



GRAPH 8 OPIOID IN FIRST 24 HRS

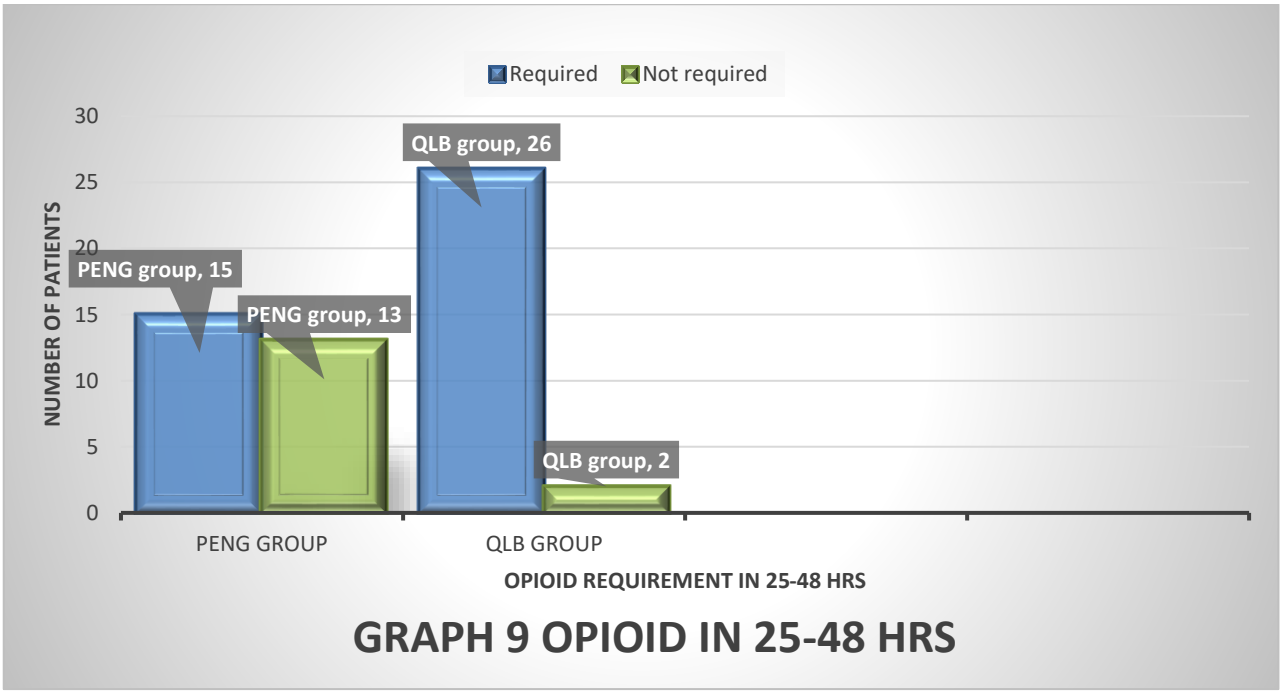
During the first 24 hours following surgery, only 4 out of 28 patients in the PENG group required an opioid (tramadol) as rescue analgesia to manage postoperative pain. In contrast,

a significantly higher number of patients 15 out of 28 in the QLB group needed tramadol to achieve adequate pain relief during the same period.

*Table 9 OPIOID IN 25-48 HRS*

| Opioid in 25-48 hrs | PENG group (n=28) | QLB group (n=28) |
|---|---|---|
| Required | 15 | 26 |
| Not required | 13 | 2 |
| Total | 28 | 28 |

Between 25 and 48 hours postoperatively, 15 out of 28 patients in the PENG group required an opioid (tramadol) as rescue analgesia to control their pain. In comparison, a much larger proportion 26 out of 28 patients in the QLB group needed tramadol during the same time frame to achieve adequate pain relief.



GRAPH 9 OPIOID IN 25-48 HRS

In this study, tramadol was administered as the first-line rescue analgesic for managing postoperative pain across all three groups. Notably, none of the patients in any group required a second-line rescue analgesic, such as fentanyl, indicating that pain relief was

adequately achieved with tramadol alone.

**QUADRICEPS STRENGTH: -**

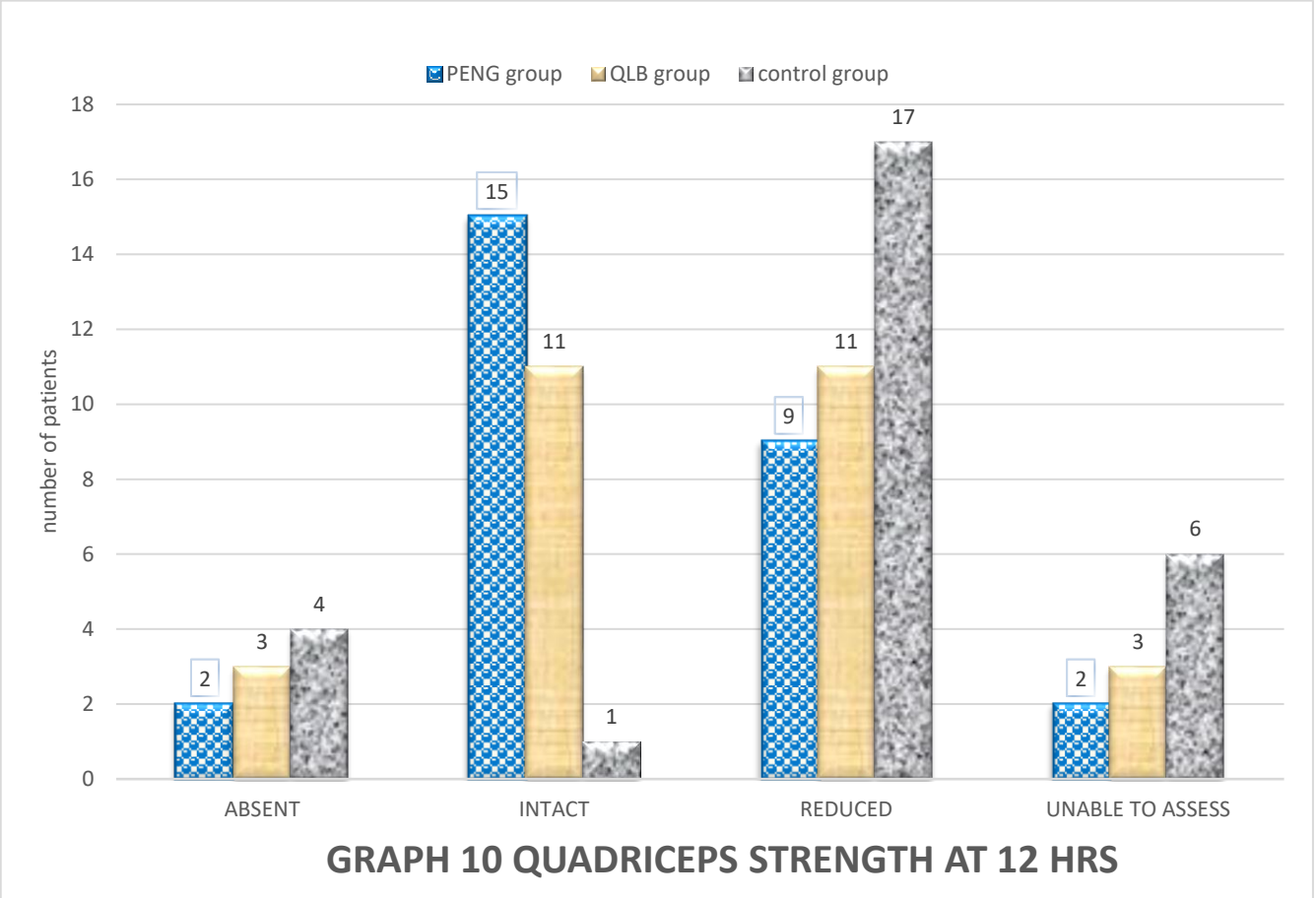
*Table 10 QUADRICEPS STRENGTH AT 12 HRS*

| Quadriceps strength at 12hrs | PENG group | | QLB group | | Control group | |
|---|---|---|---|---|---|---|
| | No. of patients | % | No. of patients | % | No. of patients | % |
| Absent | 2 | 7.1% | 3 | 10.7% | 4 | 14.3% |
| Intact | 15 | 53.6% | 11 | 39.3% | 1 | 3.6% |
| Reduced | 9 | 32.1% | 11 | 39.3% | 17 | 60.7% |
| Unable to assess | 2 | 7.1% | 3 | 10.7% | 6 | 21.4% |
| Total | 28 | 100 | 28 | 100 | 28 | 100 |

In this study, quadriceps strength at 12 hours postoperatively was preserved in the majority of patients in the PENG group, with 15 out of 28 demonstrating intact strength. Comparatively, 11 out of 28 patients in the QLB group and only 1 out of 28 in the control group maintained intact quadriceps strength.

Among the total of 84 patients, quadriceps strength was completely absent in 9 patients, distributed as follows: 2 in the PENG group, 3 in the QLB group, and 4 in the control group. Due to pain reduction in quadriceps strength was observed in 37 out of 84 patients, with

the majority belonging to the control group. Additionally, in 11 patients, the assessment of quadriceps strength was not possible due to pain or lack of cooperation.

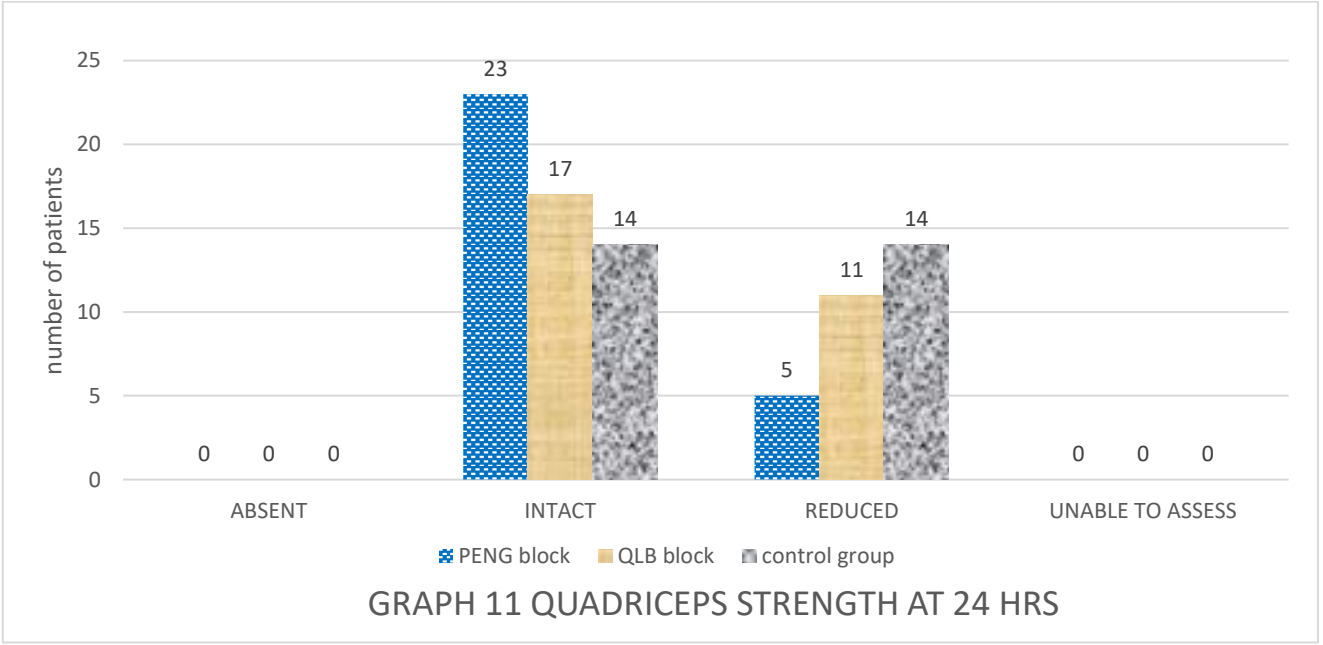


GRAPH 10 QUADRICEPS STRENGTH AT 12 HRS

*Table 11 QUADRICEPS STRENGTH AT 24 HRS*

| Quadriceps strength at 24 hrs | PENG group | | QLB group | | Control group | |
|---|---|---|---|---|---|---|
| | No. of patients | % | No. of patients | % | No. of patients | % |
| Absent | 0 | 0% | 0 | 0% | 0 | 0% |
| Intact | 23 | 82.1% | 17 | 60.7% | 14 | 50.0% |
| Reduced | 5 | 17.9% | 11 | 39.3% | 14 | 50.0% |
| Unable to assess | 0 | 0% | 0 | 0% | 0 | 0% |
| Total | 28 | 100 | 28 | 100 | 28 | 100 |

At 24 hours after surgery, the majority of patients in the PENG group, specifically 23 out of 28 (82.1%), had intact quadriceps strength, representing the highest proportion of preserved strength among the three groups. In contrast, 17 out of 28 patients in the QLB group and 14 out of 28 patients in the control group demonstrated intact quadriceps strength at 24 hrs. This indicates a clear advantage in muscle strength preservation in the PENG group. Furthermore, it was observed that quadriceps strength had improved in all patients across all groups by the 24-hour mark, reflecting a positive trend in recovery postoperatively. Quadriceps strength at 48hrs in all patients in all three groups was intact.



GRAPH 11 QUADRICEPS STRENGTH AT 24 HRS

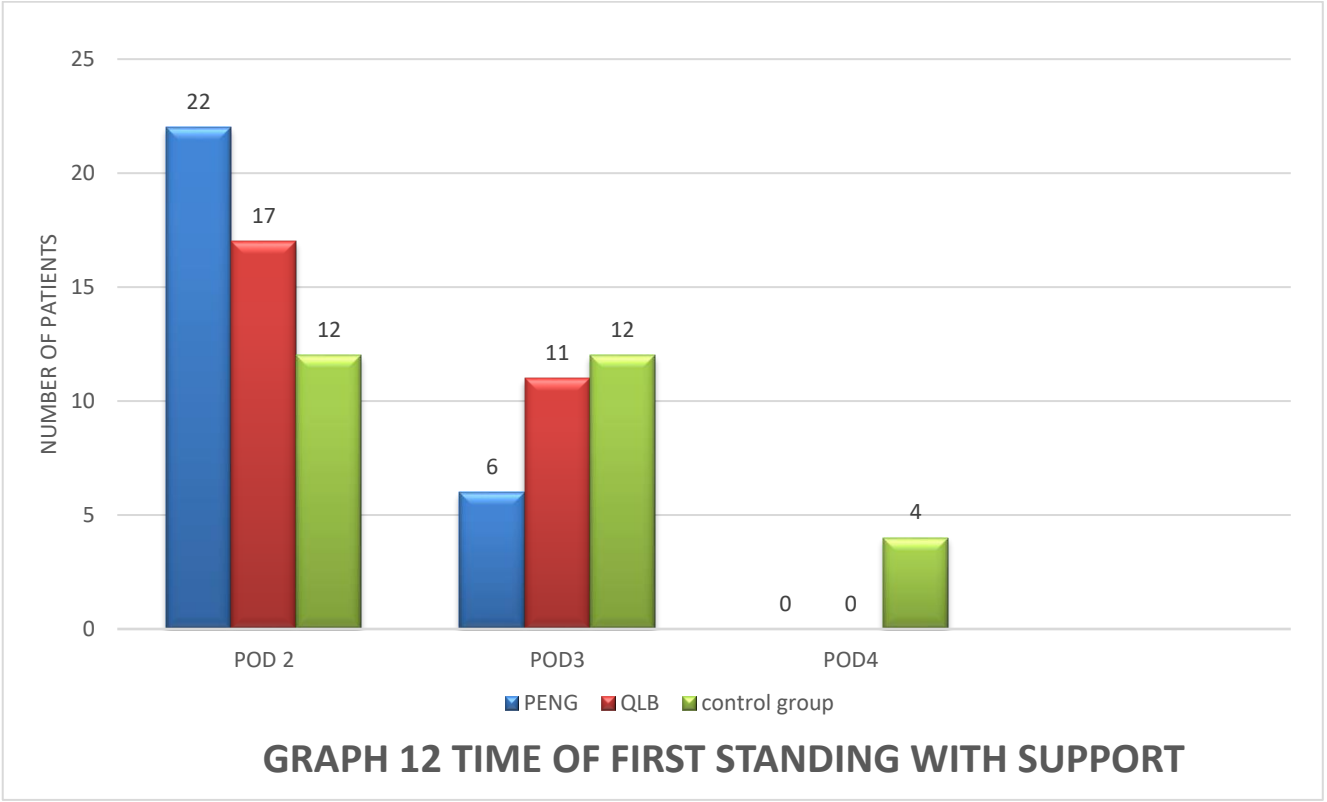
## TIME OF FIRST STANDING WITH SUPPORT:

*Table 12 TIME OF FIRST STANDING WITH SUPPORT*

| Time of first standing with support | PENG group | | QLB group | | Control group | |
|---|---|---|---|---|---|---|
| | Number of patients | % | Number of patients | % | Number of patients | % |
| POD 2 | 22 | 78.6% | 17 | 60.7% | 12 | 42.9% |
| POD 3 | 6 | 21.4% | 11 | 39.3% | 12 | 42.9% |
| POD 4 | 0 | 0.0% | 0 | 0.0% | 4 | 14.3% |
| Total | 28 | 100 | 28 | 100 | 28 | 100 |

The majority of patients were able to stand with support on postoperative day 2. Specifically, 22 patients in the PENG group, 17 in the QLB group, and 12 in the control group were able to achieve this milestone on day 2.

By postoperative day 3, the number of patients who could stand with support increased: 6 patients in the PENG group, 11 in the QLB group, and 12 in the control group. However, in the control group, 4 patients had a delayed ability to stand with support. This delay was attributed to slower recovery of quadriceps strength, suggesting that the absence of a block contributed to a longer recovery time for muscle strength because of pain, immobility and delayed the time to standing with support.




GRAPH 12 TIME OF FIRST STANDING WITH SUPPORT

**DISCHARGE TIME AFTER SURGERY: -**

*Table 13 Mean discharge time*

| | Discharge time in days | | |
|---|---|---|---|
| | Mean | SD | P value |
| PENG | 5.43 | 0.836 | 0.007 |
| QLB | 5.93 | 1.245 | |
| Control group | 5.96 | 1.294 | |

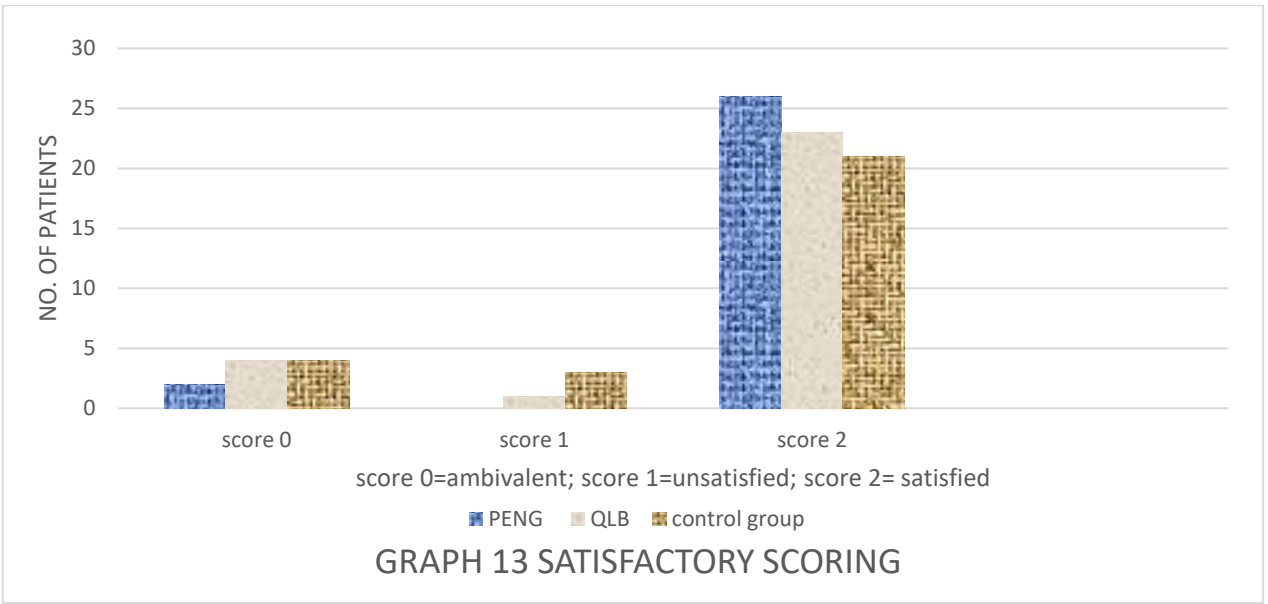
The PENG group had a significantly shorter discharge time (mean of 5.43 days) compared to the QLB (5.93 days) and control groups (5.96 days), with a P-value of 0.007 indicating statistical significance.

## SATISFACTORY SCORING AT TIME OF DISCHARGE:

*Table 14 Satisfactory scoring score 0=ambivalent; score 1=unsatisfied; score 2= satisfied*

| Satisfactory scoring | PENG group | | QLB group | | Control group | |
|---|---|---|---|---|---|---|
| | No. of patients | % | No. of patients | % | No. of patients | % |
| Score 0 | 2 | 7.1% | 4 | 14.3% | 4 | 14.3% |
| Score 1 | 0 | 0.00% | 1 | 3.6% | 3 | 10.7% |
| Score 2 | 26 | 92.9% | 23 | 82.1% | 21 | 75.0% |
| Total | 28 | 100 | 28 | 100 | 28 | 100 |

Almost all patients expressed satisfaction with their care during their hospital stay, with the PENG group showing the highest levels of satisfaction. The satisfaction scores for patients in the QLB group and the control group were similar, with no significant differences observed between the two groups. This suggests that, while the PENG group experienced greater satisfaction overall, the level of satisfaction in the QLB and control groups remained comparable throughout the hospital stay.



GRAPH 13 SATISFACTORY SCORING

**SAFETY AND ADVERSE EVENTS:**

In our study, there were no instances of patient falls across all groups, highlighting the safety of the analgesic techniques used. Additionally, no adverse events such as postoperative nausea, vomiting, hematoma formation, pruritus, or urinary retention were observed in any of the groups. Importantly, no nerve injuries occurred, likely due to the use of ultrasound-guided techniques, which ensured precise needle placement. Furthermore, no signs of local anesthetic toxicity were noted, as we employed smaller volumes of local anesthetic at lower concentrations, further enhancing the safety profile of the blocks used.

# DISCUSSION

Proximal femur fractures are common in older individuals, often associated with multiple co-morbidities that complicate postoperative analgesia management. Excessive opioid use can lead to significant side effects, including acute delirium, urinary retention, and constipation, which may prolong hospital stays and delay rehabilitation. Reducing opioid consumption during hospitalization not only minimizes these complications but also improves overall outcomes.[82] This emphasizes the need for alternative or multimodal analgesic strategies to achieve adequate pain relief while reducing reliance on opioids.

In this study we compared the effectiveness of PENG block, QLB, with control group in managing postoperative pain and functional recovery in proximal femur fractures patients posted for nailing or arthroplasty. By evaluating outcomes such as VAS pain scores across the three groups at multiple time points, quadriceps strength, opioid consumption and time of first standing with support the study aimed to identify a strategy that balances effective pain relief with minimal side effects. The findings emphasize the importance of selecting regional analgesia techniques to optimize recovery and reduce opioid-related complications in this high-risk population.

In our study, the majority of patients belonged to the elderly age group, with 35 patients aged 61-70 years and 25 patients aged 51-60 years. The mean age was 55.50 ±13.489 years in the PENG group, 59.43 ±10.322 years in the QLB group, and 59.07 ±10.732 years in the control group. The age distribution across the three groups was comparable, with no statistically significant difference ($p = 0.554$). M. Lorentzon et al. highlighted that women, especially postmenopausal, are more prone to proximal femur fractures due to osteoporosis

from reduced estrogen levels and longer life expectancy.[83] Our study similarly observed a higher prevalence of female patients 53.5%, reflecting these trends.

Based on the findings from previous studies, we selected specific volumes and concentrations for the anesthetic agents in our study. Laura Giron Arango et al., Ashok Jadon et al., used 20 ml of 0.25% bupivacaine for the PENG block in hip surgeries. [6,17] In hip arthroplasty cases, Promil Kukreja et al. administered 25 ml of 0.25% bupivacaine for the QL block,[22] while Christopher L. Mucrum et al. employed 20-30 ml of 0.5% ropivacaine for the QL block in hip arthroscopy procedures.[20] Therefore in our study, we choose to administer 20 ml of 0.25% bupivacaine for the PENG block and 25 ml of 0.25% bupivacaine for the QL block.

In this study, the PENG group showed significantly lower VAS scores compared to the QLB and control groups, particularly at 30 minutes and during spinal anesthesia (3.21 ± 0.63 and 2.46 ± 0.74, $p < 0.05$). The PENG group also exhibited better pain relief at discharge from PACU (1.00 ± 0.82), 12 hours (2.61 ± 0.63), and 48 hours (2.25 ± 0.70, $p <0.05$). No significant differences were found at rest, pre-block movement, admission to PACU, or 24 hours ($p > 0.05$). These results are consistent with Q.-R. Wang et al. (2021-22), who also reported superior pain relief in PENG blocks after THA with VAS scores 48.4±8.8, QLB 50.2±10.1 ($p < 0.05$) using 20ml 0.5% ropivacaine in PENG block and 30ml 0.3% ropivacaine in QLB.[24] However, Tayfun et al.[23] used 0.5% bupivacane 20ml in peng block, 30ml in QLB and Abdelsalam et al.[84] used 0.25% bupivacaine of 20 ml in both PENG block & QLB. They both concluded that QLB and PENG blocks showed similar trends in VAS scores and provided comparable analgesia for hip arthroplasty.

In this study in first 12 hours postoperatively, the PENG group required significantly less rescue analgesia (7.14%) compared to the QLB group (46.42%) and the control group (100%). From 13–48 hours, the PENG group consistently needed less opioid ie., tramadol as first rescue analgesia, with 46.2% of patients not requiring any analgesia over 48 hours. Opioid consumption was significantly lower in the PENG group (7.14 ± 17.817 mg in the first 24 hours and 26.79 ± 25.394 mg in 25–48 hours) compared to the QLB group (41.07 ± 45.243 mg in the first 24 hours and 112.50 ± 52.042 mg in 25–48 hours), with p-values $< 0.05$. These results demonstrate the superior efficacy of the PENG block in providing prolonged pain relief and reducing opioid use post-hip arthroplasty.

In agreement with our results, G. Pascarella et al.,[18] and Han wu et al.,[85] reported that the PENG block reduced postoperative opioid use compared to control group, while Promil Kukreja et al.[19] demonstrated that the posterior QLB improved analgesia in total hip arthroplasty with an opioid-sparing effect when compared with control group.[18,19,85] Additionally, Kukreja et al. compared QLB alone to a combination of QLB and PENG in hip arthroplasty, concluding that the combination block provided superior pain relief and reduced opioid consumption, particularly in revision THA cases.[22]

Our results showed that, the PENG group consistently demonstrated superior preservation of quadriceps strength, particularly at 12 and 24 hours postoperatively, with 15 out of 28 maintaining intact strength at 12 hours and 23 out of 28 at 24 hours. The QLB group showed a moderate level of quadriceps strength preservation, with 11 out of 28 at 12 hours and 17 out of 28 at 24 hours. The control group exhibited the lowest preservation, with only 1 out of 28 maintaining strength at 12 hours and 14 out of 28 at 24 hours. By 48 hours, all groups exhibited complete recovery of quadriceps strength. Overall, while all groups showed

improvement over time, the PENG group had a significantly higher proportion of patients with intact quadriceps strength at earlier time points, indicating its superior efficacy in preserving muscle strength postoperatively, with the QLB group showing a moderately favourable outcome and the control group demonstrating the least benefit. Reflecting on our results, Tayfun et al. found similar trends in quadriceps strength preservation across the PENG and QLB blocks. In their study, 80% of patients in the PENG block group maintained quadriceps strength at 12 hours postoperatively, compared to 73.3% in the QLB group.[23] These findings are consistent with our study, where 53.6% of patients in the PENG group and 39.3% in the QLB group preserved quadriceps strength at 12 hours. By 24 hours, both studies observed that 100% of patients in both the PENG and QLB groups had intact quadriceps strength, aligning with our findings of complete recovery of muscle strength by this time. This comparison supports the efficacy of the PENG block in preserving quadriceps strength, particularly in the early postoperative period, and highlights the positive trend in recovery over time for both techniques.

In another study D-Yin Lin et al. compared PENG block with F.N.B in hip surgeries and concluded that Quadriceps strength was better preserved in the PENG group postoperative period, 60% intact in the PENG group and not intact in the F.N.B. group.[16] The PENG block, which involves the injection of local anesthetic around the hip joint, spares the motor fibers of the femoral nerve that control the quadriceps muscle, while providing effective analgesia for hip joint procedures. This selective blockade helps reduce postoperative pain without significantly affecting motor function, leading to better preservation of quadriceps strength compared to other regional anesthetic techniques like the QLB (Quadratus Lumborum Block), FNB. The PENG block's ability to provide pain relief while

maintaining muscle strength is particularly advantageous in patients undergoing hip surgeries, where preserving motor function is crucial for early rehabilitation and mobility.

By postoperative day 2, the majority of patients were able to stand with support, with 22 patients in the PENG group, 17 in the QLB group, and 12 in the control group reaching this milestone. By day 3, the ability to stand with support increased, with 6 additional patients in the PENG group, 11 in the QLB group, and 12 in the control group. Delayed ability to stand in the control group, observed in 4 patients, was associated with severe postoperative pain leading to arthrogenic muscle inhibition, prolonged immobility resulting in disuse atrophy of the quadriceps muscle, and inadequate pain control hindering early mobilization. Additionally, higher opioid consumption induced sedation and reduced physical activity, while persistent inflammation and psychological factors, such as fear of movement, further contributed to the delayed recovery of quadriceps strength compared to patients receiving regional blocks. This suggests that the lack of a regional block contributed to a longer recovery time and delayed the achievement of this functional milestone.

Our study showed similar results to previous studies, such as those by Pascarella G et al., Lin DY, Morrison C et al., and Aliste J et al., which demonstrated that the PENG block facilitates early mobilization and faster motor recovery in patients undergoing hip surgeries. [16,18,86] Like these studies, our findings indicate that the PENG block provides effective pain control while preserving motor function, particularly in the quadriceps, enabling quicker recovery of mobility postoperatively. The preservation of strength in key muscles, such as the quadriceps, plays a crucial role in improving functional outcomes and supporting early ambulation, aligning with the observed benefits of the PENG block in enhancing rehabilitation for hip surgery patients.

While the PENG group showed a significantly shorter discharge time compared to the QLB and control groups, it is important to note that discharge timing in our hospital is influenced by various factors, such as the surgeon's clinical judgment, patient preferences, and financial considerations. Therefore, the observed differences in discharge time may not solely reflect the effects of the anesthetic technique. Given these multiple contributing factors, the discharge time data may not be entirely reliable as a measure of recovery, as it is contingent upon decisions made by the healthcare team and the patient's personal circumstances.

We found that almost all patients expressed satisfaction with their care during their hospital stay, with the PENG group reporting the highest levels of satisfaction. The satisfaction scores for patients in the QLB and control groups were similar, with no significant differences observed between the two groups. However, it is important to note that patient satisfaction is influenced by many factors beyond the effectiveness of the block, such as the hospital environment, staff interactions, and overall comfort during the stay. Therefore, while our study observed higher satisfaction in the PENG group, these results may not be entirely reliable, as satisfaction is multifaceted and cannot be solely attributed to the analgesic technique used. Our study found no patient falls or adverse events across all groups, demonstrating the safety of the analgesic techniques used. No cases of nausea, vomiting, hematoma, pruritus, or urinary retention occurred. Ultrasound-guided regional blocks ensured precise needle placement, preventing nerve injuries. Additionally, the use of lower concentrations and volumes of local anesthetic minimized the risk of toxicity, enhancing overall safety.

The primary limitation of our study was the potential for bias, as patients were aware that they were receiving an intervention aimed at reducing pain, which may have influenced their perception and reporting of pain relief. Additionally, the study was conducted on a relatively small sample size, which may limit the statistical power and generalizability of the findings. Furthermore, the inclusion of patients undergoing different types of surgeries may have introduced variability in pain levels and responses to the intervention, potentially affecting the consistency of the results.

# CONCLUSION

The study concluded that the Pericapsular Nerve Group (PENG) block is a superior regional anaesthesia technique compared to the Quadratus Lumborum Block (QLB) and control group approaches in patients undergoing proximal femur surgeries. The PENG block provided more effective pain relief, reduced opioid consumption, and prolonged the time to first rescue analgesia while preserving quadriceps strength, enabling early mobilization and faster recovery. The QLB also offered adequate analgesia but with less consistent preservation of quadriceps strength. Both blocks were found to be safe, with no significant adverse events reported. The findings suggest that the PENG block is an optimal choice for postoperative pain management in hip arthroplasty, balancing efficacy, functional recovery, and safety.

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# ETHICAL CLEARANCE CERTIFICATE

Azadi Ka Amrit Mahotsav

# BLDE

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Declared as Deemed to be University u/s 3 of UGC Act, 1956

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**INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE**

The Ethical Committee of this University met on **Saturday, 18th March, 2023 at 11.30 a.m. in the CAL Laboratory, Dept. of Pharmacology,** scrutinized the Synopsis/ Research Projects of Post Graduate Student / Under Graduate Student /Faculty members of this University /Ph.D. Student College from ethical clearance point of view. After scrutiny, the following original/ corrected and revised version synopsis of the thesis/ research projects has been accorded ethical clearance.

**TITLE: "POST OPERATIVE ANALGESIA AND OPIOID -SPARING EFFICACY OF ULTRA SOUND -GUIDED PERICAPSULAR NERVE GROUP (PENG) BLOCK VERSUS QUADRATUS LUMBORUM BLOCK (Q.L.B.) IN PROXIMAL FEMUR FRACTURE PATIENS: A COMPARATIVE STUDY".**

**NAME OF THE STUDENT/PRINCIPAL INVESTIGATOR: DR.SAHINI VENKATA LAKSHMI NARASIMHA SESHA SAI**

**NAME OF THE GUIDE: DR.K.NIRMALA DEVI, ASSOCIATE PROFESSOR, DEPT. OF ANAESTHESIOLOGY.**

Dr. Santoshkumar Jeevangi
Chairperson
IEC, BLDE (DU),
VIJAYAPURA

**Chairman,**
**Institutional Ethical Committee,**
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Member Secretary
IEC, BLDE (DU),
VIJAYAPURA

**MEMBER SECRETARY**
**Institutional Ethics Committee**
**BLDE (Deemed to be University)**
**Vijayapura-586103. Karnataka**

Following documents were placed before Ethical Committee for Scrutinization.

- Copy of Synopsis/Research Projects
- Copy of inform consent form
- Any other relevant document

Smt. Bangaramma Sajjan Campus, B. M. Patil Road (Sholapur Road), Vijayapura - 586103, Karnataka, India.
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# PLAGARISM CERTIFICATE



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**SAMPLE INFORMED CONSENT FORM**

B.L.D.E(DEEMED TO BE UNIVERSITY) SHRI B.M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE,
VIJAYAPURA – 586103, KARNATAKA

TITLE OF THE PROJECT: "POST- OPERATIVE ANALGESIA AND OPIOID-SPARING EFFICACY OF ULTRASOUND- GUIDED PERICAPSULAR NERVE GROUP (PENG) BLOCK VERSUS QUADRATUS LUMBORUM BLOCK (QLB) IN PROXIMAL FEMUR FRACTURE PATIENTS: A COMPARATIVE STUDY"

PRINCIPAL INVESTIGATOR: Dr. S V L N SESHA SAI
DEPARTMENT OF ANAESTHESIOLOGY,
BLDE'S (DEEMED TO BE UNIVERSITY),
SHRI.B.M. PATIL MEDICAL COLLEGE
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GUIDE: DR. K NIRMALA DEVI
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DEPARTMENT OF ANAESTHESIOLOGY,
BLDE (DEEMED TO BE UNIVERSITY),
SHRI B. M. PATIL MEDICAL COLLEGE
HOSPITAL AND RESEARCH CENTRE
VIJAYAPURA -586103.

PURPOSE OF RESEARCH:

I have been informed that this study is: "POST- OPERATIVE ANALGESIA AND OPIOID- SPARING EFFICACY OF ULTRASOUND- GUIDED PERICAPSULAR NERVE GROUP (PENG) BLOCK VERSUS QUADRATUS LUMBORUM BLOCK (QLB) IN PROXIMAL FEMUR FRACTURE PATIENTS: A COMPARATIVE STUDY".

I have been explained about the reason for conducting this study and selecting me/my ward as a subject for this study. I have also been given a free choice for either being included or not in the study.

PROCEDURE:

I understand that I will be doing "POST- OPERATIVE ANALGESIA AND OPIOID-SPARING EFFICACY OF ULTRASOUND- GUIDED PERICAPSULAR NERVE GROUP (PENG) BLOCK VERSUS QUADRATUS LUMBORUM BLOCK (QLB) IN PROXIMAL FEMUR FRACTURE PATIENTS: A COMPARATIVE STUDY".

RISKS AND DISCOMFORTS:

I understand that I/my ward may experience some discomfort while doing the procedure, and that necessary measures will be taken to reduce them.

BENEFITS:

I understand that I/my wards participation in this study will help in finding out POST-OPERATIVE ANALGESIA AND OPIOID- SPARING EFFICACY OF ULTRASOUND-GUIDED PERICAPSULAR NERVE GROUP (PENG) BLOCK VERSUS QUADRATUS LUMBORUM BLOCK (QLB) IN PROXIMAL FEMUR FRACTURE PATIENTS: A COMPARATIVE STUDY:

I understand that medical information produced by this study will become a part of this Hospital records and will be subjected to the confidentiality and privacy regulation of this hospital. Information of a sensitive, personal nature will not be a part of the medical records but will be stored in the investigator's research file and identified only by a code number. The code key connecting name to numbers will be kept in a separate secure location. If the data are used for publication in the medical literature or for teaching purpose, no names

will be used and other identifiers such as photographs and audio or video tapes will be used only with my special written permission. I understand that I may see the photograph and videotapes and hear audiotapes before giving this permission.

REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study at any time. Dr. S.V.L.N.SESHA SAI is available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of this study, which might influence my continued participation. If during this study, or later, I wish to discuss my participation in or concerns regarding this study with a person not directly involved, I am aware that the social worker of the hospital is available to talk with me. And that a copy of this consent form will be given to me to keep for careful reading.

REFUSAL OR WITHDRAWAL OF PARTICIPATION:

I understand that my participation is voluntary and I may refuse to participate or may withdraw consent and discontinue participation in the study at any time without prejudice to my present or future care at this hospital. I also understand that Dr. S.V.L.N.SESHA SAI will terminate my participation in this study at any time after he has explained the reasons for doing so and has helped arrange for my continued care by my own physician or therapist, if this is appropriate.

INJURY STATEMENT:

I understand that in the unlikely event of injury to me/my ward, resulting directly to my participation in this study, if such injury were reported promptly, then medical treatment would be available to me, but no further compensation will be provided. I understand that by my agreement to participate in this study, I am not waiving any of my legal rights.

I have explained to _____,

the purpose of this research, the procedures required and the possible risks and benefits, to the best of my ability in patient's own language.

| | | |
|---|---|---|
| Date: | Dr. K NIRMALA DEVI | Dr. S.V.L.N.SESHA SAI |
| Time: | (Guide) | (Investigator) |

STUDY SUBJECT CONSENT STATEMENT

I confirm that Dr.S.V.L.N.SESHA SAI has explained to me the purpose of this research, the study procedure that I will undergo, and the possible discomforts and benefits that I may experience in my own language. I have been explained all the above in detail in my own language, and I understand the same. Therefore, i agree to give my consent to participate as a subject in this research project.

_____ _____

(Participant) Date

_____ _____

(Witness to above signature) Date

**SCHEME OF CASE TAKING**

**PROFORMA**

POST-OPERATIVE ANALGESIA AND OPIOID-SPARING EFFICACY OF ULTRASOUND-GUIDED PERICAPSULAR NERVE GROUP(PENG) BLOCK VERSUS QUADRATUS LUMBORUM BLOCK(Q.L.B.) IN PROXIMAL FEMUR FRACTURE PATIENTS: A COMPARATIVE STUDY

Name: Age/ Sex:

I.P. No: DATE

Group allotted by randomization: Group P / Group Q/ Group C

1. Type of surgery:

2. Indication:

Significant History:

General Physical Examination:

Pallor Y/N Icterus Y/N Cyanosis Y/N Clubbing Y/N

Koilonychia Y/N Lymphadenopathy Y/N Edema Y/N Teeth Y/N

Dentures Y/N

Vital Parameters

Pulse (beats per minute):0 Blood Pressure:

Respiratory Rate: Temperature:

Systemic Examination

1. CVS 2.RS:

3. C.N.S. 4.Per Abdomen:

Airway Assessment:

Mallampati Grade: Cervical Spine:

Mouth opening: Neck Movement:

A.S.A. Grade:

Investigation

Haemoglobin: T.L.C.:

S. Urea: S. Creatinine:

R.B.S.: Platelet count:

Urine Routine:

Chest Xray: E.C.G.:

Block time:

Anaesthesia start time:

Surgery start time:

Surgery end time:

TABLE 1

| PARAMETERS | GROUP P | GROUP Q | GROUP C |
|---|---|---|---|
| Time of rescue analgesia (hrs) | | | |
| Tramadol consumption in first 24hrs | | | |
| Tramadol consumption in 25-48hrs | | | |
| No.of patients requiring fentanyl | | | |
| Total fentanyl doses | | | |

TABLE 2

| | VAS score |
|---|---|
| At rest | |
| On movement pre block | |
| 30 minutes | |
| During spinal | |
| Admission to PACU | |
| Discharge at PACU | |
| 12hrs | |
| 24hrs | |
| 48hrs | |

TABLE 3

| Quadriceps strength | Intact | Reduced | Absent | Unable to assess |
|---|---|---|---|---|
| 12hrs | | | | |
| 24hrs | | | | |
| 48hrs | | | | |

TABLE 4

| | |
|---|---|
| Time of first standing with support | |
| Discharge time | |
| Satisfactory score | |

# MASTER CHART

## GROUP P

| Name | Age | Sex | Diagnosis | procedure | Vas at rest | On movement pre block | 30min | During spinal | Admission to pacu | Discharges at PACU | 12hrs | 24hrs | 48hrs | Time of rescue analgesia in | Tramadol consumption in 24hrs in mg | 24-48hrs in mg | No. Of pts requiring fentanyl | Total fentanyl dose | Quadriceps strength at 12hrs | 24hrs | 48hrs | time of first ambulating with support | discharge time | satisfactory score at time of discharge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sundaki | 65 | F | Right rf fracture | ORIF with PFN | 5 | 7 | 3 | 3 | 1 | 2 | 2 | 4 | 2 | 24 | 0 | 50 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Gurubasamma | 70 | F | Right neck of femur fracture | Right bipolar hemiarthroplasty | 4 | 7 | 3 | 2 | 1 | 2 | 3 | 4 | 2 | 24 | 0 | 100 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Kalavathi | 68 | F | Right rf fracture | ORIF with TFN | 7 | 8 | 3 | 2 | 0 | 1 | 3 | 4 | 1 | 18 | 50 | 100 | 0 | 0 | Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Somavva | 40 | F | Left rf fracture femur | Left bipolar hemiarthroplasty | 6 | 8 | 4 | 3 | 0 | 0 | 2 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Pratap | 33 | M | Traumatic Right rf fracture | ORIF with TFN | 7 | 9 | 4 | 4 | 0 | 0 | 3 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Laxmi | 37 | F | Right rf fracture | ORIF with PFN | 6 | 9 | 4 | 3 | 0 | 2 | 4 | 3 | 2 | 12 | 50 | 50 | 0 | 0 | Unable to assess | Reduced | Intact | Pod3 | 7days | 2 |
| Basamma | 70 | F | Left femur sub trochanteric fracture | ORIF with TFN | 7 | 8 | 4 | 3 | 0 | 1 | 3 | 5 | 4 | 24 | 0 | 50 | 0 | 0 | Reduced | Intact | Intact | Pod3 | 7days | 0 |
| Pandranna | 55 | M | Left neck of femur fracture | Left bipolar hemiarthroplasty | 5 | 8 | 3 | 2 | 0 | 1 | 2 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | Absent | Reduced | Intact | Pod3 | 7days | 0 |
| Irrinkaki | 69 | F | Left basicervical neck of femur fracture | Left modular bipolar hemiarthro | 6 | 7 | 2 | 2 | 0 | 0 | 3 | 2 | 3 | 28 | 0 | 50 | 0 | 0 | Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Parashuram | 55 | M | Left rf fracture femur | ORIF with PFN | 6 | 8 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Mallamkee | 60 | F | Traumatic Right rf fracture | ORIF with PFN | 5 | 9 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | Absent | Reduced | Intact | Pod3 | 7days | 2 |
| Sonuka | 62 | M | Right basicervical NOF fracture | Right bipolar hemiarthroplasty | 5 | 7 | 2 | 1 | 0 | 0 | 3 | 4 | 2 | 24 | 50 | 50 | 0 | 0 | Unable to assess | Reduced | Intact | Pod3 | 7days | 2 |
| Chandramma | 58 | F | Left rf fracture femur | ORIF with TFN | 4 | 7 | 3 | 2 | 0 | 0 | 2 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Padma | 30 | F | Left rf fracture femur | Left bipolar hemiarthroplasty | 7 | 9 | 4 | 4 | 0 | 0 | 3 | 4 | 2 | 24 | 0 | 50 | 0 | 0 | Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Shantamma | 63 | F | Right rf fracture | ORIF with PFN | 6 | 8 | 3 | 2 | 0 | 1 | 2 | 4 | 1 | 24 | 0 | 100 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Rajesh | 28 | M | Left rf fracture femur | ORIF with TFN | 5 | 7 | 3 | 2 | 1 | 2 | 2 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Parvati | 37 | F | Right rf fracture | ORIF with TFN | 5 | 7 | 3 | 2 | 0 | 1 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Gudisab | 67 | M | Left femur sub trochanteric fracture | Left bipolar hemiarthroplasty | 6 | 8 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 28 | 0 | 50 | 0 | 0 | Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Lakshmibai | 59 | F | Left rf fracture femur | Left bipolar hemiarthroplasty | 6 | 7 | 3 | 3 | 1 | 1 | 2 | 3 | 2 | 28 | 0 | 50 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Mallikarjun | 41 | M | Right neck of femur fracture | ORIF with TFN | 5 | 7 | 3 | 2 | 0 | 2 | 2 | 4 | 2 | 24 | 0 | 100 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Lakkappa | 60 | M | Left neck of femur fracture | ORIF with PFN | 4 | 6 | 3 | 2 | 0 | 1 | 2 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Ratnabai | 64 | F | Right rf fracture | ORIF with PFN | 5 | 7 | 3 | 3 | 0 | 1 | 3 | 5 | 3 | 24 | 0 | 150 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Basanna | 67 | M | Left basicervical neck of femur fracture | Left modular bipolar hemiarthro | 6 | 7 | 4 | 3 | 0 | 0 | 2 | 4 | 2 | 24 | 0 | 100 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Prakash | 51 | M | Left rf fracture femur | ORIF with PFN | 5 | 7 | 3 | 2 | 0 | 1 | 2 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Basavaraj | 42 | M | Left rf fracture femur | ORIF with TFN | 7 | 7 | 4 | 3 | 1 | 2 | 3 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | Reduced | Intact | Intact | Pod3 | 7days | 2 |
| Rangavva | 70 | M | Left neck of femur fracture | Left modular bipolar hemiarthro | 5 | 7 | 4 | 3 | 0 | 0 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |
| Sankappa | 70 | M | Traumatic left neck of femur fracture | Left bipolar hemiarthroplasty | 7 | 9 | 4 | 3 | 2 | 2 | 4 | 3 | 3 | 12 | 50 | 100 | 0 | 0 | Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Yesvant | 65 | M | Left rf fracture femur | ORIF with TFN | 6 | 8 | 3 | 2 | 0 | 0 | 3 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | Intact | Intact | Intact | Pod2 | 5days | 2 |

## GROUP Q

| Name | Age | Sex | Diagnosis | Procedure | Vas at rest | On movement pre block | 30min | During spinal | Admission to pacu | Discharge at PACU | 12hrs | 24hrs | 48hrs | Time of rescue analgesia in | Tramadol consumption in 24hrs in mg | 24-48hrs in mg | No. Of pts requiring fentanyl | Total fentanyl doses | Quadriceps strength at 12hrs | 24hrs | 48hrs | time of first standing with support | discharge time | satisfactory score at time of discharge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Laxmibai | 70 | F | Right neck of femur fracture | Right modular bipolar hemiarthroplasty | 8 | | 9 | 5 | 5 | 0 | 0 | 3 | 5 | 2 | 24 | 0 | 100 | 0 | 0 Intact | Intact | Intact | Pod2 | 5days | 2 |
| Sangamma | 65 | F | Left T Treasure of femur | Left modular bipolar hemiarthroplasty | 5 | | 7 | 5 | 4 | 0 | 1 | 3 | 5 | 3 | 24 | 0 | 100 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Mallaiahgouda | 39 | M | Right T Treasure of femur | CRIF with PFN | 7 | | 9 | 4 | 5 | 1 | 2 | 2 | 4 | 2 | 24 | 0 | 50 | 0 | 0 Intact | Intact | Intact | Pod2 | 5days | 2 |
| Hasseenbhanu | 45 | F | Left T Treasure of femur | Left bipolar hemiarthroplasty | 6 | | 8 | 5 | 5 | 2 | 2 | 4 | 3 | 3 | 12 | 50 | 50 | 0 | 0 Unable to assess | Reduced | Intact | Pod3 | 7days | 2 |
| Lakshmibai | 50 | F | Left T Treasure of femur | CRIF with PFN | 6 | | 7 | 4 | 4 | 1 | 2 | 4 | 2 | 4 | 12 | 50 | 50 | 0 | 0 Reduced | Reduced | Intact | Pod3 | 7days | 2 |
| Shashidhar | 68 | M | Left neck of femur fracture | Left bipolar hemiarthroplasty | 8 | | 8 | 5 | 4 | 0 | 2 | 2 | 4 | 3 | 24 | 0 | 100 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Kamala | 65 | F | Left neck of femur fracture | Left bipolar hemiarthroplasty | 5 | | 6 | 5 | 4 | 0 | 1 | 3 | 5 | 2 | 24 | 0 | 150 | 0 | 0 Reduced | Reduced | Intact | Pod3 | 7days | 2 |
| Apparao | 61 | M | Left T Treasure of femur | CRIF with TFN | 6 | | 8 | 4 | 3 | 2 | 1 | 4 | 4 | 2 | 12 | 50 | 200 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Mahipal | 50 | M | Left neck of femur fracture | Left modular bipolar hemiarthroplasty | 6 | | 8 | 5 | 3 | 1 | 2 | 4 | 5 | 4 | 12 | 50 | 200 | 0 | 0 Intact | Intact | Intact | Pod2 | 5days | 2 |
| Kallappa | 55 | M | Left T Treasure of femur | CRIF with PFN | 5 | | 6 | 4 | 3 | 0 | 2 | 4 | 4 | 3 | 12 | 50 | 200 | 0 | 0 Absent | Reduced | Intact | Pod3 | 8days | 0 |
| Rajeshri | 67 | F | Left neck of femur fracture | Left modular bipolar hemiarthroplasty | 5 | | 6 | 4 | 3 | 0 | 1 | 3 | 5 | 3 | 24 | 0 | 150 | 0 | 0 Intact | Intact | Intact | Pod2 | 5days | 2 |
| Rashimbee | 40 | F | Right T Treasure of femur | CRIF with PFN | 6 | | 8 | 5 | 4 | 2 | 0 | 3 | 5 | 3 | 24 | 0 | 150 | 0 | 0 Intact | Intact | Intact | Pod2 | 5days | 2 |
| Dundamma | 52 | F | Traumatic Right T Fracture | CRIF with TFN | 7 | | 7 | 5 | 5 | 0 | 1 | 5 | 3 | 5 | 12 | 50 | 150 | 0 | 0 Unable to assess | Reduced | Intact | Pod3 | 9days | 0 |
| Kallappa | 66 | M | Left T Treasure of femur | CRIF with PFN | 8 | | 9 | 5 | 4 | 0 | 0 | 4 | 3 | 3 | 12 | 50 | 150 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Bowrenna | 53 | F | Left neck of femur fracture | Left bipolar hemiarthroplasty | 7 | | 8 | 6 | 4 | 1 | 2 | 5 | 2 | 4 | 12 | 50 | 150 | 0 | 0 Unable to assess | Reduced | Intact | Pod3 | 7days | 0 |
| Ratnabai | 64 | F | Left T Treasure of femur | CRIF with PFN | 6 | | 6 | 4 | 3 | 1 | 1 | 4 | 2 | 3 | 12 | 50 | 100 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Ramesh | 32 | M | Right neck of femur fracture | Right modular bipolar hemiarthroplasty | 5 | | 7 | 4 | 4 | 0 | 0 | 4 | 2 | 3 | 12 | 50 | 0 | 0 | 0 Intact | Intact | Intact | Pod2 | 5days | 2 |
| Ammpamma | 70 | F | Right T Treasure of femur | CRIF with PFN | 5 | | 6 | 5 | 5 | 0 | 1 | 2 | 3 | 4 | 48 | 0 | 0 | 0 | 0 Intact | Intact | Intact | Pod2 | 5days | 2 |
| Devaki | 60 | F | Right neck of femur fracture | Right modular bipolar hemiarthroplasty | 6 | | 7 | 5 | 4 | 0 | 1 | 3 | 4 | 3 | 24 | 0 | 100 | 0 | 0 Reduced | Reduced | Intact | Pod3 | 7days | 2 |
| Shivayya | 53 | M | Left T Treasure of femur | CRIF with PFN | 7 | | 8 | 5 | 4 | 0 | 2 | 3 | 5 | 2 | 18 | 50 | 150 | 0 | 0 Reduced | Reduced | Intact | Pod3 | 8days | 0 |
| Bhimappavva | 67 | M | Right T Treasure of femur | CRIF with TFN | 6 | | 6 | 4 | 3 | 1 | 2 | 4 | 5 | 2 | 12 | 50 | 150 | 0 | 0 Reduced | Reduced | Intact | Pod3 | 7days | 1 |
| Shivamma | 70 | F | Left neck of femur fracture | Left modular bipolar hemiarthroplasty | 5 | | 7 | 4 | 3 | 2 | 1 | 3 | 4 | 2 | 18 | 50 | 100 | 0 | 0 Intact | Intact | Intact | Pod2 | 5days | 2 |
| Ambabai | 60 | F | Left neck of femur fracture | Left modular bipolar hemiarthroplasty | 6 | | 7 | 5 | 3 | 1 | 2 | 2 | 4 | 2 | 24 | 0 | 100 | 0 | 0 Intact | Intact | Intact | Pod2 | 5days | 2 |
| Sunilambbi | 70 | F | Left neck of femur fracture | Left bipolar hemiarthroplasty | 5 | | 7 | 4 | 4 | 0 | 2 | 3 | 4 | 3 | 24 | 0 | 100 | 0 | 0 Intact | Intact | Intact | Pod2 | 5days | 2 |
| Shivaraji | 70 | M | Left T Treasure of femur | CRIF with TFN | 6 | | 8 | 5 | 4 | 0 | 2 | 4 | 3 | 2 | 12 | 50 | 100 | 0 | 0 Absent | Reduced | Intact | Pod3 | 7days | 2 |
| Basappa | 65 | M | Left neck of femur fracture | Left modular bipolar hemiarthroplasty | 7 | | 8 | 5 | 4 | 1 | 2 | 4 | 3 | 3 | 12 | 50 | 100 | 0 | 0 Absent | Reduced | Intact | Pod3 | 7days | 2 |
| Ragavva | 70 | F | Right neck of femur fracture | Right modular bipolar hemiarthroplasty | 6 | | 6 | 4 | 3 | 1 | 1 | 2 | 3 | 3 | 32 | 0 | 100 | 0 | 0 Intact | Intact | Intact | Pod2 | 5days | 2 |
| Sangappa | 60 | M | Right T Treasure of femur | Right modular bipolar hemiarthroplasty | 5 | | 7 | 4 | 4 | 0 | 2 | 3 | 3 | 3 | 28 | 0 | 100 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |

# GROUP C

| Name | Age | Sex | Diagnosis | Procedure | Vas at rest | On movement pre block | 30min | During spinal | Admission to pacu | Discharge at PACU | 12hrs | 24hrs | 48hrs | Time of rescue analgesia in | Tramadol consumption in 24hrs in mg | 24-48hrs in mg No. Of pts requiring Fentanyl | Total fentanyl dose | Quadriceps strength at 24hrs | 24hrs | 48hrs | time of first standing with support | discharge time | satisfactory score at time of discharge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kamalakki | 65 | F | Right neck of femur fracture | Right modular bipolar hemiarthroplasty | 5 | 7 | 6 | 5 | 0 | 1 | 4 | 4 | 3 | 6 | 200 | 200 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Rakesh | 66 | M | Right IT fracture | CRIF with PFN | 5 | 7 | 6 | 5 | 0 | 2 | 3 | 4 | 3 | 6 | 200 | 200 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Pandurang | 70 | M | Right IT fracture | Right modular bipolar hemiarthroplasty | 7 | 8 | 7 | 5 | 2 | 2 | 2 | 4 | 4 | 6 | 200 | 200 | 0 | 0 Intact | Reduced | Intact | Pod3 | 7days | 2 |
| Sumangala | 44 | F | Left IT fracture of femur | CRIF with PFN | 7 | 8 | 7 | 6 | 2 | 3 | 4 | 3 | 2 | 6 | 200 | 200 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Bramanna | 57 | M | Right IT fracture | CRIF with PFN | 6 | 8 | 7 | 5 | 0 | 2 | 4 | 2 | 2 | 6 | 200 | 200 | 0 | 0 Absent | Intact | Intact | Pod2 | 5days | 2 |
| Buramaiah | 70 | M | Right neck of femur fracture | Right bipolar hemiarthroplasty | 5 | 6 | 7 | 5 | 3 | 2 | 2 | 4 | 3 | 6 | 200 | 200 | 0 | 0 Reduced | Reduced | Intact | Pod3 | 7days | 2 |
| Someera | 60 | M | Left IT fracture of femur | CRIF with TFN | 5 | 7 | 7 | 5 | 0 | 3 | 3 | 5 | 3 | 6 | 200 | 200 | 0 | 0 Reduced | Reduced | Intact | Pod3 | 7days | 2 |
| Sangappa | 70 | M | Left IT fracture of femur | CRIF with TFN | 6 | 7 | 7 | 4 | 2 | 3 | 4 | 4 | 2 | 6 | 200 | 200 | 0 | 0 Unable to assess | Reduced | Intact | Pod3 | 7days | 2 |
| Neela | 67 | F | Left neck of femur fracture | Left bipolar hemiarthroplasty | 7 | 8 | 7 | 5 | 1 | 3 | 4 | 5 | 3 | 6 | 200 | 200 | 0 | 0 Reduced | Reduced | Intact | Pod4 | 10days | 1 |
| Chandramm | 60 | F | Left neck of femur fracture | Left bipolar hemiarthroplasty | 5 | 6 | 5 | 4 | 1 | 2 | 4 | 4 | 2 | 6 | 200 | 200 | 0 | 0 Unable to assess | Reduced | Intact | Pod3 | 7days | 2 |
| Yellaiaw | 57 | F | Right neck of femur fracture | Right bipolar hemiarthroplasty | 5 | 7 | 6 | 5 | 0 | 2 | 3 | 5 | 3 | 6 | 200 | 200 | 0 | 0 Reduced | Reduced | Intact | Pod3 | 7days | 2 |
| Shankaiah | 68 | F | Traumatic Right IT fracture | Right bipolar hemiarthroplasty | 6 | 6 | 6 | 5 | 0 | 2 | 3 | 5 | 3 | 6 | 200 | 200 | 0 | 0 Absent | Intact | Intact | Pod2 | 5days | 2 |
| Dayanand | 41 | M | Right neck of femur fracture | Right bipolar hemiarthroplasty | 8 | 7 | 6 | 6 | 2 | 1 | 5 | 3 | 4 | 6 | 200 | 200 | 0 | 0 Reduced | Reduced | Intact | Pod3 | 7days | 2 |
| Ningamma | 67 | F | Left neck of femur fracture | Left bipolar hemiarthroplasty | 5 | 6 | 5 | 5 | 1 | 3 | 4 | 3 | 4 | 6 | 200 | 200 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Pratap | 36 | M | Right IT fracture | CRIF with TFN | 5 | 6 | 6 | 5 | 0 | 3 | 5 | 2 | 3 | 6 | 200 | 200 | 0 | 0 Unable to assess | Reduced | Intact | Pod4 | 8days | 0 |
| Siddamma | 70 | F | Left neck of femur fracture | Left bipolar hemiarthroplasty | 4 | 6 | 5 | 6 | 0 | 3 | 4 | 2 | 3 | 6 | 200 | 200 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 0 |
| Mallamma | 65 | F | Right IT fracture | CRIF with TFN | 6 | 7 | 6 | 6 | 1 | 2 | 4 | 2 | 2 | 6 | 200 | 200 | 0 | 0 Reduced | Intact | Intact | Pod3 | 7days | 2 |
| Rudrappa | 59 | M | Right neck of femur fracture | Right bipolar hemiarthroplasty | 5 | 6 | 5 | 5 | 0 | 3 | 4 | 3 | 3 | 6 | 200 | 200 | 0 | 0 Reduced | Intact | Intact | Pod3 | 7days | 0 |
| Gurubai | 60 | F | Left neck of femur fracture | Left bipolar hemiarthroplasty | 5 | 6 | 6 | 5 | 2 | 3 | 5 | 3 | 2 | 6 | 200 | 200 | 0 | 0 Unable to assess | Reduced | Intact | Pod4 | 8days | 1 |
| Nilavva | 70 | F | Left neck of femur fracture | Left bipolar hemiarthroplasty | 5 | 7 | 6 | 5 | 0 | 2 | 5 | 4 | 3 | 6 | 200 | 200 | 0 | 0 Unable to assess | Reduced | Intact | Pod4 | 8days | 1 |
| Harish | 40 | M | Left neck of femur fracture | Left bipolar hemiarthroplasty | 6 | 8 | 7 | 5 | 2 | 3 | 3 | 3 | 2 | 6 | 200 | 200 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Cheramma | 65 | F | Left neck of femur fracture | Left bipolar hemiarthroplasty | 7 | 9 | 8 | 6 | 1 | 3 | 3 | 3 | 2 | 6 | 200 | 200 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Kamalakki | 65 | F | Left IT fracture of femur | CRIF with PFN | 7 | 9 | 7 | 6 | 2 | 3 | 3 | 2 | 3 | 6 | 200 | 200 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Shivappa | 67 | M | Right neck of femur fracture | Right bipolar hemiarthroplasty | 6 | 9 | 6 | 5 | 0 | 3 | 4 | 3 | 2 | 6 | 200 | 200 | 0 | 0 Unable to assess | Reduced | Intact | Pod3 | 7days | 0 |
| Iraiya | 55 | M | Right neck of femur fracture | Right bipolar hemiarthroplasty | 5 | 8 | 7 | 6 | 0 | 3 | 3 | 2 | 2 | 6 | 200 | 200 | 0 | 0 Reduced | Intact | Intact | Pod2 | 5days | 2 |
| Basamma | 45 | F | Left neck of femur fracture | Left bipolar hemiarthroplasty | 6 | 7 | 6 | 6 | 0 | 2 | 4 | 4 | 3 | 6 | 200 | 200 | 0 | 0 Absent | Reduced | Intact | Pod3 | 8days | 2 |
| Perveti | 55 | F | Right IT fracture | CRIF with PFN | 7 | 9 | 6 | 5 | 2 | 2 | 5 | 4 | 2 | 6 | 200 | 200 | 0 | 0 Absent | Reduced | Intact | Pod3 | 10days | 2 |
| Ramaiyan | 40 | M | Traumatic Right IT fracture | Right bipolar hemiarthroplasty | 6 | 7 | 6 | 4 | 2 | 3 | 5 | 3 | 2 | 6 | 200 | 200 | 0 | 0 Reduced | Intact | Intact | Pod2 | 6days | 2 |

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