LUMBAR PLEXUS BLOCK – LANDMARK TECHNIQUE (PSOAS COMPARTMENT BLOCK) ANAESTHESIA TUTORIAL OF THE WEEK 263

18TH JUNE 2012

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QUESTIONS
Please answer the following questions either true or false:

1. The following nerves arise from the lumbar plexus;
   a. Lateral Cutaneous Nerve of the Thigh
   b. Obturator nerve
   c. Tibial nerve
   d. Saphenous nerve
   e. Sural nerve
2. Stimulation of hamstrings or knee flexion are acceptable motor responses using the PNS prior to LA injection.
3. Complications of Lumbar Plexus block include;
   a. Epidural block
   b. Sub arachnoid/intrathecal injection
   c. Cardiovascular collapse
   d. Psoas muscle haematoma
   e. Renal capsular haematoma

INTRODUCTION
The Lumbar plexus describes the origins of 4 of the nerves supplying the lower limb (femoral, lateral cutaneous nerve of the thigh, obturator and genitofemoral) along with the ilioinguinal and iliohypogastric nerves. Blockade of the plexus has been described since the early 1970s and is a useful technique for providing analgesia of large parts of the leg. It is principally used for post-operative analgesia for major orthopaedic surgery of the hip, femur and knee. Since Winnie’s original description of the posterior approach to the lumbar plexus in 1974 there have been several alternative descriptions, which will be described and discussed in this article. Capdevilla’s description, essential a modification of Winnie’s original technique, developed from CT anatomic studies, is probably the current technique of choice. Although Winnie described an anterior approach (via the femoral nerve) to the “lumbar plexus block” (the so called 3 in 1) in 1973, subsequent studies have shown the plexus is not at all reliably blocked via injections at this site and therefore will not be discussed in this tutorial. Publication in 2002 of a large study from France raised concerns over the safety of lumbar plexus blocks as the incidence of serious complication was calculated as 80 per 10,000 compared to an overall incidence of 5 per 10,000 for regional anaesthetics. This was principally attributed to inadvertent epidural and intrathecal spread or administration of local anaesthetic drugs. However, with appropriate skills and training it remains a useful and safe technique for regional anaesthetists.

This Tutorial will cover the relevant anatomy, a description of the posterior approaches blocking the lumbar plexus (and the debate about the merits of each) and complications. Ultrasound guided techniques will not be covered in this article. There is also a brief review of the literature surrounding the use of lumbar plexus blocks in clinical practice.
ANATOMY

The Lumbar Plexus describes the association of nerves derived from the segmental lumbar spinal roots. The lumbar plexus receives input from L1 (variable input from T12) to L4 and produces the femoral nerve, lateral cutaneous nerve of the thigh, obturator nerve, as well as the iliohypogastric, ilioinguinal and genitofemoral nerves.

Lumbar Plexus Origins
The lumbar plexus is formed from the ventral rami of L1-L3 (sometimes including T12), with a major contribution from L4. The nerve roots then run anteriorly to form the lumbar plexus, which lies between the quadratus lumborum and psoas major muscles. The plexus and branches then angle caudally to descend within the mass of the psoas major muscle, anterior to the transverse processes of the lumbar vertebrae.

The L1 nerve root (occasionally with a contribution from T12), splits into an upper and a lower branch. The upper branch then divides into the iliohypogastric and ilioinguinal nerves. The lower branch forms the genitofemoral nerve with a contribution from L2 nerve root.

The ventral branches of L2, L3 and L4 form the obturator nerve. The dorsal roots of L2 and L3 have lesser branches, which make up the lateral cutaneous nerve of the thigh, and greater branches, that along with the dorsal root of L4 are the origins of the femoral nerve.

![Image of Lumbosacral Plexus]

**Figure 1. Lumbosacral plexus**

The **femoral nerve** is the largest terminal branch of the lumbar plexus. It emerges from the lower part of the psoas major muscle and iliacus muscle deep to the iliacus fascia. It innervates the pectineus muscle before entering the thigh by passing underneath the inguinal ligament to lie lateral to the femoral artery. It provides sensory supply to the anterior thigh and the medial lower leg, and motor supply to the quadriceps muscle.
The obturator nerve also descends through the psoas major muscle and emerges near the pelvic brim. It enters the thigh by passing through the obturator foramen, where it divides into the anterior and posterior branches. Motor supply is to the obturator externus and adductor muscles, with sensory innervations to the hip and knee joints. Sensory innervation, and therefore block, can be variable, with adductor muscle weakness being the most reliable sign of obturator nerve block.

The lateral cutaneous nerve of the thigh arises from the lateral part of the psoas muscle and crosses the iliacus, running towards the anterior superior iliac spines. It passes under the inguinal ligament 1cm medial to the anterior superior iliac spines to supply sensory innervation to the anterior and lateral aspects of the thigh.

The iliohypogastric nerve divides into the anterior and lateral cutaneous branches just above the iliac crest. The anterior cutaneous branch innervates the skin over the anterior aspect of the abdomen above the pubis, and the lateral branch supplies the skin over the posterolateral aspect of the gluteal region.

The ilioinguinal nerve emerges caudal to the iliohypogastric nerve at the lateral border of the psoas muscle. It provides sensory innervation to the superomedial thigh and genital region.

The genitofemoral nerve divides into genital and femoral branches. The genital branch supplies the skin of scrotum in men and the skin of the mons pubis and labium majus in women. The femoral branch lies lateral to the femoral artery in the femoral sheath and supplies sensory innervations to the skin over the upper part of the femoral triangle.

INDICATIONS
This block is mainly indicated for the management of pain following unilateral lower limb surgery principally of the knee, femur or hip. It is less useful as a sole anaesthetic technique because there is no blockade of the sciatic nerve, which has major innervation of the posterior thigh, the lower leg and usually has some innervation of both the hip and knee joint. Thus complete anaesthesia or analgesia of the whole lower limb requires the addition of a sciatic nerve block.

Alternatives for providing regional anaesthesia or analgesia of the lower limb are central neuroaxial blockade: Epidural or Sub-Arachnoid (spinal) technique. These techniques generally produce bilateral effects such as reduced mobility, which may be undesirable or unnecessary, and are frequently associated with the risk of urinary retention. They also have their own risks and complications, especially the feared epidural haematoma or abscess.

LUMBAR PLEXUS BLOCK

General considerations
As with all regional anaesthesia procedures: consent must be obtained from the patients, iv access established and standard monitoring attached, resuscitation facilities must be available and the procedure carried out in an aseptic manner.

Lumbar plexus blocks, like all regional anaesthetic techniques, should ideally be performed on awake or lightly sedated patients, however many practitioners will safely undertake the block following general or spinal anaesthesia. At least some sedation is recommended for posterior approaches to the lumbar plexus because it is a deep block, with the needle having to pass through a reasonable amount of muscle mass. A small, sub-cutaneous and intradermal injection of lidocaine (or similar) at the point of needle insertion is recommended for patient comfort.

Absolute contraindications
Patient refusal
Local anaesthetic allergy
Local sepsis or infection at puncture site (or within psoas muscle)
INR > 1.5 or < 12 hours post LMWH (many practitioners consider a posterior approach to lumbar plexus comparable to central neuroaxial blockade.)
Relative contraindication and cautions
Systemic sepsis, especially for catheter placement.
Poor cardiac function or fixed cardiac output – The risk of epidural and subarachnoid spread from the posterior approaches means that caution should be exercised in considering this block in patients with poor cardiac function or fixed cardiac output. However, lumbar plexus block may be the best option for analgesia in major lower limb surgery in such patients.

Dose and volume of Local Anaesthetic
This is a “tissue plane” block and thus requires a large volume of local anaesthetic to obtain a reliable block of the plexus. Volumes of 30 to 40 mls are recommended. The dose of local anaesthetic needs to be considered in the context of the size of the patient and any other local anaesthetic administered (e.g. a sciatic nerve block) to ensure maximum safe dose is not exceeded. The psoas muscle is a relatively vascular area and systemic absorption of local anaesthetic can be significant.

Total dose of local anaesthetic should not exceed maximum recommended doses (i.e. 150mg or 2mg/kg of Bupivacaine/levobupivacaine/marcaine or 300mg of Ropivacaine). Due to the vascularity of the psoas muscle it would be wise to stay well under the maximum dose. A suitable example would be 30mls 0.25% Bupivacaine for <75kg patient and 40mls 0.25% Bupivacaine for >75kg patient.

Posterior Approaches to the lumbar plexus

Patient Position
There are several posterior landmark based approaches to the lumbar plexus all of which require the patient to be in the lateral position with the operative side uppermost, the hips and knees are flexed to 90 degrees;

Landmarks

![Image of landmarks](image.png)

Fig. 2. Landmarks of the lumbar plexus.
1. Tuffiers line
2. Superior Iliac spine Posterior
3. Lumbar plexus
**Winnie’s approach**, (Figure 3).

An intercristal line is drawn at L4/L5, and another parallel with the spine through the Posterior Superior Iliac Spine (PSIS). The needle is inserted at the intersection of these lines with a slight medial inclination. The needle should be between the transverse processes of L4 and L5. The needle can be redirected caudally if the transverse process of L5 is encountered. Winnie used paresthesia as his end point but as described later in this article today the accepted end point for the lumbar plexus is stimulation of the femoral nerve component, observed by contraction of the quadriceps muscle (see section on identification of the lumbar plexus for more details).

![Fig 3. Winnie's approach](image)

**Chayen approach** (Fig 4.)

The L4 spinous process is identified (from the intercristal line, see Fig 4). Needle insertion is 3cm caudad and 5 cm lateral. This should elicit contact with the L5 Transverse process, the needle is then re-angled slightly cranially to pass between L4 and L5 Transverse Processes advancing a further 1-2cm past the transverse process. The endpoint is twitching/ contraction of of the ipsilateral quadriceps.

![Fig. 4. Chayen approach](image)

**Dekrey’s approach** (Fig 5)

This more proximal technique (published in Parkinson et al.1989) described an approach from the L3 vertebrae. The puncture site is 3-4cm lateral to the spinous process of L3, with the needle directed slightly cephalad to contact the transverse process of L3 (Fig. 5). The needle is then redirected caudally and advanced approximately 1.5cm further to reach the lumbar plexus – seeking quadriceps contraction.

![Fig. 5. Dekrey approach](image)

**Capdevila’s approach** (Fig 6.)

The spinous process of L4 is identified. A line is drawn from the centre of the L4 spinous process laterally, to intersect with a line that passes through the posterior superior iliac spine parallel to the vertebral column on the side to be blocked. The puncture point is at the junction of the lateral one third and medial two thirds of the line joining L4 to the line passing through the PSIS. The needle is advanced at right angles to the skin until the transverse process of L4 is encountered. The needle is then directed caudally, no more than 20mm.

![Fig. 6. Capdevila approach](image)
Identification of the lumbar plexus

Loss of resistance
The early descriptions of lumbar plexus blocks describe a “loss of resistance” on passing through the fascia of the psoas major muscle. Whilst these techniques, along with paraesthesia, are not part of modern regional anaesthesia, a “pop” can be felt with a short bevelled needle.

Peripheral nerve stimulation
For details on use of the nerve stimulator and other considerations when performing peripheral nerve blocks please refer to ATOTW 134 ‘Peripheral nerve blocks- Getting started.’

The accepted end point for the lumbar plexus is stimulation of the femoral nerve, observed by contraction of the quadriceps muscle. Quadriceps contraction which produces patella twitching should be sought with an initial current of 1-2mA, and once elicited the current should be reduced until contraction is still present at <0.5mA. (If muscle contraction is lost before 0.5mA then gentle needle repositioning is required). Contraction should stop below a current of 0.2mA, otherwise intraneural needle position should be suspected. Stimulation of the sciatic nerve (e.g. contraction of hamstrings) indicates the needle position is too caudal.

Ultrasound
This is a difficult block to perform purely with ultrasound for two principle reasons. Firstly, the plexus is situated quite deep in the body (70-85mm). Secondly, the plexus is covered by the transverse processes, and bones create an acoustic shadow, below which no image is produced. However, there have been descriptions of its use in conjunction with PNS but these will not covered in this tutorial.

Comparison of the techniques

Winnie’s technique is still widely in practice, although the medial angulation of the needle is difficult to control and can easy lead to epidural or sub-arachnoid placement. This logically leads on to the work of Capdevila (2002), who used CT scans of normal subjects to determine the distance of the lumbar plexus from the midline, as well as the depth of the plexus from the skin and from the transverse process. He reliably found the plexus to be located 2/3 (0.6–0.8) of the way from the midline to the line through the PSIS (as described by Winnie). He thus advocated this as the entry point but with a perpendicular needle trajectory to reduce the risk of epidural or sub-arachnoid spread. He also found that the plexus was a steady 15mm deeper than the transverse process. The depth of the lumbar plexus from the skin was a median (range) 83.50 (61–101) mm in men and 71 (57–93) mm in women.

The technique of Chayen uses a more caudal approach, but caution is needed as the L5 Transverse process is the shortest and thus the needle may not encounter bone leading to inadvertently deep needle passage. A more caudal needle position is also more likely to inadvertently stimulate the sciatic nerve

The risk of using the more cranial approach of Dekrey is that kidneys may descend as low as L3/L4 during deep inspiration and thus increases the risk of renal capsular perforation and haematoma.

COMPLICATIONS OF LUMBAR PLEXUS BLOCK

Complications from needle puncture

Direct trauma to nerves. This is a rare complication, in the order of 1:5,000 for long term injury. This may be reduced by using short bevelled needles.

Intra-neural injection can cause neurological damage, especially with high pressure injections. Steps to avoid this include not accepting a motor response using a PNS below 0.2mA and ensuring that the motor response stops after initial injection of local anaesthetic (1ml). Injection of the local anaesthetic should be easy with no pain reported from the patient.
Damage to abdominal viscera. Renal damage has been reported, principally from the L3 approach, although correct identification of specific lumbar vertebrae is notoriously unreliable.

Retro-peritoneal haematomas are possible and significant blood loss can be concealed.

Psoas abscess. Rare with good aseptic technique but if occurs these deep infections can be difficult to treat.

Complications from incorrect local anaesthetic placement

Epidural spread is common. This may be as a result of spread or diffusion into the epidural space, or as a result of direct injection of local anaesthetic into the epidural space. Published reports put the incidence of epidural spread variably between 3-27% with about 7% as a realistic overall figure. The effects can be unilateral or bilateral, and it is the loss of sympathetic tone that results in the major consequences. Most patients will tolerate a unilateral sympathectomy, but it may cause haemodynamic instability. However, cardiovascular collapse can result from a profound, bilateral epidural block from misplaced local anaesthetic.

Spinal, or sub-arachnoid, injection. High volume LA into the CSF can produce a “total spinal”, with cardiovascular collapse, apnoea, seizures and loss of consciousness.

Complications from local anaesthetic

Intravascular injection and LA toxicity from the highly vascular psoas muscle are real concerns. Clinical studies show that the plasma concentration of local anaesthetic does remain below toxic levels after posterior lumbar plexus block. Plasma levels do rise more steeply when combined with a proximal sciatic nerve block, although still below toxic levels.

Overall risk

The principal concern of posterior lumbar plexus blocks is the high incidence of serious complications reported from a large prospective study in France. Of the 150,000 blocks reported, 394 were posterior lumbar plexus blocks, but they recorded 2 cases of respiratory failure and one of cardiac arrest leading to death, this gives a serious complication rate of 80 per 10,000. This compares to <5 per 10,000 for all other blocks (including spinals and epidurals). It is reported that all these complications were from cephalad spread from epidural or intrathecal spread.

EVIDENCE FOR CLINICAL USE OF LUMBAR PLEXUS BLOCKS

A meta-analysis by Touray et al reviewed the efficacy and safety of lumbar plexus blocks (LPB) for hip and knee surgery as both an intra-operative technique, and for postoperative analgesia.

Hip surgery

• This review concluded there was insufficient evidence for the use of lumbar plexus block combined with sciatic nerve block and sedation as an alternative to a GA or spinal anaesthetic for hip surgery.
• For postoperative analgesia following hip surgery, LPB may reduce pain compared with opioids in the first 4-8 hours, which can be extended through the use of a continuous infusion via a catheter, with evidence that continuous infusions are equivalent to continuous epidural block.
• Single injection lumbar plexus block was found to be superior to femoral nerve block and was associated with a more consistent block of the obturator nerve.
Knee surgery

- LPB combined with either a sciatic nerve block or sedation or both is equivalent to GA and neuroaxial anaesthesia for knee arthroscopy, but there is insufficient evidence to support the use of this technique as an alternative to GA and neuroaxial anaesthesia for Total Knee Arthroplasty.
- Continuous LPB is superior to patient controlled opiate administration for pain after knee surgery, and compared with other regional techniques it is likely that continuous LBP, combined with a sciatic nerve block, is equivalent to epidural analgesia for pain relief after knee surgery. It is likely that there is no difference in analgesic effect between isolated LPB and FNB for knee surgery. However, when these blocks are combined with a sciatic nerve block, LPB provides superior analgesia compared with FNB.
- More research is required to define the role of LPB in intra-operative anaesthesia and to confirm any beneficial effects on variables such as intra-operative haemodynamics and peri-operative blood loss.

**Posterior lumbar plexus blocks provide analgesia in the territory of the femoral nerve, lateral cutaneous nerve and obturator nerve (and genitofemoral, ilioinguinal and iliohypogastric nerves).**

- Useful in major lower limb orthopaedic surgery of the hip, femur and knee
- Can be used in conjunction with sciatic nerve for anaesthesia of the lower limb
- Capdevila approach is current technique of choice.
- Has the potential for serious complications, mainly from epidural or spinal spread.

**ANSWERS**

1. The following nerves arise from the lumbar plexus;
   - a. Lateral Cutaneous Nerve of the Thigh  True
   - b. Obturator nerve  True
   - c. Tibial nerve  False (branch of sciatic nerve)
   - d. Saphenous nerve  True (branch of femoral nerve)
   - e. Sural nerve  False (branch of sciatic nerve)

2. Stimulation of hamstrings or knee flexion are acceptable motor responses using the PNS prior to LA injection. **FALSE, this indicates the needle is too medial or caudal.**

3. Complications of Lumbar Plexus block include;
   - a. Epidural block
   - b. Sub arachnoid/intrathecal injection
   - c. Cardiovascular collapse
   - d. Psoas muscle haematoma
   - e. Renal capsular haematoma

**All True. They have all been reported.**
ACKNOWLEDGEMENTS
Our thanks to Drs Alice Roberts, David Conn and Barry Nicholls for the kind use of their diagrams, images and photos.

REFERENCES and FURTHER READING

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