

# Psoas compartment block

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## Key points

Psoas compartment block consistently blocks the femoral, lateral femoral cutaneous, and obturator nerves (the true '3-in-1' block).

It provides excellent postoperative analgesia after major hip and knee surgery.

Combined with a sciatic nerve block, it provides unilateral lower limb anaesthesia below the hip.

Sedation is required for patient comfort.

The block must be monitored and evaluated as for neuraxial block in order to avoid serious complications.

Psoas compartment block (PCB) is a peripheral regional anaesthetic technique that blocks the main components of the lumbar plexus, namely the femoral, lateral femoral cutaneous (LFC), and obturator nerves as they run within the psoas major muscle. The psoas compartment block is also known as the posterior lumbar plexus block.

A posterior approach to the lumbar plexus was first described by Winnie and colleagues.<sup>1</sup> They described an approach for 'lumbosacral' block but provided no data on the extent of neural block. The term 'psoas compartment block' was coined by Chayen and colleagues<sup>2</sup> to describe a loss of resistance technique with injection of solution into the 'compartment' between the quadratus lumborum and psoas major muscles. There have been a number of other approaches described since, including an approach by Capdevila and colleagues<sup>3</sup> based on modifications to Winnie's landmarks using computed tomography.

## Clinical anatomy

The lumbar plexus is formed by the first to the fourth lumbar nerve roots that enter the psoas major muscle after leaving the intervertebral foramina.<sup>4</sup> There is a contribution from the 12th thoracic nerve root in 50% of cases. The nerves formed by the second to fourth lumbar nerve roots (femoral, LFC, and obturator nerves) run within the psoas major muscle before exiting it at various levels [i.e. LFC (L3-4), femoral (L4-5), and obturator (L5-S1)]. The femoral and LFC nerves run in a fascial sleeve that divides the psoas muscle into an anterior part (two-thirds of the muscle mass) and a posterior third. The obturator nerve may also run in this fascial plane, but in 50% of cases, it is separated from the other nerves by a muscle fold. The erector spinae and quadratus lumborum muscles are superficial and posterior to the psoas muscle and lie medial and lateral to the psoas, respectively.

The femoral nerve innervates the anteromedial thigh and medial border of the leg (saphenous nerve) and provides motor fibres to the quadriceps. The LFC is purely sensory and supplies the lateral thigh. The obturator nerve

supplies motor fibres to the adductors of the thigh. As the obturator nerve provides no sensory innervation in 59% of people and then only of the popliteal fossa, motor assessment is necessary.<sup>5</sup> Studies using these criteria have failed to demonstrate obturator block after femoral block; therefore, the psoas compartment block is the only true '3-in-1' lumbar plexus block.<sup>5</sup>

Lumbar plexus block occurs after spread of solution within the fascial plane with cephalad spread to the lumbar roots.<sup>6</sup> In 25% of cases, block of the first sacral root also occurs and in 70% of cases an ilioinguinal/iliohypogastric block is found.<sup>7</sup>

## Imaging

### Ultrasound

The use of ultrasonographic imaging for PCB in adults unfortunately has failed to reproduce the excellent images obtained for other peripheral blocks such as brachial plexus or femoral nerve blocks.<sup>8</sup> The main reason is the depth of the plexus at 5–8 cm necessitating the use of lower frequency ultrasound probes (5–8 MHz), resulting in reduced image resolution. Nevertheless, the use of ultrasonographic imaging in conjunction with peripheral nerve stimulation enhances block performance by providing an indication of psoas muscle depth, position of the kidney, and spread of solution. The use of a curved array transducer improves imaging.

With ultrasound, the psoas muscle is seen as a hyperechoic structure interspersed with hypoechoic dots or speckles in the transverse plane. In children, the lumbar plexus is seen and appears an ovoid structure within the psoas muscle; hypoechoic speckles representing nerve fibres surrounded by hyperechoic areas of the epineurium.

### Magnetic resonance imaging

The use of MRI to investigate the spread of solution after psoas compartment block has provided excellent imaging of both anatomy and spread of solution to the lumbar plexus. The MRI has demonstrated that the distribution of solution after psoas compartment block occurs most commonly within the psoas major muscle

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along the internal fascial plane, surrounding the lumbar branches with cephalad spread to lumbar nerve roots.<sup>6</sup> The introduction of solution within the fascial plane results in cleavage of the psoas muscle, facilitating the distribution of solution to the lumbar nerve roots (Fig. 1). This mechanism of spread to the nerve roots ensures that obturator nerve block occurs in 85–90% of cases despite the nerve commonly lying outside the psoas fascial plane as described earlier.<sup>9</sup>

### Computed tomography

Capdevila and colleagues<sup>3</sup> have used CT imaging to investigate the performance of psoas compartment block in adults and children. The positions of the lumbar plexus and psoas muscle relative to the bony landmarks of the fourth lumbar spinal process (SP) and posterior superior iliac spine (PSIS) were evaluated. The ratio of the distance from the SP to the lumbar plexus and the distance from the SP to the PSIS was found to have a median of 0.68 in adults and 0.76 in children, regardless of body mass index. These data have resulted in a modification of Winnie's approach by Capdevila and colleagues.<sup>3</sup> CT imaging also demonstrated the depth of the lumbar plexus from skin of 61–101 mm in men and 57–93 mm in women, providing a guide to the depth of needle insertion.

### Technique

#### Single shot

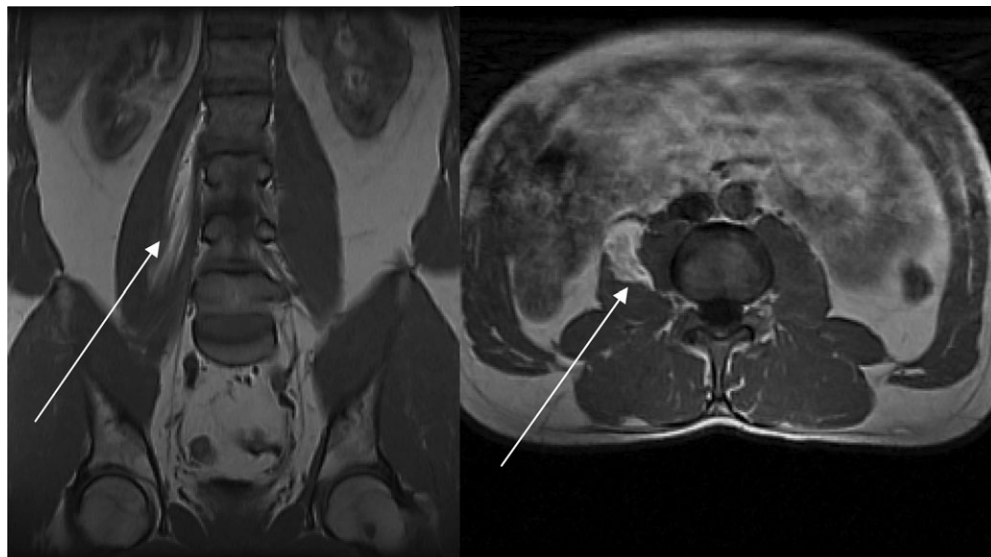
As mentioned previously, a number of approaches exist for psoas compartment block<sup>7</sup>; however, the approach by Capdevila and colleagues, using a nerve stimulation technique, will be described

here. Contra-indications are lack of consent, inexperience, coagulopathy, local infection, and distorted anatomy.

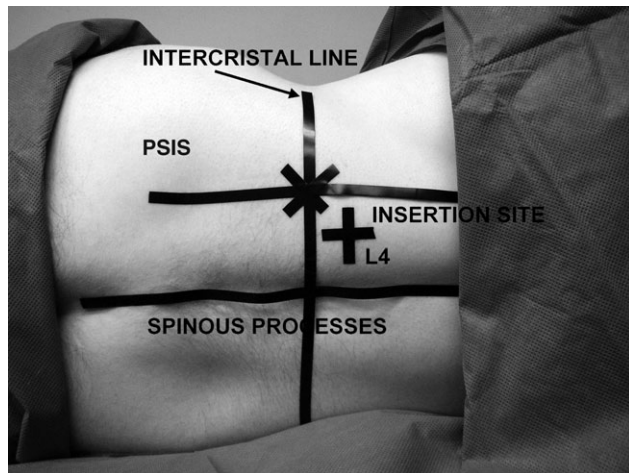
Intravenous access, ECG, pulse oximetry, and blood pressure monitoring are established. Emergency equipment and medications are checked. Sedation is required for patient comfort as a result of the needle depth. The patient is placed in the lateral (Sims) position with the side to be blocked uppermost (Fig. 2). The hip on the side to be blocked is flexed to 30° and the ipsilateral knee flexed to 90°. The skin is prepared with antiseptic solution.

The site of needle insertion is determined as follows. A line is drawn connecting the iliac crests (intercrystal line). The SPs are marked and PSIS is identified. A line through the PSIS is drawn parallel to the line joining the SPs. The site of needle insertion is at the junction of the lateral third and medial two thirds of a line between the SPs and the PSIS and 1 cm cephalad to the intercrystal line (L4). The needle is inserted perpendicular to all planes. A 100 mm stimulating needle is inserted connected to a nerve stimulator with a starting output of 1.5 mA and 2 Hz. The needle is advanced until quadriceps twitches are elicited or bony contact (presumed to be transverse process of L4) is made. If bone is encountered, the needle is withdrawn and directed caudad under the transverse process and advanced no further than 15–20 mm, until twitches of the quadriceps muscles are elicited with currents between 0.3 and 0.5 mA. After negative aspiration, 20 ml of local anaesthetic solution is injected incrementally over 3–5 min with regular aspiration for blood or cerebrospinal fluid (CSF).

Haemodynamic monitoring is continued for 45 min after block and assessment of contralateral spread by sensory testing must be done; contralateral motor block may be minimal or absent. The extent of block of the femoral and LFC is assessed by sensory testing of their dermatomal distribution. The obturator nerve block is confirmed by motor assessment of thigh adduction. The use of



**Fig. 1** Spread of contrast (arrow) in the coronal (left image) and axial (right image) planes clearly demonstrating spread to the lumbar nerve roots and cleavage of the psoas muscle, respectively.



**Fig. 2** Surface anatomy landmarks for psoas compartment block via Capdevila and colleagues' approach. \*Line through posterior superior iliac spine (PSIS). +Site of needle insertion.

sensory assessment for obturator nerve block is not appropriate because of its limited or absent sensory distribution. Block onset is 15–20 min with lidocaine 1.5% and 30–45 min for levobupivacaine 0.5%.<sup>9</sup>

### Continuous psoas compartment block

The use of a continuous regional anaesthetic technique for PCB is extremely effective, resulting in mean visual analogue scores (VAS) of 10 mm (rest) and 15–30 mm (movement) during the first 48 h postoperative after total hip arthroplasty (THA)<sup>3</sup> or total knee arthroplasty (TKA).<sup>10</sup> Continuous psoas compartment block is performed as per single-shot psoas compartment block using a continuous nerve block set and needle.

The close proximity of the epidural and intrathecal spaces can result in catheter misplacement. Therefore, following catheter insertion (4–5 cm beyond skin to plexus depth), negative aspiration for blood and CSF must be performed and a test dose administered to determine whether intravascular or intrathecal placement has

occurred. If the practitioner wishes to first give a volume of local anaesthetic to 'open up' the tissue planes to facilitate catheter insertion, then the catheter must not be used until a test dose can be administered after the anaesthetic effects of the first bolus have worn off.

An infusion of 8–10 ml h<sup>-1</sup> of 0.2% solution of a long-acting local anaesthetic (levobupivacaine or ropivacaine) is usually sufficient, but the potential for bilateral anaesthesia, haemodynamic disturbance or both must be assessed regularly, especially after a bolus injection.

### Clinical indications

The PCB can be used for both analgesia and anaesthesia, as detailed in Table 1. The use of psoas compartment block for anaesthesia of the lower limb is limited as a result of the inconsistency of sacral plexus block.<sup>9</sup> The addition of a sacral plexus block results in effective anaesthesia of the lower limb, especially below the hip. Although major hip surgery can be performed with this combined technique, the variable innervation of the surgical site from the T12 and L1 dermatomes makes this an unreliable method for anaesthesia.<sup>11</sup> Descriptions of major lower limb surgery performed under psoas compartment block were most likely secondary to unintentional bilateral spread of local anaesthetic agent or the concurrent use of sedation or i.v. analgesia.<sup>9</sup> Anaesthesia is possible as a sole technique for anterior knee operations such as anterior cruciate ligament repair.<sup>12</sup>

The primary indication for psoas compartment block is post-operative analgesia after major hip or knee surgery. The continuous technique results in excellent pain relief during the first 48 h after operation. Single-shot psoas compartment block after THA reduces postoperative morphine requirements compared with patient controlled morphine alone.<sup>13</sup> Single-shot psoas compartment block, as part of a multimodal analgesic technique, results in median verbal rating scores of zero in the first 24 h after THA or TKA.<sup>3,10</sup> The use of psoas compartment block both as a single and as a continuous technique has been described in the management of chronic hip or knee pain.<sup>7</sup>

**Table 1** Clinical indications, advantages and complications of psoas compartment block. \*Combined with sciatic nerve block; \*\*Advantages over patient controlled morphine analgesia, spinal anaesthesia, epidural anaesthesia, or intrathecal morphine

Analgesia	Anaesthesia	Advantages**	Complications
Total hip arthroplasty	Anterior cruciate ligament repair	Lower pain scores	Epidural spread
Revision hip arthroplasty	Knee arthroscopy	Less morphine consumption	Total spinal anaesthesia
Total knee arthroplasty	Patellar tendon repair	Less hypotension	Hypotension
Hip hemi-arthroplasty	Skin graft/biopsy thigh	Less nausea/vomiting	Systemic toxicity
Surgical repair of fractured femur (neck/shaft)	Saphenous vein stripping*	Less urinary retention	Retropertoneal haematoma
	Tourniquet pain*	Less pruritus	Renal puncture
Procedures where used for anaesthesia	Any lower limb surgery below the hip*	Less postoperative blood loss	
		Reduced admission rates	
		Greater patient satisfaction	
		Earlier hospital discharge	

## Evidence-based current practice

### Anaesthesia

There are few studies comparing traditional anaesthetic techniques with psoas compartment block. de Visme and colleagues<sup>11</sup> reported that combined psoas compartment block and sciatic nerve block compared with spinal anaesthesia resulted in less hypotension and improved analgesia in elderly patients undergoing hip fracture repair.<sup>11</sup> In a study by Jankowski and colleagues,<sup>12</sup> patients undergoing knee arthroscopy with psoas compartment block had less postoperative pain, greater satisfaction and less postoperative recovery room admission rates compared with general anaesthesia.

Ganidagli and colleagues<sup>14</sup> found that psoas compartment block with sciatic nerve block for knee arthroscopy resulted in patients having less pain, lower 24 h opioid requirements, and greater satisfaction compared with sciatic nerve block combined with a femoral nerve block. This may result from the psoas compartment block consistently blocking the obturator nerve.

### Analgesia

The benefits of both single-shot and continuous psoas compartment block on postoperative pain compared with i.v. PCA morphine have already been discussed. The analgesic efficacy of psoas compartment block has been compared with femoral nerve block after THA and TKA. After THA, there was no difference between single shot psoas compartment block and femoral nerve block in terms of morphine consumption and VAS after 4 h.<sup>15</sup> Both continuous femoral nerve block and psoas compartment block result in similar morphine consumption and pain scores up to 48 hours after TKA.<sup>10</sup> However, it should be noted that in both studies the primary outcome on which the power analysis was based was the comparison of either block techniques with PCA morphine and not the other peripheral block. Examining the data more closely reveals a trend towards a reduction in morphine consumption and pain scores when psoas compartment block is compared with femoral nerve block. The possibility that psoas compartment block may be more effective than femoral nerve block is supported by the findings of a larger study showing that the addition of an obturator nerve block to femoral nerve block results in lower morphine consumption and lower pain scores compared with femoral nerve block alone in patients undergoing TKA.<sup>16</sup>

Compared with other regional analgesic techniques, psoas compartment block has been shown to be as effective as epidural block for analgesia after THA, but with less nausea, urinary retention, motor block, and orthostatic hypotension.<sup>17</sup> In a study of 53 patients undergoing THA, single-shot psoas compartment block was less effective than intrathecal morphine for pain management (VAS 25 vs 3 mm); however, urinary retention was three times more common with intrathecal morphine ( $P < 0.5$ ) with an incidence of pruritus of 18.5 vs 3.8%.<sup>18</sup>

Mannion and colleagues<sup>19,20</sup> investigated the use of perineural adjuncts such as clonidine and tramadol for single-shot psoas compartment block and demonstrated that neither prolongs the analgesic or anaesthetic action of levobupivacaine 0.5%. However, i.v. clonidine administered at the time of block performance does prolong the postoperative analgesia by 6 h.

### Controversies

Although psoas compartment block is effective for analgesia and anaesthesia for major lower limb surgery with numerous benefits (Table 1), its use instead of the femoral nerve block is the subject of major debate. These concerns are based on the findings of a major French study of complications after regional anaesthesia that found five serious complications after 394 psoas compartment blocks, but none after 10 309 femoral nerve blocks.<sup>21</sup> The complications related to psoas compartment block were all either secondary to the occurrence of bilateral anaesthesia (intrathecal/epidural) or vascular administration of local anaesthetic.

It was previously thought that the major determinate of bilateral anaesthetic spread was the approach taken for psoas compartment block.<sup>22</sup> However, a recent study comparing the technique with the lowest reported incidence<sup>3</sup> with that with the greatest incidence<sup>1</sup> found no difference between the two approaches.<sup>9</sup> In fact, the study revealed an incidence of >35% of bilateral spread for both approaches with no serious complications. Previous reports of lower incidences were most likely as a result of inadequate assessment of bilateral anaesthesia. The results suggest that the cause of bilateral spread is not related to the approach with factors such as volume of local anaesthetic most likely being responsible.

Traditionally, the psoas compartment block has been performed with large volumes (30–40 ml) of local anaesthetic. Obviously, the injection of these volumes into the intrathecal, epidural, or intravascular compartments will have serious consequences (Table 1). Further investigation is required to determine whether smaller volumes are safer. In the author's clinical practice, 15–20 ml of solution is sufficient for effective lumbar plexus block and injection is always preceded by careful and frequent aspiration. The use of a test dose or radiological imaging is recommended to confirm catheter placement.

### Conclusions

In conclusion, the psoas compartment block is the most effective block for lumbar plexus block.<sup>5,9</sup> It offers advantages over other techniques in terms of analgesia and anaesthesia. However, the potential for serious complications is of concern. These complications are avoidable by ensuring effective monitoring of the block, avoidance of large volumes, incremental injection of solution, and confirmation of catheter position.

Although the role of the psoas compartment block has yet to be completely defined, it is likely that its use will increase. Currently, it is recommended for postoperative pain after THA by the

PROSPECT working group ([www.postoppain.org](http://www.postoppain.org)). In modern orthopaedic practice, the use of anticoagulants, especially newer agents such as Fondaparinux, continues to increase concerns regarding neuraxial anaesthesia/analgesia, especially for continuous techniques.<sup>24</sup> These concerns are not substantiated for plexus blocks. Finally, in a small prospective study, Ilfeld and colleagues<sup>25</sup> have recently shown that THA can be converted into an overnight procedure by the use of a continuous technique for psoas compartment block provided at home by a portable infusion pump.

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