# Comparison of the Three-in-One and Fascia Iliaca Compartment Blocks in Adults: Clinical and Radiographic Analysis

X. Capdevila, MD, MSc, Ph. Biboulet, MD, M. Bouregba, MD, Y. Barthelet, MD, J. Rubenovitch, MD, BSc, and F. d'Athis, MD

Department of Anesthesiology, Lapeyronie University Hospital, Montpellier, France

The 3-in-1 (Group 1) and fascia iliaca compartment (Group 2) blocks, two single-injection, anterior approach procedures used to simultaneously block the femoral, obturator, and lateral femoral cutaneous (LFC) nerves, were compared in 100 adults after lower limb surgery. Pain control, sensory and motor blockades, and radiographically visualized spread of local anesthetic solution were studied prospectively. Both approaches provided efficient pain control using 30 mL of 2% lidocaine with 1:200,000 epinephrine and 0.5% bupivacaine and 5 mL of contrast media (iopamidol). Complete lumbar plexus blockade was achieved in 18 (38%) Group 1 and 17 (34%) Group 2 patients ($n$ = 50 patients per group). Sensory block of the femoral, obturator, genitofemoral, and LFC nerves was obtained in 90% and 88%, 52% and 38%, 38% and 34%, and 62% and 90% of the patients in Groups 1 and 2, respectively ($P <$ 0.05). Sensory LFC blockade was obtained more rapidly for the patients in Group 2 ($P < 0.05$). Concurrent internal and external spread of the local anesthetic solution under the fascia iliaca and between the iliacus and psoas muscles was noted in 62 of the 92 block procedures analyzed radiographically. Isolated external spreads under the fascia iliaca and over the iliacus muscle were noted in 10% and 36% of the patients in Groups 1 and 2, respectively ($P < 0.05$). The local anesthetic solution reached the lumbar plexus in only five radiographs. We conclude that the fascia iliaca compartment block is more effective than the 3-in-1 block in producing simultaneous blockade of the LFC and femoral nerves in adults. After both procedures, blockade was obtained primarily by the spread of local anesthetic under the fascia iliaca and only rarely by contact with the lumbar plexus. **Implications:** In adults, the two anterior approaches, 3-in-1 and fascia iliaca compartment blocks, provide effective postoperative analgesia. The fascia iliaca compartment technique provides faster and more consistent simultaneous blockade of the lateral femoral cutaneous and femoral nerves. Sensory block is caused by the spread of local anesthetic solution under the fascia iliaca and only rarely to the lumbar plexus.

(Anesth Analg 1998;86:1039–44)

After hip, femoral shaft, and knee surgery, the lumbar plexus block provides high-quality analgesia (1–3). It is superior to that obtained from the systemic administration of morphine (4,5) and has fewer side effects than epidural anesthesia (6).

Although various approaches to the lumbar plexus have been studied, Winnie (7) described a multiple nerve block of the lumbar plexus nerve supplying the thigh that could be obtained with a single injection of 20 mL or more of local anesthetic. While reducing the number of peripheral blocks required to provide adequate anesthesia, this 3-in-1 technique was shown to be inconsistent in producing blockade of both the lateral femoral cutaneous (LFC) nerve of the thigh and the obturator nerve (8–10). Neither the use of neurostimulators (8) nor increasing the administered doses of local anesthetic (9) improved the global success rate of the 3-in-1 block.

The report of a fortuitous 3-in-1 blockade resulting from a LFC nerve of the thigh block (11), and the consideration of the anatomical configuration of the fascia iliaca covering the femoral nerve and its branches (7,12) led to the identification of the fascia iliaca compartment. Dalens et al. (10) developed a new procedure, the fascia iliaca compartment block, and compared it with the classical 3-in-1 block in a study including 120 children. The new technique was reported to provide a higher success rate, with blockade of the three main lumbar plexus nerves supplying the thigh in more than 90% of procedures. Furthermore, neither expensive equipment (i.e., neurostimulators)

Accepted for publication January 28, 1997.
Address correspondence to X. Capdevila, MD, Department of Anesthesiology, Lapeyronie University Hospital, 292 Av du Doyen Gaston Giraud, 34295 Montpellier, France.


0003-2999/98/$5.00

nor specific skills was required to perform the technique, as the injection site was distant from the femoral neurovascular elements.

To our knowledge, no prospective study concerning the use of this block on adults has yet been reported, and extrapolating the results derived from children is difficult because there are developmental differences (e.g., disjunction of the fasciae, nerve sensitivity to local anesthetics). The present study was designed to prospectively compare the fascia iliaca compartment and 3-in-1 blocks performed on adults after hip, femoral shaft, or knee surgery. We studied the anesthetic efficacy and the correlation between the radiographic spread of local anesthetic and the clinical distribution of anesthesia.

## Methods

One hundred ASA physical status I and II adults were included in this study once institutional approval and written, informed patient consent were obtained. The patients, all scheduled to undergo either hip, femoral shaft, or knee surgery, were randomly assigned to two groups. The postoperative pain management programs included a 3-in-1 block for the patients in Group 1 and a fascia iliaca compartment block for those in Group 2. Each group included 50 patients. All of the patients were orally premedicated using 0.05 mg/kg midazolam. General anesthesia was induced IV using 4 mg/kg thiopental and 3 $\mu$g/kg fentanyl, and orotracheal intubation was facilitated using 0.3 mg/kg atracurium. General anesthesia was maintained using isoflurane 0.8%–1.5% in 50% $O_2$/50% $N_2O$ and a continuous infusion of fentanyl (0.05 $\mu g \cdot kg^{-1} \cdot min^{-1}$), which was stopped 30 min before the end of the surgical procedures. Once the patients were awakened and their tracheas were extubated, the lumbar plexus blocks were performed by one of three anesthesiologists experienced in lower extremity regional anesthetic techniques.

The 3-in-1 blocks were performed using electrical stimulation (Digistim®; Organon Technica, Durham, NC) via a 50-mm insulated needle (22-gauge Stimuplex®; Braun, Melsungen, Germany) for precise nerve location. With patients in a supine position, the puncture site was located 1 cm below the inguinal ligament and 0.5 cm lateral to the femoral artery. After local disinfection, the block needle was inserted and advanced cephalad in a sagittal plane at a 30° angle to the skin. The local anesthetic solution was injected over a 2-min period during which quadriceps femoris muscle twitches were elicited (i.e., cephalad knee cap movement) for 0.5-mA impulses delivered at a frequency of 1 Hz. During injection, firm pressure was applied manually just distally to the puncture site, to encourage the cephalad distribution of the anesthetic.

The fascia iliaca compartment block was also performed while patients were in the supine position. A projection of the inguinal ligament was drawn on the skin and trisected. The puncture site was marked 1 cm caudal to the point at which the lateral met the middle third of the inguinal ligament line. After disinfection, the block needle (18-gauge Tuohy; Perican®; Braun) was inserted and advanced at a 75° angle to the skin. The first loss of resistance was felt as the needle's tip crossed the fascia lata. The needle was advanced further at the same angle until the second loss of resistance was felt as the fascia iliaca was pierced. The angle to the skin was then decreased to 30°, and the needle was advanced 1 cm cephalad. The local anesthetic solution was injected over a 2-min period with firm pressure applied manually just distal to the puncture site. If there was swelling in the groin after injection, the region was massaged. Both of these manipulations were performed to encourage the cephalad distribution of the injected solution.

The local anesthetic solution used for all patients in this study was an equal volume mixture of 2% lidocaine with 1:200,000 adrenaline and 0.5% bupivacaine. The components were chosen to provide a short onset of action and a duration of action equal to that of bupivacaine alone. Each patient was injected with 30 mL of the anesthetic solution, to which 5 mL of contrast media (Iopamidol 300; Shering Pharmaceutical, Lys-Lez-Lannoy, France) was added. A frontal radiograph of the pelvic region was taken 20–30 min after each injection. The arterial blood pressure was evaluated noninvasively at regular intervals, and electrocardiographic tracings, respiratory rate, pulse oximetry, and end-tidal $CO_2$ were monitored continuously during all procedures.

Sensory blockade was evaluated using cold (ether on a cotton compress) and pain (pinprick) perception tests at 10-min intervals throughout the 30-min period after injection (T + 10 min, T + 20 min, T + 30 min). Testing was performed on the sensory innervation territories of the LFC, femoral, genitofemoral, and obturator nerves. Motor blockade was evaluated at T + 30 min by testing knee extension (i.e., femoral nerve) and thigh adduction (i.e., obturator nerve). The results of these sensory and motor tests were reported as either yes (presence of a total sensory and/or motor blockade) or no (partial or absent sensory and/or motor blockade) of a given nerve territory. At T + 30 min, the blockade was considered complete when anesthesia spread concomitantly to the LFC, femoral, and obturator nerves; incomplete if the spread was not concomitant to all three nerves; and absent if none of the three nerves was anesthetized. All adverse effects were noted.

Propacetamol (2 g three times daily) was systematically administered IV to all patients on arrival in the postanesthesia care unit. Patients scored their pain at

T + 30 min using both a simple verbal scale (0 = no pain, 1 = slight pain, 2 = strong but tolerable pain, 3 = intolerable pain) and a visual analog scale (VAS) ranging from 0 mm (no pain) to 100 mm (worst possible pain). The time to onset of pain was measured as the time between injection and the reappearance of pain.

The radiographs of the pelvic region were interpreted by two blind physicians, one of whom is a radiologist. The image obtained from the spread of the contrast media-local anesthetic solution mixture was classified into three zones (Figure 1): Zone A = under the psoas muscle fascia, internal spread; Zone B = under the iliacus muscle fascia, external spread; Zone C = to the roots of the lumbar plexus, from the second to the fourth lumbar vertebrae inclusively.

Statistical comparisons were performed using the Kruskal-Wallis test for nonparametric data, and the $\chi^2$ test for qualitative parameters. The evolution of the different nerves' sensory blockades over the three test times in the two groups were compared using repeated-measure analysis of variance. Results are expressed as median (range). Differences were considered statistically significant at $P < 0.05$.

## Results

One hundred patients, 59 male and 41 female, were included in this study. No differences between Groups 1 and 2 were noted concerning age (42 ± 7 and 44 ± 5 yr), weight (73 [47–110] kg and 73 [50–120] kg) and height (172 [157–187] cm and 173 [152–185] cm), or type of surgery (Table 1).

The evaluations of pain, using both scales, were comparable in the two groups. The median values of the VAS scores 30 min after injection were 18 (0–40) in Group 1 and 15 (0–45) in Group 2. In Group 1, 12 patients scored their pain at 0 on the simple verbal scale, 28 scored it at 1, and 7 scored it at 2. In Group 2, 15 patients scored their pain at 0 on the simple verbal scale, 30 scored it at 1, and 5 scored it at 2. No patient in the study scored their pain at 3 on the simple verbal scale. Four patients in Group 2 scored their pain at 45 on the VAS. Two of these patients had no blockade (failure), and the other two had incomplete blockade limited to only the LFC nerve. The median duration of sensory blockade was comparable in Groups 1 and 2: 277 (140–1140) min and 322 (150–1290) min, respectively.

The number of femoral, genitofemoral, and obturator nerve blockades noted at 10-min intervals during the 30 min after each injection showed no significant intergroup differences (Table 2). The sensory blockades of the genitofemoral and obturator nerves appeared gradually in both groups, whereas those of the femoral nerve appeared rapidly. In contrast, statistically significant intergroup differences were noted concerning the sensory blockades of the LFC. A more rapid onset and more consistent presence of blockade at T + 30 min was observed for the Group 2 patients. The sensory and motor blockade evaluations at T + 30 min are reported in Table 3. Two sensory blockades were limited to only the LFC in Group 2, and two were limited to only the femoral nerve in Group 1. There were no intergroup differences in the number of motor blockades concerning the femoral nerve and the obturator nerve. However, when comparing motor and sensory blockades for a given nerve, significant differences were noted concerning the obturator nerve in both patient groups. The number and proportion of complete blockades was comparable in Groups 1 and 2: 18 (36%) and 17 (34%), respectively. There were no complications or neurological sequelae in either group.

1
2
3

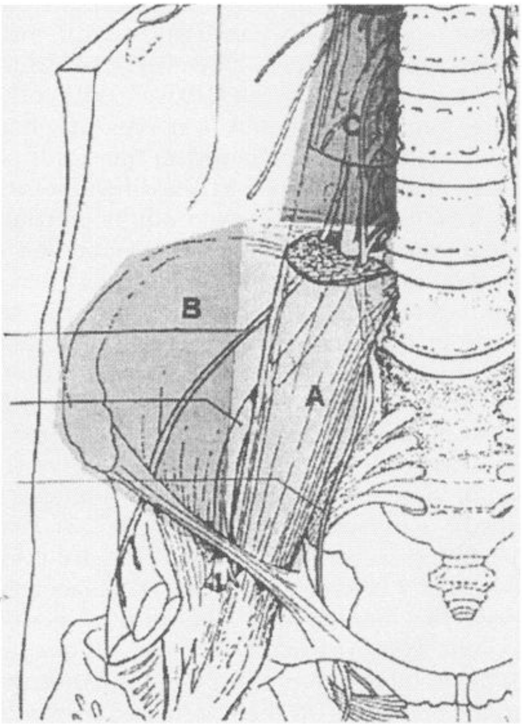


**Figure 1.** The zones reached by the spread of local anesthetic under the fascia iliaca. A, Internal spread under the psoas muscle fascia. B, External spread under the iliacus muscle fascia. C, Spread to the roots of the lumbar plexus. 1 = lateral femoral cutaneous nerve, 2 = femoral nerve, 3 = obturator nerve.

**Table 1.** Surgical Indications in Two Patient Groups Anesthetized Using Either 3-in-1 (Group 1) or Fascia Iliaca Compartment Blocks (Group 2)

| | Group 1 | Group 2 |
|---|---|---|
| Total hip replacement | 4 | 1 |
| Femoral osteotomy | 16 | 17 |
| Fracture of the femur | 1 | 1 |
| Knee arthroscopy | 10 | 11 |
| Knee ligament reconstruction | 8 | 7 |
| Fracture of the patella | 6 | 7 |
| Total knee replacement | 5 | 4 |

**Table 2.** Sensory Blockades of the Femoral (F), Lateral Femoral Cutaneous (LFC), Obturator (OBT), and Genitofemoral (GF) Nerves

| | F | | | LFC | | | OBT | | | GF | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time after injection (min) | 10 | 20 | 30 | 10 | 20 | 30 | 10 | 20 | 30 | 10 | 20 | 30 |
| Group 1 | 35 | 39 | 45 | 13 | 24 | 31† | 13 | 22 | 26† | 9 | 15 | 19† |
| Group 2 | 39 | 43 | 44 | 32* | 44* | 45* | 7 | 12 | 19† | 6 | 9 | 17† |

Group 1 patients underwent a 3-in-1 block ($n = 50$).
Group 2 patients underwent a fascia iliaca compartment block ($n = 50$).
* $P < 0.05$ time comparison between groups.
† $P < 0.05$ sensory blockade comparison of each nerve among the three times in both groups.

**Table 3.** Total Motor and Sensory Blockades 30 Minutes After 3-in-1 (Group 1) and Fascia Iliaca Compartment (Group 2) Blocks

| | Sensory blockade | | | | Motor blockade | |
|---|---|---|---|---|---|---|
| | F | LFC | OBT | GF | F | OBT |
| Group 1 | 45/50 (90%) | 31/50 (62%) | 26/50 (52%) | 19/50 (38%) | 38/50 (76%) | 16/50† (32%) |
| Group 2 | 44/50 (88%) | 45/50* (90%) | 19/50 (38%) | 17/50 (34%) | 40/50 (80%) | 10/50† (20%) |

F = femoral nerve, LFC = lateral femoral cutaneous nerve, OBT = obturator nerve, GF = genitofemoral nerve.
* $P < 0.05$ Group 1 versus Group 2.
† $P < 0.05$ motor versus sensory blockade for the same nerve.

The analysis of 92 radiographs, correlated with the clinical blockade present at T + 30 min, led to the classification of 62 radiographs as Zone A + B spreads (Table 4). A significantly greater frequency of Zone B spreads were noted in the Group 2 patients' radiographs (Table 4, Figure 2). Sensory blockade of the obturator nerve was absent in all patients showing only Zone B spreads (under the iliacus muscle fascia). All of these patients ($n = 21$) presented a LFC nerve sensory blockade, associated in 19 cases with femoral nerve sensory blockade. Zone A + C (lumbar plexus) (Table 4, Figure 2) spreads were noted in five patients, four of whom were in Group 1. Complete sensory blockade at T + 30 min was noted for all patients presenting a Zone A + C spread.

## Discussion

In this study, we demonstrated that the fascia iliaca compartment block is more effective than the 3-in-1 block in producing simultaneous blockade of the LFC and femoral nerves in adults. However, both techniques provide sensory blockade of the three lumbar plexus nerves that supply the thigh in only 35% of procedures. The extended spread of the local anesthetic solution under the fascia iliaca was unpredictable (13), and a small number of radiographic images showed lumbar plexus spread. These findings are in accordance with the literature (8,9,14) and illustrate the difficulties encountered in obtaining a complete 3-in-1 blockade via the anterior approaches in adults.

The fascia iliaca compartment block is easy to perform, requires no expensive equipment, and is accessed via a minimal risk approach. Although sensory blockade of the femoral nerve is provided by both block procedures equally, that of the LFC is obtained both more rapidly and consistently with the fascia iliaca compartment block. However, in contrast with the findings of Dalens et al. (10), sensory blockade of the three main lumbar plexus nerves supplying the thigh was not usually achieved in our adult population. This may be explained by the difficulty in extrapolating results from children to adults. Furthermore, only total sensory blockades of a given nerve territory were retained in our study.

In our study, the failure of a complete sensory blockade of the three nerves depends essentially on obturator nerve blockade. This finding, previously reported in the literature (8,14,15), underlines the fact that despite the fascia iliaca crossing required to obtain a sensory blockade of the femoral nerve (12), the spread of local anesthetic to the three principal nerves is difficult to obtain and unpredictable (13). Although the local anesthetic can travel sufficiently under the fascia situated between the psoas and iliacus muscles to block the femoral and LFC nerves, it does not always migrate proximally in sufficient quantities to block the obturator nerve (16). The genitofemoral and obturator nerves lie on the internal edge of the psoas muscle, in a different muscle plane than the femoral and LFC nerves (17). The anesthetic solution reaches these nerves after a greater delay, and with less consistency. This is confirmed by the delayed sensory

**Table 4.** Radiographic Correlations Between the Spread of Local Anesthetic Solution and the Sensory Blockade of the Three Main Nerves Supplying the Thigh

| | Group 1 ($n$ = 48) | | | | Group 2 ($n$ = 44) | | | |
|---|---|---|---|---|---|---|---|---|
| | $n$ | F | LFC | OBT | $n$ | F | LFC | OBT |
| Zone A | 4* | 4* | 2* | 1* | 0 | 0 | 0 | 0 |
| Zone B | 5 | 5 | 5 | 0 | 16* | 14* | 16* | 0 |
| Zones A + B | 35 | 30 | 20 | 19 | 27 | 23 | 24 | 18 |
| Zones A + C | 4 | 4 | 4 | 4 | 1 | 1 | 1 | 1 |

Group 1 patients underwent a 3-in-1 block.
Group 2 patients underwent a fascia iliaca compartment block.
F = femoral nerve sensory blockade; LFC = lateral femoral cutaneous nerve sensory blockade; OBT = obturator nerve sensory blockade; Zone A = under the psoas muscle fascia, internal spread; Zone B = under the iliacus muscle fascia, external spread; Zone C = to the roots of the lumbar plexus, from the second to the fourth lumbar vertebrae inclusively.
* $P < 0.05$ Group 1 versus Group 2.

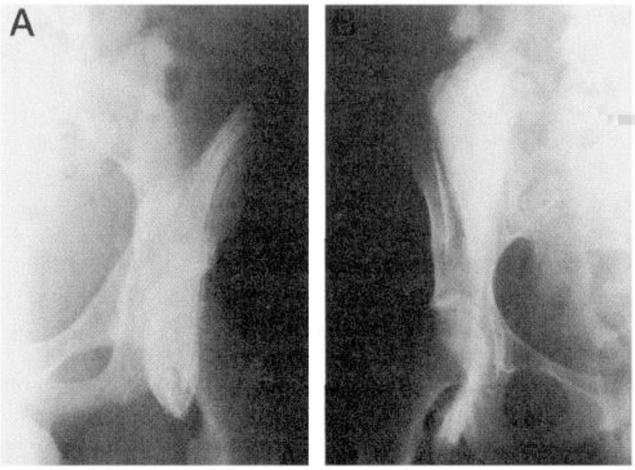


**Figure 2.** A, External spread of the local anesthetic solution under the iliacus muscle fascia. Sensory blockade was noted in the lateral femoral cutaneous (LFC) and femoral nerve territories. B, Spread of the local anesthetic solution to the roots of the lumbar plexus via the fascia iliaca compartment. Sensory blockade was noted in the LFC, genitofemoral, obturator, and femoral nerve territories.

blockade of the genitofemoral and obturator nerves seen in the two patient groups, compared with the rapid onset of the femoral sensory blockade. This also applies to the delayed onset of the LFC blockade seen in Group 1. The insufficient concentrations of local anesthetic reaching the obturator nerve might also partially explain the differences noted in this study between the sensory and motor blockades (16). Because the obturator is a mixed nerve, a given concentration of anesthetic solution reaching the nerve might have blocked sensory fibers while leaving most motor fibers unaffected. Finally, the four fascia iliaca compartment blocks leading to two total sensory blockade failures and two isolated LFC blockades illustrate that although it is easy to perform, some experience is required to fully master the technique.

The low VAS and simple verbal scale scores recorded for the patients of both study groups confirm the analgesic value of blocking nerves that arise from the lumbar plexus after surgery of the femoral shaft and the knee (1–6). The adequate analgesic effect obtained despite the low percentage of complete three nerve blocks can be explained by the predominant femoral nerve innervation of the femur and the knee. Effective postoperative knee analgesia by means of a femoral nerve block has been demonstrated previously (18). The highest VAS scores noted within our patient population were associated with either completely failed blocks or isolated LFC blockades. The duration of analgesia was shorter in our study compared with that in the Dalens et al. (10) study. Using a mixture of 1% lidocaine and 0.5% bupivacaine, both with 1:200,000 adrenaline, Dalens et al. reported 6.2 ± 1.4 hours of analgesia in their 3-in-1 group and 5.0 ± 1.3 hours in their fascia iliaca compartment group. Most surgical procedures performed in our patient population were performed on the knee, in which posterior innervation is assured by the sciatic nerve, which is unaffected by anterior approach blocks. In addition, some of our patients underwent continuous passive motion of the operated limb during the postoperative period. As reported in the literature, this decreases the duration of analgesia of a 3-in-1 blockade (19).

The radiographic analysis of the local anesthetic-contrast media solution's spread demonstrates unpredictable distribution. Only five patients showed lumbar plexus spread in our study. The lumbar plexus spread of local anesthetic leads to a complete 3-in-1 blockade equivalent to that of a posterior approach plexus block (8). Most of our procedures (62 of 92) led to a mixed spread into Zones A and B. This preferential pattern corresponds with the fascia iliaca, covering the iliacus and psoas muscles as well as the nerve trunks. The local anesthetic passes under the fascia, providing a multiple nerve trunk blockade, as reported by Dalens et al. (10,16) and Spillane (20). The quality of the sensory blockade depends on the extension of the local anesthetic spread under the fascia (16). The absence of correlation between radiographs demonstrating a Zone A spread and the clinically observed complete obturator nerve blockade is probably due to the radiological technique used. From its position covering the iliacus muscle, the fascia iliaca passes posterior to the psoas muscle before returning to envelop the muscle around its posterior, lateral, and then anterior aspect, where it envelops the obturator nerve. A Zone A image observed on a frontal radiograph cannot be used to distinguish the spread of local anesthetic limited to only the posterior aspect of psoas muscle from the spread that encircles the muscle, reaching the obturator nerve. The difference noted in Group 1 between the zone of diffusion and the LFC sensory blockade is probably the result of only com- [redacted] subfascial distance between the point of injection and the LFC. In contrast to the 3-in-1 block, the fascia iliaca compartment block involves a shorter subfascial distance, which allows more local anesthetic to reach the nerve. Finally, isolated iliacus spreads were noted preferentially in Group 2. The resulting external anesthetic spreads did not reach the obturator nerve, thereby confirming previously published results (13).

In conclusion, both the fascia iliaca compartment and 3-in-1 blocks provide effective postoperative analgesia in adults. The fascia iliaca compartment technique provides faster and more consistent sensory blockade of the LFC nerve. The sensory blockade obtained using both of the anterior approaches is primarily due to the spread of local anesthetic under the fascia iliaca, and only rarely to the lumbar plexus.

## References


1. Anker-Moller E, Spangberg N, Dahl JB, et al. Continuous blockade of the lumbar plexus after knee surgery: concentrations and analgesic effect of bupivacaine 0.250% and 0.125%. Acta Anaesthesiol Scand 1990;34:468–72.
2. Dahl JB, Christiansen CL, Daugaard JJ, et al. Continuous blockade of the lumbar plexus after knee surgery: Postoperative analgesia and bupivacaine plasma concentrations. Anaesthesia 1988;43:1015–8.
3. Edwards E, Wright M. Continuous low dose 3-in-1 nerve blockade for postoperative pain relief after total knee replacement. Anesth Analg 1992;75:265–7.
4. Matheny JM, Hanks GA, Rung GW, et al. Comparison of patient-controlled analgesia and continuous lumbar plexus block after anterior cruciate ligament reconstruction. Arthroscopy 1993;9:87–90.
5. Serpell MG, Millar FA, Thomson MF. Comparison of lumbar plexus block versus conventional opioid analgesia after total knee replacement. Anaesthesia 1991;46:275–7.
6. Schultz P, Anker-Moller E, Dahl JB, et al. Postoperative pain treatment after open knee surgery: continuous lumbar plexus block with bupivacaine versus epidural morphine. Reg Anesth 1991;16:34–7.
7. Winnie AP. The 3-in-1 block: is it really 4-in-1 or 2-in-1? Reg Anesth 1992;17:176–9.
8. Parkinson SK, Mueller JB, Little WL, et al. Extent of blockade [redacted] 1989;68:243–8.
9. Seeberger MD, Urwyler A. Paravascular lumbar plexus block extension after femoral nerve stimulation and injection of 20 vs 40 ml mepivacaine 10 mg/ml. Acta Anaesthesiol Scand 1995;39:769–73.
10. Dalens B, Vanneuville G, Tanguy A. Comparison of the fascia iliaca block with the 3-in-1 block in children. Anesth Analg 1989;69:705–13.
11. Sharrock NE. Inadvertent "3-in-1" block following injection of the lateral cutaneous nerve of the thigh. Anesth Analg 1989;59:887–8.
12. Khoo ST, Brown TCK. Femoral nerve block: the anatomical basis for a single injection technique. Anaesth Intensive Care 1983;11:40–2.
13. Cauhepe C, Olivier M, Colombani R, et al. The "3 in 1" block: myth or reality? Ann Fr Anesth Reanim 1989;8:376–8.
14. Madej TH, Ellis FR, Halsall PJ. Evaluation of "3-in-1" lumbar plexus block in patients having muscle biopsy. Br J Anaesth 1989;62:515–7.
15. Lang SA, Yip RW, Chang PC, et al. The femoral "3-in-1" block revisited. J Clin Anesth 1993;5:292–6.
16. Dalens B, Tanguy A, Vanneuville G. Lumbar plexus blocks and lumbar plexus nerve blocks. Anesth Analg 1989;69:852–4.
17. Farny J, Drolet P, Girard M. Anatomy of the posterior approach to the lumbar plexus block. Can J Anaesth 1994;41:480–5.
18. Rosenblatt R. Continuous femoral anesthesia for lower extremity surgery. Anesth Analg 1980;59:631–2.
19. Tierney E, Lewis G, Hurtig JB, et al. Femoral nerve block with bupivacaine 0.25 per cent for postoperative analgesia after open knee surgery. Can J Anaesth 1987;34:455–8.
20. Spillane WF. 3-in-1 blocks and continuous 3-in-1 blocks. Reg Anesth 1992;17:175–6.