# Comparison of Continuous 3-in-1 and Fascia Iliaca Compartment Blocks for Postoperative Analgesia: Feasibility, Catheter Migration, Distribution of Sensory Block, and Analgesic Efficacy

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**Background and Objectives:** Efficacy and technical aspects of continuous 3-in-1 and fascia iliaca compartment blocks were compared.

**Methods:** Forty-four patients scheduled for cruciate ligament repair or femur surgery were randomly divided into 2 groups. After surgery with the patient anesthetized, catheters were placed for continuous 3-in-1 blocks by means of a nerve stimulator (group 1). In group 2, the catheter was inserted for continuous fascia iliaca compartment block without the use of a nerve stimulator. In both groups, a 5-mg/kg bolus of 0.5% ropivacaine was administered followed by continuous infusion of 0.1 mL/kg/h of 0.2% ropivacaine for 48 hours. In the postoperative period, all the patients received parenteral propacetamol (6 g daily) and ketoprofen (200 mg daily) and 0.1 mg/kg of subcutaneous morphine as rescue analgesia if the visual analog scale (VAS) pain values were greater than 30 mm. We evaluated the technical difficulties relative to catheter placement, the location of the catheter, the analgesic efficacy, and the distribution of the sensory block at 1 hour, 24 hours, and 48 hours.

**Results:** Catheter placement was faster in group 2, and the absence of nerve stimulation decreased material costs ($P < .05$). No significant difference was observed between groups concerning location of the catheter tip under the fascia iliaca. In both groups, the distribution of the sensory block and its course were similar except for those of the obturator nerve (more sensory blocks in group 1, $P < .05$). No significant difference was noted between the groups regarding median VAS pain values and consumption of morphine during the 48-hour period. No major side effect was observed.

**Conclusions:** The authors conclude that a catheter for continuous lumbar plexus block can be placed more quickly and at lesser cost using the fascia iliaca technique than the perivascular technique with equivalent postoperative analgesic efficacy. *Reg Anesth Pain Med 2003;28:309-314.*

**Key Words:** Continuous 3-in-1 block, Fascia iliac compartment block, orthopedic surgery, postoperative pain relief.

Major orthopedic surgery of the lower limbs is painful. Numerous authors have reported the necessity of effective control of postoperative pain, particularly in high-risk patients.[1,2] Parenteral opioids are insufficient to relieve the pain of knee arthroplasty or ligament reconstruction with early postoperative mobilization.[3] The implementation of a lumbar plexus or femoral catheter can prolong postoperative analgesia for several days to facilitate effective functional rehabilitation.[4,5] Anterior placement of a continuous lumbar plexus block is conventionally performed using the method reported by Winnie et al.[6] The analgesic result is dependent on the final position of the tip of the catheter,[7] and numerous authors have reported that the obturator nerve is inconsistently blocked by the 3-in-1 block.[7-9] This results in ineffective analgesia, therefore limiting the usefulness of 3-in-1 block.[9-11] A sensory block of the 3 main nerves of the lumbar plexus was successfully ob-

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tained in 90% of children receiving a fascia iliaca compartment technique[12] but in only 34% of adult patients.[13] A fascia iliaca catheter placement can be performed without nerve stimulation or use of paresthesias, and the point of puncture is far from major inguinal vessels and nerves. Although both approaches can be used to place a perineural catheter,[4-11] there are no published comparisons of these 2 techniques for anesthetizing the nerves of the lumbar plexus. The purpose of the present study was to compare sensory block distribution, analgesic efficacy, and possible technical difficulties because of catheter placement by these 2 methods after major lower limb surgery.

## Materials and Methods

After ethics committee approval and written informed consent, 44 patients scheduled for major orthopedic surgery were randomly included in this prospective study. Before surgery, the patients were randomized into 1 of 2 groups. Group 1 patients had continuous 3-in-1 block (Winnie's technique[6]), and group 2 patients had continuous fascia iliaca compartment block (Dalens' technique[12]). All the patients received oral premedication with 0.5 mg alprazolam. Induction of anesthesia was achieved in standardized fashion with sufentanil (0.5 $\mu$g/kg) and propofol (2.5 mg/kg). Anesthesia was maintained with sufentanil (0.4 $\mu$g/kg/h) and desflurane (end tidal fraction, 3.5% to 4.5%) with 60% nitrous oxide and 40% oxygen. Sufentanil was discontinued 30 minutes before the end of surgery. All blocks were performed during the immediate postoperative period under general anesthesia.

The 3-in-1 blocks (group 1) were performed using a nerve stimulator (B Braun, Melsungen, Germany) with a 50-mm insulated needle (19-gauge multiset; Pajunk, Geisingen, Germany). With patients in the supine position, the puncture site was located 2 cm below the inguinal ligament and 1 cm lateral to the femoral artery. After eliciting quadriceps femoris motor response (i.e., cephalad patellar movement) at 0.5 mA (1 Hz, 100 $\mu$s), a 21-gauge catheter was inserted from 12 to 15 cm in a cephalad direction. The puncture site for the fascia iliaca compartment blocks (group 2) was marked 1 cm caudal to where the lateral third of the inguinal ligament line met the middle third. The needle (18-gauge Tuohy, Perican, B Braun) was inserted and advanced at a 75° angle until a first, and then a second loss of resistance were felt (corresponding to the fascia lata and fascia iliaca, respectively). Then a catheter was inserted from 12 to 15 cm in the cephalad direction. In both groups, 0.5 mL/kg of 0.5% ropivacaine was injected during a 2-minute period through the catheter, and 0.1 mL/kg/h of 0.2% ropivacaine were continuously infused for 48 hours. All catheters were systematically opacified in the postanesthetic care unit with 5 mL of iopamidol 200 (Iopamiron, Lys les Lannoy, France). An anteroposterior film of the pelvis in the reclining position showed the zone of diffusion of the contrast media and the location of the catheter tip under the fascia iliaca. This position was qualified as medial (over the psoas muscle), intermediate, lateral (over the iliacus muscle), or close to the branches of the lumbar plexus (vertebrae L3 to L5).

The duration of catheter placement (amount of time between the initial puncture and the threading of the catheter) was recorded, as was the number of punctures necessary for the localization of either the femoral nerve in group 1 or the fascia iliaca in group 2.

The visual analog scale (VAS, ranging from 0 to 100 mm) pain values during movement were noted at 1 hour, 24 hours, and 48 hours. All patients systematically received analgesia started during the immediate postoperative period. This analgesia consisted of 2 g of intravenous propacetamol 3 times daily associated with 100 mg of intravenous ketoprofen twice daily. In case of insufficient analgesia (VAS > 30 mm), the patients received 0.1 mg/kg of subcutaneous morphine as rescue analgesia.

The sensory block was assessed at 1 hour, 24 hours, and 48 hours by testing for cold and light touch in the sensory distribution of the femoral nerve (the anterior aspect of the knee), obturator nerve (medial and posterior aspect of the knee), and lateral femoral cutaneous nerve (lateral aspect of the thigh). The incidence of adverse effects such as epidural diffusion of the local anesthetic, puncture of vascular structures, failure of catheter placement, signs of local anesthetic toxicity, nausea, vomiting, and urinary retention requiring placement of a bladder catheter was systematically recorded throughout the study.

Statistical analysis was performed using SAS software, SAS institute version 6.12 (Cary, NC). Values were expressed as mean (± standard deviation), median (extreme values), and percentages. The statistical power was calculated using the overall variance of the observed VAS values. The initial hypothesis was that a difference in VAS of at least 20% would be clinically significant for 2 groups of 20 patients per group. For a risk alpha of 5%, the observed power of the VAS results was 90%. Regarding the consumption of morphine, the statistical power was calculated using the overall variance of the observed consumption of morphine. The initial hypothesis was that a difference of 5 mg would be clinically significant for two groups of 20 patients

**Table 1.** Demographic Features, Indications, and Duration of Operations for Both Groups

| | Group 1 | Group 2 |
|---|---|---|
| Number of patients | 20 | 20 |
| Age (yr) | 62 ± 7 | 58 ± 6 |
| Sex M/F | 10/10 | 9/11 |
| Weight (kg) | 78 ± 14 | 72 ± 14 |
| Height (cm) | 168 ± 7 | 170 ± 8 |
| Cruciate Ligament repair / femoral osteotomy | 12/8 | 13/7 |
| Duration of surgery (h) | 3.1 ± 0.7 | 2.7 ± 0.5 |

per group. For a risk alpha of 5%, the observed power of the morphine consumption results was only 47%.

For quantitative data, comparisons between the groups were performed by the chi-squared test or Fisher's exact test when the number of subjects was too small for validity of the chi-squared test. Mean values were compared using the Mann-Whitney-Wilcoxon nonparametric test. In each group, the study of the course of the VAS over time was performed with the Friedman test (analysis of variance for repeated measurements). Cold sensation and light touch results were analyzed for central tendency. A test was considered to be significant if $P < .05$.

## Results

All patients had American Society of Anesthesiologists scores from 1 to 3 and were scheduled for knee ligament reconstruction or femur surgery (trauma, osteotomy). The same surgical team performed the operations. Catheter placement was performed by 1 of 3 anesthesiologists accustomed to both techniques.

The demographic data concerning the patients, type of surgery, and duration of surgery were comparable in the 2 groups (Table 1). We noted 4 failures of catheter placement, 2 in each group (not significant). These patients were excluded from the study. There was no significant difference between the 2 groups concerning the number of attempts necessary for catheter placement (Table 2). The time spent on catheter placement (Table 2) was significantly shorter in group 2 than in group 1 ($P <$ .05). Material cost per patient was higher in group 1: \$22 ± \$3 as opposed to \$11 ± \$2 in group 2 ($P <$ .05) because of the use of an insulated needle and the estimated depreciation (initial cost plus cost of repairs divided by the number of individual applications of the device and additional cost per patient for nonreusables) of the nerve stimulator. The location of the tip of the catheter under the fascia iliaca is shown in Table 3. There was no significant difference between the groups concerning the position of the catheter tip under the fascia iliaca. The distribution of the sensory block according to the location of the tip of the catheter under the fascia iliaca is also shown in Table 3.

Sensory block over time in the distribution of the femoral, lateral femoral cutaneous, and obturator nerves for the 2 groups is shown in Figure 1. A significant decrease was observed in the percentage of sensory block between the first postoperative hour and the 48th postoperative hour for the lateral femoral cutaneous nerve and the obturator nerve ($P < .05$). There was no significant difference between the groups concerning the sensory block for the distribution of the femoral nerve and that of the lateral femoral cutaneous nerve at 1 hour, 24 hours, and 48 hours. In contrast, there was a significant difference in sensory block between the groups in the obturator nerve distribution ($P < .05$) (Fig 1).

The median values of the VAS and the amounts of rescue analgesia at 1 hour, 24 hours, and 48 hours are shown in Table 4. There was no significant difference between the 2 groups concerning the values of VAS and consumption of morphine throughout the study.

One case of direct vascular puncture by an insulated needle occurred in group 1. The course of this patient was favorable after external compression for approximately 10 minutes. No case of local anesthetic systemic toxicity was observed during the study. No patient had epidural diffusion of the block. No other adverse effects were reported in either group.

## Discussion

After major orthopedic surgery of the lower limb, continuous fascia iliaca compartment and 3-in-1 blocks using 0.2% ropivacaine provided optimal

**Table 2.** Number of Punctures and Time Required for Placement of Continuous Peripheral Nerve Block in the 2 Groups

| | < 2 Punctures (%) | > 3 Punctures (%) | Time < 5 min (%) | Time > 5 min (%) | Time > 15 min (%) |
|---|---|---|---|---|---|
| Group 1 | 75 | 25 | 45 | 25 | 30 |
| Group 2 | 85 | 15 | 80* | 20 | 0* |

*$P < .05$ versus group 1.

**Table 3.** Location of Catheter Tip Under the Fascia Iliaca in the Two Groups and Percentage of Patients Having a Sensory Block at 1 Hour Depending on the Tip Location

| Locations | Lateral (%) | Medial (%) | Intermediate (%) | Near Plexus (%) |
|---|---|---|---|---|
| Group 1 | 20 | 35 | 35 | 10 |
| Group 2 | 40 | 20 | 35 | 5 |

**Nerve sensory blocks**

| | Lateral (%) | | Medial (%) | | Intermediate (%) | | Near Plexus (%) | |
|---|---|---|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 1 | Group 2 | Group 1 | Group 2 | Group 1 | Group 2 |
| Femoral | 100 | 100 | 85 | 75 | 100 | 85 | 100 | 100 |
| LFC | 75 | 87.5 | 60 | 75 | 85 | 85 | 100 | 100 |
| Obturator | 20* | 0* | 100 | 100 | 85 | 70 | 100 | 50 |

Abbreviation: LFC, lateral femoral cutaneous.
*$P < .05$ versus other catheter tip locations.

pain relief. In both approaches, the course of the catheter under the fascia iliaca was unpredictable and the area of the sensory block was mainly centered within the distribution of the femoral nerve by the 24th hour. The placement of a catheter using the fascia iliaca compartment technique is faster, an appreciable advantage when there is substantial operating room turnover.

Continuous peripheral nerve block (CPNB) is recommended for pain relief after orthopedic surgery of the lower limbs.[5,6,14] The use of PNB in orthopedic surgery allows an overall decrease in the discharge time in ambulatory practice.[15-17] Nevertheless, increased patient turnover time and higher costs for the material used in comparison with general or spinal anesthesia have been cited as drawbacks to this technique.[15,16] In light of this, continuous fascia iliaca compartment block warrants consideration because less time is required for catheter placement and material cost per patient is less. In the present study, the patients were relatively slim and this is held to facilitate the fascia iliaca approach.

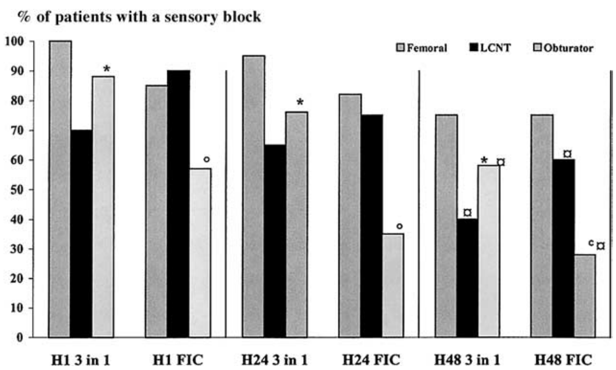


**Fig 1.** Percentages of patients with sensory block at 1 hour, 24 hours, and 48 hours in the 2 groups. Femoral, femoral nerve; Obturator, obturator nerve; LFCN, lateral femoral cutaneous nerve; 3-in-1, 3-in-1 block; FIC, fascia iliaca compartment block. *$P < .05$ versus group 2 for the obturator nerve; °$P < .05$ versus femoral and LFC nerves in group 2; ¤$P < .05$ versus 1 hour in both groups for the obturator and lateral femoral cutaneous nerves.

Catheter course was unpredictable in both groups. This result confirms reports regarding single-shot and continuous PNB.[7,13] The distribution of the sensory block is not influenced by the use of a nerve stimulator or by the volume of the solution of local anesthetic[11] but depends on the location of the catheter under the fascia iliaca.[7] In our study, positioning the catheter tip directly over the plexus was rare in both groups. Using CT assessment, Ganapathy et al.[10] found 40% of catheters in such a position. In such cases, the catheter tip is situated beyond the superior third of the sacroiliac joint, a position considered to be ideal by the latter authors because it provided a block of the 3 principal nerves of the lumbar plexus in 100% of cases.

Our results show no difference between the 2 groups concerning the distribution of sensory block in the 3 principal nerves of the lumbar plexus at 1 hour, 24 hours, and 48 hours, except for the obturator nerve. There is no anatomic fascial sheath that can convey a catheter from below the inguinal ligament to the lumbar plexus,[18,19] but the site of puncture in group 2 theoretically contributed to greater diffusion of the local anesthetic solution toward the iliacus muscle and the lateral femoral cutaneous nerve. Conversely, when the tip of the catheter was situated in a lateral position, sensory block of the obturator nerve was obtained in only 10% of cases. Although the local anesthetic solution injected via the catheter can course far enough under the fascia iliaca to block femoral and lateral femoral cutaneous nerves from a lateral location, the solution does not reach the obturator nerve. Difficulty in assessing sensory block of the obturator

**Table 4.** Pain Score Values and Amount of Morphine for Rescue Analgesia in Both Groups at 1 Hour, 24 Hours, and 48 Hours

| | H1 3-in-1 | H1 FIC | H24 3-in-1 | H24 FIC | H48 3-in-1 | H48 FIC |
|---|---|---|---|---|---|---|
| Pain scores (mm) median (extremes) | 20 (0–80) | 20 (0–50) | 10 (0–50) | 20 (0–65) | 0 (0–60) | 10 (0–60) |
| Morphine consumption (mg) median (extremes) | 0 (0–10) | 0 (0–12) | 0 (0–40) | 3 (0–30) | 0 (0–60) | 10 (0–30) |

Abbreviations: 3-in-1, continuous 3-in-1 block, FIC, continuous fascia iliaca compartment block.

nerve probably explains this difference, thus study limitations concerning the results of obturator nerve sensory block should be considered. Some authors recommend evaluation of motor function (adduction of the thigh)[8,9] or even electromyographic studies of the nerve[20] because use of sensory evaluation may lead to errors because of the variability or potential absence of sensory distribution from the obturator nerve.[9]

The analgesic efficacy of CPNB was equivalent in both groups. There was a significant decrease of sensory block within the distribution of the LFC and obturator nerves over time. The volume effect of local anesthetic bolus did not occur with the limited hourly volume of local anesthetic administered to the patients in the postoperative period, but this did not result in a significant increase in the VAS pain values or in morphine consumption during the first 48 hours. The differential block phenomenon is a rational explanation for this observation. The greater sensitivity of poorly myelinated fibers to low concentrations of local anesthetics,[21] the length of nerve in contact with the anesthetic solution,[22] and degradation of the coding of nociceptive information passed on without blocking propagation of the impulse[23] might lead to this differential block. The excellent postoperative analgesia and minimal morphine requirements were because in part of the CPNB techniques but perhaps also to more minor procedures rather than total knee arthroplasties. The highest values of VAS and of morphine consumption noted in both groups were probably because of deficient analgesia in the distribution of the obturator or sciatic nerves. A recent study by Ganapathy et al.[10] showed the analgesic efficacy of this type of approach. After knee arthroplasty, they observed less consumption of morphine in a group receiving 0.2% bupivacaine when compared with a group receiving 0.1% bupivacaine and to a placebo group.

No neural lesions were observed in the present 40 patients. For the fascia iliaca approach, the femoral vascular and neural bed is classically situated medially, away from the point of puncture. Consequently, this approach presents a smaller theoretical risk of direct vascular or neural lesions. In the authors' hospital, almost all CPNB are performed preoperatively in premedicated patients. These CPNB are primarily used for postoperative analgesia. Nevertheless, there are a certain number of circumstances that call for achievement of these blocks under general anesthesia or heavy sedation (for example, uncooperative patients; catheter situated in the operative fields, preventing its placement before surgery; or pediatric anesthesia). In such cases, it is necessary to minimize the risk of vascular or neurologic injury because of masking the alert signal of pain in cases of intrafascicular injection.[24] The use of a nerve stimulator or the fascia iliaca compartment block may arguably minimize the risk of direct neural lesions but does not totally eliminate it.[25-27] Anatomic variations in its position under the inguinal ligament are probably sufficient to account for the possibility of puncture wounds of the femoral nerve, even during a more lateral approach.[28] Despite the small number of patients in the present study, the present authors speculate that continuous fascia iliaca compartment block is theoretically advisable in anesthetized patients.

In conclusion, the placement of a catheter toward the lumbar plexus through the fascia iliaca approach achieves analgesia equivalent to that of the reference perivascular method, can be done more quickly, and may avoid direct contact of the needle with the femoral nerve. This method is recommended if one wishes to obtain a lumbar plexus block via an anterior approach.

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