

Comparison Between 0.125% And 0.25% Bupivacaine Administrated Through Continuous Three In One Block With Fluoroscopic Catheter Tip Confirmation For Postoperative Pain After Total Knee Arthroplasty

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Citation

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Abstract

Background:

The three - in - one technique of simultaneously blocking the femoral, the lateral femoral cutaneous (LFC) and the obturator nerves by a single injection of a local anesthetic was first described in 1973, and it was suggested that the underlying mechanism was one of cephalad spread resulting in a blockade of the lumbar plexus. Many subsequent studies have, however, reported sub optimal analgesia levels, particularly in the obturator nerve distribution.

Aims & Objective:

The aim of this prospective study was to compare 0.125% Bupivacaine and 0.25% Bupivacaine administered by continuous infusion in obtaining effective postoperative analgesia and sensory blockade in the area of distribution of the femoral, obturator and lateral cutaneous nerves.

Materials & Methods:

86 patients were randomly allocated to either group A (0.125%) or group B (0.25%). All patients received a standard anesthetic; postoperatively 19 to 20 cm of a catheter was placed in the femoral sheath after femoral nerve location with a nerve locator. Contrast media (3ml Iohexol USP) was injected, and the catheter tip was located by means of an anteroposterior pelvic radiograph. A 20 ml equal volume mixture of 0.5% bupivacaine and 2% lidocaine was injected through the catheter. Thirty minutes after injection pain scores and sensory blockade was evaluated in the cutaneous distribution of the lateral femoral cutaneous, femoral and obturator nerves. In ten patients (8.6%) the catheter could not be threaded, eight patients (6.8%) drug could not be injected, two patients (1.72%) had vascular punctures and in six patients (5.16%) there was catheter dislodgement before the 48-hour period, these patients were withdrawn from the study.

Results & Conclusion:

Comparing group A and B patients, sensory block was achieved in 100% for the femoral nerve in both the groups, 90% and 96% for the lateral femoral cutaneous nerve and 54% and 96% for the obturator nerve ($p < 0.05$). Visual analog scale pain scores on movement were significantly lower in-group B than group A ($P < 0.05$). We conclude continuous three-in-one block with 0.25% bupivacaine infused at 2ml/h, with fluoroscopy confirmation of the catheter tip near the lumbar plexus provides a more efficient pain relief after total knee arthroplasty than a continuous of 0.125% bupivacaine at 2ml/h. Of the two concentrations, superior analgesic effect of 0.25% bupivacaine can be attributed to the motor blockade of the mixed nerves (femoral and obturator) compared to the differential blocking of these nerves by the 0.125% bupivacaine.

INTRODUCTION

The use of peripheral nerve blocks is recommended after orthopedic surgery. Continuous peripheral nerve blocks have

improved postoperative pain relief, rehabilitation, and patient satisfaction compared with IV narcotics for both upper and lower extremity procedures (1,2,3,4, 5). The continuous three in one block first described by Winnie et al

(₆) is as effective as epidural analgesia with lower side effects (urinary retention, nausea & risk of spinal subarachnoid hemorrhage in anticoagulated patients) (_{3,4}).

Whilst the three in one block described by Winnie provides anaesthesia in the distribution of the femoral, obturator and lateral cutaneous nerve, subsequent studies have indicated an inconsistency in the degree of obturator nerve block with this technique (_{7,8}).

The aim of this study was to compare 0.125% Bupivacaine and 0.25% Bupivacaine administered by continuous infusion in obtaining effective post operative analgesia and sensory blockade in the area of distribution of the femoral, obturator and lateral cutaneous nerves.

MATERIALS & METHODS

After informed consent and with institutional approval, 86 ASA physical status I – II patients Scheduled for elective Unilateral TKA under general anesthesia were included in this study. Patients were excluded if they had coagulation abnormalities, age < 18 or > 80 yrs, preexisting neurological deficit, severe cardio respiratory disease or hepatic or renal impairment, diabetes or inability to understand pain scales.

All patients received a standard anesthetic. Premedication was intra muscular glycopyrrolate 0.2 mg 1 h before induction of anesthesia. Anesthesia was induced with intravenous fentanyl (1µg/kg), thiopental (3-5 mg/kg), vecuronium (0.1 mg/kg). The trachea was intubated and the lungs ventilated with oxygen, nitrous, and halothane. Muscle relaxation was maintained throughout the operation with intermittent bolus doses of intravenous vecuronium. At the end of the procedure, neuromuscular blockade was reversed with intravenous neostigmine (2.5mg) and glycopyrrolate (0.4mg).

Patients were prospectively randomized to one of two groups. After extubation, under aseptic conditions, the sheath was located with an 18 G Tuohy needle using the landmarks of Winnie, et al, with the double loss of resistance technique and was further confirmed with a nerve locator when a current of 0.5 amps elicited a quadriceps contracture. An 18 G portex epidural catheter was then passed through the Tuohy needle, so that 19 to 20 cm of a catheter was placed in the femoral nerve sheath. Contrast media (3ml Iohexol USP) was injected through the epidural catheter, and the catheter tip was located by means of an anteroposterior pelvic radiograph under C- arm guidance. The catheter was

adjusted to the ideal position (catheter tip located within 2cm of the cephalad extremity of the sacroiliac joint or between the sacral promontory and the lateral aspect of L4 & L5 vertebral bodies) (₉).

Figure 1

Figure 1: Dye confirmation of the catheter tip



Initially, 20 mL of equal volume mixture of 0.5% bupivacaine and 2% lidocaine was injected through the catheter to obtain a three-in-one block. This was immediately followed by an infusion of either (0.125%) group A or (0.25%) group B at 2 mL/h, which was then continued into the postoperative period for 48 hours. In both groups intermittent intra muscular ketorolac 30 mg every 8 hourly was prescribed to be given on patient request as a rescue analgesic.

A 100mm visual analogue scale, which was completed by the patient at 30 minutes, 6, 12, 24 and 48 hours after the operation, assessed postoperative pain, this constituted the scores at rest. Immediately after surgery, all the patients were observed on identical physical therapy regimens with active and assisted knee and hip flexion extension exercises daily. A member of the surgical team blinded to the study was made to assess the patient tolerability during physical therapy and rehabilitative measures and this formed the scores on movement.

Sensory blockade was evaluated in the cutaneous distribution of the lateral femoral cutaneous, femoral and obturator nerves by using an ether-soaked swab and the total dose of postoperative analgesic requirements by each patient in the 48 h period was noted.

Patient pain scores and analgesic requirements were

compared with the Mann-Whitney U-test.

RESULTS

Eight six patients initially participated in the study; In ten patients (8.6%) the catheter could not be threaded, eight patients (6.8%) drug could not be injected, two patients (1.72%) had vascular punctures and in six patients (5.16%) there was catheter dislodgement before the 48 hour period, these patients were withdrawn from the study. In the end, there were thirty patients in each group.

There were no significant demographic differences between the groups (table 1). The postoperative visual analogue scale pain scores and analgesic requirements are shown in table 2. Comparing group A and B patients 30 minutes after local anesthetic injection, sensory block was achieved in 100% for the femoral nerve in both the groups, 90% and 97% for the lateral femoral cutaneous nerve and 53% and 90% for the obturator nerve ($p < 0.05$) as shown in table 3.

Figure 2

Table 1: Clinical Characteristics of 60 patients undergoing Total Knee arthroplasty. Data are mean (SEM or range)

	Group A (n = 30)	Group B (n = 30)
Male / Female	12 / 18	14 / 16
Mean age (yr)	66.9	65.9
Mean weight (kgs)	68.7	68.3

Figure 3

Table 2: Post Operative Pain Scores (O= No Pain; 100 = Worst Pain Imaginable) And Analgesic Requirements In Both The Groups.

	Group A (n = 30) 0.125%		Group B (n = 30) 0.25%	
	AT REST	ON MOVEMENT	AT REST	ON MOVEMENT
VAS at 6 h	56.6		28.5	
VAS at 12 h	65.8	72.6	32.5	40.2
VAS at 24 h	69.7		34.8	
VAS at 48 h	71.3	81.7	33.8	42.6
Analgesic required in 48 h				
No. Of doses	3.57		1.30	
Total ketorolac dose (mg)	108.76		38.53	

Data are mean (SEM or range), $p < 0.05$.

Figure 4

Table 3: Sensory Blockade 30 Minutes After Local Anesthetic Injection In Both The Groups.

	Femoral	Lateral femoral cutaneous nerve	Obturator
Group A (0.125%)	100% (30/30)	90% (27/30)	53.3%* (16/30)
Group B (0.25%)	100% (30/30)	97% (29/30)	90% (27/30)

* = $p < 0.05$ in comparison to the other group.

DISCUSSION

The cutaneous and articular innervations of the knee joints are as follows: the anterior branch of the lateral femoral cutaneous nerve supplies the skin of the lateral aspect of the thigh and also contributes a branch to the patellar plexus, which supplies the knee joint. The anterior branch of the obturator nerve supplies the skin of the medial aspect of thigh. The posterior branch of the obturator nerve contributes an articular filament to the articular capsule of the knee. The femoral nerve is composed of two divisions. The anterior division supplies the skin of the anterior aspect of the thigh as far as and including the knee. The posterior division gives rise to the saphenous nerve, which supplies the prepatellar, skin, the skin of the medial aspect of the distal lower limb and the knee joint via its contribution to the patellar plexus. The sciatic innervation of the knee is relatively minor in the posterior aspect of the joint.

Total knee replacement produces severe pain in 60% and moderate pain in 30% of patients (₁₀). There are several methods available for postoperative pain relief, like systemic or epidural opiates, and epidural local anesthetics. Opiates are associated with side effects like nausea, vomiting, pruritus, and respiratory depression, whereas epidural local anesthetics may cause bilateral motor blockade (₁₀), shivering, and hypotension.

The three-in-one technique will block the femoral, obturator and the lateral cutaneous nerves and has favorable cardio respiratory profile. The block is easier to perform compared with other techniques of regional anesthesia and does not require any special positioning of the patient. After knee surgery, postoperative pain can be associated with reflex spasm of the quadriceps muscle, causing further pain and impaired muscle function leading to delayed rehabilitation (_{3,11}). Abolition of quadriceps muscle spasm by femoral nerve blockade contributes to the effectiveness of the technique. These studies correlate with our observation of

better pain relief obtained in patients with the 0.25% group, the local anesthetic concentration which as a greater likelihood of motor blockade and abolition of muscular spasm.

In a study by Capdevila et al (9), successful three-in-one blocks was observed in 91% of patients in whom the tip of the catheter was in the lumbar plexus area. This percentage decreased to 52% when the catheter tip was positioned medially under the fascia iliaca (deficient sensory blockade principally involving the lateral femoral cutaneous nerve) and to only 27% when the catheter was positioned laterally (deficient blockade of the obturator nerve). This finding, previously reported in the literature for the single shot three-in-one block (12,13,14,15), emphasizes that the local anesthetic solution passes under the fascia, providing multiple nerve trunk blockade. As there is no anatomical fascial sheath capable of conveying a local anesthetic solution injected from below the inguinal ligament to the lumbar plexus, the spread of the local anesthetic solution is difficult to obtain. Hence they suggested that any comparison of different local anesthetics administered by three-in-one block catheters or of two anesthetic techniques of regional anesthesia (continuous three-in-one block and fascia iliaca compartment blocks, for example), is possible only if the position of the catheter tip is verified to avoid methodological biases in the analysis of results.

We had successfully positioned at the ideal catheter site as demonstrated by Capdevila et al (catheter tip located within 2cm of the cephalad extremity of the sacroiliac joint or between the sacral promontory and lateral aspect of L4 - & L4 vertebral bodies) in 62.5 % of our patients. With the usage of a higher concentration of local anesthetics delivered close to the lumbar plexus at a constant rate, the blockade of mixed nerves like femoral and obturator were achieved in a greater percentage of our patients in the group B (0.25% bupivacaine). Still, the total dose of bupivacaine used is lower (60mg/day in the 0.125% group and 120mg/day in the 0.25% group) than the earlier reported studies as the catheters were confirmed to be in the ideal position.

But the extent of anesthesia during a continuous three-in-one block varied with time. The femoral nerve block is well maintained because the catheter is near the femoral nerve, whereas the obturator and lateral femoral cutaneous nerve blocks are more evanescent with time. However, effective pain relief VAS scores, 25 at rest and 40 on movement was observed in most patients of the 0.25% group and in some of

the patients of 0.125% group at 48 hours postoperatively. We did not include the duration of rehabilitation or the length of hospital stay as a means of assessment of Perioperative analgesic technique.

In summary, this prospective, randomized, double blinded-study concludes that continuous three-in-one block with 0.25% bupivacaine infused at 2ml/h, with fluoroscopy confirmation of the catheter tip near the lumbar plexus provides a more efficient pain relief after total knee arthroplasty than a continuous of 0.125% bupivacaine at 2ml/h. Of the two concentrations, superior analgesic effect of 0.25% bupivacaine can be attributed to the motor blockade of the mixed nerves (femoral and obturator) compared to the differential blocking of these nerves by the 0.125% bupivacaine.

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