Addition of femoral nerve block to epidural infusion for pain control post total knee arthroplasty: Does it make a difference?

Melvin KANDASAMY, Muhammad MAAYA, Raha ABDUL RAHMAN, Nadia MD NOR, Nurlia YAHYA
Department of Anaesthesiology and Intensive Care, Faculty of Medicine, Universiti Kebangsaan Malaysia Medical Centre, Malaysia

ABSTRACT

Introduction: Effective post-operative analgesia is a major factor in functional outcome after total knee arthroplasty (TKA). To reduce post-operative pain and expedite recovery, peripheral nerve blocks, such as the femoral nerve block (FNB) have been used as an adjunct to the analgesic regime. We assessed whether the addition of a FNB to continuous epidural analgesia (CEA) would improve pain control after TKA. **Materials and Methods:** A prospective, randomised, controlled study was conducted on 58 patients undergoing TKA and randomised into two groups. The CEA+FNB Group received a single-shot FNB of 30 ml 0.5% bupivacaine using a nerve stimulator technique. The CEA Group acted as a control group and did not receive FNB. Patients in both groups then received combined spinal-epidural anaesthesia for the surgery. Post-operative epidural infusion with 0.1% bupivacaine and 2 µg/ml of fentanyl, at 6 ml/hr was continued up to 48 hours post-operatively. Visual analogue scale (VAS) scores, motor blockade, requirement of rescue analgesia and patient satisfaction were recorded. **Results:** VAS scores were not significantly different between the CEA+FNB and CEA groups during rest (3 vs. 2) and flexion (5 vs. 6) on postoperative day-1 and during rest (1 vs. 2) and flexion (4 vs. 4) on postoperative day-2. There was no significant difference in rescue analgesia required, the volume of epidural infusion, motor blockade or patient satisfaction between both groups. **Conclusion:** We concluded that the addition of FNB to epidural infusion did not improve analgesia after TKA.

Keywords: Epidural analgesia, femoral nerve block, regional anaesthesia, total knee arthroplasty

INTRODUCTION

The efficacy of post-operative pain relief after total knee arthroplasty (TKA) is a major factor in determining functional outcome. [1] In an effort to reduce postoperative pain and expedite recovery, peripheral nerve blocks, such as femoral nerve block (FNB) have been used as adjuncts to the analgesic regime. [2-4]

Correspondence author: Melvin KANDASAMY, Department of Anaesthesiology and Intensive Care, Faculty of Medicine, Universiti Kebangsaan Malaysia Medical Centre, Jalan Yaacob Latif, Bandar Tun Razak, Cheras, 56000, Kuala Lumpur, Malaysia.
Tel: +60127922820; Fax: +603 91456585.
E mail: melvinkandasamy@gmail.com

Continuous femoral nerve block (CFNB) has been shown to be superior to single-shot FNB in terms of analgesia but no difference was found in hospital length of stay or long-term functional recovery. [5] However, a single-shot FNB is technically easier to perform, does not need a catheter or extra equipment, is less costly and does not need continuous monitoring. In two previous studies, a single-shot FNB in conjunction with patient-controlled epidural analgesia significantly improved analgesia for the first 48 hours after TKA. [6, 7]

Pain after TKA is best treated by a multi-modal approach, using a combination of oral and intravenous analgesics, epidural analgesia, intrathecal or epidural opioids, intracapsular infiltration or peripheral nerve blocks. [8, 9] In our centre, continuous epidural analgesia (CEA) is our main modality for analgesia following TKA. However, pain relief by CEA alone was sometimes insufficient, warranting additional or alternative means of analgesia. The objective of this study was to assess whether the addition of a single-shot FNB to CEA would improve analgesia after TKA.

MATERIALS AND METHODS

The study was a single centre prospective, randomised, controlled study. Following approval from the University's institutional ethics committee, 66 patients aged between 18 to 80 years planned for unilateral TKA with American Society of Anesthesiologists (ASA) physical status I or II were recruited into this study. Patients with known allergy to the study drugs, contraindications to central or peripheral nerve blockade or inability to understand the pain scale were excluded from the study.

During the preoperative assessment rounds, informed consent was obtained from the patients. They were then instructed on the use of the visual analogue scale (VAS), which ranged from zero to ten, where zero indicated no pain and ten was the worst pain imaginable. Patients were given oral midazolam 3.75 mg on the night before surgery and just prior to transfer to the operating theatre.

Patients were randomly assigned to the CEA+FNB group or CEA group using computer generated randomised numbers. Anaesthesia was administered by a single operator who had 4 years of anaesthetic experience and had performed more than 30 femoral nerve blocks. After placement of standard monitors which included a pulse oximeter, electrocardiogram and non-invasive blood pressure monitor, patients in the CEA+FNB group received a single-injection FNB before they were given combined spinal-epidural anaesthesia (CSEA). A 22-gauge 50mm Stimuplex® (B Braun) needle was inserted 1cm lateral to the femoral pulse at the level of the inguinal crease using a nerve stimulator with a frequency of 2Hz , pulse width of 0.1ms and initial current of 1mA. Thirty ml of levobupivacaine 0.5% was then injected after eliciting a 'patellar dance' at 0.3 - 0.5mA. The limb was examined 10-15 minutes later for sensory loss to pin-prick over the distribution of the femoral nerve to confirm the success of the FNB.

Patients in both groups received CSEA with subarachnoid administration of 12.5mg of heavy bupivacaine 0.5% + 25µg of fentanyl. Upon attaining a sensory level to L1 by means of pin-prick, surgery was commenced and the patient's vital signs were monitored

during surgery. Additional bolus doses of epidural 0.5% bupivacaine were given intraoperatively if required. At the post-anaesthetic care unit (PACU), sensory level to L1 was reconfirmed and epidural infusion of 0.1% levobupivacaine and 2µg/ml fentanyl was initiated at 6 ml/hour. This was recorded as time zero. Additional bolus doses of 3-5ml 0.25% levobupivacaine were given if the VAS score was more than 3.

Patients were discharged from PACU after one hour. The epidural infusion was continued for up to 48 hours postoperatively. Oral analgesia (celecoxib 400mg daily and paracetamol 1gm six- hourly) was given to all patients on the morning of the first postoperative day (POD 1). All patients were followed up by the Acute Pain Service team who were blinded to the study procedure.

For rescue analgesia in the ward, 3-5ml bolus doses of 0.25% bupivacaine were given and the infusion rate increased in increments of 2 ml/hour to achieve a VAS score ≤ 3. Time for first requirement of rescue analgesia was recorded. If the patient still complained of pain after a maximum of 3 boluses over a 30 minute period (VAS score >3), the epidural infusion was terminated and the patient was given Patient Controlled Analgesia (PCA) using IV morphine. These patients were then withdrawn from the study.

VAS scores were recorded on the morning of the first and second POD (POD2), both at rest and with passive flexion of the operated limb. Motor power of the operated lower limb was also assessed using the Bromage score (Table 1). On POD2, patients were asked whether or not they were satisfied with the quality of postoperative analgesia provided.

Table 1. Bromage score.

Bromage Score	Degree of motor blockade
1	Complete motor block: unable to flex hip and knee
2	Flexion only at knee
3	Flexion at knee & ankle
4	Flexion at hip, knee and ankle

Statistical analysis: Based on a previous study [6], power analysis determined that a minimum of 29 subjects in each group would be required to give an 80% power at a 2-sided alpha error of 0.05 to detect a clinically significant reduction of 40% in the VAS scores. Statistical analysis was performed using SPSS Version 12. Parametric data was compared using Student's t-test and non-parametric data compared using Mann-Whitney U-test. A p value of < 0.05 was considered significant.

RESULTS

A total of 66 patients were recruited into the study but eight patients were excluded due to non-functioning epidurals. There was no significant difference in the demographic characteristics between the two groups as shown in Table 2.

The VAS scores at rest and during passive knee flexion, on POD1 and POD2 are depicted in Figure 1. The minimum, maximum and median VAS scores were all higher during flexion as compared to rest in both groups. However, the difference in VAS scores between both groups at rest and with flexion, on both days, was not statistically significant ($p>0.05$)

Table 2: Comparisons of demographics in the two groups.

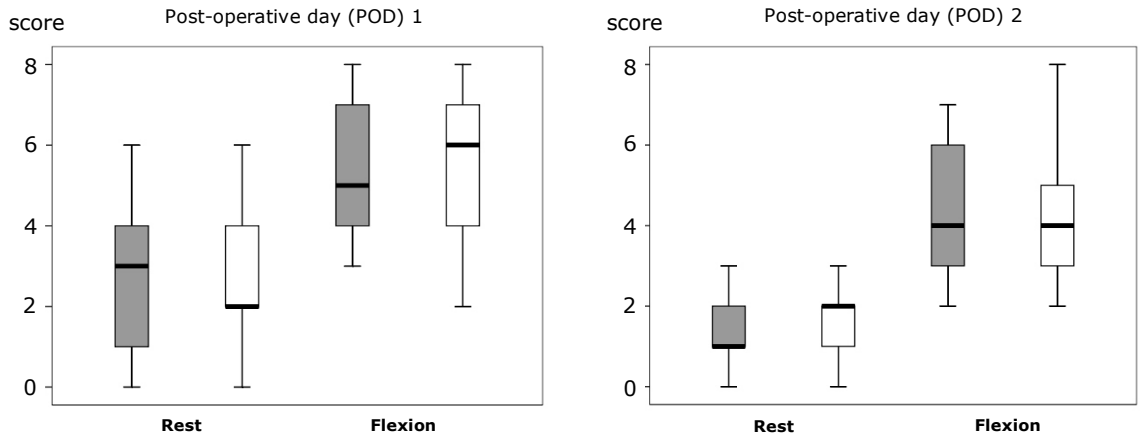
	CEA + FNB (n=29)	CEA (n=29)
Age (year)	66.6 ± 7.1	65.1 ± 7.1
Male / Female	7 / 22	5 / 24
Body Mass Index (kg/m^2)	27.2 ± 1.6	26 ± 2.1
ASA I / II	12 / 17	16 / 13
Ethnicity (Malay/Chinese/Indian/Others)	13 / 11 / 4 / 1	11 / 14 / 4 / 0

CEA; continuous epidural analgesia, FNB; femoral nerve block, ASA; American Society of Anesthesiologists

There was no significant difference in the number of patients requiring rescue analgesia at PACU and in the ward, time to first rescue, mean volume of epidural infusion and patient satisfaction between both groups (Table 3).

DISCUSSION

Previous studies on the effects of FNB as an adjunct to standard modes of analgesia after TKA have produced conflicting results. Hirst *et al.* could not confirm improvements in analgesia provided by the addition of a single-injection FNB to patient-controlled analgesia beyond the immediate recovery period. [10] However, two other studies found that the addition of a single-injection FNB to patient-controlled epidural analgesia (PCEA) improved analgesia after TKA for up to 48 hours. [6, 7] The authors hypothesized that this may have been due to a pre-emptive analgesic effect offered by the FNB and the prevention of quadriceps spasm, which is a major contributor to post-operative TKA pain. [6, 7] Quadriceps spasm usually begins as soon as patients begin to ambulate. Massive nociceptive afferents produce sensitisation not only of the peripheral nociceptors, but also of dorsal horn neurons. Consequently, non-nociceptive input, such as touch or proprioception, triggers increased reflex excitability with consequent spasm of the muscles supplied by the same and adjacent spinal segments. Thus, blocking the massive afferent nociceptive input with peripheral nerve blocks would prevent quadriceps spasm, reduce pain and increase mobili-

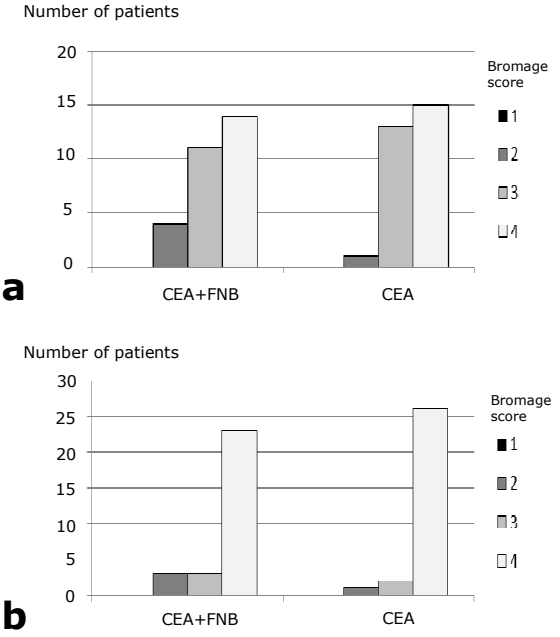


Figs. 1: VAS scores during rest and passive flexion on post-operative day 1 (POD1) and POD2.

Table 3: Comparisons of the two groups.

	FNB + CEA (n=29)	CEA (n=29)	p value
Rescue analgesia at recovery	4 (13.8)	6 (20.7)	0.235
Rescue analgesia in ward	9 (31)	10 (34)	0.627
Time to first rescue (min)	432	372	0.229
Epidural volume in 48 hours (ml)	233 ± 14.3	228 ± 9.7	0.137
Number of satisfied patients	17 (58.6)	19 (65.5)	0.293

CEA; continuous epidural analgesia, FNB; femoral nerve block



Figs 2: Bromage scores of the operated limb on a) POD1 and b) POD2.

The lack of an additive analgesic effect of the FNB in this present study could be due in part to the timing of the block. Hirst *et al.* found that the effects of a single-injection FNB lasted about 18 hours. [10] Ideally, FNB should be given postoperatively, so as to prolong its analgesic effects. In three studies, FNB was performed postoperatively and resulted in improved analgesia. [2, 4, 11] However, there are a number of possible problems when the FNB is given postoperatively when the effects of neuroaxial blockade are present. First, the success of FNB cannot be confirmed. Second, there is a higher theoretical risk of nerve injury while performing FNB. However, in the above studies, FNB was performed before resolution of spinal anaesthesia in one [2] and during general anaesthesia in another. [4] No reports of nerve injury were noted in either of the studies involving a total of 66 patients. The use of ultrasound could theoretically further increase the safety of nerve blocks by preventing direct needle trauma to a nerve and by directly visualising local anaesthetic distribution. In an audit of 6,950 patients who underwent peripheral nerve blockade, only three patients had a block-related nerve injury giving an incidence of 0.4 per 1,000 blocks. [12] Twenty-three percent of these blocks were performed under general or neuroaxial anaesthesia. Due to the low overall incidence of nerve injury, no significant differences could be detected between the different groups. However, the American Society of Regional Anaesthesia and Pain Medicine recommends that regional anaesthesia blocks should not be routinely performed in adults with concurrent general anaesthesia or heavy sedation. [13] General anaesthesia or heavy sedation removes any ability for the patient to communicate symptoms of potential nerve injury, to recognise and report warning signs of needle-to-neuroaxis proximity such as paresthesia or pain on injection of local anaesthetic. Howev–

er, it may be considered in selected patients e.g. those with dementia, developmental delay or when unintended movement could compromise vital structures close to the proximity of the regional block.

Continuous FNB with the catheter technique may offer a more prolonged effect compared to a single-injection FNB. [5] Salinas *et al.* found that continuous FNB provided superior analgesia up to 72 hours, but did not decrease the length of stay or affect long-term functional outcome. However, continuous FNB requires more expertise, specialised equipment and entails all the risks of a continuous local anaesthetic infusion. [10] Indwelling groin catheters may become infected with prolonged placement. In one series, up to 57% of femoral catheters were colonized at the time of continuous FNB discontinuation. [14]

The knee joint receives innervation from the femoral, sciatic and obturator nerves. The relative contribution of each of these nerves to postoperative pain is unclear. In the study by Hirst *et al.*, all of their patients who had received FNB complained of pain at the back of the knee, suggesting that both the obturator and sciatic nerves also provide a major contribution to innervation of the knee joint. [10] Thus, FNB in isolation would be unable to provide complete analgesia following TKA. In a study by Morin *et al*., patients who had a combination of continuous FNB with continuous sciatic nerve block experienced superior analgesia compared to continuous FNB alone, but had more weakness and required more assistance from therapists.[15] In this study, CEA was used to provide supplementary analgesia for areas which were not innervated by the femoral nerve.

It is disconcerting that 31% of patients in the CEA+FNB group and 34% of patients in the CEA group experienced breakthrough pain and required frequent reviews and adequate top-ups to obtain satisfactory analgesia. Of these patients, 44% in the CEA+FNB group and 66% in the CEA group required their first top-up within seven hours postoperatively. In both groups, the median VAS scores during flexion was higher than at rest on both POD 1 (5 versus 3 in the CEA+FNB group and 6 versus 2 in the CEA group) and POD 2 (4 versus 1 and 4 versus 2). This significant degree of pain can inhibit physiotherapy and delay recovery. The overall quality of analgesia in both groups was poor, as evidenced by the high VAS scores and poor patient satisfaction.

Several ways to overcome this problem have been suggested. Firstly, the usage of PCEA would have been superior to CEA. Besides improvement in analgesia, patients on PCEA require fewer physician interventions and reduced local anaesthetic doses. [16, 17] Secondly, the addition of intrathecal morphine would have improved analgesia as shown by Sites *et al*. [18] and Grace *et al*. [19] who studied TKA and total hip replacement respectively. Earlier administration of oral analgesics may also contribute to better pain relief by giving the combination of oral paracetamol and celecoxib on the day of surgery itself as soon as the patient was allowed oral intake.

There were several limitations in this study. Pain was only assessed at a single point of time on POD 1 and 2. Thus, we would have been unable to assess the adequacy of pain relief at other times throughout the day.

The delay in starting oral analgesics may have contributed considerably to the poor quality of pain relief in both groups.

In conclusion, the addition of FNB to CEA as compared to continuous epidural analgesia alone did not improve analgesia after TKA.

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