The Knee xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

The Knee

Effectiveness of continuous versus single injection femoral nerve block for total knee arthroplasty: A double blinded, randomized trial

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ARTICLE INFO

Article history:
Received 17 May 2017
Received in revised form 21 March 2018
Accepted 1 April 2018
Available online xxxx

Keywords:
Femoral nerve block
Single injection femoral nerve block
Continuous catheter femoral nerve block
Randomized control trial
Total knee arthroplasty

ABSTRACT

Background: Effective analgesia following total knee arthroplasty (TKA) is important for maximizing patient satisfaction, early participation in physical therapy and reducing the hospital stay. This trial compared continuous catheter femoral nerve block (cFNB) to single injection femoral nerve block (sFNB) in terms of analgesia, opioid consumption, and participation in physical therapy and associated side effects.

Methods: This randomized, double blinded trial was conducted in a non-university hospital setting, without major changes to anesthesia or surgical clinical pathways. A total of 85 patients scheduled for primary TKA were randomized to receive either cFNB (n = 44) or sFNB (n = 41). All patients had FNB with 0.5% ropivacaine bolus followed by subarachnoid block for surgery. Postoperatively, 0.2% ropivacaine infusion was commenced in cFNB group and a sham catheter was taped to the skin in sFNB group. All patients received a structured multimodal analgesia regimen throughout hospital stay. The primary outcomes were peak resting visual analogue scale (VAS) scores and morphine consumption at 48 h postoperatively.

Results: VAS scores (Mean difference 0.25, 95% Confidence Interval (CI) −0.56 to 1.06; [$P = 0.196$]) and morphine consumption (Mean difference 0.95 mg, 95% CI −9.99 to 11.89; [$P = 0.863$]) were not significantly different among patients who received cFNB versus sFNB at 48 h. There was no difference in hospital stay ($P = 0.517$) or long-term functional recovery between the two groups ($P = 0.385$).

Conclusions: sFNB block provides equal pain relief compared with cFNB, after TKA with no significant difference in opioid consumption, hospital stay, physical therapy outcomes or associated side effects.

1. Introduction

Pain following total knee arthroplasty (TKA) can be severe and challenging to control. Adequate pain control after TKA is important to reduce complications, improve patient satisfaction, enable patients to participate in physical therapy, and ultimately facilitate a speedy recovery [1]. In a 2014 meta-analysis, Chan et al. determined that pain control following TKA using femoral nerve block (FNB) is better

Abbreviations: TKA, total knee arthroplasty; cFNB, catheter femoral nerve block; sFNB, single injection femoral nerve block; VAS, visual analogue scale.

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https://doi.org/10.1016/j.knee.2018.04.001
0968-0160/

than patient controlled analgesia (PCA) with opioids and is also comparable to continuous epidural analgesia [2]. A reduced incidence of nausea and vomiting in the FNB group compared to the PCA or the epidural was also observed [2]. While this meta-analysis provides evidence that continuous catheter FNB (cFNB) provided better analgesia compared to single injection FNB (sFNB), this conclusion is based on only four randomized controlled trials (RCTs) with moderate methodological quality [2]. Other RCTs have found no significant advantage of cFNB over sFNB [1]. Hence, the limited number of studies has led to calls for new trials comparing sFNB with cFNB [3]. Nationally, the average length of stay (LOS) for primary TKA among Medicare beneficiaries is approximately 3.5 days [4]. In comparison, the average LOS for primary TKAs at our healthcare center is approximately 2.5 days (n = 301). Given this relatively low LOS, we were interested to determine the utility of a cFNB in terms of further reduced LOS. The aim of this study was to compare the level of pain control, total opioid consumption, the analgesic need for a rescue nerve block, and functional outcomes between cFNB and sFNB after TKA. We analyzed data collected on patients receiving multimodal analgesia with FNB (catheter or single injection), subarachnoid block with bupivacaine and fentanyl, intra-articular injection by the surgeon and opioid and non-opioid analgesics on a "scheduled" and an "as needed" basis in order to test the hypothesis that cFNB improves analgesia, decreases opioid consumption and improves early rehabilitation compared with sFNB after TKA.

2. Materials and methods

After an approval from the Institutional Review Board and prior to patient enrollment, this trial was registered with clinicaltrials.gov (registration number of NCT02106481). All patients with American Society of Anesthesiologists (ASA) physical status I, II and III scheduled to undergo unilateral primary TKA were asked to participate in the study during their visit to the pre anesthesia clinic. If they agreed and met the criteria for participation in the study, a written informed consent was obtained during their visit.

2.1. Randomization

A computer generated simple random sampling technique was used. It assigned patients to either sFNB or cFNB subgroups. Respective infusion was ordered and documentation was then forwarded to the pharmacy, identifying the study patient. On the day of surgery, the anesthesiologist performed the respective procedure according to the randomization. Subsequently, infusion pump and tubing were connected with femoral catheters. In both groups, the pump was covered with a brown opaque bag to conceal the contents of the bag. The pharmacy labelled infusion for cFNB as 'Study Drug R' and normal saline for sFNB as 'Study Drug R' in the electronic medication order. The patient, surgeon, nursing staff and physical therapists were blinded to the nature of the block and infusion.

2.2. Participants

Patients between the ages of 18 to 80 years, scheduled to undergo primary unilateral TKA and agreeing to participate in the study with an effective FNB and with no contraindication for spinal or regional anesthesia were included. Patients with a history of opioid dependence or opioid consumption greater than or equal to 30 mg of morphine per day, allergy to study medications, known hepatic or renal insufficiency/disease, peripheral neuropathy, morbid obesity (BMI > 40 kg/m^2), or pregnant or incarcerated, were excluded.

Screening and enrollment of patients occurred between April 2014 to December 2015; 270 patients were screened and 99 subjects were enrolled in the study. The enrollment process is further detailed in Figure 1.

2.3. Surgical technique

All knee replacements were performed via a minimally invasive mid-vastus approach. A tourniquet was inflated prior to incision and deflated prior to closure. The knee replacements were all cruciate retaining, cemented total knees with patella resurfacing. Intra-articular injection was performed by the surgeon after capsular closure with 30 ml of 0.25% bupivacaine with 1:200,000 epinephrine, 20 ml of two percent lidocaine and 10 mg of morphine.

2.4. Multimodal analgesia regimen

Both regular and as-needed analgesics, anxiolytics and anti-emetics were part of the established protocol prior to surgery. All the patients received oral naproxen 500 mg, gabapentin 600 mg and acetaminophen 1000 mg before surgery. After the surgery, patients received the following scheduled analgesics: ketorolac 15 mg IV every six hours (max four doses), morphine 15 mg extended release oral twice a day and acetaminophen 1000 mg every six hours. For breakthrough pain, oxycodone, five to 15 mg orally every three hours, was administered as needed and hydromorphone 0.5 mg IV every hour as needed. For anxiety hydroxyzine 25 mg oral every six hours or alprazolam 0.25 mg oral every six hours were prescribed as needed. Ondansetron four milligrams was prescribed for nausea and vomiting.

2.5. Interventions

On the day of surgery, FNB was performed in the pre-operative area. In the group randomized to receive cFNB, a stimulating femoral catheter (StimuCath™) was inserted through an 18 G needle using ultrasound (Sonosite™) and a nerve

Please cite this article as: Dixit V, et al, Effectiveness of continuous versus single injection femoral nerve block for total knee arthroplasty: A double blinded, randomized ..., Knee (2018), https://doi.org/10.1016/j.knee.2018.04.001