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Original Research Article

Continuous Femoral Nerve Block with Equipotent Doses of Bupivacaine and Ropivacaine for Postoperative Analgesia after Unilateral Total Knee Replacement: A Comparative Study

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Conflict of interest: Nil

Abstract

Background: Postoperative pain after total knee replacement (TKR) can delay early mobilisation and rehabilitation. Continuous femoral nerve block is an effective technique for postoperative analgesia. Ropivacaine, with lower cardiotoxic potential and reduced motor blockade, may offer advantages over bupivacaine at equipotent concentrations.

Objective: To compare the efficacy and safety of equipotent doses of ropivacaine 0.2% and bupivacaine 0.125% administered through ultrasound-guided continuous femoral nerve block for postoperative analgesia after unilateral total knee replacement.

Methods: This prospective observational cohort study included 80 ASA I–II patients undergoing elective unilateral TKR under subarachnoid block. Patients were divided into two groups: Group R received 0.2% ropivacaine and Group B received 0.125% bupivacaine via femoral nerve catheter. A 20 ml bolus followed by continuous infusion at 5 ml/hr was administered for 48 hours. Postoperative pain was assessed using Numerical Rating Scale (NRS) at specified intervals up to 48 hours. Motor blockade was evaluated using Modified Bromage Scale. Rescue analgesic consumption and adverse effects were recorded.

Results: Both groups were comparable with respect to demographic parameters. NRS pain scores at all postoperative time intervals were similar between two groups ($p > 0.05$). Rescue analgesic consumption did not differ significantly. At 24 hours, motor blockade was significantly less in group R compared to group B($p = 0.014$). No motor blockade was observed at 48 hours in either group. No significant adverse effects were noted.

Conclusion: Ultrasound-guided continuous femoral nerve block using 0.2% ropivacaine provides postoperative analgesia comparable to 0.125% bupivacaine following total knee replacement, with the advantage of reduced motor blockade. Ropivacaine may therefore be a preferable agent for facilitating early postoperative rehabilitation.

Keywords: Total Knee Replacement; Continuous Femoral Nerve Block; Ropivacaine; Bupivacaine; Postoperative Analgesia.

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Introduction

Postoperative pain relief after knee surgeries, especially total knee replacement, is a major concern in the postoperative period for rapid recovery. Pain is severe in up to 60% of patients and moderate in 30% of patients after TKR [1]. It causes undue distress, hindering early intense physical therapy which is the most important factor for optimal postoperative knee rehabilitation. Studies have shown that regional techniques provide superior pain relief and faster postoperative knee rehabilitation than systemic analgesics in TKR [2]. Investigators have reported a significant reduction in pain after femoral nerve block for patients undergoing total knee replacements, knee arthroscopy and other painful open knee procedures [3]. Among the local anaesthetics, Bupivacaine enables prolonged and effective regional anaesthesia but may cause severe cardiotoxicity.

Ropivacaine produces less motor block and is also a potent producer of frequency-dependent block in less myelinated fibres, offering the prospect of a better differential blocking effect than that provided by Bupivacaine [4]. These properties would be particularly well-suited to orthopaedics because a good sensorimotor dissociation may facilitate rehabilitation and improve patient well-being.

There is a paucity of literature comparing low doses of bupivacaine and ropivacaine in continuous femoral nerve block for postoperative analgesia after TKR. This study is designed to compare the safety and efficacy of equipotent doses of Bupivacaine and Ropivacaine in continuous femoral nerve block in patients undergoing TKR for postoperative analgesia.

Aims and Objectives

To compare equipotent doses of 0.2% Ropivacaine with 0.125% Bupivacaine in ultrasound guided continuous femoral nerve block for post knee replacement surgeries in terms of.

1. Postoperative analgesia using Numerical Rating Scale.
2. Degree of motor blockade in each group.
3. Side effects in the postoperative period.

Materials and Methods

This is a prospective observational cohort study conducted at the Department of Anesthesiology, Dr. Moopen's Medical College, from November 2023 to September 2024. After obtaining approval from the institutional research and ethical clearance committee of the hospital, 80 patients belonging to American Society of Anesthesiologists' physical status grade I and II, scheduled for elective TKR under subarachnoid block were included in the study after getting informed written consent. Patients having allergy to local anesthetics, local sepsis, coagulation disorders, and neurological disorders were excluded from the study. Pre-anaesthetic evaluation and investigations like complete blood count, coagulation profile, electrocardiogram, chest x-ray, and X-ray of the affected knee joint were carried out before taking up the patient for surgery. Patients were premedicated with T. alprazolam 0.25mg orally the night before surgery and standard fasting protocols were followed. The use of a numeric rating scale (NRS) was explained to the patient in the preoperative waiting area. The effectiveness of analgesia was measured by the NRS on movement at 1, 2, 4, 8, 24 and 48 hours postoperatively. Intravenous tramadol 50mg and intramuscular diclofenac 75 mg were given as first and second rescue analgesic respectively when NRS≥4. Under aseptic conditions femoral catheter was secured under ultrasound guidance preoperatively with 20G contiplex-D™ catheter (B Braun, Germany) with a pre-terminal hole that was inserted through a 5cm 18G needle. All patients were given a preferential unilateral subarachnoid block (SAB) in lateral position after recording baseline heart rate, non-invasive blood pressure and oxygen saturation. SAB was performed using 2ml of 0.5% hyperbaric bupivacaine with 60mcg of buprenorphine as adjuvant. Hemodynamics was maintained with fluids and vasopressors and maintained within 20% of baseline. Patients were divided into two groups of 40 each to receive either 0.2% Ropivacaine (Group R) or 0.125% Bupivacaine (Group B) infusion via femoral catheter for postoperative analgesia. A 20ml bolus of the drug, followed by a continuous infusion of 5ml/hr, was started once Modified Bromage Scale was ≥2, using an elastomeric pump (Multirate Infuser IV, with 250ml capacity) and continued for the next 48 hours. Infusion was discontinued if the catheter was blocked or if any leakage was noticed at the catheter site and they were excluded from the study. Infusion was stopped at 48 hours and the catheter was removed 12 hours after last dose of prophylactic low molecular weight heparin. Motor blockade was assessed using Modified Bromage Scale (0- no motor blockade,1-flexion/extension at knee;2-no flexion/extension at knee;3–complete blockade) at 24 and 48 hours postoperatively.

The following side effects due to the administration of infusion drugs and rescue analgesics (Tramadol and Diclofenac) were noted during postoperative period. Nausea, vomiting, shivering, pruritus, respiratory depression (respiratory rate <10), hypotension, drowsiness, euphoria or dysphoria and urinary retention were observed. Hypotension was defined as decrease in systolic blood pressure > 20% of baseline and atropine was given when heart rate reduced >20% from baseline.

Chi-square test and fisher exact test were used to test significance of the homogeneity of sex distribution. Student t-test was used to find significance of the mean difference of analgesia (NRS scores), consumption of rescue analgesic, motor blockade and to test the homogeneity of samples on age and weight. Changes in variables within each group were analysed with multiple paired t-tests. A p-value ≤0.05 was considered statistically significant. Values were presented as mean ± standard deviation. The statistical software SPSS version 18 was used for analysing the data.

Results

Both groups were comparable with respect to demographic parameters. NRS pain scores at all postoperative time intervals were similar between two groups ($p > 0.05$).

Table 1: Showing NRS Pain scores.

NRS score	Group B	Group R	P Value
1 hour	0	0	
2 hours	1.25	0.9	0.199
4 hours	2.93	3.13	0.352
8 hours	3.38	3.05	0.206
24 hours	2.3	2.17	0.355
48 hours	1.95	2.05	0.254

Table 2: Showing consumption of rescue analgesics

Rescue analgesic	Group B (N=40)	Group R (N=40)	P Value
Tramadol	15(37.5%)	13(32.5%)	0.850
Diclofenac	4(10%)	4(10%)	1.0

Consumption of rescue analgesic was almost equal between the two groups. Motor blockade as assessed with Modified Bromage Scale at 24 and 48 hours of infusion in Group B and Group R was statistically significant, with Group B and Group R having 13 and 4 patients respectively, having MBS grade 1 blockade at 24hr (p=0.014), and at 48 hrs both groups had no motor block (MBS grade 0)

Discussion

The provision of postoperative analgesia after painful surgery continues to be a major challenge. The emphasis is also on shorter hospital stay, cost-effective use of resources, and early mobilisation of the patient. Effective pain control is a major concern in the postoperative management of knee surgeries and one that has a significant impact on our health care system. Any technique, if used for postoperative analgesia, should confer certain advantages over the others, in terms of better pain relief, decreased consumption of supplemental analgesics and should allow early mobilisation, thus speeding up the rehabilitation of the patient.

Epidural analgesia remains the "gold standard" for pain relief after TKR [5]. However, peripheral nerve block is gaining popularity because the incidence of side effects associated with epidural analgesia may be avoided. The peripheral nerve block is an analgesic modality with unique characteristics that meet various challenges and complement multimodal therapies. Newer continuous catheter techniques can also sustain the benefits of postoperative pain control, while single injection blocks regress 10 to 18 hours after the injection of long-acting local anaesthetic. There is evidence that, when compared with placebo, femoral nerve block improves immediate postoperative analgesia, prolongs the time to first requested analgesic and reduces 24-hour morphine consumption by 45% [6]. Single- injection femoral nerve blocks have been shown to significantly improve postoperative analgesia and reduce the length of hospital stay compared with systemic opioid therapy after TKR [7,8]. Placement of a femoral nerve catheter allows prolonged site-specific regional analgesia. Among the local anaesthetics, Bupivacaine enables prolonged and effective regional anaesthesia but may cause severe cardiotoxicity. Several in vitro studies have shown that ropivacaine produces less block in motor fibres and a faster onset of block in sensory fibres than bupivacaine. Ropivacaine is also a potent producer of frequency-dependent block in sensory fibres, which offers the prospect of a better differential blocking effect than that provided by bupivacaine. These properties would be particularly well-suited to orthopaedics because a good sensorimotor dissociation may facilitate rehabilitation and improve patient well-being. This study is designed to compare the safety and efficacy of equipotent doses of Bupivacaine and Ropivacaine in continuous femoral nerve block in patients for postoperative analgesia following unilateral TKR. We also compared the motor blockade and rescue analgesic consumption and looked for side effects, if any.

There was no statistically significant difference between the groups with regard to age, sex, weight. The pain relief and the NRS scores in both Group B and Group R were similar. The need for rescue analgesia was almost equal between the two groups. In the initial 24 hours 32.5% of patients in Group R required rescue analgesic as against 37.5% of patients in Group B. During the next 48 hours only 15% of patients in Group R and 17.5% of patients in Group B required rescue analgesics.15 patients of Group B and 13 patients of Group R required tramadol as the first rescue analgesic and 4 patients in each group required diclofenac as the second rescue analgesic, which was not statistically significant (p=0.850 and p=1.00, respectively). In our study, motor blockade was assessed with Modified Bromage Scale (MBS) at 24 and 48hours after starting infusion. 13 patients of group B and only 4 patients of group R had MBS grade 1 blockade at 24hours which was statistically significant (p= 0.014). There was no motor blockade (MBS grade0) in both groups at 48hours. Motor blockade may interfere with early mobilization if weight bearing on operative leg is

required. Most rehabilitation practices require weight bearing on postoperative days one and two only on non-operated limb.

No side effects were reported in either group. Our results confirm the efficacy of comparatively safer long-acting local anaesthetic Ropivacaine, in perioperative techniques employed for postoperative analgesia after TKR. Both Bupivacaine and Ropivacaine provided comparable postop analgesia. NRS Pain scores were similar between the two groups, with all p-values more than 0.05.

Borgeat etal compared effects of patient controlled interscalene analgesia (PCIA) with ropivacaine 0.2% and bupivacaine 0.15% on hand grip strength and analgesia after major open shoulder surgery [9]. Sixty patients randomized in a double blinded fashion received either ropivacaine or bupivacaine through an interscalene catheter. Pain score and patient satisfaction were similar in both groups at all times. They concluded that use of PCIA technique with 0.2% ropivacaine and 0.15% bupivacaine provided similar analgesia, but ropivacaine was associated with better preservation of hand grip and less paresthesia. In a study by Theodosiadis et al., the use of 0.5 % ropivacaine versus bupivacaine for a 3-in-1 block during TKR was compared in terms of efficacy and safety [10]. The onset of block, duration of post op analgesia, level of motor block and any side effects were compared. Complete analgesia was maintained throughout the procedure. There was no significant difference between ropivacaine and bupivacaine groups in terms of mean duration of analgesia ($p=0.66$), the mean VAS scores at all points and the mean total morphine consumption. They concluded that both ropivacaine and bupivacaine had similar anaesthetic and analgesic effects, but the former had a significantly faster onset time.

The main limitation of our study was that the pain threshold could be variable depending on the patient's level of tolerance to pain. Hence, the Numerical Rating Scale, which was used for assessing pain in this study, can be a variable factor.

Conclusion

USG-guided continuous femoral nerve block with Ropivacaine (0.2%) provides effective analgesia as Bupivacaine (0.125%) but with less motor block in post knee replacement patients, which is ideal for postoperative rehabilitation, with no added side effects.

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