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Ultrasound Guided Femoral Nerve Block with Bupivacaine versus Bupivacaine and Tramadol for Postoperative Analgesia in Patients Undergoing Total Knee Arthroplasty under Spinal Anesthesia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Background: Effective pain control in Total knee arthroplasty (TKA) is important for optimizing the rehabilitation process in order to achieve patient satisfaction with a good functional outcome as well as reduce hospitalization duration and costs. Combined use of aesthetic with tramadol has been reported to achieve a longer duration of sensory and motor block. The aim of this study is to evaluate the quality and duration of postoperative analgesia produced by ultrasound guided femoral nerve block (FNB) by bupivacaine versus (bupivacaine & tramadol) in patients undergoing total knee arthroplasty under spinal anesthesia.
Methods: This prospective randomized controlled double blinded study was carried out on 60 patients aged above 50 years; American Society of Anesthesiologists physical status (ASA) I-III scheduled for total knee arthroplasty under spinal anesthesia. Patients were randomized to one of two equal groups: Group I control (C): received FNB with 30 ml 0.25% bupivacaine. Group II tramadol (T): received FNB with 30ml 0.25% bupivacaine and 100 mg tramadol.

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Results: Postoperative heart rate was significantly increased in group C than group T at 8h, 12h, 16h and 24h. Postoperative mean arterial blood pressure was significantly increased in group C than group T at 6h, 8h, 12h, 16h and 24h. There were 30 (100%) patients required rescue analgesia in group C and 19 (63.33%) patients in group T which was increased significantly in group C than group T. The time to first analgesic requirement was significantly decreased in group C than group T. Total morphine consumption was increased significantly in group C than group T. VAS was increased significantly in group C than group T at 6, 8, 12, 16 and 24 hours. Adverse effects were insignificantly different between both groups.
Conclusion: Adding tramadol (100 mg) to 0.25% bupivacaine (to a volume of 30 ml) during US guided FNB of TKA under spinal anesthesia was associated with better postoperative analgesia when compared with 0.25% bupivacaine alone.

Keywords: Femoral nerve block; tramadol; postoperative analgesia; knee arthroplasty; spinal anesthesia.

1. INTRODUCTION

Total knee arthroplasty (TKA) is known to be a very painful orthopedic procedure. Despite the fact that individual surgical technique and corresponding amount of tissue damage are usually similar from case to case in uncomplicated primary TKA, the level of postoperative pain varies widely among patients. About half of patients experience moderate or severe pain in the first days after surgery, and this pain may become even worse once rehabilitation is started. Effective pain control is therefore important for optimizing the rehabilitation process in order to achieve patient satisfaction with a good functional outcome as well as reduce hospitalization duration and costs [1-3].

A femoral nerve block (FNB) is a useful and commonly undertaken regional anesthetic block. It is considered a basic level block as it is relatively superficial, easy to identify and the potential for complications is low. FNB will provide analgesia for surgical procedures involving the anterior thigh and the hip and knee joints [4]. There are numerous recent randomized controlled trials and meta-analyses have examined the advantages and disadvantages of the use of various individual adjuvants thought to potentially enhance local anesthetic peripheral nerve blockade [5].

Adjuvants are added to decrease the dose of local anesthetic and to improve quality and duration of analgesia [6].

Tramadol is a central analgesic with dual mechanisms of effect that cause activation of the opioid and non-opioid systems to inhibit pain. The non-opioid effect is mediated through α_2 agonistic and serotonergic activities, and the opioid effect through μ-receptors with local anesthetic action on peripheral nerves. Tramadol is effective in antagonizing glutamate N-methyl D-aspartic acid receptors in the pathophysiology of chronic pain [7]. Combined use of anesthetic with tramadol has been reported to achieve a longer duration of sensory and motor block [8].

The aim of this study is to evaluate the quality and duration of postoperative analgesia produced by ultrasound guided FNB by bupivacaine versus (bupivacaine & tramadol) in patients undergoing total knee arthroplasty under spinal anesthesia.

2. PATIENTS AND METHODS

This prospective randomized controlled double blinded study was carried out in Tanta University Hospitals from August 2019 to January 2020. After approval from institutional ethical committee, an informed consent was taken from each patient. Sixty patients aged above 50 years; American Society of Anesthesiologists physical status (ASA) I-III scheduled for total knee arthroplasty under spinal anesthesia were included in this study.

2.1 Exclusion Criteria

- Patient refusal.
- General contraindication to regional nerve block: e.g.
  - Local infection.
  - Spinal deformity.
  - History of allergy to local anesthetics (amides).
  - Patients with coagulopathies.

- Patients with a history of seizures, known severe systemic diseases.
- Kidney, liver, respiratory, cardiac diseases.
- Neurological deficit in lower limb.
- Body mass index > 40 Kg/m^2.

2.2 Randomization and Blinding

Patients were randomized to one of two equal groups (30 patients in each): Group I control (C): received FNB with 30 ml 0.25% bupivacaine. Group II tramadol (T): received FNB with 30ml 0.25% bupivacaine and 100mg tramadol.

Simple randomization was done before anaesthesia using 60 opaque sealed envelopes, 30 for each group, indicating group assignment. The person who prepared the study medications and opened the next envelope in the sequence to reveal the treatment allocation, was not involved in preoperative and postoperative data collection or anaesthesia management of the patients. Also, the anaesthesiologist who collected the data, the person who performed the statistical analysis and the anaesthesiologist concerned with intraoperative management were blind. Moreover, the patients were unaware of their group assignment.

2.3 Preoperative Assessment was Done by

1. History taking.
2. Clinical examination.
3. Routine laboratory investigations including: CBC, coagulation profile, liver function tests, kidney function tests.
4. During the preanesthetic assessment, all patients were familiarized with visual analogue scale (VAS), from 1 to 100 with 1 represent no pain while 100 represent maximum intolerable pain.

2.4 Intraoperative

All patients were monitored with non-invasive blood pressure measurements, electrocardiography and pulse oximetry. An intravenous line was inserted, and infusion of lactated Ringer's solution was given, and all patients were supplied with oxygen (4 L/min) via a face mask.

All patients were given spinal anesthesia by midline approach at the L3/4 or L4/5 level with 25 G Quincke needle and 2.5 mL of hyperbaric bupivacaine 0.5% with 0.5 mL fentanyl (25 µg).

After the surgery was completed, ultrasound guided FNB was done by 30 ml 0.25% bupivacaine in patients of group I control (C) and 30 ml 0.25% bupivacaine with 100 mg tramadol in patients of group II tramadol (T).

2.5 Technique of FNB

With the patient in the supine position, the skin over the femoral crease was disinfected and the transducer was positioned to identify the femoral artery and nerve. Once the femoral nerve was identified, the needle was inserted in-plane 1 cm away from the lateral edge of the transducer in a lateral to medial orientation and advanced toward the femoral nerve.

Once the needle tip was adjacent (either above, below, or lateral) to the nerve, and after careful aspiration, 1–2 mL of local anesthetic was injected to confirm proper needle placement. Proper injection will push the femoral nerve away from the injection. Additional needle repositions and injections are done only when necessary.

2.6 Block Assessment

Sensory blockade is assessed by cold or pinprick test on the anterior and medial aspect of the thigh (femoral nerve) and on the medial aspect of the lower leg (saphenous nerve). Motor blockade is evaluated by asking the patient to extend the knee (e.g., to elevate the foot from the table) [9].

2.7 Postoperative

Postoperatively, all patients were admitted to PACU for 1 to 2 hours. Routine analgesia (intravenous paracetamol 1 gm every 8 hours) was administrated. If the VAS was 40 or more, a morphine increment was added as a rescue analgesia according to the patient body weight (in patients with body weight < 70 kg, 2 mg morphine was given, while 3 mg morphine was given in patients with body weight > 70 kg) [10].

2.8 Measurements

2.8.1 Primary outcome

Number of patients required rescue analgesia in the first 24 hours after surgery in each group was recorded.

2.8.2 Secondary outcomes

1. Heart rate and mean arterial blood pressure were recorded at different time interval (base line before induction of spinal anesthesia, every 10 min for the first **30** min then every 30 min till completion of surgery).
2. Postoperative pain was assessed by the visual analogue scale (VAS; 1 no pain while 100 is the maximum pain) and recorded at (Just before femoral block, 2, 4, 6, 8, 12, 16 and 24 hours).
3. The time till administration of first rescue analgesia.
4. Total analgesic consumption at 24 hours after surgery.
5. Any undesirable side effects during the first 24 hours were recorded (nausea – vomiting – pruritis – hemodynamic changes caused by spinal anesthesia as hypotension and bradycardia, local anesthetic toxicity: bradycardia, convulsions, respiratory depression).

2.9 Sample Size Analysis

The sample size calculation was performed using G*Power (Kiel University, Kiel Germany) software version 3.1.9.2. The calculated sample size was (27) in each group based on the following consideration: 0.05 α error (two-sided), 0.2 β error (Power of the study 80%), group ratio 1:1 and relative reduction in the number of patients requiring rescue analgesia in the first 24 hours after surgery was 25 % with tramadol. The sample size increased to 30 per group for dropout.

2.10 Statistical Analysis

Statistical analysis was done by SPSS v25 (IBM©, Chicago, IL, USA). Shapiro-Wilks test and histograms were used to evaluate the normality of the distribution of data (parametric or not). Quantitative parametric data were presented as mean and standard deviation (SD) and were analyzed by unpaired student t-test. Quantitative non-parametric data were presented as median and interquartile range (IQR) and were analyzed by Mann Whitney-test. Qualitative data were presented as number and percent and were compared by chi-square (X^2) or Fisher's Exact test when appropriate. A two tailed P value <0.05 was considered statistically significant.

3. RESULTS

In this study, 88 patients were assessed for eligibility, 19 patients did not meet the criteria and 9 patients refused to participate in the study. The remaining 60 patients were randomly allocated into two groups (30 patients in each one); Group C: received FNB with 30 ml 0.25% bupivacaine and Group T: received FNB with 30ml 0.25% bupivacaine and 100mg tramadol. All 60 patients were followed-up and analyzed statistically (Fig. 1).

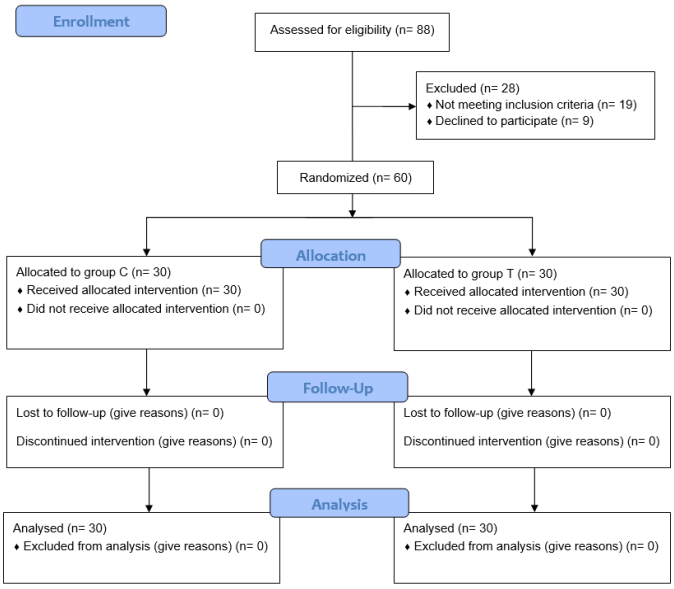

Fig. 1. CONSORT flow diagram of the participants through each stage of the trial.

Patients' characteristics (age, weight, sex and ASA physical status) and duration of surgery show insignificant difference between both groups Table 1.

Intraoperative heart rate shows an insignificant difference between both groups at the baseline, 30, 60 min and at the end of the surgery Fig. 2.

Intraoperative mean arterial blood pressure shows insignificant difference between both groups at the baseline, 30, 60 min and at the end of the surgery Fig. 3.

Postoperative heart rate (beats/min) was significantly increased in group C than group T at 8h, 12h, 16h and 24h (P = 0.013, 0.033, 0.024 and 0.029 respectively) and shows insignificant difference between both groups at 0h 2h, 4h and 6h Fig. 4.

Postoperative mean arterial blood pressure (mmHg) was significantly increased in group C than group T at 6h, 8h, 12h, 16h and 24h (P = 0.018, 0.023, 0.025, 0.038 and 0.010 respectively) and shows insignificant difference between both groups at 0h, 2h and 4h Fig. 5.

VAS was insignificantly different between both groups at the baseline, 2 and 4 hours and was increased significantly in group C than group T at 6, 8, 12, 16 and 24 hours Fig. 6.

There were 30 (100%) patients required rescue analgesia in group C and 19 (63.33%) patients in group T. Comparison between both groups was increased significantly in group C than group T. The time (in hours) to first analgesic requirement was significantly decreased in group C than group T. Total morphine consumption (mg) was increased significantly in group C than group T. Nausea occurred in 5 (16.7%) patients in group C and in 4 (13.3%) patients in group T. Vomiting occurred in 3 (10%) patients in group C and group T. Hypotension occurred in 5 (16.7%) patients in group C and in 6 (20%) patients in group T. Bradycardia occurred in 5 (6.7%) patients in group C and in 3 patients in group T. Adverse effects (nausea, vomiting, hypotension and bradycardia) were insignificantly different between both groups Table 2.

Table 1. Patients' characteristics in both groups

		Group C (n = 30)	Group T (n = 30)	P value
Age (years)		61.0 ± 6.28	58.73 ± 5.41	0.139
Weight (Kg)		75.3 ± 10.60	76.7 ± 9.64	0.577
Sex	**Male**	18 (60%)	20 (66.7%)	0.592
	Female	12 (40%)	10 (33.3%)	
ASA	**ASA I**	5 (16.7%)	6 (20%)	0.582
physical status	**ASA II**	19 (63.3%)	22 (73.3%)	
	ASA III	6 (20%)	3 (10%)	
Duration of surgery (min)		106.6 ± 10.20	104.3 ± 10.08	0.349

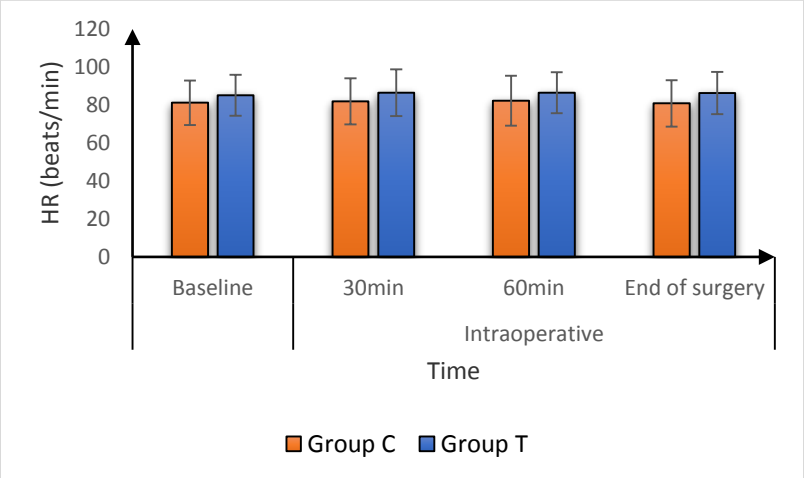

Fig. 2. Intraoperative heart rate in both groups

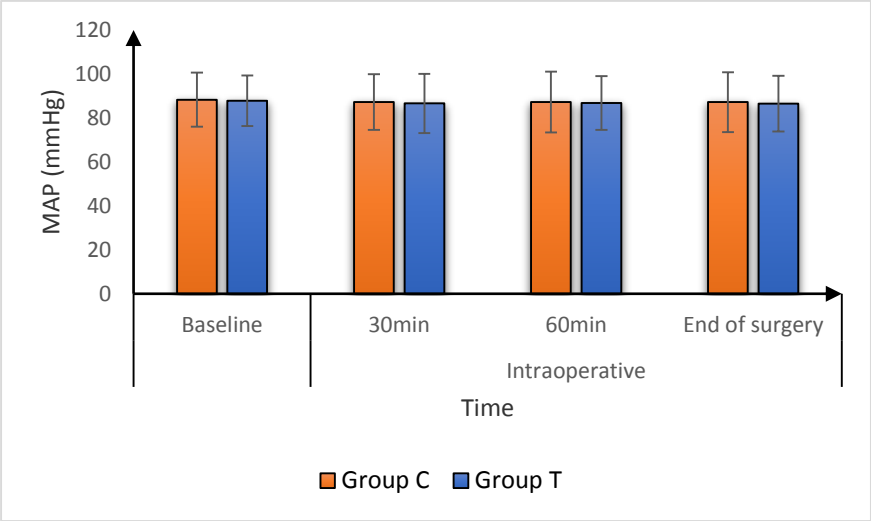

Fig. 3. Intraoperative mean arterial blood pressure in both groups

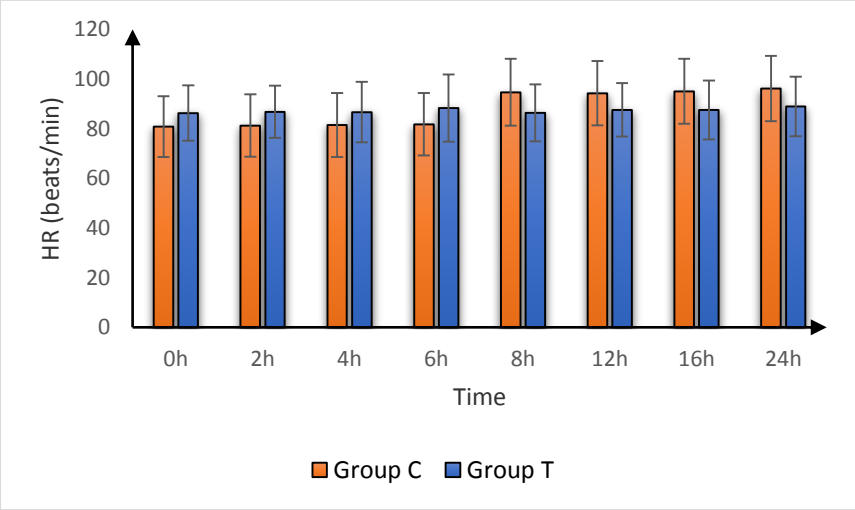

Fig. 4. Postoperative heart rate in both groups

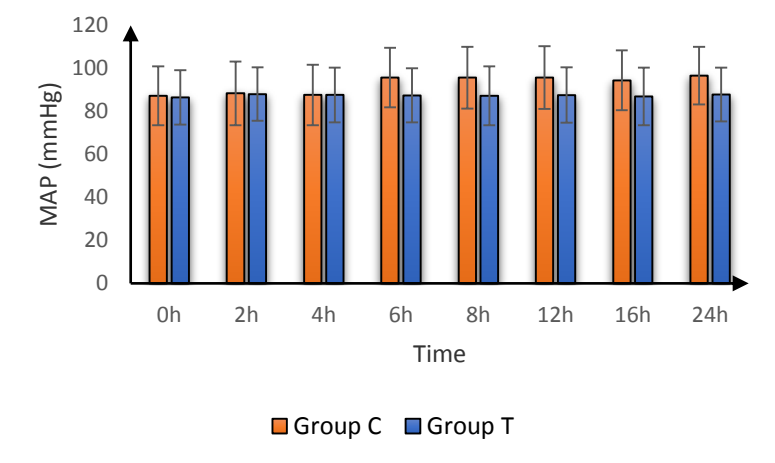

Fig. 5. Postoperative mean arterial blood pressure in both groups

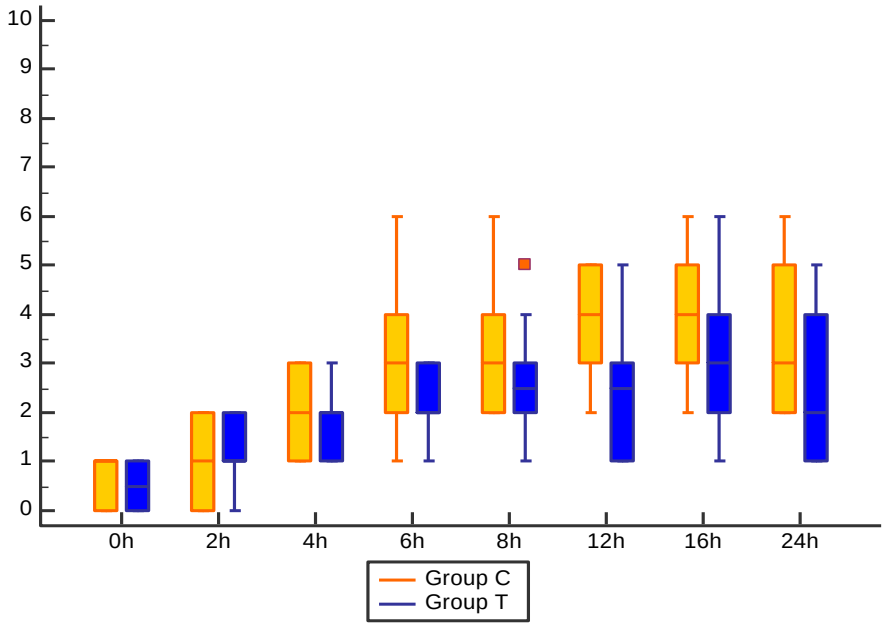

Fig. 6. Visual analogue scale (VAS) in both groups

Table 2. Number of patients required rescue analgesia and adverse effects in both groups

	Group C (n = 30)	Group T (n = 30)	P value
Required rescue analgesia	30 (100%)	19 (63.33%)	<0.001*
Nausea	5 (16.7%)	4 (13.3%)	1
Vomiting	3 (10%)	3 (10%)	1
Hypotension	5 (16.7%)	6 (20%)	0.739
Bradycardia	2 (6.7%)	3 (10%)	1

**significant as P value < 0.05*

4. DISCUSSION

FNB in combination with oral and parenteral analgesia has been used to provide effective postsurgical analgesia. FNB has been generally described as safe and effective, and single-shot FNB has been shown to improve analgesia and reduce morphine requirements postoperatively [11]. Adjuvants are added to decrease the dose of local anesthetic and to improve quality and duration of analgesia. Adjuvants such as dexamethasone, tramadol are added to local anesthetics to improve the quality of nerve blocks. Tramadol is an analgesic with mixed opioid and nonopioid activity. Tramadol seems to pass the neuronal membrane and diffuse within the interstitial or axonal fluid since it is a lipophilic drug [12]. The nonopioid activity is through alpha two agonist mechanism and serotonin and noradrenaline reuptake inhibition in central nervous system. It inhibits the reuptake of norepinephrine and serotonin from the nerve endings, and it is supposed to potentiate the effect of local anesthetics when mixed together [13].

As regards postoperative heart rate and mean arterial blood pressure, in agreement with our results, (Mohammed et al., 2018) [14] included 60 patients aged between 18 and 80 years planned for total knee replacement surgery. Patients were randomized into two groups: group B (30 ml of 0.25% bupivacaine) and group BD (28 ml of 0.25% bupivacaine + 2 ml dexamethasone 8 mg). Hemodynamics were insignificantly different between both groups intraoperative but postoperative was significant increase in control group.

In agreement with our results, (Youssef et al., 2017) [15] showed A total of 90 ASA I or II patients, aged 17–50 years, scheduled for lower extremities surgeries under sciatic nerve block classic posterior approach were randomized into three equal groups. All groups received 20 ml of local anesthetics, which consisted of 10 ml

bupivacaine 0.5%- and 8-ml lidocaine 2% mixed with 2 ml saline in the control (C) group, 2 ml of 150 mg magnesium sulfate made in saline in the magnesium (M) group, and 2 ml of 100 mg tramadol in the tramadol (T) group. They demonstrated that heart rate and mean arterial blood pressure in the three groups, was insignificant difference in preoperative and intraoperative data in the same group or in between the three groups while was increased in control group postoperatively.

As regards the time to first analgesic requirement and rescue analgesia and total morphine consumption. In agreement with our results, (Mohammed et al., 2018) [14] demonstrated the time to first analgesic requirement was significantly decreased .Also, increased rescue analgesia consumption in bupivacaine group without additive in FNB. Also, (Youssef et al., 2017) [15] who compare the effect of addition of tramadol and magnesium sulfate as adjuvants to local anesthetics lidocaine 2% and bupivacaine 0.5% in sciatic nerve block classic posterior approach. They demonstrated that Magnesium sulfate and tramadol as adjuncts to local anesthetics increase the duration of sensory and motor sciatic nerve block. The time for first rescue analgesia was longer in groups M and T, and they both showed decreased postoperative analgesic consumption.

As regards, VAS was increased significantly in group C than group T at 6, 8, 12, 16 and 24 hours. In agreement with our results, (Youssef et al., 2017) [15] who compare the effect of addition of tramadol and magnesium sulfate as adjuvants to local anesthetics lidocaine 2% and bupivacaine 0.5% in sciatic nerve block classic posterior approach .They demonstrated There was a significant increase in VAS in group C than group M and then group T. (Armanious et al., 2020) [16] was in contrast to our results. Patients scheduled for knee arthroplasty with combined spinal-epidural anesthesia were eligible for enrollment in this double blind, randomized trial. Patients received either FNB or ACB with a 20 cc of 0.5% of bupivacaine with 5 µg/ml epinephrine. They demonstrated that VAS at rest except at 24 h was significantly lower in FNB group with p value 0.003 with bupivacaine only.

As regards, adverse effects (nausea, vomiting, hypotension and bradycardia) were insignificantly different between both groups. In agreement with our results, (Armanious et al., 2020) [16] Patients scheduled for knee arthroplasty with combined spinal-epidural anesthesia were eligible for enrollment in this double blind, randomized trial. Patients received either FNB or ACB with a 20 cc of 0.5% of bupivacaine with 5 µg/ml epinephrine. They demonstrated no significant difference in 24hr post-operative incidence of nausea among FNB with bupivacaine. Also, (Mohammed et al., 2018) [14] included 60 patients aged between 18 and 80 years planned for total knee replacement surgery with FNB guided with ultrasound. They demonstrated no adverse effects (nausea, vomiting, hypotension and bradycardia) in bupivacaine group without additive in FNB. Moreover, (Youssef et al., 2017) [15] who compare the effect of addition of tramadol and magnesium sulfate as adjuvants to local anesthetics lidocaine 2% and bupivacaine 0.5% in sciatic nerve block classic posterior approach .They demonstrated no significant difference on comparing adverse effects in the three groups.

The current study recommends using ultrasound-guided FNB with Tramadol (100mg) in combination with 30 ml 0.25% bupivacaine superior than 30 ml 0.25% bupivacaine alone in patients undergoing total knee arthroplasty. Additional studies including a large number of patients are required for generalization of these results. Also, further studies assessment of adding Bupivacaine in different concentrations and volumes by ultrasound-guided FNB. Also, further studies using sedative and additive in different doses in combination with bupivacaine in ultrasound-guided FNB.

5. CONCLUSION

Adding tramadol (100 mg) to 0.25% bupivacaine (to a volume of 30 ml) during US guided FNB for TKA under spinal anesthesia was associated with better postoperative analgesia when compared with 0.25% bupivacaine alone.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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