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Research Article

A dose reduction study of local anesthetic with addition of dexmedetomidine on postoperative epidural analgesia after total knee arthroplasty

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KEYWORDS

Bupivacaine;
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Abstract *Background:* Epidural analgesia is still the preferred method of postoperative analgesia for total knee arthroplasty in many countries. Dexmedetomidine is a new alpha-2 agonist which had many beneficial effects when administered epidurally. The aim of study was to provide effective postoperative analgesia with hemodynamic stability through reduction of the amount of epidural local anesthetic by adding dexmedetomidine.

Methods: 75 patients, 50–70 years old, ASA physical status I–III undergoing total knee arthroplasty were randomly divided into three equal groups, group I received 0.125% bupivacaine 5 ml/h for postoperative analgesia, group II received 4 ml of a mixture of bupivacaine 0.125% and dexmedetomidine 0.2 μg/kg/h and group III received 3 ml of a mixture of bupivacaine 0.125% and dexmedetomidine 0.2 μg/kg/h. Postoperative pain were scored by visual analog scale (VAS), sedation score, postoperative nalbuphine consumption and hemodynamic parameters were recorded every 4 h for 48 h postoperatively.

Results: The demographic data were comparable in all groups. VAS (visual analog scale) of pain showed a significant reduction between the two groups II, III and group I with insignificant difference between groups II and III at both rest and movement. The mean of nalbuphine consumption during the study period was significantly reduced in group II, III than in group I with insignificant difference between groups II and III. Sedation scores were significantly higher in groups II and III compared to group I. Heart rate was more reduced in groups II and III than in group I with insignificant difference between the groups. The mean arterial blood pressure was significantly reduced in group I than groups II and III from hour 8 till the end of the study.

Conclusion: Dexmedetomidine is an effective adjuvant to epidural bupivacaine for postoperative analgesia after total knee arthroplasty through reducing the amount of local anesthetic.

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1. Introduction

Total knee arthroplasty is associated with sever early postoperative pain which remains the major factor that limits patients seeking TKA [1]. Improving the pain management techniques has significant impact on stress response and postoperative outcome [2,3]. The use of epidural analgesia is the preferred technique of analgesia in many European countries for total knee arthroplasty, as revealed by a declarative European survey [4]. Epidural techniques are commonly used in postoperative analgesia for elderly patients, with the combination of a local anesthetic and an opioid being preferred [5,6]. However, the occurrence of serious adverse effects (eg, hypotension, respiratory depression, deep bradycardia) and unwanted adverse events (eg, nausea, vomiting, motor block) with these analgesic regimens make it necessary to continue research about different and more optimal analgesia methods [6,7]. The α-2 agonists, particularly the combination of clonidine with local anesthetics administered via the epidural or spinal route, have been found to be effective in pain management [8–10]. Dexmedetomidine, another α-2 receptor agonist, is firstly used in ICUs for sedation of patients [11–13]. The effective analgesia obtained with dexmedetomidine has been widely discussed [14–16]. However, clinical studies on its spinal and epidural use are limited, also it has got numerous beneficial effects when used epidurally [17].

Hence, in the present study we have hypothesised that adding epidural adjunct dexmedetomidine to low volumes of bupivacaine, aiming to reduce the complications of epidural local anesthetics and opioids, and provide suitable postoperative analgesia for patients undergoing total knee arthroplasty without hemodynamic instability.

2. Materials and methods

After approval of the institutional ethics committee and Pan African Clinical Trial Registry (www.pactr.org) PACTR 201503001068335. Written consents of 75 patients, 50–70 years old, American Society of Anesthesiology (ASA) physical status I–III, admitted to Menoufiya University Hospitals, undergoing elective total knee arthroplasty were included in this prospective, double-blinded, randomized controlled study. Exclusion criteria included morbid obese, age older than 70 years, known allergy to bupivacaine or dexmedetomidine, renal or hepatic insufficiency, cardiac conduction disturbances, neurological or psychiatric diseases and coagulation disorders. Patients were randomly classified into three parallel groups (20 patients in each group) using closed envelope technique. A good intravenous line was accessed by 18 gauge intravenous cannula and Ringer's solution infused at a rate of 6–15 ml/kg/hour. All patients received midazolam 2 mg IV five minutes before epidural anesthesia was performed. Routine monitoring was applied pre-operatively including ECG, NIBP and pulse oximetry and the baseline measurements were recorded. A combined spinal and epidural technique was used for anesthesia and postoperative analgesia. A 16 G Tuohy needle was used to insert an epidural catheter at the L3–4 or L4–5 interspaces. In all patients, a midline approach was used, with the epidural space identified using loss of resistance then the epidural catheter was introduced into epidural space for 3–4 cm and a test dose of 2 ml of lidocaine 2% containing adrenaline 1:200,000 was given to exclude both intrathecal and intravenous injection. Then spinal anesthesia was given by 15 mg 0.5% heavy bupivacaine. Patients in group I (control group) received only 5 ml/h of bupivacaine 0.125%, group II received 4 ml/h of a mixture of bupivacaine 0.125% and dexmedetomidine 0.2 μg/kg/h and group III received 3 ml/h of a mixture of bupivacaine 0.125% and dexmedetomidine 0.2 μg/kg/h. Post-operative pain scores were assessed using a 10 cm visual analog scale (VAS) (0 = no pain and 10 = worst pain imaginable) during rest (primary outcome) and movement (secondary outcome). According to the patient's request to analgesia when VAS $\geqslant$ 4, post-operative incremental doses of I.V. 4 mg nalbuphine were given and recorded. The patient's level of sedation was assessed using the inverted observer's assessment of alertness/sedation scale [18], with a score of 1 = completely awake, 2 = awake but drowsy, 3 = asleep but responsive to verbal commands, 4 = asleep but responsive to tactile stimulus, and 5 = asleep and not responsive to any stimuli. The post-operative data (e.g. pain, sedation) and cardio-respiratory parameters (heart rate, blood pressure and SpO_2) were monitored and recorded every 4 h for 48 h.

2.1. Statistical analysis

A power analysis was performed using a power of 85% and an α value 0.05. We assumed that the minimum difference of pain scores at rest (primary outcome of the study) was 20% and standard deviation 20%. The sample size was calculated to be 23 patients so we decided to include 25 patients in each group in the study. We used GraphPad Stat Mate version 2 statistics program for power analysis.

Statistical analysis was done using SPSS program. Descriptive statistics were expressed as mean + SD unless otherwise stated. One way analysis of variance (ANOVA) with Student Newman–Keuls post-hoc test was used for comparison of the means of continuous variables and normally distributed data. The Chi-square test was used otherwise. P-value < 0.05 was considered statistically significant.

3. Results

The demographic data of the patients in the three groups were comparable with regards to age, sex, weight and height (Table 1). During the course of the study, VAS (visual analog scale) of pain at rest showed a significant reduction between group I and both groups II and III with insignificant difference between groups II and III at rest during the first 24 h and insignificant reduction between the studied groups during the rest of the study (Table 2), while VAS of pain at movement, showed significant reduction between group I and the other 2 group with insignificant difference between groups II and III all over the study period (Table 3). The mean of nalbuphine consumption during the study period was significantly reduced in group II and group III more than in group I with insignificant difference between groups II and III (Table 4). The sedation score was significantly higher in groups II and III (which received dexmedetomidine) compared to group I with insignificant difference between the two groups II and III (Table 5). Whereas heart rate was reduced in both groups II, III used