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EVALUATION OF POSTOPERATIVE ANALGESIC EFFICACY OF BUPIVACAINE WITH DEXMEDETOMIDINE AS ADJUVANT IN ULTRASOUND GUIDED ADDUCTOR CANAL BLOCK IN PATIENTS UNDERGOING TOTAL KNEE ARTHROPLASTY.

Anaesthesiology

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ABSTRACT

Background: The aim of anaesthesia in Total Knee Arthroplasty (TKA) is to provide adequate analgesia and early ambulation. **Materials And Methods:** This study was a randomized study based on computer generated randomisation table and conducted in our hospital on 135 patients undergoing unilateral TKR under spinal anaesthesia. After the completion of surgery, the adductor canal block was performed with ultrasound guidance in both the groups. In group A, 20ML of 0.25% Bupivacaine was only used but in group B dexmedetomidine was added to bupivacaine (total volume of 20 mL; 0.25%) at a dose of 0.50mcg/kg. The primary outcome of the study was to compare duration of analgesia after the adductor canal block. **Results:** Duration to rescue analgesia(hours) in Group A: 12.91±4.57; Group B: 18.34±8.41 (p=0.001) and total opioid consumption (24hrs tramadol needed in mg) Group A : 62.22±19.80; Group B :33.23±11.95 (P=0.033) was significantly lower in Group B . VAS Score is significantly lesser in Group B at 6 and 12 hour time points. **Conclusion:** The addition of dexmedetomidine 0.5mcg/kg to 0.25% bupivacaine in adductor canal block results in longer duration of analgesia; less 24 hours opioid consumption ,without any adverse effect after unilateral total knee arthroplasty surgery.

KEYWORDS

INTRODUCTION :

Total knee Arthroplasty (TKA) is one of the commonly performed orthopedic surgery but is often associated with severe pain. The aim is to provide adequate analgesia so as to facilitate early ambulation. Multimodal analgesia with the use of central and peripheral nerve blocks, non-steroidal anti-inflammatory Drugs (NSAIDS), paracetamol, opioids, etc. is most suited for this surgery. Since ages combined spinal epidural anaesthesia remained as mainstay for TKR. However, epidurals for postoperative analgesia has its own complications such as catheter related issues and side effects of opioids. In addition, the use of systemic opioids and NSAIDs especially in elderly population is not widely recommended. The recent success of adductor canal block in providing post-operative analgesia and early ambulation has evoked interest in studying the effects of opioid sparing anaesthetics such as local anaesthetics and some safer adjuvants like dexmedetomidine. With the advent of ultrasonography (USG), adductor canal block (ACB) can be administered with a high success rate.[1,2]In recent years, ACB has been successfully used for postoperative pain control after knee surgery.[1,3] Also, the adductor-canal-blockade significantly enhanced ambulation ability assessed by the Timed Up and Go (TUG) test.[4] Hence the present study was done to compare the duration of analgesia of adductor canal block using bupivacaine with and without dexmedetomidine after unilateral total knee arthroplasty.

MATERIALS AND METHODS :

This was a comparative and randomized controlled study among the two trial groups conducted in BIRRD Trust Hospital, Tirupathi after approval by the institutional ethics committee. Total 130 patients of either sex belonging to ASA grade I or II, aged from 18 to 75 years undergoing elective unilateral total knee arthroplasty under spinal anaesthesia were included in this study. Patients who are allergic to any of the study drugs, having cardiac or renal disease, any neurological ailment, contraindication to spinal anaesthesia and pregnancy were excluded from the study.

Patients were divided into two different groups (n=65 each) using computer generated randomization table; Group A: 20 ml solution of Bupivacaine (0.25%) was given in ACB. Group B: 20 ml solution of Bupivacaine (0.25%) with 0.5mcg/kg dexmedetomidine was given in ACB. The primary outcome of the study was to compare the duration of postoperative analgesia. The secondary outcomes were to compare 24-hour opioid consumption after surgery and any adverse effects following the study intervention.

For sample size calculation it was hypothesized that addition of Dexmedetomidine to Bupivacaine will increase the duration of analgesia by 50%. Thus, the sample size was calculated as 65 in each group to attain minimum 90% power and to reduce the alfa error to 5% (to achieve 95% confidence level) using sample size calculation software MEDCALCTM (Ostend, Belgium).

Standard pre-anaesthetic evaluation and basic lab investigations were done a day prior to the surgery. The entire procedure was explained to the patient and written informed consent was obtained. Patients were shifted to the operation theatre (OT) on the day of surgery and all standard ASA monitors were attached. All the patients were given subarachnoid block with 2.5 mL 0.5% hyperbaric bupivacaine and through 25G Quincke spinal needle via L3-L4 intervertebral space after local infiltration with 2% lignocaine.

General anaesthesia was administered in those patients who either had inadequate effect of subarachnoid block or where subarachnoid block was contraindicated. For analgesia in such cases Fentanyl 2 µg/kg IV was used. The same team of orthopedic surgeons performed all the surgeries.

After completion of the surgery, the adductor canal block (ACB) was performed by an experienced anaesthesiologist with help of a linear ultrasound probe (5–10 MHz; SonoSite SII Ultrasound System FUJIFILM SonoSite, Inc. 21919 30th Drive SE Bothell, WA 98021 USA). An independent researcher generated the randomization code on the basis of a computer-generated randomization table using www.graphpad.com. The assessor was the nurse of the ward and blinded to the study groups. The patient and the surgeon were also blinded to the study group allocation. In Group A, 20 mL bupivacaine (0.25%) and in Group B, 20ml bupivacaine (0.25%) combined with 0.5 µg/kg dexmedetomidine was administered. Patients were positioned with the lower limb of the operated side slightly abducted at the hips and flexed at the knees. At mid-thigh level, an ultrasound-guided ACB was performed using a linear ultrasound probe (7 L4P, 5–10 MHz; SonoSite SII Ultrasound System FUJIFILM SonoSite, Inc. 21919 30th Drive SE Bothell, WA 98021 USA) and a 21-gauge 10 cm short beveled needle (Stimuplex TM, B Braun Medical) in plane with the transducer, from lateral to medial (Figure 1) with the needle tip targeted anterolateral to the femoral artery and below the Sartorius muscle (Figure 2). A bolus of 2 ml of normal saline was used to confirm the location of needle tip. A volume of 20 ml of block solution was injected in 5 ml aliquots through the injection port of the needle after

negative aspiration. The spread of the drug between the sartorius and the femoral artery was seen real time on ultrasound (Figure 3).

The patients were observed for 60 minutes and Heart rate (HR), non-invasive blood pressure (NIBP) and oxygen saturation (SpO2) were monitored continuously at 15 min interval for the 1st hour after the block and then 6-hourly for the next 24 hours.

Fig. 1: Approach of adductor canal block (ACB) b using USG probe and StimuplexTM needle

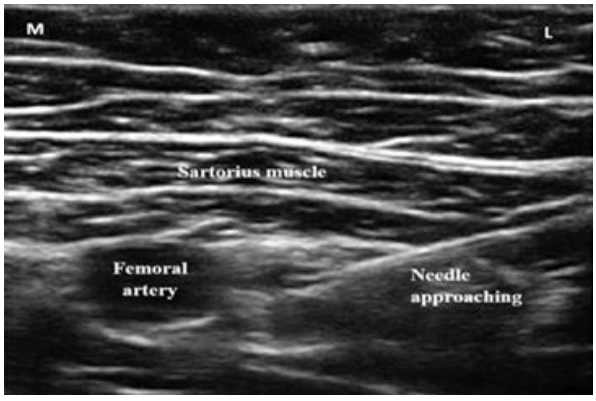

Fig. 2: USG image of femoral artery and needle approach for adductor canal block

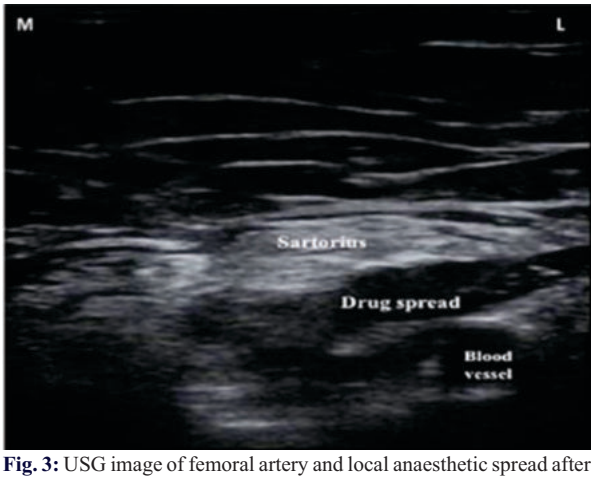

Fig. 3: USG image of femoral artery and local anaesthetic spread after adductor canal block

Sedation score was assessed using Ramsey Sedation scale (RSS) at 15,30, 45 and 60 minutes after ACB and then at an interval of 6 hours up to 24 hours. VAS Score was used to assess pain at 6, 12, 18 and 24 hours timepoints during the post-operative period. Quality of postoperative analgesia was assessed using VAS (0–10 scale, 0 - no pain, and 10 - worst possible pain). If the patient complained pain (VAS >4) Intravenous tramadol 100 mg was given as rescue analgesia and repeated every 20 min till the VAS reached 4 after ACB. Time to first rescue analgesia and the total tramadol consumption in 24 hours were noted. The ward nurse collected the data in the post-operative period such as HR, NIBP and SpO2. Bradycardia and hypotension were defined as 20% decrease from the baseline HR and mean arterial pressure respectively and were treated with atropine and intravenous fluid boluses. Any adverse event such as shivering, giddiness, nausea, vomiting, paraesthesia, local pain and signs of local anaesthetic systemic toxicity were noted during the study. The collected data was analyzed using the IBM Statistical Package for Social Science (SPSS 24.0 version, IBM Corp., Armonk, N.Y., USA) and it was normally distributed as assessed by Shapiro-wilk test. Quantitative variables like age of the patients, BMI, duration to rescue analgesia, total opioid consumption, VAS, RSS scores were expressed as mean±standard deviation (SD) and compared using ANOVA as well as Bonferroni post-hoc analysis. Qualitative variables like incidence of adverse events were expressed as frequencies and percentages. They were compared using Chi-square test or Fisher's exact test whenever appropriate. A p-value less than 0.05 was considered statistically significant.

RESULTS:

Demographic variables like age and BMI were comparable between the groups (Table 1). Duration to rescue analgesia (Table 2) in Group B (18.34±8.41) was significantly longer and total opioid consumption in Group B (33.23±11.95) was significantly lower when compared to Group A (12.91±4.57) and (62.22±19.80) with **p=0.001**. (Table 3) VAS scores were significant only at 6 hours [In Group A (3.33±4.6) Group B (1.33±2.3) with **p=0.001**] and 12 hours [In Group A (4.33±5.6) Group B (1.67±3.9) with **p=0.01**] after ACB whereas RSS scores, mean HR, mean arterial pressure values (MAP) and SpO2 were comparable between both the groups even after Bonferroni post-hoc analysis. The was no adverse events reported in any of patients included in the study.

Table 1 : Demographic Data :

Parameters	Group A (n=65) [Mean±SD]	Group B (n=65) [Mean±SD]	p-value
Age	65.14±10.81	65.24±10.89	0.518
BMI	26.46±2.13	26.51±1.95	0.568

Table 2: Duration Of Analgesia And Opioid Consumption:

Parameter	Group A (n=65) [Mean±SD]	Group B (n=65) [Mean±SD]	p-value
Duration of Rescue Analgesia(hours)	12.91±4.57	18.34±8.41	0.001
Total opioid consumption (mg)	62.22±19.80	33.23±11.95	0.001

Table 3: VAS Scores

VAS Score	Group A (mean±SD)	Group A (mean±SD)	p-value
At 6 hours	3.33±4.6	1.33±2.3	0.001
At 12 hours	4.33±5.6	1.67±3.9	0.001
At 18 hours	5.37±1.37	5.87±2.49	0.437
At24 hours	5.67±1.83	5.97±2.34	0.536

DISCUSSION:

Higher incidence of osteoarthritis in middle age groups has led to increasing rates of Total knee Arthroplasty. It will be painful for the first 24 hours after total knee replacement (TKR) surgery, lasting up to 3 days in many cases. Adequate analgesia following TKR is key for early recovery, rehabilitation and shorter hospital stay. Multimodal analgesic techniques have been used, including intravenous narcotic pain medication, continuous femoral nerve block and epidural analgesia. All these are effective methods but each is limited by side effects. Earlier femoral nerve block (FNB) has been considered as the main peripheral nerve block for postoperative analgesia following knee surgery. However, quadriceps muscle weakness was the major downside of FNB which led to search for alternative nerve blocks.

In recent years, ACB has earned a lot of importance because it causes minimum quadriceps muscle weakness in spite of providing good analgesia post surgery. Combining adjuvants like dexmedetomidine may increase the efficacy of analgesia. Thus we conducted this study with the aim to compare the duration of analgesia of adductor canal block using bupivacaine alone versus bupivacaine with addition of dexmedetomidine as adjuvant after unilateral total knee arthroplasty and the secondary outcomes were the total opioid consumption,

success of early ambulation, and any adverse effects following the study interventions.

Many studies have shown good analgesia and better quadriceps strength with ACB for unilateral TKA. [1,5–8] The main nerve blocked in the adductor canal is saphenous nerve, the main sensory nerve. Other nerves such as nerve to vastus medialis, obturator nerve (articular branches), medial femoral cutaneous nerve, and medial retinacular nerve also traverse through the adductor canal and will have a motor component[4]. Dexmedetomidine is a highly selective, specific, and potent α-2 adrenergic receptor agonist that has anxiolytic, sedative, analgesic, sympatholytic and antihypertensive properties.[9,10] Many studies have illustrated that dexmedetomidine combined with local anesthetics can increase the postoperative analgesic effect and also prolong the duration of analgesia after TKR.[11] Duration to rescue analgesia was significantly higher in group B when compared to group A and the results were similar to observations made by other investigators.[12]

Packiasabapathy, et al concluded that 0.25% bupivacaine with dexmedetomidine at 2 µg/kg dose in femoral nerve block in patients undergoing unilateral TKR prolonged the duration of post-operative analgesia but there was significant decrease in systolic and mean blood pressure post-surgery till 4 and 8 hours.[12] In view of the potential adverse effects of high dosages, we used dexmedetomidine 0.5 µg/kg. Total opioid consumption was significantly less in group B as compared to group A in present study and similar observations were made by other investigators packiasabapathy, et al and M Abdulatif et al.[12,13] In our study, total opioid consumption was significantly less in group B than the group A with no dexmedetomidine. There was no significant difference in the sedation score between the two groups at all-time points. Pain score was significantly lower in group B as compared to group A (at 6 hours and 12 hours).

Pan L et al. also concluded that pain scores significantly decreased at different time points postoperatively when dexmedetomidine was used as an adjunct to nerve blocks.[11]Motor strength was important factor to keep track of for the patients as well as for the surgeons because early rehabilitation is essential and helpful for the success of TKA.

Dexmedetomidine combined with local anesthetics in nerve block could increase motor strength compared to local anesthetics alone.[11,14] There was no significant difference in heart rate between the two groups at all time points. There was no significant difference in systolic BP and diastolic BP between the two groups at all time points except at time point 6 hours where systolic BP in group A was significantly higher than group B, which was apparently of no clinical significance.

Our study has shown the efficacy of ultrasound guided adductor canal block as a best analgesic modality in patients undergoing unilateral TKA surgery and also validates the efficacy of dexmedetomidine (0.5 µg/kg) as adjuvant to bupivacaine in adductor canal block for prolonging the duration of analgesia without haemodynamic compromise or temporary motor deficit. Better analgesia, lower opioid consumption and minimal adverse effects are the possible contributory factors. Our study findings were also suggestive of the fact that 0.50 µg/kg is the adequate dose for providing analgesia after TKA without hemodynamic compromise and also associated with no early need of rescue analgesics. Limitation of the study was the multimodal analgesia (oral paracetamol and diclofenac) which were used as per institutional protocol. These medications might have reduced requirement of dexmedetomidine and may have potentiated the effects of dexmedetomidine.

CONCLUSION :

The addition of dexmedetomidine as an adjuvant, at a dose of 0.5 µg/kg to 0.25% bupivacaine in adductor canal block results in longer duration of analgesia, less 24 hours opioid consumption and without any adverse effect after unilateral total knee arthroplasty surgery.

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