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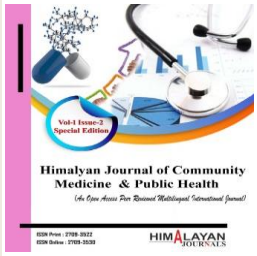

Research Article

Evaluation of Rescue Analgesic Requirement in Ultrasound Guided 4-in-1 Nerve Block with Bupivacaine in Combination with Dexmedetomidine in Two Doses for Knee and Below Knee Orthopaedic Surgeries

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Abstract: ***Background:*** This study compared the Rescue analgesic requirement in ultrasound-guided 4-in-1 nerve blocks with Bupivacaine and Dexmedetomidine in two doses for knee and below-knee orthopaedic operations. ***Material & Methods:*** Patients who were scheduled for below-knee and knee procedures under SAB underwent a comparison study. 100 patients in all were divided into two groups at random. In a USG-guided 4 in 1 block, Group A received 29ml of 0.125% bupivacaine along with 0.5g/kg of dexmedetomidine to make a total 30ml solution, while Group B received 29 ml of 0.125% bupivacaine along with 1g/kg of dexmedetomidine to make a total 30ml solution. ***Results:*** In this study, time to first rescue analgesia in group A and group B was 579.12±62.43 min and 730.66±93.15 min respectively. Patients in group A required early intervention in terms of rescue analgesia. It was significantly longer in group B in comparison to group A (P = 0.0001). Duration of post-operative analgesia in group A and group B was 666.48±82.45 min and 801.96±92.97 min respectively. In this study, duration of analgesic effect was significantly longer in group B in comparison to group A (P = 0.0001). In this study, total rescue analgesic doses per patient were significantly more in group A in comparison to group B (P = 0.0001). In this study, total number of bolus doses of rescue analgesia was 123 in group A and 62 in group B which is almost double in group B in comparison to group A. ***Conclusion:*** Present study concluded that time to first rescue analgesia was significantly longer in group B in comparison to group A. Similarly, total rescue analgesic doses per patient were significantly more in group A in comparison to group B and Total bolus doses of rescue analgesia is almost double in group A as compared to group B.

Keywords: Rescue analgesic requirement, Bupivacaine, Dexmedetomidine, Two Doses, Orthopaedic surgeries.

INTRODUCTION:

Poor post-operative pain management can have a wide range of negative implications on the orthopaedic patient. The effects of poorly controlled pain are further highlighted, and it is crucial to give these patients the greatest pain control possible. The association between poorly managed acute postoperative pain and increased long-term morbidity and mortality.[1]

The RA techniques used for knee and below knee surgeries have been extensively studied and have provided excellent options for perioperative care for every age group of patients. Various studies have confirmed the early recovery with adductor canal block over femoral nerve block, with motor sparing effect for knee surgeries.[2]

The combination of the femoral nerve block with sciatic nerve block has provided adequate analgesia with lower consumption of perioperative opioids and rescue analgesia, for knee and below knee surgeries. The superior efficacy of the combined adductor canal block with the sciatic nerve block comes with associated technical difficulties including positioning of patients differently for both the blocks. The peripheral nerve block, like adductor canal block and sciatic nerve block combined, have better outcome in knee and below knee surgeries. But the positional and technical difficulties with these blocks can be overcome by using a single injection 4-in-1 block technique.[3]

Specifically, the saphenous, obturator, sciatic, and vastus medialis nerves are all blocked by the four-in-one block. For knee and below knee procedures, it can ease the procedure and improve post-operative analgesia. [3] For postoperative pain relief following knee surgeries, this block is an easily administered nerve block that blocks the sciatic nerve distribution.[4]

Various local anaesthetic agents have been used with safety and efficacy in performing blocks. Adjuvants when co-administered with local anaesthetic agents, improve the speed of onset and duration of analgesia, and counteract disadvantageous effects of local anaesthetics. Dexmedetomidine is an alpha-2 adrenergic receptor agonist presynaptic activation of the α2 adrenoceptor inhibits the release of norepinephrine, terminating the propagation of pain signals. Postsynaptic activation of α2 adrenoceptors in the central nervous system (CNS) inhibits sympathetic activity and thus can decrease blood pressure and heart rate. Combined, these effects can produce analgesia, sedation, and anxiolysis.[5-7]

We hypothesised that 0.125% bupivacaine with two different doses of dexmedetomidine 0.5µg/kg and 1 µg/kg may have different Rescue analgesic requirement when administered in ultrasound guided 4-in-1 block. Since this block is a relatively new block and only a couple of studies are available in literature, it would be worthwhile to compare the Rescue analgesic requirement of 4-in-1 block with bupivacaine in combination with dexmedetomidine in two doses.

AIM AND OBJECTIVES:

To compare the Rescue analgesic requirement and the time of first rescue analgesia in ultrasound guided 4-in-1 nerve block with Bupivacaine in Combination with Dexmedetomidine in Two Doses for knee and below knee orthopaedic surgeries.

MATERIAL AND METHODOLOGY:

- **Study Area:** Department of Anaesthesiology, Dr. R.P.G.M.C. Kangra at Tanda, Himachal Pradesh, India.

- **Study Population:**

All consecutive patients in the age group 18-60 years including both genders scheduled for knee and below knee surgery under subarachnoid block (SAB) were enrolled for this study after obtaining written informed consent.

- **Study Duration:**

After approval by Institutional Ethics Committee(IEC), this prospective, randomized, double blinded, study was carried out over a period of 18 months including data collection, data organization, presentation, data analysis and data interpretation.

- **Sample Size:**

All patients within this duration and fulfilling our inclusion criteria were included in the study. The patients were divided into two groups -group A and group B. For each group, 50 patients were evaluated after randomization.

- **Inclusion Criteria:**
  - ASA grade I and II patients scheduled for knee and below knee surgery under SAB with expected duration of 2 hours were intended in the current study.
  - BMI 18.5-29.9 Kg/m^2.

- **Exclusion Criteria:**
  - Patient's refusal for spinal anaesthesia or 4- in -1 block.
  - Patients with anatomical deformities.
  - Patients with coagulopathies and bleeding disorders.
  - Patients with hypersensitivity to study drugs.
  - Patients on anticoagulants.
  - Local infection at the site where needle for block is to be inserted
  - Patients with known bradyarrhythmia, heart block, significant cognitive impairment.
  - Failure of spinal anaesthesia.

- **Study Design:**

It was a prospective, randomized, double-blind study. The patients undergoing knee and below knee surgery were randomly divided into two groups (A and B). Randomization was achieved by computer-generated random number table. The randomization group assigned was enclosed in a sealed opaque envelope to ensure concealment of allocation sequence. After shifting the patient inside operation theatre, sealed envelope was opened by anaesthesiologist not involved in the study to prepare the drug solution according to allocation. The drug solution made was then made and handed over to the team member giving the block.

- **Methodology:**

The study commenced after obtaining institutional scientific review and protocol committee, ethics committee approval and written informed patient's consent.

The enrolled patients, after fulfilling all the inclusion and exclusion criteria, were divided into 2 groups:

- **Group A**- received 29 ml of 0.125% bupivacaine with 0.5 µg/kg dose of dexmedetomidine (1 ml) making it to a total 30 ml solution, in USG guided 4-in-1 block.

- **Group B**- received 29 ml of 0.125% bupivacaine with 1 µg/kg dose of dexmedetomidine (1 ml) making it to a total 30 ml solution, in USG guided 4-in-1 block.

❖ **Anaesthetic Procedure:**

Pre-anaesthetic assessment was done one day prior to surgery. All patients were explained about the procedure, advantages, and risks of the procedure. The patients were educated about the 11-point Verbal Rating Scale (VRS) where 0 is no pain and 10 is worst imaginable pain. Thereafter written consent was taken and clinical details were recorded in a predesigned proforma.

All the patients were kept nil orally for 8 hours before surgery and pre-medicated with tablet alprazolam 0.25 mg and tablet ranitidine 150 mg the night before surgery and 2 hours before surgery with a sip of water. In the operation theatre, an 18-gauge intravenous (IV) cannula was secured followed by 0.9% sodium chloride (normal saline [NS]) infusion. After establishing standard anaesthesia monitoring, baseline parameters such as heart rate (HR), non-invasive blood pressure and peripheral oxygen saturation were recorded. Patients were given SAB after cleaning and draping,in sitting position using 26-gauge Quincke spinal needle at L3–L4 interspace with 3.0ml 0.5% hyperbaric bupivacaine after ensuring free flow of cerebrospinal fluid. After confirmation of adequate level (T6) the surgeon was allowed to proceed with thesurgery. All patients were monitored intraoperatively for systolic, diastolic, mean blood pressure, heart rate,and oxygen saturation. Any hypotension episode (defined as a reduction in mean arterial blood pressure> 30% of baseline) was treated with injection ephedrine 6 mg bolus and episodes of bradycardia (HR < 50 beats/min) was treated with injection atropine 0.02 mg/kg.After completion of surgery, the patients were shifted to PACU and monitored for the regression of sensory block to T_{10} level, following which they were given the ultrasound guided 4- in -1 nerve block.

❖ **Procedure of the Block:**

The patient was positioned in supine position with the ipsilateral leg kept in external rotation, slight abduction and knees slightly flexed (frog leg position). The medial femoral condyle wasmarked.

A linear high frequency ultrasound probe, ultrasoundSonositeMicromaxx® (Sonosite®, Bothell, WA, USA) wasused. After skin disinfection with povidone iodine, sterile drapes were applied.The linear probe (8–12 Hz) covered with sterile plastic sheath and with sufficient application of sterilised gel wasplaced over the femoral condyle and vastus medialis muscle identified and scanned proximally. The vastus and sartorius intersection (antero-medial intermuscular septum) were identified and the probe was taken proximal till the superficial femoral artery appears in the adductor hiatus. The probe was then slid slowly proximally till the descending genicularartery branching from superficial femoral artery is visualized in the hiatus. This point was the injection point which is 8-10cm above the femoral condyle. Under all aseptic precautions,a22-gaugeechogenic needle wasused by an ultrasound-guided in-planefrom lateral to medial side under to reach perivascular region and after negative aspiration, the test drug was injected to spread around the femoral artery and also in a plane to push the Sartorius muscle up and hence blocking four nerves namely saphenous, obturator, sciatic and nerve to vastus medialis.

Subsequently, each patient was observed for pain, vitals and side effects at hourly intervals as mentioned in the proforma (i.e., 0, 1, 2, 4, 6, 12, 18 and 24 hours) for 24 hours by an anaesthesiologist blinded to group assignment. For the first 24 hours, the protocol for postoperative analgesia consisted of standard orders for injection i.v paracetamol 1gm i.v for VAS > 4followed by injection i.v. diclofenacaqueous solution 1.5 mg/kg if pain not relieved with the former. For breakthrough pain, patients were treated with injection i.v. tramadol 0.5 mg/kg as and when required. The patients were evaluated for the time to request for first rescue analgesia, frequency of rescue analgesia required and total number of doses of rescue analgesics in each case.

❖ **Statistical Analysis:**

The data were recorded into Microsoft® Excel workbook 2019 and exported into SPSS v21.0 (IBM, USA) for statistical analysis. Categorical variables were expressed as frequency, percentage and compared using Chi square test. Quantitative variables were expressed as mean, standard deviation and compared using Student t-test. P value <0.05 was considered significant.

❖ **Ethical Justification:**

The study was approved by IEC (HFW-H/DRPGMC/Ethics/2019/221; dated 21/12/2019) at Dr. RPGMC Kangra at Tanda. All the patients were included after they agreed to give their consent.

OBSERVATIONS & RESULTS:

The present study was aimed to compare the Rescue analgesic requirement in ultrasound guided 4-in-1 nerve block with Bupivacaine in Combination with Dexmedetomidine in Two Doses for knee and below knee orthopaedic surgeries. After Institutional Ethics Committee approval and written informed consent, one hundred and eight patients of ASA I and II category, aged between 18–60 years, were recruited in the study. Eight patients, however, were excluded from the study as per the exclusion criteria. Fifty patients in each group completed the study successfully (Figure-A).

A total of 100 patients were randomly divided into 2 groups. The groups made have been elaborated as following:

❖ **Group A** - 29 ml of 0.125% bupivacaine with 0.5µg/kg dose of dexmedetomidine (1ml) making it to a total 30 ml solution, in USG guided 4 in 1 block.

- **Group B** - 29 ml of 0.125% bupivacaine with 1µg/kg dose of dexmedetomidine (1ml) making it to a total 30 ml solution, in USG guided 4 in 1 block.

In this study, mean age of the participant was 40.64±11.44 years in Group A and 40.12±12.55 years in Group B ranging from 18 years to 60 years. Maximum participant in Group A (n = 18) aged between 41 and 50 years and in Group B (n = 17) were aged between 30 and 40 years. Only 10 participants aged below 30 in both the groups. The study population comprised of 36 males in Group A and 31 males in Group B and 14 females in Group A and 19 females in Group B. There was no significant difference of gender between both groups (P = 0.287) (Table 1).

Table 1: Distribution of participants according to socio-demographic variables

	Group-A (n=50)	Group-B (n=50)	P-value
Age group (years)			
<30	10 (20%)	10 (20%)	
30-40	14 (28%)	17 (34%)	0.288
41-50	18 (36%)	10 (20%)	
>50	8 (16%)	13 (26%)	
Age (mean±SD)	40.64±11.44	40.12±12.55	0.829
Gender			
Male	36 (72%)	31 (62%)	0.287
Female	14 (28%)	19 (38%)	
Anthropometric characteristics			
Weight (Kg)	65.12±8.59	64.14±8.72	0.573
Height (cm)	167.95±7.53	165.71±7.49	0.139
BMI (Kg/m^2)	28.21±3.25	27.62±3.75	0.408

In this study, we compared three anthropometric characteristics namely height, weight, and BMI. The mean weight in group A was 65.12±8.59kg and in group B was 64.14±8.72kg (P = 0.573). The mean height in group A was 167.95±7.53cm and in group B was 165.71±7.49cm (P = 0.139). The mean BMI in group A was 28.21±3.25kg/m^{2}and in group B was 27.62±3.75 kg/m^2 (P = 0.408). There was no significant difference between both groups in terms of weight, height, and BMI (Table-1).

In this study, there was no significant comparison between both the groups according to ASA grade. Distribution of patients in ASA grade 1 is non-significant in group A as compared to Group B (P = 0.827). In this study, mean duration of surgery in group A and group B was 84.70±30.60min and 91.60±31.90min respectively. There was no significant difference of duration of surgery between both groups (P = 0.272). (Table-2)

Table 2: Distribution of participants according to ASA grades and Mean Duration of surgery

ASA Grade	Group-A (n=50)	Group-B (n=50)	P-value
Grade-1	43	42	0.827
Grade-2	7	6	
Mean Duration of surgery (min)	84.70±30.60	91.60±31.90	0.272

Time to first rescue analgesia was measured from the time after giving 4- in -1 block to the administration of 1st rescue analgesic based on VRS≥5 or on the patient's request or which so ever earlier. In this study, time to first rescue analgesia in group A and group B was 579.12±62.43 min and 730.66±93.15 min respectively. Patients in group A required early intervention in terms of rescue analgesia. It was significantly longer in group B in comparison to group A (P=0.0001) (Table-3).

Table 3: Time to first rescue analgesia and Rescue analgesic requirement per patient

	Group A	Group B	P value
Time to first rescue analgesia (Min)	579.12±62.43	730.66±93.15	0.0001
Total number of rescue analgesic doses	3.4±1.01	2.1±0.92	<0.001

On VAS>=5 patients received injection paracetamol 1gm i.v. followed byrescue bolus injection of diclofenac aqueous solution i.v. 1.5mg/kg stat if pain still persisted. Subsequent administration of injection tramadol 0.5mg/kg i.v.was given for breakthrough pain. In this study, total rescue analgesic doses per patient were significantly more in group A in comparison to group B (P=0.0001)

In this study, total Number of bolus doses of rescue analgesia was 123 in group A and 62 in group B. Bolus requirement in group A started at 4th hour whereas patients in group B required 1st dose at 6th hour

indicating longer pain free period. Total bolus doses of rescue analgesia is almost double in group A as compared to group B which is significantly more. (Table-4).

Table 4: Total bolus doses of rescue analgesia in different groups

	Group-A (n=50)	Group-B (n=50)
0-Hour	0	0
1-Hour	0	0
2-Hour	0	0
4-Hour	14	0
6-Hour	18	24
12-Hour	29	15
18-Hour	28	12
24-Hour	34	11
Total	**123**	**62**

DISCUSSION:

Regional anaesthesia techniques provide important advantages compared with general anaesthesia and systemic analgesia, including excellent pain control, reduced side- effects, and shortened stay in the post anaesthesia care unit.[8,9]

Local anaesthetics provide analgesia for limited period of time when used as single injection. To extend the duration of analgesia beyond the operating time, various methods have been used with the aim of prolonging the local anaesthetic action, like continuous infusion of local anaesthetics via indwelling catheters and use of various adjuvants with local anaesthetics.[10,11]

The evolution from central neuraxial blocks like combined spinal epidural etc. to regional blocks like the Femoral, sciatic, Adductor, combined femoral and sciatic for targeting pain free TKA has paved way to more and more research into the subject. As the knee joint is supplied by various nerves (genicular nerves) from the femoral, obturator and sciatic nerves; hence, needs a comprehensive yet simple technique for complete analgesia postoperatively.

Recently, Roy *et al.,* have proposed technique of ultrasound-guided 4- in -1 block for knee and below knee surgeries.[3] This technique has not been studied much in detail. Hence, we compared the Rescue analgesic requirement in ultrasound-guided 4-in-1 block with bupivacaine in combination with dexmedetomidine in two doses for knee and below knee orthopaedic surgeries for postoperative analgesia.

In this study, time to first rescue analgesia in group A and group B was 579.12±62.43 min and 730.66±93.15 min respectively. It was significantly longer in group B in comparison to group A (P=0.0001). In the study by Ray *et al.,* the two groups were comparable for the first dose of analgesic and the total requirement of rescue analgesia in 24 h (statistically nonsignificant P value). This suggested that 1.0 mcg dose of dexmedetomidine as an adjuvant has no added advantage over 0.5 mcg dose in the postoperative period.[12] Kamhawy *et al.,* (2019) assessed the role of added dexmedetomidine to bupivacaine during combined sciatic and posterior lumbar plexus blocks during femur surgery regarding period of sensory and motor blocks, efficacy of its analgesic effect and incidence of adverse effects. They were all randomly chosen into two groups which have undergone combined sciatic nerve and posterior lumbar plexus blocks as solo anaesthetic technique by peripheral nerve blocks. Group I: patients received bupivacaine 0.5% with no additives. Group II: patients received dexmedetomidine 100 µg with bupivacaine 0.5%.Patients in Group 1 requested analgesia earlier after surgery, as well as they had significantly higher morphine consumption postoperatively compared to those in Group II (p = 0.001).[13]

CONCLUSION:

In this study, the time to first rescue analgesia was significantly longer in group B in comparison to group A. Similarly, total rescue analgesic doses per patient were significantly more in group A in comparison to group B and Total bolus doses of rescue analgesia is almost double in group A as compared to group B. It is concluded that the use of1µg/kg dexmedetomidine as an adjunct to 0.125% bupivacaine in USG guided 4- in -1 nerve block reduces decreases the demand for rescue analgesia and also decreases the total number of bolus doses of rescue analgesia in comparison to 0.5µg/kg dexmedetomidine.

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