Original Research Article

Effects of perineural administration of Dexmedetomidine in combination with Bupivacaine in a femoral-sciatic nerve block

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Abstract

Background: In few studies, Dexmedetomidine was used an adjuvant to local anesthetics in peripheral nerve blocks.

Aim: This study was aimed to examine the effect of adding Dexmedetomidine to Bupivacaine 0.5% during the femoral sciatic nerve blocks and to evaluate its effect in prolonging post-operative analgesia.

Materials and methods: This was a prospective, double blinded, randomized study which consisted of 80 patients, Patients were randomly allocated into two groups (40patients each): In group BD, (Bupivacaine-Dexmedetomidine hydrochloride), one mL, containing 100 µg, was added to 39 mL of Bupivacaine 0.5%. In group B; 1 mL of normal saline was added to the same volume of Bupivacaine 0.5%.

Results: There were no statistically differences between the two groups in demographic data and surgical characteristics. The onset time of sensory block, motor block and surgical anesthesia time were significantly shorter in group BD when compared to group B. The durations of sensory block, motor block and analgesia were longer in BD group when compared to group B. Systolic arterial pressure (SAP) and heart rate were significantly lower in group BD when compared to group B from 10 to 90minutes after initiation of block ($P<0.05$), diastolic arterial pressure was similarly lower in group BD at 45, 60, and 90 minutes following initiation of block.

Conclusion: This study showed that a prolonged duration of analgesia was associated with addition of Dexmedetomidine 100µg to bupivacaine 0.5% during US-guided combined femoral and sciatic block for below knee surgery and is also associated with significant bradycardia requiring treatment.

Key words

Bradycardia, Analgesia, Femoral-sciatic nerve blocks.

Introduction

Severe and long lasting post-operative pain is a common problem in below knee injury that requires large doses of opiates [1]. Peripheral nerve blocks for lower extremity surgery have been evaluated by few studies and have compared them with spinal anesthesia [2, 3]. Combined sciatic femoral nerve block for lower extremity surgery offers better satisfactory anesthesia with a clinical profile similar to that of spinal anesthesia has been shown by these studies. The lower pain scores during early post-operative hours were associated with sciatic femoral nerve blocks which were significant [4]. To increase the duration post-operative analgesia, several perineural adjuvant medications were used. Few studies examined the effect following femoral-sciatic nerve block [5]. Dexmedetomidine is a highly selective and specific α2 adrenoceptor agonist [6]. The focus of interest was systemic administration of Dexmedetomidine for their sedative, perioperative sympatholytic, analgesic and cardiovascular stabilizing effects with decreased anesthetic requirements. The effects of mixing Dexmedetomidine with local anesthetics during peripheral nerve and nerve plexus blocks in humans were studied in few investigations. These studies have proven and shown that Dexmedetomidine is used as an adjuvant perineurally to local anesthetics for peripheral nerve blocks and it can prolong the duration of the blockade and analgesia post-operatively. This study hypothesized that the addition of Dexmedetomidine to Bupivacaine 0.5% would increase the time to first request of post-operative analgesia, shorten the sensory and motor block onset time, and enhance the duration of sensory and motor blockade. This study was aimed to examine the effect of adding Dexmedetomidine to Bupivacaine 0.5% during the femoral-sciatic nerve blocks and to evaluate its effect in prolonging post-operative analgesia.

Materials and Methods

This was a prospective, double blinded, randomized study which consisted of 80 patients with American Society of Anesthesiologists physical status I to III, who were undergoing below knee surgery under combined femoral sciatic block. Patients having cardiac, pulmonary, renal, hepatic, neurological, neuromuscular, or psychiatric disorders, coagulopathy were excluded from the study. Patients who were pregnant with body mass index greater than 35 kg/m^2, those patients who were receiving adrenoceptor agonists or antagonists, anticoagulants, antiplatelets other than acetyl salicylic acid, history of hypersensitivity to any of the study medications, and those patients who refused to participate in the study were excluded from the study. Recordings of attachments like standard anesthesia monitors including a three-lead electrocardiogram, pulse oximeter, and non-invasive blood pressure, and baseline measurements. Administration of supplemental oxygen through a nasal cannula at a flow rate of 1-2 L/min was done. Using 20 gauges cannula, intravenous (IV) access was achieved. Prior to block needle insertion, before the start of the block, patients were given 1-2 mg of midazolam IV as a premedication 10-15 min in addition to 50 μg of fentanyl. Using the closed envelope method, patients were randomly allocated into two groups (40 patients each): In group BD, Bupivacaine-Dexmedetomidine hydrochloride one mL, containing100 μg, was added to 39 mL of Bupivacaine 0.5%. In group B; 1 mL of normal saline was added to the same volume of Bupivacaine 0.5%. In both groups, the 40 mL of the mixture was used for both femoral and sciatic block. The study solutions were prepared by an anesthesiologist who did not participate in the study and looked identical. Patients were placed with the operative lower limb in the neutral position in the supine position. Skin disinfection

with povidone iodine and sterile drapes were applied. To identify the femoral artery, using a two-dimensional ultrasonographic scanning, a lubricated high-frequency, 8-12 MHz, straight array ultrasound (US) probe covered with a sterile plastic sheath of Sonoscape A5 portable US machine was placed perpendicular to the skin just beneath the inguinal crease. The femoral nerve was visualized as a hyperechoic structure, 1-2 cm lateral to the femoral artery. At the needle insertion site, infiltration with 3 mL of lidocaine 1% was performed. In line with the US transducer probe, a short bevel 40 mm, 21 gauges insulated nerve block needle was inserted parallelly. Under the US guidance, the needle was advanced slowly until it approached the femoral nerve. 15 mL of the prepared study solutions were deposited around the femoral nerve according to group assignment by an anesthesiologist who was unaware of the nature of study drug solution, after a negative aspiration of blood. Sonological observation in real time of the satisfactory spread of the drug around the femoral nerve was done. Then patients were positioned in lateral decubitus, with flexed hip and knee with the operative side uppermost. A line was drawn between the lateral prominence of the greater trochanter and the ischial tuberosity which were identified with palpation. A lubricated low-frequency, 5-2 MHz, curved array US probe covered with a sterile plastic sheath was used to scan the sciatic nerve at depth between 6 and 8 cm, after skin disinfection with povidone iodine and sterile drapes were applied. The "subgluteal space" appeared as a hypoechoic line between the gluteus maximus and the quadratus femoris muscles. The sciatic nerve was seen as a hyperechoic triangle with an approximate diameter of 1.5-2 cm within the subgluteal / space at this level. A short bevel 100 mm, 21 gauges insulated nerve block needle was inserted parallel and in line (in the plane) with the US transducer. According to the group assignment, after a negative aspiration of blood, the needle was advanced slowly until it became close to the sciatic nerve under the US guidance, 25 mL of the study solutions were deposited around the sciatic nerve in real time. Hemodynamics parameters like heart rate (HR), systolic arterial blood pressure (SAP), and diastolic arterial blood pressure (DAP) were recorded at 0 (baseline), 5, 10, 15, 30, 45, 60, 90, and 120 min after completion of the blockade were recorded.

Statistical Analysis

To compare the continuous data between the two groups, unpaired student's t-test was used. For analysis of categorical data, the chi-square test was used. For comparison of differences between the groups, repeated measure analysis of variance was used. Data were expressed as mean ± standard deviation or number (%). P value ≤0.05 was considered to be statistically significant.

Results

Table - 1 shows that there were no statistically differences between the two groups in demographic data.

Table - 2 shows that there were no statistically differences between the two groups in surgical characteristics.

Table - 3 shows that the onset time of sensory block, motor block and surgical anesthesia time were significantly shorter in group BD when compared to group B. The durations of sensory block, motor block and analgesia were longer in BD group when compared to group B.

Table - 4 shows that in group B the total analgesia requirement over 24 hours was 241.35±50.18 and in group BD, it was 100±80.24, P value was less than 0.01. 40% of patients needed analgesia in group B and 25% needed analgesia in group BD.

Systolic arterial pressure (SAP) and heart rate were significantly lower in group BD when compared to group B from 10 to 90 minutes after initiation of block (P<0.05), Diastolic arterial pressure was similarly lower in group BD at 45, 60, and 90 minutes following initiation of block. Bradycardia was seen in 8 patients in BD group

and no patient in B group. It was treated with atropine and did not recur again. Hypotension occurred in 3 patients in BD group and none in B group. No side effects were reported in both the groups. Hypertension, hypoglycaemia or hyperglycemia was not observed in any groups.

Table - 1: Demographic data.

Variable	Group B (n=40)	Group BD (n=40)	P value
Age (Years)	36.2±10.48	39.21±10.25	0.63
Height (cms)	168±2.87	174±3.29	0.22
Weight (Kgs)	75.1±10.7	76.28±6.44	0.40
Female/Male	18/22	10/30	0.45

Table - 2: Surgical Characteristics.

Variable	Group B (n=40)	Group BD (n=40)	P value
Duration of Surgery (min)	125±25.98	126.21±35.27	0.80
Type of Surgery			
Orthopaedic	23	25	0.527
Plastic	8	7	0.749
Vascular	6	5	0.998

Table - 3: Characters of the block and post-operative analgesia in both the groups.

Variable	Group B (n=40)	Group BD (n=40)	P value
Onset time of sensory block(min)	20.8±1.47	17.28±3.21	0.0012
Onset time of motor block(min)	25.89±2.58	21.98±2.11	0.0012
Surgical anaesthesia time(min)	30.87±1.87	24.08±2.82	0.0000
Duration of sensory block(min)	414.65±55.14	595.32±101.58	0.0001
Duration of motor block(min)	248±40	336±32.74	0.0001
Duration of analgesia (min)	463.28±57.11	808.98±114.27	0.0001

Table - 4: Total analgesia requirement over 24 hours in both the groups.

Variable	Group B (n=40)	Group BD (n=40)	P value
Total analgesia requirement over 24 hours	241.35±50.18	100±80.24	0.0002
Number of patients needed analgesia,%	40(100%)	25(62.5%)	0.0002
No. of patients developed bradycardia,%	0	8(20%)	0.0046
No. of patients developed hypotension,%	0	3(7.5%)	0.1500

Discussion

In this study, the effect of adding dexmedetomidine 100 µg to bupivacaine 0.5% used for US-guided combined sciatic and femoral nerve block for below-knee surgery was examined. Enhanced postoperative analgesia was observed on addition of dexmedetomidine through lengthening the time to the first analgesic request and reducing the postoperative analgesic consumption. More rapid onset of motor and sensory block with increased duration of block was observed. Kathuria S, et al. [7] reported in their study that sensory block and motor block onset was earlier in group which received 0.5% Ropivacaine with 50 µg Dexmedetomidine than in group which received 0.5% Ropivacaine and with intravenous infusion of 50 µg Dexmedetomidine in normal saline and group which received 0.5% ropivacaine. Sensory block and motor block duration was prolonged in group which received 0.5% Ropivacaine with 50µg Dexmedetomidine than in group which received 0.5% Ropivacaine and with intravenous

infusion of 50 μg Dexmedetomidine in normal saline and group which received 0.5% Ropivacaine, whereas in the present study, the onset time of sensory block, motor block and surgical anesthesia time were significantly shorter in group which received Bupivacaine-Dexmedetomidine hydrochloride one mL, containing 100 μg, was added to 39 mL of Bupivacaine 0.5% when compared to group which received 1 mL of normal saline was added to the same volume of Bupivacaine 0.5%. The durations of sensory block, motor block and analgesia were longer in group which received Bupivacaine-Dexmedetomidine hydrochloride one mL, containing 100μg, was added to 39 mL of Bupivacaine 0.5% when compared to group which received 1 mL of normal saline was added to the same volume of Bupivacaine 0.5%. In Marhofer D, et al. [8] study, there were three groups, namely 3 ml Ropivacaine 0.75% (R), 3 ml Ropivacaine 0.75% plus 20 μg Dexmedetomidine (RpD), or 3 ml Ropivacaine 0.75% plus systemic 20 μg Dexmedetomidine (RsD) sensory onset time of UNB was not different between the study groups, whereas motor onset time was significantly faster in Group RpD when compared with the other study groups [mean (sd)] [21 (15) vs 43 (25) min in Group RsD and 47 (36) min in Group R, $P<0.05$ Group RpD vs other groups]. The duration of sensory block was 350 (54) min in Group R, 555 (118) min in Group RpD, and 395 (40) min in Group RsD ($P<0.01$ Group RpD vs other groups, $P<0.05$ Group RsD vs Group R). Motor block duration was similar to the duration of sensory block. In Kosugi T, et al. [9] study, Dexmedetomidine reversibly and concentration-dependently reduced the peak amplitude of CAPs (IC_{50} = 0.40 mmol·L^{-1}). This action was not antagonized by two α_2-adrenoceptor antagonists, yohimbine and atipamezole; the latter antagonist itself reduced CAP peak amplitude. Clonidine and oxymetazoline, two other α_2-adrenoceptor agonists, also inhibited CAPs; the maximum effect of clonidine was only 20%, while oxymetazoline was less potent (IC_{50} = 1.5 mmol·L^{-1}) than dexmedetomidine. On the other hand, (±)-adrenaline, (±)-noradrenaline, α_1-adrenoceptor agonist (-)-phenylephrine and β-adrenoceptor agonist (-)-isoprenaline (each 1 mmol·L^{-1}) had no effect on CAPs. Tetracaine reversibly reduced CAP peak amplitude (IC_{50} of 0.014 mmol·L^{-1}). Brummett CM, et al. [10] reported that enhancement in the duration of sensory and motor blockade significantly was observed when high-dose Dexmedetomidine added to Bupivacaine. Dexmedetomidine alone did not cause significant motor or sensory block. All of the nerves analyzed had normal axons and myelin at 24 hours and 14 days. Bupivacaine plus Dexmedetomidine showed less perineural inflammation at 24 h than the Bupivacaine group when compared with the saline control. Dalle, et al. [11] conducted a study which explained the direct action of α2-adrenoceptor agonists on the C nerve fibers of rabbit nerves. Popping DM, et al. [12] reported that clonidine prolonged the duration of postoperative analgesia (weighted mean difference 122 min; 95% confidence interval [CI] 74-169), sensory block (weighted mean difference 74 min; 95% CI 37-111), and motor block (weighted mean difference 141 min; 95% CI 82-199). In a subgroup of patients receiving an axillary plexus block, these effects were independent of whether clonidine was added to an intermediate or a long-acting local anesthetic. Clonidine increased the risk of arterial hypotension (odds ratio 3.61; 95% CI 1.52-8.55; number-needed-to-harm 11), orthostatic hypotension or fainting (odds ratio 5.07; 95% CI 1.20-21.4; number-needed-to-harm 10), bradycardia (odds ratio 3.09; 95% CI 1.10-8.64; number-needed-to-harm 13), and sedation (odds ratio 2.28; 95% CI 1.15-4.51; number-needed-to-harm 5).

Conclusion

This study showed that a prolonged duration of analgesia was associated with addition of Dexmedetomidine 100 μg to Bupivacaine 0.5% during US-guided combined femoral and sciatic block for below knee surgery and is also associated with significant bradycardia requiring treatment.

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