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Unilateral bupivacaine-fentanyl or bupivacaine-sufentanil spinal anaesthesia for arthroscopic knee surgery

RENATA KROBOT
JADRANKA PREMUŽIĆ
PATRICIA GRBČIĆ
NENAD VUCELIĆ

General hospital Varaždin, Department of anaesthesiology and intensive care, Ivana Meštrovića 2, 42000 Varaždin, Croatia

Correspondence:
Renata Krobot
General hospital Varaždin
Department of anaesthesiology and intensive care
Ivana Meštrovića 2, 42000 Varaždin, Croatia
E-mail: renata.krobot@vz.t-com.hr

Abbreviations:
ASA – American Society of Anaestheiologist
SAP – systolic arterial pressure
DAP – diastolic arterial pressure
MAP – mean arterial pressure
HR – heart rate

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Abstract

Background and purpose: *Unilateral spinal anaesthesia provides high cardiovascular stability and short ambulatory stay. Intrathecal coadministration od local anaesthetics and opioids has potent synergistic analgesic effect. We compared unilateral hyperbaric bupivacaine spinal anaesthesia with fentanyl or sufentanil in patients undergoing knee arthroscopy.*

Materials and methods: *40 ASA I-II adults received unilateral spinal anaesthesia with hyperbaric bupivacaine 4mg coadministered with either fentanyl 20μg (Group F,n=20) or sufentanil 2 μg (Group S, n=20). Sensory and motor block, hemodynamic data, side-effects and time to first analgesic were recorded.*

Results: *Anaesthesia was successful in all 40 patients. Upper level of sensory block on operative leg was Th12 (Th12-Th8) in Group F and Th12 (Th11-Th9) in Group S, P=0.89. Complete motor block had 5 (25%) Group F and 3 (15%) Group S patients, P=0.69. uration of motor block was 78 ± 15 and 77 ± 13 min in Group F and Group S, respectively, P=0.89. Maximum decrease of baseline systolic arterial pressure was 16 ±9 in Group F and 17 ± 7% in Group S, P=0.81 and of HR 16 ± 7 and 16 ± 8%, P=0.90, respectively. Time to first analgesic was 285 ± 123 min in Group F and 355 ± 110 min in Group S, P=0.04. Pruritus had 7 (35%) Group F and 5 (25%) Group S patients, P=0.73.*

Conclusions: *Unilateral hyperbaric bupivacaine spinal anaesthesia with fentanyl or sufentanil resulted in similar sensory and motor block and cardiovascular stability but bupivacaine-sufentanil combination provided prolonged first analgesic time.*

INTRODUCTION

Unilateral spinal anaesthesia is a technique of spinal anaesthesia in which the use of small doses of hypobaric or hyperbaric local anaesthetic solutions slowly injected through directional, pencil-point needle and lateral decubitus position maintained for a certain period, restricts the distribution of spinal block preferentially to the operative side *(1)*. Unilateral spread of spinal block provides high cardiovascular stability, increased autonomy after surgery, early recovery and short ambulatory stay *(2, 3)*.

Various intrathecal adjuvants, such as opioids, epinephrine, neostigmine and clonidin have been often coadministrated with local anaesthetics to improve the quality and duration of spinal block or to minimize the dose of local anaesthetic injected to reduce adverse effects of sympathetic blockade *(4)*. Administration of opioids into the subarachnoid space produces a marked and selective inhibition of small fibers Aδ and C involved in the pain sensation and thus enhances sensory without increasing motor or sympathetic blockade. However, intrathecal opioids also may produce several side effects, such as nausea, vomiting, pruritus and respiratory depression in a dose dependent fashion *(4)*.

Recently, only a few studies investigated intrathecal local anaesthetic-opioid coadministration in patients receiving unilateral spinal anaesthesia *(5-9)*. In this prospective, randomized, double-blind study we compared clinical profile of unilateral spinal anaesthesia produced with hyperbaric bupivacaine 4 mg coadministered with either fentanyl 20 μg or sufentanil 2 μg in patients undergoing arthroscopic knee surgery.

MATERIAL AND METHODS

After obtaining written informed consent, a total of 44 ASA physical status I-II patients undergoing knee arthroscopic surgery under unilateral spinal anaesthesia were included in study. One patient with contraindication to regional anaesthesia and three other patients receiving chronic analgesic therapy were excluded. Remaining 40 patients were premedicated with peroral midazolam (7.5 mg) 45 minutes before spinal block. A 20-gauge intravenous cannula was inserted on the forearm and intravenous infusion of 7 mL/kg of Ringer solution was started after arrival in the operating room. Standard intraoperative monitoring, including pulse oxymetry, heart rate and noninvasive blood pressure was used.

Using a sealed enveloped technique, patients were randomly assigned to one of two groups. In Group F (n = 20), patients intrathecally received 4 mg of hyperbaric bupivacaine coadministered with 20 μg of fentanyl (0.5% plain bupivacaine 0.8 mL + fentanyl 0.4 mL + 40% dextrose 0.3 mL) and in Group S (n = 20), patients intrathecally received 4 mg of hyperbaric bupivacaine coadministered with 2 μg of sufentanil (0.5% plain bupivacaine + sufentanil 0.4 mL + 40% dextrose 0.3 mL).The both hyperbaric anaesthetic-opioid solutions in total volume of 1.5 mL and final dextrose concentration of 8% were aseptically prepaired just before spinal injection by an anestehsiologsit who was not involved in further patient care. Patients were placed in the lateral position lying on the operated side. Dural puncture was performed at the L3-L4 intervertebral space, using a 22-gauge introducer and 27-gauge pencil-point spinal needle with the orifice directed toward the dependent side. Anaesthetic solution was slowely injected over 60 seconds and lateral position was maintained for 15 minutes before patient was placed supine. Sensory and motor blocks were evaluated bilaterally by an independent anaesthesiologist not informed about study design and blinded to the injected anaesthetic solution. The level of sensory block was assessed by loss of pinprick sensations every 5 minutes from the end of spinal injection until the maximum level was reached. Motor blockade was assessed using a modified Bromage scale (0 = no motor block; 1 = hip blocked; 2 = hip and knee blocked; 3 = hip, knee and ankle blocked) (10), every 5 minutes during the first 30 minutes after spinal injection and then every 15 minutes until the complete motor block regression. In case of inadequate surgical anaesthesia, 100 μg of fentanyl with or without midazolam 2.5 mg was applied. Sedation score (0 = awake; 1 = asleep, open eyes to verbal stimulus; 2 = asleep, open eyes to physical stimuli; 3 = unarouseable) every 15 minutes during the first 2 hours after spinal injection was noted. Hemodynamic data (systolic, diastolic and mean arterial pressure and heart rate) were recorded every 10 minutes for the first 60 minutes after spinal injection. Clinically relevant hypotension (decrease in systolic arterial blood pressure ≥ 30% from start value) was initially treated with a rapid intravenous infusion of 250 mL of Ringer solution, and if that was ineffective, intravenous bolus of ephedrine 5–10 mg was given. Clinically relevant bradycardia (decrease in heart rate to less than 45 bpm) was treated with 0.5 mg of intravenous atropine. Postoperatively, rescue analgesic therapy (75 mg of intravenous diclofenac) was given on patient request and the time between spinal injection and first analgesic was recorded. Time to first micturition and side effects, such as pruritus, nausea, vomiting, respiratory depression (frequency of breathing < 8 per min or SaO_2 < 90%), postdural puncture headache or neurological complications were also documented. Data were statistically analysed and expressed as mean ± standard deviation (SD) or median ± range for quantitative variables and percentage of patients for nominal variables. Averages were compared using unpaired two-sample t-test or Mann-Whitney U test when appropriated and proportions were compared using Fisher's exact test. P value less than 0.05 was considered statistically significant.

RESULTS

Groups were comparable with respect to patient characteristics and operation time (Table 1) and basal values of systolic, diastolic and mean arterial blood pressure and heart rate (Table 2). Anaesthesia was adequate in all 40 patients and none of the patients in both groups required fentanyl or midazolam supplementation. Maximum level of sensory block on operative side was Th12 (Th12-Th8) in Group F and Th12 (Th12-Th9) in Group S, P=0.89.

Motor block was strictly unilateral (modified Bromage score=0 on the nonoperative side throughout the study period) in all 40 patients in both groups. Complete motor block (modified Bromage score 3) on operative leg had 5 (25%) Group F and 3 (15%) Group S patients, P=0.69. The mean modified Bromage score on operative leg during 180 min after block placement are shown in Figure 1. Duration of motor block was 78 ± 15 min and 77 ± 13 min in Group F and Group S, respectively,

TABLE 1

Patients characteristics and operation time.

	Group F (n = 20)	Group S (n = 20)	P
Age (years)	40 ± 19	37 ± 16	0.33
Gender			
male	14 (70)	12 (60)	0.74
female	6 (30)	8 (40)	
Weight (kg)	83 ± 14	79 ± 16	0.34
Height (cm)	172 ± 8	174 ± 10	0.39
ASA physical status			
I	12 (60)	15 (75)	0.50
II	8 (40)	5 (25)	
Operation time (min)	37 ± 12	39 ± 16	0.80

Values are mean ± standard deviation or number of patients; ASA: American Society of Anaesthesiologist

TABLE 2

Basal hemodynamic parameters.

	Group F (n = 20)	Group S (n = 20)	P
SAP (mmHg)	135 ± 12	129 ± 15	0.49
DAP (mmHg)	74 ± 8	72 ± 13	0.58
MAP (mmHg)	94 ± 10	91 ± 13	0.40
HR (bpm)	78 ± 14	74 ± 12	0.36

Values are mean ± standard deviation. SAP: systolic arterial pressure; DAP: dyastolic arterial pressure; MAP: mean arterial pressure; HR: heart rate

P=0.89. There were no significant differences between the two groups regarding systolic and diastolic arterial pressure (Figure 2), mean arterial pressure and heart rate (Figure 3) during all 60 minutes after spinal administration. Maximum decrease of SAP start value was 16 ± 9% in Group F and 17 ± 7% in Group S, P = and of HR 16 ± 7% and 16 ± 8%, P=0.90, respectively. No case of clinically relevant hypotension nor bradycardia were reported.

Time to first analgesic was 285 ± 123 min in Group F and 355 ± 110 min in Group S, P=0.04 and time to first micturition 241± 96 min and 229 ± 107 min, P = 0.79. Mild pruritus had 7 (35%) Group F and 5 (25%) Group S patients, P = 0.73. Sedation score ≥ 2 had 2 (10%) Group F and 4 (20%) Group S patients, P = 0.66. No postoperative headache, nausea, vomiting, respiratory depression or neurological complications were recorded.

DISCUSSION

Intrathecal anaesthesia is a relatively simple technique that provides deep and fast nerve block in large part of body through a relatively simple injection of a small amount of local anaesthetic *(4)*. Unilateral spinal anaesthesia, using small doses of nonisobaric local anaesthetic solutions slowly injected through directional pencile-point needle and lateral decubitus position maintained for at least 10 minutes, allows the spread of spinal block preferentially to the operative side. Unilateral distribution minimizes the effect of sympathetic blockade and represents a good option for elderly, compromised and ambulatory surgery patients *(11-13)*.

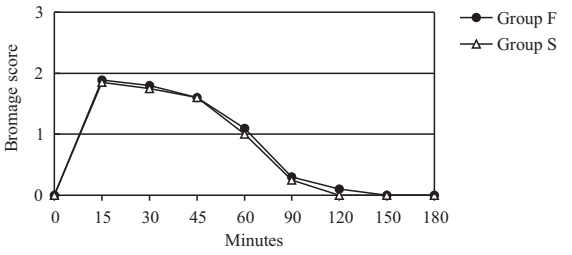

Figure 1. *Modified Bromage score on operative leg during 180 min after spinal injection.*

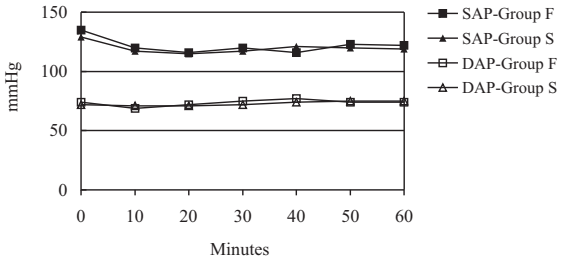

Figure 2. *The mean systolic arterial pressure (SAP) and diastolic arterial pressure (DAP) during the first 60 minutes after spinal injection.*

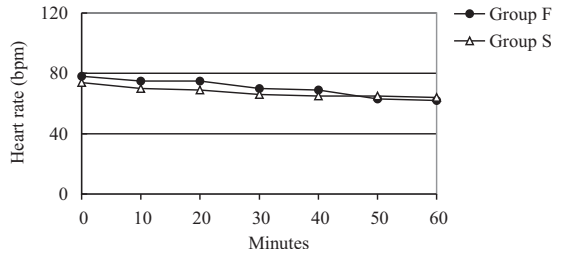

Figure 3. *The mean heart rate during the first 60 minutes after spinal injection.*

Intrathecal coadministration of local anaesthetics and opioids has a potent synergistic analgesic effect *(14)*. A dose of 0.1 mg morphine added to intrathecally administered bupivacaine improved the quality of pain control with minimal side effects *(15)*. However, morphine, because of its hydrophilicity, also has an enlarged potential for rostral migration in the CSF, possibly leading to a late respiratory depression *(4)*. Lipophilic opioids, like fentanyl and sufentanil, have a faster onset of action and lower risk for delayed respiratory depression *(16)*.

In this study we compared clinical profile of unilateral spinal anaesthesia produced with hyperbaric bupivacaine coadministered with either fentanyl or sufentanil in patients undergoing knee arthroscopy. We administered

20 μg of fentanyl or 2 μg of sufentanyl assuming that equipotent dose ratio for fentanyl/sufentanyl was 10:1. The study demonstrated similar sensory and motor block and cardiovascular stability in both groups. However, time to first analgesic was significantly prolonged in bupivacaine-sufentanil group and similar was observed in study reported by Kim *et al. (17)* but they compared intrathecal coadministration of fentanyl and sufentanil in assumed equipotent dose ratio 5:1 (fentanyl 25 μg compared to sufentanil 5 μg in patients undergoing transurethral prostatectomy). Kaira *et al.* compared the efficacy of bupivacaine-fentanyl and bupivacaine-sufentanil for epidural labor analgesia and concluded that sufentanil was 10 times more potent than fentanyl as an analgesic for continuous epidural labor analgesia *(18)*.

In study reported by Hamber and Viscorni, the duration of postoperative analgesia for fentanyl and sufentanil was reported to be 1–4 and 2–5 h, respectively, after intrathecal administration as an adjunct to surgical spinal anaesthesia and analgesia *(16)*. In this study, first postoperative analgetic drug given on patients request was administered 285 min (4 hours and 45 min) and 355 min (5 hours and 55 min) in bupivacaine-fentanyl and bupivacaine-sufentanil group, respectively.

Intrathecal opioids are known to inhibit bladder function, but in our study, we found no case of urinary retention requiring bladder catetherization in all 40 patients. Pruritus is a common and dose-realted complication in the patients receiving intrathecal opioids and the reported rate is 10–75% (5, 6, 19). In present investigation, coadministration of fentanyl resulted in mild pruritus in 35% and of sufentanil in 25% of the patients and did not require treatment. Respiratory depression, nausea and vomiting are well known complication of intrathecal opioids, but in our study no clinical manifestations of respiratory depression, nausea and vomiting were observed.

In conclusion, results of this prospective, randomized, double-blind study demonstrate that both, unilateral hyperbaric bupivacaine 4 mg + fentanyl 20 μg and hyperbaric bupivacaine 4 mg + sufentanil 2 μg spinal anaesthesia, provided adequate sensory block in operated leg and resultetd in similar motor block, cardiovascular stability and first micturition time in patients undergoing knee arthroscopic surgery. However, bupivacaine-sufentanil combination was found to be superior because it provided prolonged first analgesic time and significantly longer duration of postoperative analgesia.

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