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ORIGINAL ARTICLE

Comparison of 0.25% levobupivacaine and 0.25% bupivacaine for posterior approach interscalene brachial plexus block

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Abstract
Purpose This study compares the onset time and quality of posterior approach interscalene brachial plexus block produced by 0.25% levobupivacaine and 0.25% bupivacaine.
Methods Sixty adult patients undergoing open or closed shoulder surgery were enrolled in this double-blind, randomized study, and they were randomly allocated to receive 40 ml of 0.25% levobupivacaine (Group L, $n = 30$) or 0.25% bupivacaine (Group B, $n = 30$). The patients were assessed at 5 min intervals after local anesthetic injection in order to determine loss of shoulder abduction and loss of pinprick sensation in the $C_{5–6}$ dermatomes. The mean onset time of motor and sensory block and onset time of complete motor and sensory block were documented in both groups.
Results In both groups, mean onset time of sensory block was <5 min and mean onset time of complete sensory block was <25 min. The onset times for sensory block and complete sensory block were not statistically different between the groups ($P > 0.05$). In both groups, mean onset time of motor block was <10 min but the mean onset time of complete motor block was <30 min. The onset times of motor block and complete motor block were not statistically different among the groups ($P > 0.05$). After the injection of the local anesthetic, 27% of Group L and 87% of Group B had complete motor block. Four patients in Group L had no motor block.
Conclusion We conclude that 0.25% levobupivacaine and 0.25% bupivacaine have similar motor and sensory block onset times and qualities when used in posterior approach interscalene brachial plexus block, and provide comfortable anesthesia and analgesia for shoulder surgery.

Keywords Brachial plexus block · Interscalene · Posterior approach · Levobupivacaine · Bupivacaine

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Introduction

Levobupivacaine is the latest local anesthetic introduced into clinical practice. Levobupivacaine is a *S*(−)-enantiomer of the racemic formulation of bupivacaine. While both the *R*- and *S*-enantiomers of bupivacaine show anesthetic activity, preclinical studies suggested that levobupivacaine might be less cardiotoxic than the racemic bupivacaine [1, 2].

Levobupivacaine has already been compared with racemic bupivacaine for spinal, epidural, and supraclavicular nerve blocks, but this new local anesthetic levobupivacaine has not been thoroughly compared with long-acting local anesthetic bupivacaine in posterior interscalene brachial plexus block [2–4].

Kappis [5] initially described posterior interscalene brachial plexus block in 1912. In 1990, Pippa et al. [6] reintroduced their approach, using a loss of resistance to air. A continuous paravertebral technique, using both the loss-of-resistance-to-air and nerve-stimulation methods, was described by Boezaart et al. [7] in 2003. The posterior approach technique for the brachial plexus appears to be effective and relatively safe for shoulder surgery [8].

The aim of this prospective, randomized, double-blinded study was to compare the onset time and quality of posterior interscalene brachial plexus block produced with 0.25% levobupivacaine to those produced with 0.25% bupivacaine in patients undergoing shoulder surgery.

Patients, materials and methods

After institutional ethical committee approval, 60 patients (classified as American Society of Anesthesiologists (ASA) physical status I–III) undergoing elective, open or closed shoulder surgery were recruited to participate into this double-blind, prospective, single-center, randomized trial. Written informed consent was obtained from each patient. The work presented here was performed in accordance with the most recent version of the Helsinki Declaration. The ages of the patients were between 18 and 70 years. Exclusion criteria included ASA physical status IV or V, coexisting cardiac, respiratory, hepatic and/or renal diseases, mental retardation, coagulopathy, pregnancy, allergy for local anesthetics, presence of neurological or neuromuscular disease, infection at the injection site, hemidiaphragmatic paralysis contralateral to the side of surgery, block failure, and not wanting to participate in the study.

Patients were randomized according to a computer-generated list of random numbers that were placed in opaque, sealed envelopes. All blocks were performed by the same anesthesiologist. Following the preoperative evaluation, the method was explained and the questions of the patients were answered on the day before the surgery. Routine monitors were applied in the operating room, including electrocardiograph, noninvasive blood pressure, and pulse oximeter (Petas, KMA275, Ankara, Turkey). A peripheral intravenous cannula was inserted into the contralateral arm. Before the block was performed, IV midazolam (0.03 mg kg^{-1}) and fentanyl (1–2 μg kg^{-1}) were given. All of the blocks were performed using the landmarks described by Pippa et al. [6]. The surface landmarks were identified with the patient in the sitting position with the head leaning forward. The needle entry site was located 3 cm lateral to the midpoint of the spinous processes of the sixth and seventh cervical vertebrae. After local skin infiltration with less than 2 mL lidocaine 2%, a 110 mm, 22-G stimulating needle (Contiplex D; B. Braun, Melsungen, Germany) connected to a nerve stimulator (Stimuplex HNS 11, B. Braun) was introduced perpendicular to the skin using a sterile technique. The insulated needle was advanced horizontally in the sagittal plane. The stimulation frequency was 2 Hz, the duration of the stimulating pulse was 0.1 ms, and the initial current intensity was 1.5 mA. The latter was gradually decreased after an appropriate motor response had been elicited. The correct placement of the needle was defined as being when isolated or mixed contractions of the deltoid muscle were evoked with an intensity of 0.3 mA. Patients were randomly assigned to receive 40 mL of one of two different solutions. Group L received 0.25% levobupivacaine (Chirocaine, Abbott Laboratories, North Chicago, IL, USA), while Group B received 0.25% bupivacaine (Marcaine, Astra Zeneca Laboratories, Sodertalje, Sweden). Local anesthetics were slowly injected with intermittent aspiration. Sensory and motor block were assessed at 5, 10, 15, 20, 25, 30, 45 and 60 min, and time 0 (zero) was defined as the end of the local anesthetic injection. Sensory block was assessed by pinprick test (27-gauge dental needle) in the dermatomes C_5–C_6 using a three-point scale (0, normal sensation; 1, dissociation or reduced sensation onset time of sensory blockade; and 2, no sensation at all, i.e., complete anesthesia), and was compared with a similar pinprick on the contralateral arm. Onset time was the time to first loss of pinprick sensation in any dermatome. Duration of sensory block was the time from onset to complete recovery of sensation. At the conclusion of surgery, all patients were transferred to the PACU (post-anesthesia care unit) or orthopedics service and reassessed to confirm sensory and motor blockade. Sensory and motor blockades were assessed in the PACU at the 0, 1st and 2nd hours, while the latter was assessed at the 4th, 6th, 12th, 18th and 24th hours in the orthopedics service by the same anesthetist.

Motor block was evaluated by abduction of the shoulder (axillary nerve, C5–C6) using a three-point scale (0, normal motor movements; 1, no movements with slight resistance, i.e., partial motor blockade; and 2, no movements, i.e., complete motor block).

Immediately after the block was considered adequate, a clinician who was unaware of the injected solution evaluated the patients to determine the loss of shoulder abduction (deltoid sign) as evidence of a successful motor blockade and sensory block by pinpricking the C_5–C_6 dermatomes every 5 min [9]. After evidence of a successful sensory and motor block had been obtained, the patient was taken to the operating room for surgery.

All episodes of local anesthetic toxicity or hemodynamic change requiring anesthesiologist intervention (increased IV fluids or inotropes) were recorded as adverse events. Side effects, including Horner's syndrome, dysphonia, difficulty breathing and clinical signs of bilateral epidural anesthesia or spinal anesthesia, were noted.

Failure to lose shoulder abduction after 45 min was considered to be a block failure. These patients underwent general anesthesia and were excluded from the statistical analysis.

Postoperative analgesia consisted of 1 g IV acetaminophen every 6 h with the first administration at the end of surgery.

Patient satisfaction was evaluated 24 h after surgery with a two-point score: 1 = satisfied—if operated on again in the future, they would ask for the same procedure;

2 = unsatisfied—if operated on again in the future, they would ask for a different anesthetic technique.

Statistical analysis

The data obtained at the end of the study were analyzed using SPSS for Windows, version 11.5. The correspondence of the continuous measured data distribution to the normal distribution was examined with the Shapiro–Wilk test. Definitional statistics for continuous measured data are presented as mean ± SD or median (min–max), and for nominal variables as case number and percentage. Statistically significant differences between groups based on mean values were checked for using Student's t test, and significant differences in median values were tested for with the Mann–Whitney U test. Categorical variables were analyzed with Pearson's χ^2 test and Fisher's exact test. A P value of <0.05 was considered statistically significant.

Nineteen patients per group were required to detect a 10-min difference in the onset time of surgical block between the two groups, accepting a two-tailed α error of 5% and a β error of 20%. Based on this potential difference, the sample size for the hospital was increased to 30 patients.

Results

There were no differences in age, gender, weight, height, duration of surgery, distance to brachial plexus, or ASA classification between the groups (Table 1). A single attempt to successfully identify the brachial plexus was sufficient in all of the patients.

There were no differences in type of surgery between the groups (Table 2).

The mean onset times for sensory block and complete sensory block (by pinprick) are depicted in Table 3. In both groups, the mean onset time for sensory block was <5 min. The onset time for sensory block was not statistically different between the groups ($P > 0.05$). In both groups, the mean onset time for complete sensory block was <25 min. The onset time for complete sensory block was not statistically different among the groups ($P > 0.05$).

In both groups, the mean onset time for motor block was <10 min. The onset of motor block was not statistically different among the groups ($P > 0.05$). In both groups, the mean onset time for complete motor block was <30 min. The onset time for complete motor block was not statistically different among the groups ($P > 0.05$).

The duration of sensory block is depicted in Table 3. The duration of sensory block was not statistically different among the groups ($P > 0.05$).

After the injection of the local anesthetic, 27% of Group L and 87% of Group B had complete motor block ($P < 0.001$). Four patients in Group L had no motor block (Table 4).

The patients then underwent surgery under regional anesthesia alone. During surgery, additional medication was not provided.

In Group B, one patient had bradycardia as a complication, but we did not experience any other complication in either group.

All patients stated they would accept the same anesthetic procedure for future operation.

Discussion

Several techniques have been proposed for brachial plexus block for shoulder surgery. Anterior, lateral, and posterior approaches have been described at the cervical level. The posterior approach technique for the brachial plexus appears to be effective, relatively safe, and well tolerated [8].

Table 1 Demographic characteristics of the two groups

Variations	Group L ($n = 30$)	Group B ($n = 30$)	P
Age (year)	46.1 ± 13.7	51.4 ± 9.7	0.449[a]
Gender (M/F)	10/20	14/16	0.456[b]
Weight (kg)	70.5 ± 9.8	72.5 ± 9.7	0.524[a]
Height (cm)	164.4 ± 7.9	159.1 ± 25.0	0.270[a]
ASA I/II/III	8/22/0	8/20/2	0.838[b]
Duration of surgery (min)	52 (15–110)	42 (20–100)	0.233[c]
Number of attempts	1 (1–2)	1 (1–2)	1.000[c]
Distance to brachial plexus (cm)	6 (5–8)	7 (6–10)	0.056[c]

Values are the median (range), mean ± SD, or number of patients (n). There were no significant differences between the two groups

[a] Student's t test

[b] Pearson's χ^2 test

[c] Mann–Whitney U test

Table 2 Type of surgery

Variations	Group L ($n = 30$)		Group B ($n = 30$)	
	n	%	*n*	%
Shoulder acromioplasty	18	60	16	53
Rotator cuff repair	10	33	12	40
Other	2	7	2	7

Values are numbers of patients (*n*) and percentages (%). There were no significant differences between the two groups

Levobupivacaine is preferred as an alternative long-acting local anesthetic to bupivacaine. An optimal local anesthetic for neural blockade must have a short onset time, a long duration of blockade, and minimal side effects.

Although there are a few studies on neural blockade using levobupivacaine, equal concentrations of levobupivacaine and bupivacaine have similar effects on regional anesthetic manipulations [10]. Levobupivacaine has not been compared with bupivacaine for posterior interscalene brachial plexus block.

In our study, the levobupivacaine 0.25% and bupivacaine 0.25% groups showed fast onset times when evaluating shoulder abduction and loss of pinprick sensation in the C_5 and C_6 dermatomes. The onset times for sensory and motor blockades in the levobupivacaine and bupivacaine groups have been reported as <5 and <10 min, respectively, and this is not a statistically significant difference. The onset times for complete sensory and motor blockade in the levobupivacaine and bupivacaine groups have been reported as being <25 and <30 min, respectively, and this is not a statistically significant difference. The duration of sensory block did not differ among the groups; it was <7 h in both. According to this evaluation, there is no clinical advantage to selecting one local anesthetic over the other based on the onset time and the duration of neural blockade. Similar to the results obtained in our study; Cox et al. reported a mean onset time of 6–8 min when comparing 0.4 mL kg^{-1} of 0.25 and 0.5% levobupivacaine and 0.5% bupivacaine for supraclavicular brachial plexus block. Clinical assessments were not significantly different in terms of onset time, dermatomal spread and durations of both sensory and motor block between the three groups. Cox et al. [4] concluded that *S*(−)-bupivacaine was suitable for use as a local anesthetic in brachial plexus block anesthesia. In some studies with levobupivacaine and bupivacaine, the duration of sensory block was reported to be longer than what we observed [4, 11–13]. This difference may be due to a low concentration, a low dosage, or a different neural blockade technique. Studies on sensory onset time, quality of sensory block, and duration of peripheral nerve block with levobupivacaine have shown different results. This more frequent rate may be explained by differences in the local anesthetic volume (20 ml vs 0.4 ml/kg) or by slight methodological differences in the assessment of blockade [4, 14, 15]. Pippa et al. [16] concluded that a lower concentration of anesthetic solution avoids complications, while an increased volume provides good analgesic cover. In our study, the rate of complete motor blockade between groups differs to that reported by Cox et al. Cox et al. [4] found that 68% of patients had a "satisfactory block" after a supraclavicular brachial plexus

Table 3 Block characteristics in the two groups

Variations	Group L	Group B	*P*
Onset time for sensory block (min)	5 (5–15) ($n = 30$)	5 (5–10) ($n = 30$)	0.624[a]
Complete sensory block (min)	25 (15–45) ($n = 30$)	22.5 (10–60) ($n = 30$)	0.880[a]
Onset time for motor block (min)	10 (5–20) ($n = 26$)	10 (5–10) ($n = 30$)	0.387[a]
Complete motor block (min)	25 (15–30) ($n = 8$)	30 (10–60) ($n = 26$)	0.412[a]
Duration of sensory block (min)	420 (300–510) ($n = 30$)	420 (240–720) ($n = 30$)	0.806[a]

Values are median (range). There were no statistically significant differences between the groups

[a] Mann–Whitney *U* test

Table 4 Motor block

Three-point scale	Group L ($n = 30$)		Group B ($n = 30$)		*P*
	n	%	*n*	%	
1 (No motor block)	4	13	–	0	0.066
2 (Partial motor block)	18	60	4	13	<0.001*
3 (Complete motor block)	8	27	26	87	<0.001*

Values are numbers of patients (*n*) and percentages (%)

* $P < 0.01$ between groups

block in a surgical setting. Urbanek et al. [14] found that 45% of patients reached complete anesthetic blockade with 0.25% levobupivacaine. After the local anesthetic had been injected, 87% of the bupivacaine group and 27% of the levobupivacaine group showed complete motor block in our study (Table 4). This study found that the rate of complete motor blockade was significantly higher in the bupivacaine group than in the levobupivacaine group during posterior approach interscalene brachial plexus nerve block. Ropivacaine, levobupivacaine, and bupivacaine belong to the pipecolylxylidine homologous series of local anesthetics that have an ability to cause differential sensory and motor neural blockade. The *S*-enantiomers, ropivacaine and levobupivacaine, produce less motor block than racemic bupivacaine when administered by the epidural route [17, 18]. There is a clinical profile of potency for motor block for the pipecolylxylidines when administered spinally: low, intermediate and high for ropivacaine, levobupivacaine and bupivacaine, respectively [19]. In posterior approach interscalene brachial plexus block, bupivacaine may be more potent, as observed for the epidural and spinal administration routes. The cause of or mechanisms behind the difference in rate of motor blockade between the two drugs may be resolved in future studies.

Based on our study, although levobupivacaine may be much more preferable because of its reduced cardiotoxic and neurotoxic side effects and less complete motor blockade, posterior interscalene brachial plexus block with 0.25% levobupivacaine and 0.25% bupivacaine at a dosage of 100 mg provides comfortable anesthesia and analgesia for shoulder surgery.

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References

1. Casati A, Borghi B, Fanelli G, Montone N, Rotini R, Fraschini G, et al. Interscalene brachial plexus anesthesia and analgesia for open shoulder surgery: a randomized, double-blinded comparison between levobupivacaine and ropivacaine. Anesth Analg. 2003;96:253–9.
2. Foster RH, Markham A. Levobupivacaine: a review of its pharmacology and use as a local anaesthetic. Drugs. 2000;59:551–79.
3. Mazoit JX, Boico O, Samii K. Myocardial uptake of bupivacaine: II. Pharmacokinetics and pharmacodynamics of bupivacaine enantiomers in the isolated perfused rabbit heart. Anesth Analg. 1993;77:477–82.
4. Cox CR, Checketts MR, Mackenzie N, Scott NB, Bannister J. Comparison of *S*(−)-bupivacaine with racemic (*RS*)-bupivacaine in supraclavicular brachial plexus block. Br J Anaesth. 1998;80:594–8.
5. Kappis M. Weitere erfahrungen mit der sympathektomie. Klin Wchnschr. 1923;2:1441.
6. Pippa P, Cominelli E, Marinelli C, Aito S. Brachial plexus block using the posterior approach. Eur J Anaesth. 1990;7:411–20.
7. Boezaart AP, Koorn R, Rosenquist RW. Paravertebral approach to the brachial plexus: an anatomic improvement in technique. Reg Anesth Pain Med. 2003;28:241–4.
8. Sandefo I, Iohom G, Van Elstraete A, Lebrun T, Polin B. Clinical efficacy of the brachial plexus block via the posterior approach. Reg Anesth Pain Med. 2005;30:238–42.
9. Wiener DN, Speer KP. The deltoid sign. Anesth Analg. 1994;79:192.
10. Casati A, Putzu M. Bupivacaine, levobupivacaine and ropivacaine: are they clinically different? Best Pract Res Clin Anaesthesiol. 2005;19:247–68.
11. Piangatelli C, De Angelis C, Pecora L, Recanatini F, Cerchiara P, Testasecca D. Levobupivacaine and ropivacaine in the infraclavicular brachial plexus block. Minerva Anesthesiol. 2006;72:217–21.
12. Klein SM, Greengrass RA, Steele SM, D'Ercole FJ, Speer KP, Gleason DH, et al. A comparison of 0.5% bupivacaine, 0.5% ropivacaine, and 0.75% ropivacaine for interscalene brachial plexus block. Anesth Analg. 1998;87:1316–9.
13. Casati A, Fanelli G, Cappelleri G, Beccaria P, Magistris L, Borghi B, et al. A clinical comparison of ropivacaine 0.75%, ropivacaine 1% or bupivacaine 0.5% for interscalene brachial plexus anaesthesia. Eur J Anaesthesiol. 1999;16:784–9.
14. Urbanek B, Duma A, Kimberger O, Huber G, Marhofer P, Zimpfer M, et al. Onset time, quality of blockade, and duration of three-in-one blocks with levobupivacaine and bupivacaine. Anesth Analg. 2003;97:888–92.
15. Crews JC, Weller RS, Moss J, James RL. Levobupivacaine for axillary brachial plexus block: pharmacokinetic and clinical comparison in patients with normal renal function or renal disease. Anesth Analg. 2002;95:219–23.
16. Pippa P, Cuomo P, Panchetti A, Scarchini M, Poggi G, D'Arienzo M. High volume and low concentration of anaesthetic solution in the perivascular interscalene sheath determines quality of block and incidence of complications. Eur J Anaesthesiol. 2006; 23:855–60.
17. Lacassie HJ, Columb MO, Lacassie HP, Lantadilla RA. The relative motor blocking potencies of epidural bupivacaine and ropivacaine in labor. Anesth Analg. 2002;95:204–8.
18. Lacassie HJ, Columb MO. The relative motor blocking potencies of bupivacaine and levobupivacaine in labor. Anesth Analg. 2003;97:1509–13.
19. Camorcia M, Capogna G, Berritta C, Columb MO. The relative potencies for motor block after intrathecal ropivacaine, levobupivacaine, and bupivacaine. Anesth Analg. 2007;104:904–7.