Dokkyo Journal of Medical Sciences
32(1) : 1～5, 2005

Originals

Differences In Duration and Magnitude of Vasodilative Effect by Sympathetic Block with Ropivacaine 0.2% and Mepivacaine 0.5% in Dogs

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SUMMARY

To clarify differences in the duration and magnitude of vasodilative effect induced by sympathetic block with ropivacaine and mepivacaine. We measured mean arterial pressure (MAP), heart rate (HR), and right and left brachial artery blood flow (BABF) before and after stellate ganglion block (SGB) used as sympathetic block in twelve dogs. The experimental protocol was designed as follows : (1) left SGB using 0.2% ropivacaine 1.0 mL (n = 6) and left SGB using 0.5% mepivacaine 1 mL (n = 6). MAP and HR did not change significantly throughout the study in either group. Left SGB with ropivacaine increased left BABF significantly from 5 min through 80 min after SGB (baseline, 100% ; peak at 10 min after SGB, 257 ± 39% ; $P < 0.01$). Left SGB with mepivacaine increased left BABF significantly from 5 min through 50 min after SGB (baseline, 100% ; peak at 10 min after SGB, 183 ± 31% ; $P < 0.01$). The values of left BABF after SGB with ropivacaine were significantly higher than those of SGB with mepivacaine from 5 min through 80 min after the block. Right BABF after left SGB decreased in both groups. Sympathetic block with 0.2% ropivacaine induces significant increases in both duration and magnitude of action in the peripheral blood flow compared with that of 0.5% mepivacaine.

Key Words : Ropivacaine, Sympathetic block, brachial artery blood flow

INTRODUCTION

Ropivacaine, a new amino-amide local anesthetic agent, is a long-acting anesthetic. Sensory and motor blocks with ropivacaine have been examined in human and animal experiments[1～3]. But, little is known about the duration and magnitude of action of ropivacaine when applied for sympathetic block. In the present study, we examined the duration and magnitude of the increase in vasodilation induced by stellate ganglion block (SGB) with ropivacaine, and compared them with those of mepivacaine in anesthetized dogs.

Received July 30, 2004 ; accepted September 21, 2004
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MATELIALS AND METHODS

This study was conducted in accordance with the animal experimental guidelines of Dokkyo University School of Medicine, which adhere to the National Institute of Health Animal Experimental Guidelines.

Twelve adult mongrel dogs of either sex (10 − 19 kg) were anesthetized with an intravenous injection of sodium pentobarbital 25 mg/kg, and the tracheas were intubated. Mechanical ventilation was adjusted to provide $PaCO_2$ between 35 and 40 mmHg using a respirator (Harvard Apparatus, Chicago, IL), and anesthesia was maintained with the intravenous administration of pentazocine 0.5 mg/kg and diazepam 0.05 mg/kg and vecuronium 0.1 mg/kg. The left femoral artery was cannulated with a

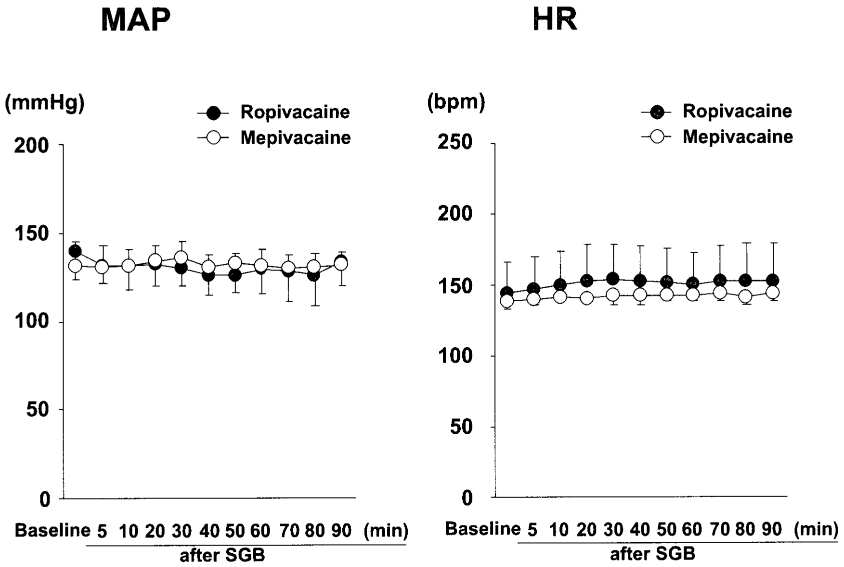

Fig. 1 Changes in mean arterial pressure (MAP) and heart rate (HR) before and after stellate ganglion block (SGB) with ropivacaine or mepivacaine. Values are shown as mean ± SD.

polyethylene catheter (outer diameter 2.75 mm) to measure mean arterial pressure (MAP), and to obtain blood samples for arterial blood gases. Electrocardiography was used throughout the experiment to monitor heart rate (HR). Bilateral brachial arteries were carefully dissected from the adjacent tissue, and 2-mm ultrasonic flow probes (transonic system) were placed in the center of the proximal portion of the arteries. Right and left brachial artery blood flow (BABF) was measured using an ultrasonic timed flowmeter [transonic T206 Transonic System Inc, lthaca, New York 14850 USA]. Physiologic saline solution was continuously infused intravenously at a rate of 3 mL/kg/hr from the left femoral vein during the study. The room temperature was kept at a constant 24 ℃.

The left stellate ganglion was then exposed by a left lateral thoracotomy at the second and third intercostal space. A 25-gauge winged needle was placed adjacent to the ganglion with suture for performing stellate ganglion block, one type of sympathetic block, and the chest was closed.

After stabilization of hemodynamic parameters for 20 min, the following baseline measurements were taken : MAP, HR, and left and right BABF. The dogs were then randomly divided into two groups : (1) left SGB with 0.2% ropivacaine 1.0 mL (n = 6) and (2) left SGB with 0.5% mepivacaine 1.0 mL (n = 6).

Hemodynamic parameters were recorded 5, 10, 20, 30, 40, 50, 60, 70, 80, and 90 min after SGB by the blinded observer. All values of BABF were described as percentages of change from the baseline value.

Blood gas analysis was performed before SGB (baseline) and at the end of the experiment.

Data are presented as mean ± SD. Statistical analyses within a group were performed by repeated-measures ANOVA with Bonferroni's correction as post hoc testing. Comparison between both groups was made by applying the Mann-Whitney's U-test. The threshold for statistical significance was $P < 0.05$.

RESULTS

MAP and HR did not change significantly throughout the study in either group (Figure 1). Figure 2 compares changes on left BABF after left SGB with ropivacaine or mepivacaine. In SGB with ropivacaine, left BABF increased significantly by 257% (baseline 100% ; 10 min after SGB) from 5 min through 80 min after the block. Significant increases in left BABF after left SGB with mepivacaine were measured from 5 min through 50 min and peaked at 183% (baseline 100%) at 10 min. Left BABF in left SGB with ropivacaine was significantly higher than those of SGB with mepivacaine from 5 min through 80 min after the block. As shown in Figure 3, right BABF in left SGB with ropivacaine decreased significantly 20 min through 90 min after the block.

Right BABF in left SGB with mepivacaine decreased significantly from 5 min to 90 min except for 60 min after

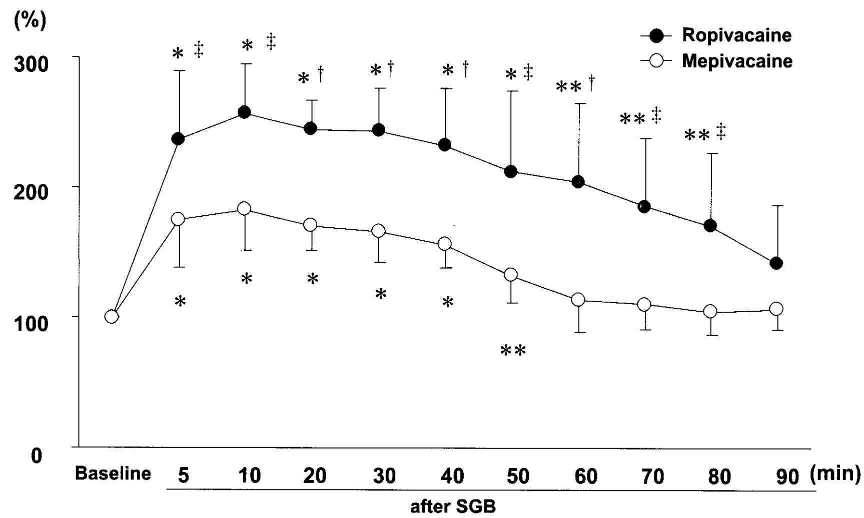

Fig. 2 Changes in left brachial artery blood flow (BABF) before and after left stellate ganglion block (SGB) with ropivacaine or mepivacaine. * $p < 0.01$ vs baseline ; ** $p < 0.05$ vs baseline. † $p < 0.01$ vs mepivacaine ; ‡ $p < 0.05$ vs mepivacaine. Values are shown as mean ± SD.

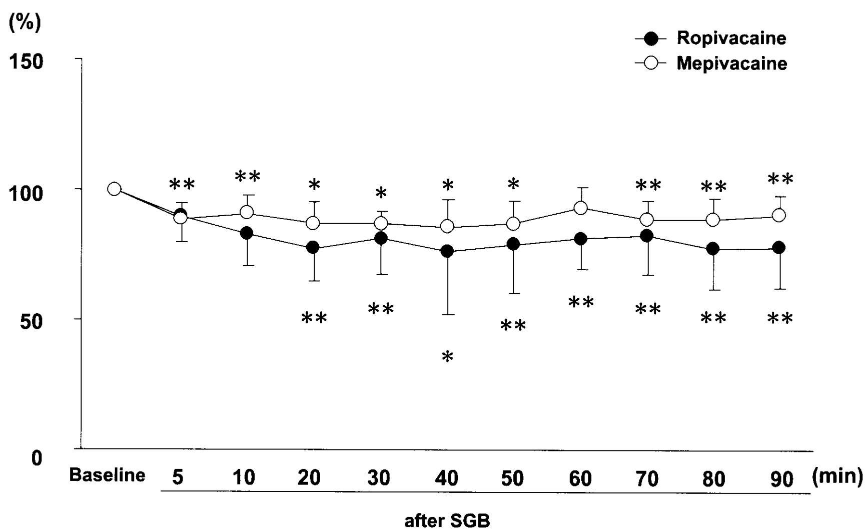

Fig. 3 Changes in right brachial artery blood flow (BABF) before and after left stellate ganglion block (SGB) with ropivacaine or mepivacaine. * $p < 0.01$ vs baseline ; ** $p < 0.05$ vs baseline. Values are shown as mean ± SD.

the block. There were no significant differences in right BABF in either group.

$PaCO_2$ was maintained at 35 to 41 mmHg and PaO_2 was maintained at 84 to 95 mmHg before SGB and at the end of the experiment in both groups.

DISCUSSION

A new local anesthetic agent, ropivacaine should be a useful alternative to bupivacaine because of its long duration of action and less cardiotoxicity compared with bupivacaine[4~7]. Cederholm *et al.*[8] examined sympathetic block for 30 min after epidural administration of 0.5% or 0.75% ropivacaine 20 mL in patients receiving transurethral surgery using skin resistance level, skin resistance response, skin temperature, and skin blood flow for evaluation of sympathetic nerve activity. The majority of patients had a marked or complete sympathetic block in the lower extremity. However, the sympathetic nerve is interrupted with a lower concentration of local anesthetics compared with the sensory nerve. Therefore, in the present study, we used 0.2% ropivacaine and 0.5% mepivacaine the were used as a lowest concentration in clinical setting because epidural block with 0.2% ropivacaine or axillary block with 0.5% mepivacaine produced even sensory block [9,10].

In the present study, SGB with 0.2% ropivacaine 1.0 mL induced a significant increase of BABF for 80 min, and significantly increased both duration and magnitude of the vasodilative effect compared with that of 0.5% mepivacaine. From our data, sympathetic block with 0.2% ropivacaine may induce approximately 1.5-fold prolongation and two-fold magnitude of increased blood flow compared with that of 0.5% mepivacaine. In the clinical studies, nerve blocks with 0.75% ropivacaine provide an onset time similar to that of 2% mepivacaine,[11~14] and postoperative analgesia is more long-lasting with ropivacaine[11~15]. Casati *et al.*[16] reported that postoperative analgesia using brachial plexus block with 0.5%, 0.75% or 1% ropivacaine was approximately two-fold longer compared with that of 2% mepivacaine. The duration of action of local anesthetics is markedly influenced by their peripheral vascular effects[17]. Mepivacaine has a vasodilative effect at clinically used concentrations, whereas the vasoconstrictive property of ropivacaine may help to prolong the longer duration of action on sympathetic block because vascular uptake of the agent surrounding neural structures is delayed.

Sympathetic block with local anesthetics has been widely used in the treatment of peripheral vascular or pain diseases. SGB produces vasodilation in the blocked side of the upper extremity to inhibit transmission of nerve impulse to the blood vessels innervated by the ganglion. Sympathetic block with local anesthetic not only produces an increase of localized blood flow but also relieves pain. Sympathetic block is useful for diagnosis and treatment in patients with pain diseases such as complex regional pain syndromes. When the patient responds to the sympathetic block, it is usually repeated with a local anesthetic. From this study, ropivacaine is preferable when a longer duration of nerve block is anticipated.

In the present study, SGB induced a decrease of contralateral BABF probably due to compensatory vasoconstriction[18]. We need to recognize this phenomenon when sympathetic block is performed in patients with peripheral vascular diseases of bilateral upper or lower extremities.

Malmqvist *et al.*[19] suggested that sympathetic block was complete when skin blood flow reached 50% or more of the baseline value 30 min after the block. In the present study, the blocked side of BABF increased significantly (by 144%) 30 min after SGB with 0.2% ropivacaine 1.0 mL. Since SGB with 0.5% mepivacaine 1.0 mL induced 67% of increase of BABF 30 min after the block, SGB with 0.2% ropivacaine may produce a more than two-fold increase of peripheral blood flow 30 min after the block compared with that of 0.5% mepivacaine.

In conclusion, SGB with 0.2% ropivacaine produces a significant increase in the blocked side of BABF for 80 min after the block and significant increases in both duration and magnitude of action in BABF compared with that of 0.5% mepivacaine in dogs.

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