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Effect of Baricity of Bupivacaine on Median Effective Doses for Motor Block

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Background: The median effective dose (ED_{50}) of a drug gives the amount or dose of drug needed to produce effective therapeutic response or desired effect in at least 50% of the population taking it. Our study focused on determining the ED_{50} required for effective motor block using hyperbaric and plain bupivacaine, and evaluated the influence of baricity on the ED_{50} required for motor block.

Material/Methods: A total of 38 patients were randomly assigned into 2 groups according to the baricity of bupivacaine: group P received plain bupivacaine and group H received hyperbaric bupivacaine. The patients were administered 0.5% plain or hyperbaric bupivacaine intrathecally. The dosage of anesthetics in each patient was calculated according to the standard up-down sequential allocation method of Dixon. The first patient in each group received a dose of 7.5 mg bupivacaine, and a dose of 1.0 mg was used as the testing interval. The dose was increased or decreased by 1.0 mg for each patient according to the estimated score of motor block.

Results: The ED_{50} required for effective motor block in spinal anesthesia was 7.20 and 10.05 mg in groups H and P, respectively. Their relative motor blocking potency ratio was found to be 0.72.

Conclusions: The ED_{50} for motor block was significantly decreased using hyperbaric bupivacaine intrathecally compared with plain bupivacaine, and the baricity of bupivacaine obviously affected the ED_{50} for the motor block.

MeSH Keywords: Anesthesia, Intratracheal • Bupivacaine • Motor Activity

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Background

Spinal anesthesia can offer profound and symmetrical sensory and motor block of high quality. Therefore, it is widely used in not only cesarean sections but also lower-extremity and urology surgery. This is because assessing motor nerve block is relatively objective, unlike accessing sensory nerve block. Therefore, many researchers opted to assess motor block to estimate the relative potency of various local anesthetics with the help of the up-down sequential allocation technique, which is widely used in regional anesthesia [1–3].

Previous studies, using the same method, determined the effects of the age of patients and the concentration of local anesthetics on the ED_{50}, the median effective dose required for effective motor block, using anesthetics such as bupivacaine and ropivacaine [4–7]. These studies were different from the other studies that compared different local anesthetics. The ED_{50} for motor block was different for different age groups of patients and different concentrations of plain bupivacaine or ropivacaine [4–7]. Some studies also found that the baricity of local anesthetics administered intrathecally influenced their anesthetic effect [8,9].

This study hypothesized that the baricity of bupivacaine might affect the ED_{50} required for effective motor block in spinal anesthesia. The aim of this study was to determine the ED_{50} required for effective motor block in spinal anesthesia using both hyperbaric and isobaric bupivacaine, by which we can assess the effect of baricity of bupivacaine on the ED_{50} required for effective motor block.

Material and Methods

Our study enrolled 38 adult patients (aged 30–55 years; graded as American Society of Anesthesiologists physical status I–II) undergoing lower-limb or trans-urethral resection of prostate (TURP) from March 10 to May 8, 2016, at China Three Gorge University's First College of Clinical Medical Science. The patients were randomly assigned into 2 groups: group H (0.5% hyperbaric bupivacaine) and group P (0.5% plain bupivacaine). The study was approved on July 8, 2014 by the local Ethics Committee of China Three Gorges University's First College of Clinical Medical Science. From all the enrolled patients, a written informed consent was obtained after clearing all their requirements related to it.

All the patients were administered combined epidural–spinal anesthesia. The exclusion criteria were as follows: patients having lumbar vertebrae abnormality, abnormal coagulation, diabetes, obesity, hypersensitivity to amide local anesthetics, and neuromuscular diseases.

The patients fasted for 8 h and were not given any premedication before anesthesia. They were given 500 mL of Ringer lactate solution intravenously. Using a 16-guage Tuohy needle, we administered the combined epidural–spinal anesthesia at the level of L3/4 interspace, positioning the patient in the left lateral decubitus position. To ensure accuracy in drug delivery, we followed the loss of resistance to air technique so that the tip of the Tuohy needle was correctly inserted into the epidural space, and the dura was punctured with a 25-gauge Whitacre spinal needle and inserted through the Tuohy needle. The research drug was immediately injected through the Whitacre spinal needle at the rate of 0.1 ml/s when the cerebrospinal fluid (CSF) appeared at the tip of the spinal needle. When the intrathecal drug injection was completed, a 3-cm epidural catheter was placed towards cephalad direction, and the patient was made to adopt supine position without delay. The surgical positioning of the patient was adjusted as needed.

The study solutions, 0.5% and 0.75% plain bupivacaine, were purchased from Zhaohui Company (Shanghai, China). In group P, plain solutions of 0.5% bupivacaine were directly used, while in group H, 0.5% hyperbaric bupivacaine was used, which was prepared by mixing 0.75% plain bupivacaine (2 mL) with 1 mL of 10% glucose as a diluent. As shown in previous studies, 0.5% plain bupivacaine was considered as hypobaric at 37°C [10], and 0.5% plain bupivacaine in 8% glucose (1.024 g/mL) was considered as hyperbaric at 20°C, compared with the density of CSF [11]. The anesthetic solution used in the present study was similar to those used in previous studies, and the doses were changed according to Dixon's up-and-down sequential allocation method [12].

The first patient of each group was given a dose of 7.50 mg 0.5% plain or hyperbaric bupivacaine, and 1.0 mg bupivacaine was used as the testing interval for both the groups, as shown in previous studies [4–6]. The dosages of bupivacaine for the next patient in both groups were defined by the scores of the previous patient of the same group, which was assessed using the modified Bromage scale [13] and the hip motor function scale [14] every minute for the first 5 min and then on the 10th min after bupivacaine was injected intrathecally (Table 1).

A stopwatch was started at the time of injecting bupivacaine intrathecally. Scores of motor block were considered to be the primary endpoint. According to the Bromage method [13], if the scores equaled 0 in both legs within 5 min, it was not acceptable and was categorized as a failure, and the dose of bupivacaine was increased by 1.0 mg in the next listed patient of the same group. However, if the scores were more than 0 in either leg within 5 min, it was considered a success, and the dose of 0.5% bupivacaine in the next patient of the same group was decreased by 1.0 mg. The midpoint of crossover from failure to success was considered an effective tool in estimating the

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Table 1. Evaluation Scales for motor block.

Score	Motor block
Bromage scale	
0	Knees and feet fully flexible
1	Able to move only knees
2	Not able to move knees; but can move the feet
3	Unable to move both knees or feet
Hip motor function scale	
0	Able to raise straight legs completely (>30°)
1	Able to raise straight legs partially (<30°)
2	Not able to raise straight legs

ED_{50} for motor block. Paul and Fisher stated that the study was completed when the crossover was more than 6 pairs [15].

Two anesthesiologists and 1 nurse were involved in this study. One anesthesiologist was responsible for the whole procedure in all the patients; the second anesthesiologist, who was unaware of the treatment groups, was responsible for assessing motor and sensory blocks; and the nurse helped in preparing fresh local anesthetics and recorded the data. The anesthesiologist who performed the puncture frequently asked the patients how they felt. The patients were informed before injecting the anesthetics. They were advised to report whenever they felt hot on the sacral or lower extremities or had a very fast pulse in the thumb, and the time of response was recorded as the onset of anesthesia after injecting intrathecal bupivacaine. If the patient felt the sensation, the local anesthetic was considered to be injected into the subarachnoid space accurately. Patients without such a feeling were excluded from the study, and the next patient listed in the same group was administered the same dose. An alcohol tab was used in the midaxillary line to test the highest level of anesthesia. The duration of motor block was assessed according to the scores of either leg (Bromage score <2) and recorded.

If the dose of intrathecal anesthesia was found inadequate for the operation or procedure, 2% lidocaine 3 mL was given through the epidural catheter and another 3~5 mL lidocaine was added through epidural catheter for achieving a satisfactory anesthesia level. Patients who could not endure the whole procedure were shifted to general anesthesia immediately. We also noted the patients who required local and general anesthesia. Anesthesiologists and patients were blinded to the anesthetics used, and the same anesthesiologist completed the whole study.

During the whole procedure, the heart rate and blood pressure of the patients were monitored using an instrument (Datex-Ohmeda, Helsinki, Finland). If there was a more than 30% decrease in systolic blood pressure of the pre-anesthetic value or less than 90 mm Hg systolic, 5 or 10 mg of ephedrine was administered intravenously. If the heart rate of the patients decreased to 55 beats/min, 0.25 mg of atropine sulfate was immediately injected.

The study data were analyzed using SPSS 17.0 software (SPSS Inc., IL, USA). Means (standard deviation) were expressed as demographic data, and the anesthesia levels were used as median (range). Comparisons of 2 means were analyzed by the independent-samples *t* test. The ED_{50} was estimated from the up-and-down sequences by using the method of Dixon and Massey [16] and logistic regression. The mean dosage was determined from the midpoints of all independent pairs of patients involving a crossover from failure to success. According to the Paul and Fisher's method [15], patients were enrolled until 6 pairs were obtained. A *P* value <0.01 was considered significant statistically.

Results

Demographic data between the groups were similar (Table 2). There was a total of 38 patients successfully punctured, and the research drug was correctly injected into the subarachnoid space. Operations were completed successfully in all the patients. One patient in each group needed an epidural supplement drug because of the longer duration of surgery; therefore, the analysis of motor block duration excluded these. The patients had no adverse effects such as headache or back pain.

The motor nerves of most patients were completely blocked 10 min after the spinal injection; however, they were not blocked completely in 3 patients in group H and 1 patient in group P during the whole procedure (Bromage scale <2). Motor block scores in bilateral legs were similar in group P, but not in group H. Five patients in group H did not show complete motor block in the unilateral leg during surgery, and these were excluded from the analysis of motor block duration. In these 2 groups, the discrepancy in the duration of motor block was obvious (Table 2).

According to the Dixon and Massey formula (16), the ED_{50} for effective motor block with spinal bupivacaine was at the dose of 7.20 mg [95% confidence interval (CI), 6.64–7.81 mg] and 10.05 mg (95% CI, 8.80–11.49 mg) in groups H and P, respectively (Table 3, Figure 1). Hyperbaric bupivacaine is estimated to be more potent than plain bupivacaine at the ED_{50} dose, with a potency ratio of 0.72 (95% CI 0.12, 0.97). Potency ratios obtained after probit regression show very similar results in most cases.

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Table 2. Group characteristics and demographic data for all patients.

Variable	Group H (*n*=18)	Group P (*n*=20)	P Value
Age (year)	43±7	41±5	P=0.439
Weight (kg)	71±7	66±9	P=0.120
Height (cm)	171±4	169±4	P=0.150
BMI (kg/m^2)	24.2±2.7	23.1±2.7	P=0.224
Operation time (min)	96±21	107±30	P=0.213
Onset (s)	24±5	48±7*	P<0.001
Duration of motor block (min)	96±26	280±60*	P<0.001

Data are reported as mean ±SD. Comparisons of 2 means were analyzed by the independent-samples *t* test. * The differences between groups were significant (*P*<0.01).

Table 3. Results of up-and-down sequences for motor block.

Group	Dixon and Massey (mg)*	Probit regression (mg)
Group H	7.20 (6.64, 7.81)	7.19 (6.40, 8.06)
Group P	10.05 (8.80, 11.49)	10.33 (9.39, 11.75)
Relative efficacy ratio	0.72 (0.12, 0.97)	0.70 (0.19, 0.93)

Results are ED_{50} (95% CI). * The differences between groups were significant (*t*=7.783, *P*<0.001).

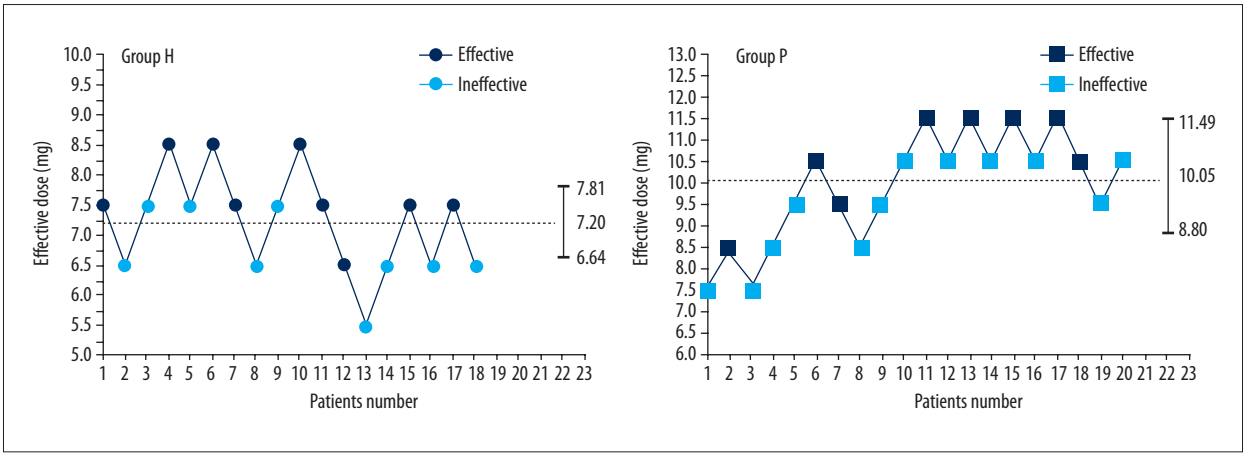

Figure 1. Motor block at minimum local anesthetic doses. Median effective doses and 95% confidence intervals are depicted in the figure. Deep blue and light blue symbols (circles and squares) represent the effective and ineffective doses, respectively.

The maximum sensory level of the patients was T_{12} (T_6, L_4) dermatomes after 5 min and T_{11} (T_5, L_1) dermatomes after 10 min in group H, and T_{12} (T_6, L_4) dermatomes after 5 min and T_{11} (T_6, L_2) dermatomes after 10 min in group P, excluding patients administered epidural supplemental drugs (Table 4).

One patient each in group H and P needed ephedrine because of hypotension; however, the hemodynamic parameters were stable in the other patients.

Discussion

This is the first study in adults which specifically assessed the motor block potencies of 2 different forms of bupivacaine. We have shown that the ED_{50} for spinal anesthesia in adults with hyperbaric bupivacaine and plain bupivacaine are 7.20 mg and 10.05 mg, respectively, which indicates that the potency ratio is 0.72 (95% CI, 0.12,0.97) for hyperbaric bupivacaine/plain bupivacaine. Our study concludes that at ED_{50} doses, hyperbaric

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Table 4. Maximum cephalad-level anesthesia.

	Group H (*n*=18)			Group P (*n*=20)		
	Effective	Ineffective	Total	Effective	Ineffective	Total
5 Min later	T_{11} (T_6, L_2)	L_1 (T_{11}, L_4)	T_{12} (T_6, L_4)	T_{10} (T_6, L_3)	L_1 (T_{10}, L_4)	T_{12} (T_6, L_4)
10 Min later	T_{10} (T_5, T_{12})	T_{11} (T_8, L_1)	T_{11} (T_5, L_1)	T_{10} (T_6, L_2)	T_{12} (T_6, L_2)	T_{11} (T_6, L_2)

Reported data as median (range). L – at the level of Lumbar dermatome; T – at the level of thoracic dermatome.

bupivacaine is estimated to be more potent than plain bupivacaine; more specifically, it concludes that the ED_{50} of plain bupivacaine is 40% larger than hyperbaric bupivacaine.

This discrepancy might be explained as follows: First, the onset of anesthesia using hyperbaric bupivacaine was faster than that using plain bupivacaine. The primary endpoint of the motor block was set 5 min after the intrathecal injection, which meant that the maximum effect of motor block was produced by hyperbaric bupivacaine, and not by plain bupivacaine, within 5 min. Second, hyperbaric bupivacaine might have strengthened the action of motor block and reduced the requirement of local anesthetics.

Many researchers successfully used the up-and-down sequential allocation technique for building a clinical model to evaluate the relative potencies of local anesthetics and determined the ED_{50} of the minimum local anesthetic dose for motor block [17,18]. This proved to be an extremely useful tool to determine the ED_{50} because it requires only a few patients to complete the research, with the added advantage of focusing on all the sampling doses in the immediate vicinity of the ED_{50} [18,19].

Previous studies also determined the ED_{50} for motor block with different age groups of patients and different concentrations of local anesthetics using the afore-mentioned method. The relative potency ratio of motor block for different baricities of bupivacaine was also determined. The ED_{50} for motor block was affected not only by the age of patients and the concentration of local anesthetics, but also by the baricity of local anesthetics.

In a previous study, the ED_{50} for effective motor block according to age was determined using 0.75% plain bupivacaine, which demonstrated that the ED_{50} for motor block in younger patients (20–30 years) is 10.22 mg [4]. The ED_{50} for motor block in this study with 0.5% plain bupivacaine was slightly lower (10.02 mg) compared with that in the previous study. This was because the patients were older (30–55 years) in the present study compared with that in the previous study (20–30 years). Another reason was the discrepancy in the concentration of local anesthetics between the 2 studies.

This study speculated that compared with plain bupivacaine, relatively smaller doses of hyperbaric bupivacaine could have the same anesthetic effect, such as motor block. Previous studies demonstrated that the dose of an anesthetic determined the recovery of sensory and motor blocks [20–22], and found obvious differences in the duration of motor block with 1 and 4 mL of 0.5% bupivacaine [23]. The duration of motor block in our current study was 96 min using hyperbaric bupivacaine and 280 min using plain bupivacaine, showing that the recovery of motor block was relatively faster using the hyperbaric bupivacaine solution in spinal anesthesia. The recovery of sensory block was similar to that of motor block. This may be beneficial for patients who do not require urological catheters.

In this study, the degree of motor block in bilateral legs was similar in group P, but not in group H. In group H, 5 patients did not show complete motor block in the unilateral leg during the entire period of surgery. This was because the onset of anesthesia was faster using hyperbaric bupivacaine than using plain bupivacaine. Although the patients were placed in a supine position as fast as possible after the intrathecal injection, the placement of the epidural catheter always took some time. The other reason was that hyperbaric bupivacaine had a tendency to accumulate downside because of its density. Therefore, a small quantity of local anesthetic acted on the upside motor nerves, and a larger quantity acted on the downside motor nerves, yielding different results in the 2 legs.

Some researchers [8] compared 0.5% hyperbaric and plain bupivacaine (4 mL) and found that hyperbaric bupivacaine attained the analgesia level faster, and the dermatomal level of complete sensory block bilaterally was higher than that obtained using plain bupivacaine. Moreover, the duration of sensory block using plain bupivacaine was obviously longer than that obtained using hyperbaric bupivacaine. The onset and intensity of motor block were similar between the 2 groups, but the duration of motor block was obviously shorter using hyperbaric bupivacaine than using plain bupivacaine.

This study also evaluated the onset of anesthesia depending on the individual's feeling after injecting bupivacaine intrathecally. The onset of anesthesia was found to be faster using hyperbaric bupivacaine than using plain bupivacaine.

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Vichitvejpaisal et al. [24] also found that the time for the sensory block to reach the T4 level was shorter in the hyperbaric bupivacaine group than in the plain bupivacaine group, which was consistent with the results of the present study. Compared with the doses used in previous studies, the onset of anesthesia was faster and the duration of motor block was shorter using hyperbaric bupivacaine compared with plain bupivacaine, although the doses used in this study were smaller, with a discrepancy in the doses of hyperbaric and plain bupivacaine.

In this study, hyperbaric bupivacaine was prepared as needed owing to the lack of commercially available solutions. Therefore, the densities of plain and hyperbaric bupivacaine were not examined, but only distinguished based on previously published studies. This was a limitation of our present study. Also, a small sample size was used in this study. The up-and-down method cannot accurately assess the ED_{95} [25,26], and demands further investigation.

Conclusions

We concluded our study with a benchmark conclusion that the ED_{50} required for effective motor block can be significantly reduced using hyperbaric bupivacaine intrathecally compared to using plain bupivacaine, and the baricity of bupivacaine affected the ED_{50} for motor block.

References:

1. Camorcia M, Capogna G, Lyons G, Columb M: Epidural test dose with levobupivacaine and ropivacaine: determination of ED(50) motor block after spinal administration. Br J Anaesth, 2004; 92(6): 850–53
2. Camorcia M, Capogna G, Lyons G, Columb MO: The relative motor blocking potencies of intrathecal ropivacaine: Effects of concentration. Anesth Analg, 2004; 98(6): 1779–82, table of contents
3. Columb MO, Lyons G: Determination of the minimum local analgesic concentrations of epidural bupivacaine and lidocaine in labor. Anesth Analg, 1995; 81(4): 833–37
4. Chen M, Chen C, Ke Q: The effect of age on the median effective dose (ED50) of intrathecally administered plain bupivacaine for motor block. Anesth Analg, 2014; 118(4): 863–68
5. Chen MQ, Chen C, Ke QB: Determination of the median effective dose for motor block of intrathecally administered different concentrations of bupivacaine in younger patients. The influence of solution concentration. Saudi Med J, 2014; 35(1): 44–49
6. Chen MQ, Xia ZY: Effect of concentration on median effective dose (ED50) for motor block of intrathecal plain bupivacaine in elderly patients. Med Sci Monit, 2015; 21: 2588–94
7. Chen MQ, Chen C, Fang W: Determination of the median effective dose (ED50) of spinal plain ropivacaine for motor block in adults. Anaesthesist, 2016; 65(5): 353–58
8. Roberts FL, Brown EC, Davis R, Cousins MJ: Comparison of hyperbaric and plain bupivacaine with hyperbaric cinchocaine as spinal anaesthetic agents. Anaesthesia, 1989; 44(6): 471–74
9. Sarvela PJ, Halonen PM, Korttila KT: Comparison of 9 mg of intrathecal plain and hyperbaric bupivacaine both with fentanyl for cesarean delivery. Anesth Analg, 1999; 89(5): 1257–62
10. Lui AC, Polis TZ, Cicutti NJ: Densities of cerebrospinal fluid and spinal anaesthetic solutions in surgical patients at body temperature. Can J Anaesth, 1998; 45(4): 297–303
11. Kuusniemi KS, Pihlajamaki KK, Pitkanen MT: A low dose of plain or hyperbaric bupivacaine for unilateral spinal anesthesia. Reg Anesth Pain Med, 2000; 25(6): 605–10
12. Columb MO, D'Angelo R: Up-down studies: Responding to dosing! Int J Obstet Anesth, 2006; 15(2): 129–36
13. Bromage PR: A comparison of the hydrochloride and carbon dioxide salts of lidocaine and prilocaine in epidural analgesia. Acta Anaesthesiol Scand Suppl, 1965; 16: 55–69
14. Collis R: Combined spinal epidural (CSE) analgesia is the preferred technique for labour pain relief. Acta Anaesthesiol Belg, 2002; 53(4): 283–87
15. Paul M, Fisher DM: Are estimates of MAC reliable? Anesthesiology, 2001; 95(6): 1362–70
16. Dixon WJ, Massey FJ: Introduction to statistical analysis. 4th ed. New York: McGraw-Hill, 1983; 428–39
17. Lacassie HJ, Habib AS, Lacassie HP, Columb MO: Motor blocking minimum local anesthetic concentrations of bupivacaine, levobupivacaine, and ropivacaine in labor. Reg Anesth Pain Med, 2007; 32(4): 323–29
18. Camorcia M, Capogna G, Berritta C, Columb MO: The relative potencies for motor block after intrathecal ropivacaine, levobupivacaine, and bupivacaine. Anesth Analg, 2007; 104(4): 904–7
19. Camorcia M, Capogna G, Columb MO: Estimation of the minimum motor blocking potency ratio for intrathecal bupivacaine and lidocaine. Int J Obstet Anesth, 2008; 17(3): 223–27
20. Lanz E, Schmitz D: [No effect of injection volume on sensory and motor blockade in isobaric spinal anesthesia]. Reg Anaesth, 1990; 13(7): 153–58 [in German]
21. Van Zundert AA, Grouls RJ, Korsten HH, Lambert DH: Spinal anesthesia. Volume or concentration – what matters? Reg Anesth, 1996; 21(2): 112–18
22. King HK, Wooten DJ: Effects of drug dose, volume, and concentration on spinal anesthesia with isobaric tetracaine. Reg Anesth, 1995; 20(1): 45–49
23. Cameron AE, Arnold RW, Ghorisa MW, Jamieson V: Spinal analgesia using bupivacaine 0.5% plain. Variation in the extent of the block with patient age. Anaesthesia, 1981; 36(3): 318–22
24. Vichitvejpaisal P, Svastdi-Xuto O, Udompunturux S: A comparative study of isobaric and hyperbaric solution of bupivacaine for spinal anaesthesia in caesarean section. J Med Assoc Thai, 1992; 75(5): 278–82
25. Sztark F, Chopin F, Bonnet A, Cros AM: Concentration of remifentanil needed for tracheal intubation with sevoflurane at 1 MAC in adult patients. Eur J Anaesthesiol, 2005; 22(12): 919–24
26. Min SK, Kwak YL, Park SY et al: The optimal dose of remifentanil for intubation during sevoflurane induction without neuromuscular blockade in children. Anaesthesia, 2007; 62(5): 446–50

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