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Original Article

Different concentrations of bupivacaine on postoperative urinary retention in patients undergoing subarachnoid anesthesia

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Abstract: Objective: Urinary retention is occurred frequently in patients received epidural anesthesia or subarachnoid anesthesia. This study was taken to seek a suitable concentration to subarachnoid block, which can satisfy the operation quickly and without indwelling catheter. Methods: 120 patients were randomly divided into 4 groups (n = 30 each). Group E: patients were received epidural anesthesia with 0.5% bupivacaine, group A: patients were received subarachnoid anesthesia with 3 ml of 0.25% bupivacaine, group B: patients were received subarachnoid anesthesia with 3 ml of 0.375% bupivacaine, group C: patients were received subarachnoid anesthesia with 3 ml of 0.5% bupivacaine. If subarachnoid anesthesia dose not satisfied the surgery, we use epidural anesthesia with 0.5% bupivacaine for remedial measure. Hemodynamic variables, the effect and satisfaction of anesthesia, the incidence of indwelling catheter were assessed. Results: Mean arterial pressure in group E at the time point of T_1 and heart rate in group C at T_1 and T_2 time point were higher than other groups ($P < 0.05$). Patients meeting the requirements of operation within 15 min in group B and C are more than that in group A ($P < 0.001$). Moreover, patients suffered indwelling catheter postoperatively in group E, A and B were also similar, while they were significantly more in group C ($P < 0.001$). Conclusions: Subarachnoid anesthesia with 3 ml of 0.375% bupivacaine exhibited more quickly satisfaction of the operation requirements as well as lower incidence of urinary retention.

Keywords: Bupivacaine, subarachnoid anesthesia, epidural anesthesia, urinary retention

Introduction

Low-dosage, low-cost and rapid effect is the most important characteristics of subarachnoid block (one of the spinal anesthesia), which is generally applied in the primary hospital [1, 2]. 0.5% bupivacaine is mostly used as a local anesthetic drugs in clinical [3]. While there are some side effects relative to complete cauda equina nerve block, which result in voiding dysfunction, especially a high incidence of urinary retention [4].

Some literatures have reported that urinary retention is a complication of subarachnoid block rather than that of epidural anesthesia; therefore, most patients would like to choose the epidural anesthesia [5, 6]. However, the epidural anesthesia needs more waiting time, which reduces the working efficiency and increases the use of drugs.

We conducted this study to seek a suitable concentration of bupivacaine to subarachnoid block, which can quickly satisfy the operation as well as without indwelling catheter. Secondary outcomes were the hemodynamic variables of patients. Primary outcome measures were more stable hemodynamic and less patients suffered indwelling catheter postoperatively when given 0.375% bupivacaine for subarachnoid anesthesia.

Materials and methods

This clinical trial was approved by the Ethics Committee of Renmin Hospital of Wuhan University, and registered at Chinese Clinical Trial Registry (ChiCTR) with registration number ChiCTR-IOR-16007781. Informed consent was obtained from all patients. Patients of either sex with the American Society Anesthesiologists physical status I-II, aged between 18 and 60

years, undergoing lower limps surgery without indwelling catheter were recruited.

Exclusion criteria included patients with other systemic diseases, relative or absolute contraindications of spinal block, the failure of puncture or subarachnoid anesthesia, the time of merging epidural catheter more than 1 min, massive bleeding or a large amount of blood or fluid transfusion during the operation, intravenous drugs used in the process of operation and operation time more than 1 h.

The patients were randomized to the four study groups by random number table method, which was prepared by an unwitting statistician. Group E: patients were received epidural anesthesia with 0.5% bupivacaine, group A: patients were received subarachnoid with 3 ml of 0.25% bupivacaine, group B: patients were received subarachnoid with 3 ml of 0.375% bupivacaine, group C: patients were received subarachnoid with 3 ml of 0.5% bupivacaine (n = 30, each). If subarachnoid anesthesia dose not satisfied the surgery, we use epidural anesthesia for remedial measure.

Before entering the operation room, all patients were sent to the anesthesia preoperative room without any premedication, then a 20-gauge intravenous cannula was inserted in the dorsum of the left hand of each patient, infusion of compound sodium lactate solution 8 ml/kg/h. Standard monitoring consisted of five-lead electrocardiography (ECG), oxygen saturation (SpO_2) and noninvasive blood pressure (BP). One anesthesiologist who was unaware of the clinical nature of the study monitored and conducted the case.

When the patients were send to the operation room, 2-3 laminar space was chosen as the puncture point. Patients in group E were punctured to epidural space, and then epidural catheter was placed to cephalic to 3 cm, injected 5 ml of 2% lidocaine for excluding the whole spinal anesthesia and 6-7 ml of 0.5% bupivacaine for surgery. Patients in group A, B and C were punctured to subarachnoid space, and then 3 ml of 0.25%, 0.375%, 0.5% bupivacaine was injected slowly and constantly, respectively. After that, epidural catheter was also placed to cephalic to 3 cm.

Patients were put on the supine position after the epidural or subarachnoid anesthesia. The time from subarachnoid injection drugs to the maximum degree of motor block were recorded in group A, B and C. The modified Bromage score was used for judgment that when the score reached the highest and whether the block effect can directly satisfy the operation. Once the block effect couldn't satisfy the operation 15 minutes after drug injection, and then epidural injected 0.5% bupivacaine. The same surgical team of orthopaedic surgeons did all the operations after the anesthetist confirming adequate analgesia, and the whole surgical procedure was commenced in 1 h.

Mean arterial pressure (MAP), heart rate (HR), and oxygen saturation (SpO_2) were recorded at six time points (T_0, baseline; T_1, 5 min after epidural or subarachnoid anesthesia; T_2, the beginning of the operation; T_3, 30 min after operation; T_4, the end of operation; T_5, out of PACU). After the operation, patients were transferred to the PACU, hemodynamic parameters and the degree of analgesia were monitored until transferred to surgical ward.

Patients were sent back to surgical wards without indwelling catheter and encouraged to early ambulation and urination on their own. Indwelling catheter when patients with postoperative bladder filled with urine, which were diagnosed by ultrasound and cannot be properly discharged. The information was recorded in 24 h postoperatively by an unwitting post-operation follow-up staff.

Our primary outcome measures were the effect of subarachnoid block and the postoperative micturition recovery; the secondary outcomes were the hemodynamic variables of patients.

Statistical analysis

Quantitative variables were expressed as Mean ± SD/SEM; Categorical variables were presented as count (%). Normally distributed data were compared using an independent sample t-test. A student's *t*-test and an ANOVA test were performed for unpaired quantitative variables. And the X^2 test was used to analyze categorical variables. All reported *P* values were two-sided, and *P* values less than 0.05 were considered significant. The statistical analyses were performed with Statistical

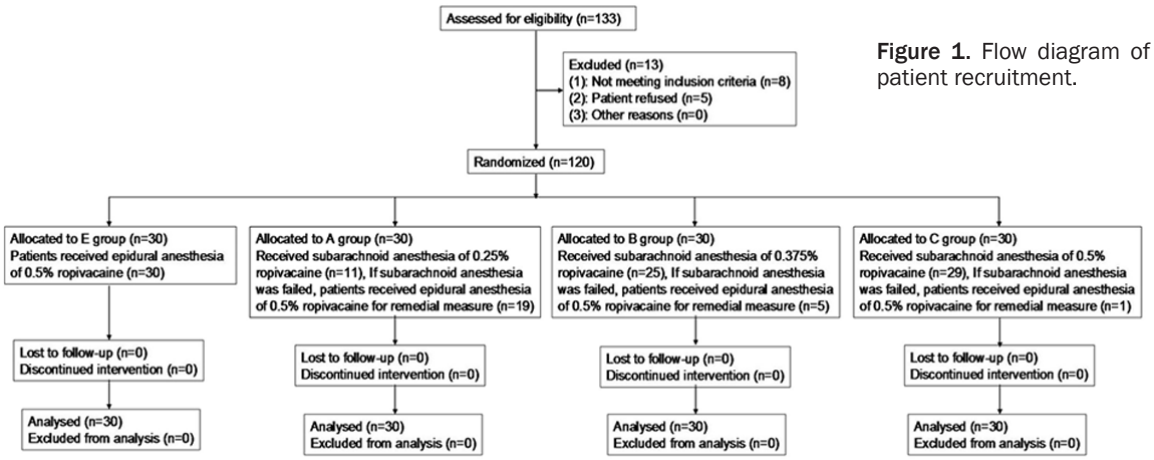

Figure 1. Flow diagram of patient recruitment.

Table 1. Subject characteristics (n = 30, $\bar{X}$ ± SD)

Characteristic	E group	A group	B group	C group
Age (years)	38.1±12.0	41.4±10.1	43.5±9.2	39.4±11.2
Gender (M/F)	17/13	15/15	14/16	13/17
Weight (kg)	63.2±10.1	60.4±6.7	61.6±7.3	57.6±9.2
Height (cm)	164.4±6.2	164.8±5.5	165.7±4.4	167.4±4.0
History of disease (cases)				
Diabetes/Hypertension/Others	5/8/3	3/6/4	6/3/2	4/6/3
Current disease and type of surgery				
Internal fixation removal/Debridement/Others	13/12/5	11/15/4	13/14/3	12/14/4
Duration of surgery	47±9 min	52±5 min	50±6 min	49±8 min
Duration of hospitalization	7±1 d	6±2 d	6±3 d	7±2 d
Outcomes and complication	None	None	None	None

Values are given as Mean ± SD, or number of patients (%).

Package for Social Sciences (version 17.0 for Windows; SPSS Inc., Chicago, IL).

Results

One hundred and twenty patients were recruited from February 2016 to August 2016. No assigned patients withdrew from the study (**Figure 1**). All patients underwent their planned surgical procedure and received their allotted pattern of anesthesia.

Table 1 shows the patient and procedural characteristics of four groups, respectively. There were no significant differences in demographic characteristics between the groups ($P > 0.05$).

There were no differences about MAP, HR, and SpO_2 at the baseline among the four groups. HR had a rising and MAP had a falling over time after the anesthesia in the subarachnoid groups (from T_1 to T_4). Moreover, compared with other groups, the difference about MAP was significant in group E at time point of T_1 ($P < 0.05$); the difference about HR was significant in group C at the time point of T_1 and T_2, ($P < 0.05$). However, the SpO_2 was similar among the four groups during the whole process ($P > 0.05$) (**Figure 2**).

The differences of the time required in patients of group A, B and C with single subarachnoid block reaches the maximum degree of motor block was no statistically significant ($P = 0.612$). The level of nerve block of group B was higher than that of group A, and group C was higher than that of group B. There was no statistically significant difference in patients who can satisfy the operation within 15 min in Group B and group C ($X^2 = 1.667$, $P = 0.197$), and both of

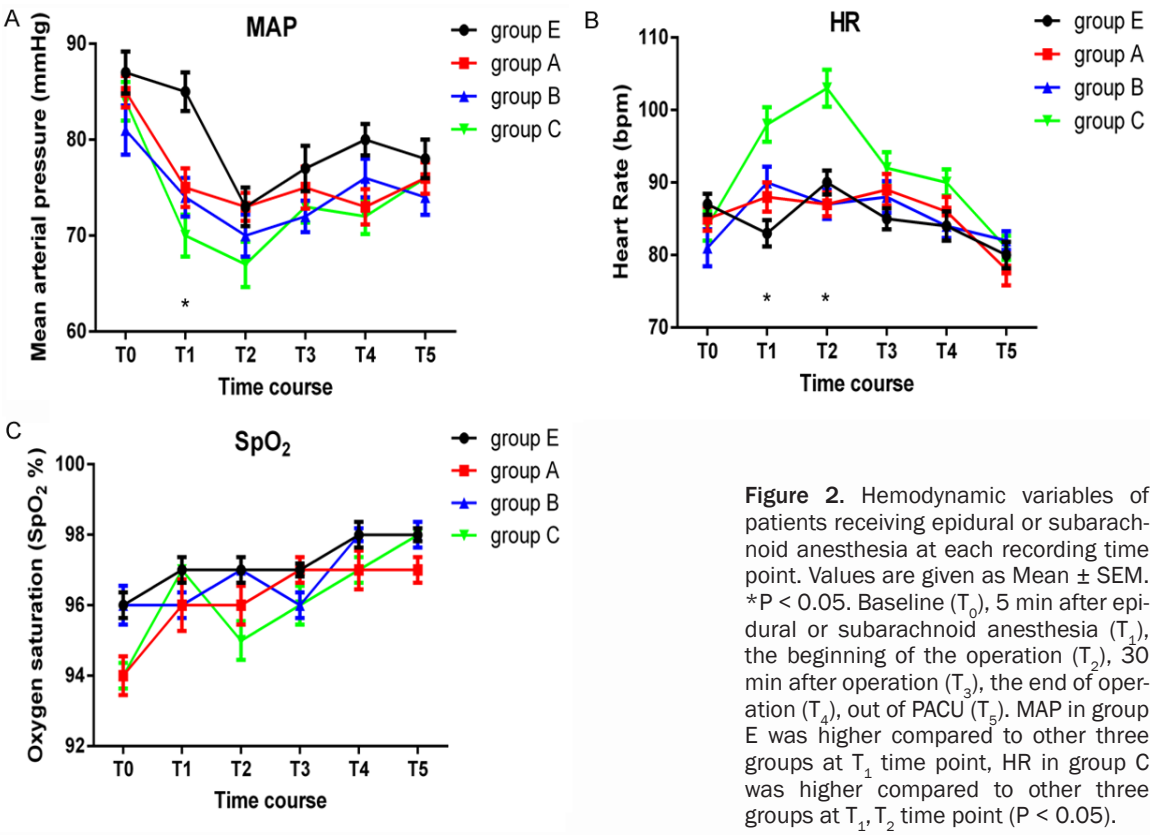

Figure 2. Hemodynamic variables of patients receiving epidural or subarachnoid anesthesia at each recording time point. Values are given as Mean ± SEM. *P < 0.05. Baseline (T_0), 5 min after epidural or subarachnoid anesthesia (T_1), the beginning of the operation (T_2), 30 min after operation (T_3), the end of operation (T_4), out of PACU (T_5). MAP in group E was higher compared to other three groups at T_1 time point, HR in group C was higher compared to other three groups at T_1, T_2 time point (P < 0.05).

Table 2. Anesthesia effects in subarachnoid groups (n = 30, $\bar{X}$ ±SD)

Group	Time for reach motor block (s)	The highest level of nerve block	Success for meet the surgery	X^2	*P* value
A	297±40	T_{12}	11	13.611	*P* < 0.001 group A vs group B
					P < 0.001 group A vs group C
B	286±53	T_{10}	25	24.300	*P* = 0.197 group B vs group C
C	277±40	T_6	29	1.667	

Table 3. The occurrence among four groups with postoperative urinary retention (n = 30)

Group	Indwelling catheter	Without Indwelling catheter	X^2	*P* value
E	5 (16.7%)	25 (83.3%)	0.131	P = 0.718 group E vs group A
			0.417	P = 0.519 group E vs group B
			19.461	< 0.001 group E vs group C
A	4 (13.3%)	26 (86.7%)	1.002	P = 0.317 group A vs group B
			21.991	P < 0.001 group A vs group C
B	7 (23.3%)	23 (76.7%)	15.017	P < 0.001 group B vs group C
C	22 (73.3%)	8 (26.7%)		

them were better than group A (compared with group B and C, X^2 = 13.611, 24.300, respectively. *P* < 0.001) (**Table 2**).

Patients suffered indwelling catheter postoperatively in group E, group A and group B were no significant differences, and they were all

less than that of group C (compared with group E, A and B, X^2 = 19.461, 21.991, 15.017, respectively. $P < 0.001$) (**Table 3**).

Discussion

This clinical study was undertaken to evaluate the postoperative urinary retention of different concentrations of bupivacaine used in subarachnoid anesthesia. Our principal findings were that there were more stable hemodynamic changes and lower incidence of urinary retention postoperatively when patients received subarachnoid anesthesia with 0.375% bupivacaine, and moreover, it's safe, low-cost and rapid effect.

Spinal anesthesia is still widely used in clinic, as it is simple to operate, high performing, cost-effective, analgesic perfectly and small impact on the body [7, 8]. However, the epidural anesthesia has a long onset time after giving drugs, and the waiting time is relatively longer; whereas, the subarachnoid block with directly effecting on the spinal cord and nerve root, provides significantly shorter waiting time, wider block range and more complete effect, which having been widely used in the lower limps and hypogastrium surgery.

Nowadays, clinical anesthesia has paid more and more attention on the comfort of the patients, which has become the major concern that could affect the prognosis of patients in perioperative period [9, 10]. Among them, reducing catheter placement can avoid related infection, which is one of the clinical measures proved by evidence-based medicine. Minimizing the occurrence of urinary retention in lower limps and hypogastrium surgery has clinical value in reducing the secondary urinary tract infection, pain and anxiety of patients [11, 12].

The spinal cord and cauda equina nerve block are easily to cause acute neurogenic bladder dysfunction, the sensory loss of abdominal and pelvic, atony of bladder, which can cause urinary retention [13]. Local anesthetics will be diluted by cerebrospinal fluid when it was injected into subarachnoid, so the same doses and concentrations of local anesthetic may cause different block scopes and depths by the different puncture position, injection directions and speed rate, as well as the spine lengths and thicknesses and different scopes of drug diffusion. When we conducted subarachnoid block by using the same drugs, the blocking time lengthened with the increase of the drug doses and concentrations [14, 15]. At the same time, the blocking time is another important reason for the occurrence of urinary retention [16-18].

Bupivacaine is easy to remain in the medullary cavity where the liquid is injected into and the level of anesthesia is uniform and easy to control the level of anesthesia [19, 20]. In this study, 0.375% bupivacaine for subarachnoid block in most cases can quickly satisfy the operation and have more stable hemodynamic variables [21, 22]. Compared with single epidural anesthesia, which can significantly reduce waiting time of anesthesia, the incidence of urinary retention has no difference, while significantly lower than that of the commonly used 0.5% bupivacaine for subarachnoid block. That may be suggest that 0.375% bupivacaine for subarachnoid block is a good choice for anesthesia in lower limps and hypogastrium surgery and other similar short operations.

In conclusion, 0.375% bupivacaine subarachnoid anesthesia combined with epidural anesthesia used in some short lower limps and hypogastrium surgery with relatively low risks could yield less waiting time of anesthesia, improve the working efficiency of doctors, reduce the pain of patients with indwelling catheter and decrease the waste of medical resources at the same time.

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Disclosure of conflict of interest

None.

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