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ORIGINAL ARTICLE

Caudal blockade shortens the time to walking exercise in elderly patients following low back surgery

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Abstract
Purpose We conducted a randomized, double-blinded study to test our hypothesis that caudal blockade as preemptive analgesia for low back surgery might accelerate time to walking exercise following surgery and reduce postoperative analgesics, thereby attaining faster recovery of cognitive function.
Methods Our study included 51 elderly patients >70 years with American Society of Anesthesiologists (ASA) physical status 1–3, who underwent lumbosacral surgery under general anesthesia. After anesthetic induction and tracheal intubation, patients in the study group (group B) were injected with simple 0.5% bupivacaine [10 ml × height (m)] as a caudal block 15 min before surgical incision, whereas patients in the control group (group C) received normal saline. After surgery, patients had access to intravenous patient-administered analgesia (IV PCA), fentanyl, for postoperative pain relief. We assessed Mini-Mental State Examination (MMSE) scores before and after the surgery, values of visual analog scale (VAS) for postoperative analgesic status, fentanyl consumption during and for 3 days after surgery, and time to begin walking exercise after surgery.
Results VAS value of group B patients was significantly lower than those in group C throughout the postoperative 48-h period ($p < 0.005$), and group B patients began walking exercise significantly earlier than those in group C [mean ± standard deviation (SD) 70.2 (14.3) in group C, and 61.9 (7.6) in group B; $p = 0.0133$]. Cognitive function level was higher in group B than in group C patients 24 h after operation.
Conclusions Caudal blockade as preemptive analgesia shortened the time to start walking exercise after surgery and accelerated recovery of postoperative cognitive function.

Keywords Caudal block · Preemptive analgesia · Cognitive function · Rehabilitation

Introduction

Patients undergoing low back surgery are strongly encouraged to start walking exercise as early as possible in the postoperative period to assess the effect of the surgery and to reduce the length of time in bed. In elderly patients, in particular, beginning walking exercise early results in better cognitive function and greater muscle strength, thus helping them regain their ability to perform activities of daily living (ADL). On the other hand, opioids and other analgesics used for postoperative pain relief may delay recovery of mental and physical status due to prolonged bed rest. Furthermore, postoperative pain itself can cause confusion, particularly in older patients [1, 2]. We hypothesized that caudal blockade as preemptive analgesia for low back surgery might accelerate walking exercise

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after surgery and reduce postoperative analgesics, thereby accelerating recovery of cognitive function. Although there have been several reports on preemptive analgesic effects of epidural blockade in lumbosacral spine surgery [3–5], the time when walking exercise begins after the surgery has not been studied as a primary outcome. As surgcal patients received opioids or nonopioid drugs as a caudal block agent in previous reports, it is unclear how preemptive epidural blockade affects postoperative analgesia. Therefore, we conducted a randomized, double-blind study to test our hypothesis that caudal blockade with local anesthetic alone prior to surgery reduces time to postoperative walking exercise.

Methods

The study protocol was approved by our institutional ethics committee, and written informed consent was obtained from each patient. Fifty-one patients >70 years who underwent low back surgery without an endoscopy were enrolled into this study. They were randomly assigned to one of two study groups: control group (group C) and caudal blockade group (group B). Randomizing was done by an envelope method. Patients who had coagulopathy, deformity of the spinal cord, skin lesions caudally, received anticoagulation therapy, had motor paralysis of lower extremities, or refused caudal blockade were excluded from this study.

Cognitive function of all patients was assessed with the Mini-Mental State Examination (MMSE) [6] the day before surgery. No premedication drugs were given, and patients were transferred to the operating room by stretcher or wheelchair. Routine monitoring was used, including Bispectral Index (BIS) monitoring. A 20-gauge intravenous catheter was inserted into the dorsal vein of the left hand. General anesthesia was induced with sevoflurane 5% in an air–oxygen mixture, followed by 2 $\mu g/kg^{-1}$ of intravenously administered fentanyl. Vecuronium bromide 0.12 mg/kg^{-1} was administered intravenously to facilitate tracheal intubation. After tracheal intubation, patients were placed in the prone position. Patients in group C received a caudal epidural injection with normal saline [10 ml × height (m)], and patients in group B received 0.5% bupivacaine at the same dose as patients in group C at least 15 min before the start of the surgical procedure. Study drugs were prepared and coded by a nurse, who was unaware of the protocol of the study, and the anesthesiologist who performed caudal blockade was blinded to the solution administered. The surgeon, blinded to the study, subcutaneously administered 20 ml of 0.5% lidocaine with 0.0005% epinephrine 3 min before the surgical procedure. The anesthesiologist titrated sevoflurane concentration in an air–oxygen mixture [fraction of inspiratory oxygen (FiO_2) = 0.45] to maintain a BIS value between 40 and 60. When systolic blood pressure or heart rate increased >30% beyond resting value (obtained on the day before surgery), fentanyl 1 $\mu g/kg^{-1}$ as a supplemental analgesic was given intravenously.

Patients were given acces to intravenous patient-controlled analgesia (IV PCA) of fentanyl for postoperative pain relief, which consisted of a base flow 30 $\mu g/h^{-1}$ of fentanyl and bolus dosage of 30 μg, with 60 min of lockout time. After the surgery, blinded investigators evaluated total doses of fentanyl during anesthesia, sevoflurane requirements during anesthesia, visual analog scale (VAS) scores in postoperative pain every 6 h for 3 days, total doses of fentanyl for postoperative pain relief, time to beginning of walking exercise, and cognitive function with MMSE at 24, 48, and 72 h after operation. Sevoflurane requirement was calculated as age-matched minimum alveolar concentration $(MAC)/h^{-1}$ [7], using the following equation:

$$\text{Sevoflurane MAC concentration} = (51.703 - 9.034 \times \ln(\text{age in year})) \cdot (8.741)^{-1}$$

According to our institutional clinical pass, patients began walking exercise between 48 h and 72 h after surgery. If the patient complained of intractable pain or the orthopedist did not permit, walking exercise was postponed. If postoperative pain control was successful and recovery satisfactory, the patient could start walking exercise earlier.

We conducted a preliminary study to assess the ideal volume of caudal blockade agent. We injected height (m) × 10 (ml) of contrast medium (240 mgI/ml^{-1} of iotrolan) in the caudal space to evaluate the degree of rostral spread of the local anesthetic for another ten patients who underwent low back surgery and required an epidurogram. Statistical analysis was done using GraphPad PRISM version 4.00 for Windows 2000 (GraphPad software, San Diego, CA, USA). A power analysis was performed using ten former patients' data for each group regarding time to ambulation. The difference between means of 18 h, with expected standard deviation (SD) of 19, revealed that 20 patients per group would provide 80% power to detect the difference, with a significance level (alpha) of 0.05 (two-tailed). Parametric data was analyzed by paired or unpaired *t* test and by chi-square test for dichotomous variables. Nonparametric data was done using the Mann–Whitney *U* test. A *p* value <0.05 was considered statistically significant. Data is expressed as mean (± SD) or median [range].

Result

The result of our preliminary study showed that the solution spread to Th11 [±1 vertebral body]. Clinical characteristics of patients are shown in Table 1. There were no significant differences in patients' profiles between the two study groups. Requirements for sevoflurane during operation represented by age-matched requirements MAC/h^{-1} were significantly less in group B than in group C patients ($p = 0.020$) (Table 2). Fentanyl consumption during operation showed no significant difference between groups. Bromage scales at awakening after surgery were 0 [0–0] in group C and 0 [0–1] in group B patients. The upper sensory blockade level determiner by the cold test was L1 [Th12-L3] in group B and none in group C patients. VAS values were less in group B than in group C patients throughout 3 postoperative days (Fig. 1). Supplemental doses of fentanyl administered by patients pushing the bolus button for 48 h after surgery were significantly less in group B than in group C [9.6 (20.7) µg in group C and 50.8 (54.8) µg in group B, $p = 0.0004$]. Dosages used in each period are illustrated in Fig. 2. Time to beginning of walking exercise was significantly shorter in group B than in group C patients [61.9 (7.6) h in group B and 70.2 (14.3) h in group C, $p = 0.0133$] (Fig. 3). Cognitive function level was higher ($p < 0.05$) in group B than in group C patients 24 h after operation (Fig. 4). Patients in both groups showed no sequela from caudal blockade, such as subarachnoidal injection, intravenous injection, epidural hematoma, nerve damage, etc.

Table 1 Patients profiles

	Group C	Group B	*P* value
Number of patients	26	25	
Gender (M/F)	17/9	11/14	NS
ASA PS (I/II/III)	10/15/1	9/14/2	NS
Age (years)	73.5 (6.5)	72.9 (5.6)	0.7187
Height (cm)	157.8 (9.5)	155.2 (7.3)	0.2863
Weight (kg)	58.3 (8.8)	60.8 (9.0)	0.3089
Type of operation			NS
Laminectomy	13	17	
Herniotomy	8	4	
Spinal posterior fusion	5	4	
Operation time (min)	124 (56.9)	111.7 (50.4)	0.4192
Anesthesia time (min)	177.7 (59.6)	159.5 (55.0)	0.1795*

Values of age, height, weight, operation time, and anesthesia time are expressed as mean ± standard deviation (SD)

The *number* written in the line of Gender, ASA PS, and type of operation means the number of patients belonging to each classification

No significance was shown between the backgrounds of patients the two groups

Table 2 Anesthetic requirement and emergence from anesthesia

	Group C	Group B	*p* value
0.5% bupivacaine (ml)	–	15.5 (0.73)	–
Fentanyl (µg/kg^{-1})	4.57 (1.4)	4.19 (0.88)	NS
Fentanyl (µg/kg^{-1} h^{-1})	1.56 (0.30)	1.69 (0.54)	NS
Sevoflurane (MAC/h^{-1})	0.73 (0.2)	0.58 (0.16)	0.0202
Time to awakening (min)	16.9 (4.4)	13.4 (2.7)	0.0010

Values are expressed as mean ± standard deviation (SD)

Sevoflurane minimum alveolar concentration (MAC)/h^{-1} and time to awakening (min) were reduced significantly in group B patients, whereas fentanyl requirement during operation shows no significance

Time to awakening was defined as the time from discontinuation of anesthetic gas to eye opening in response to verbal instruction

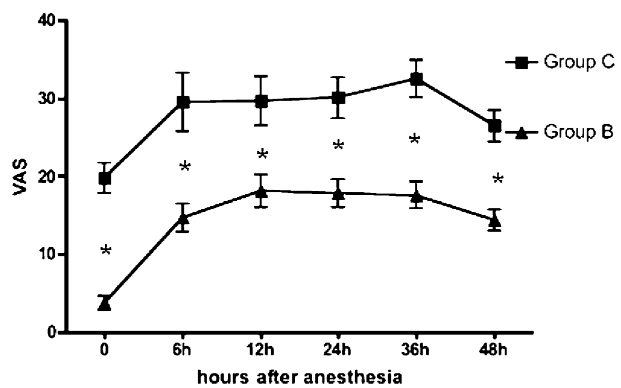

Fig. 1 Alteration of visual analog scale (VAS) values for postoperative pain relief. Graph showing mean VAS with standard error. Time *0*: waking time after surgery. Throughout the study periods, VAS values in group B patients were significantly lower than those in group C (*asterisks*)

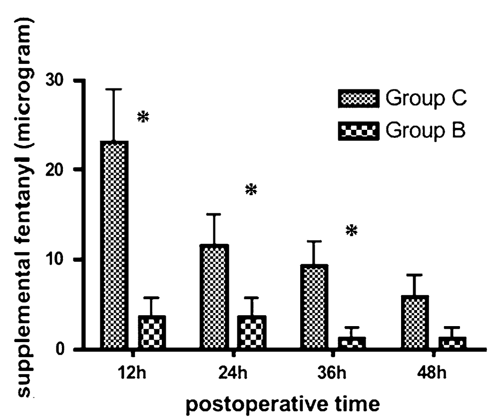

Fig. 2 Cumulative supplemental fentanyl for every 12 h after surgery. Graph showing mean dose with standard error. The supplemental doses of fentanyl were significantly smaller in group B than group C patients at 12, 24, and 36 h postoperatively (*asterisks*). *12 h*: time 0 to postoperative 12 h; *24 h* next 12 h

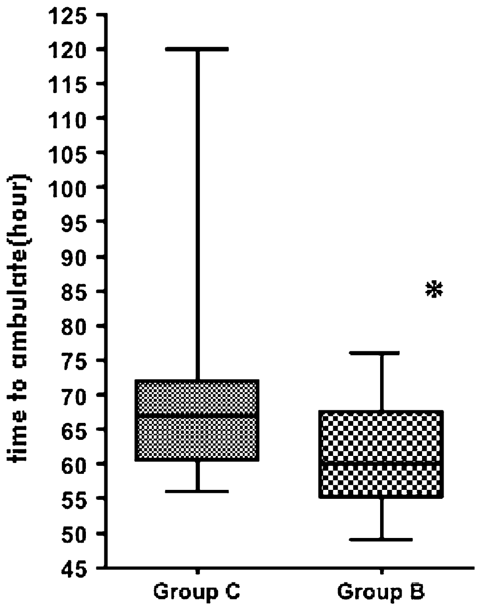

Fig. 3 Time to beginning of walking exercise was significantly shorter in group B patients (*asterisks*) than in group C [70.2 (14.3) h in group C and 61.9 (7.6) in group B, $p = 0.0133$]. *Time 0* waking time after surgery

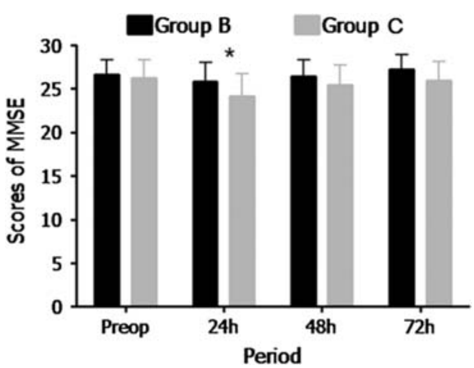

Fig. 4 Change of cognitive function expressed by Mini-Mental State Examination (MMSE). Graph showing mean MMSE with standard error. Cognitive function level was higher ($p < 0.05$) in group B than in group C patients at postoperative 24 h (*asterisks*) [24.2 (2.5) in group C and 25.9 (1.9) in group B]

Discussion

It is well known that preemptive analgesia before the onset of nociceptive stimuli can provide effective postoperative analgesia [8–10]. There are some reports regarding the effectiveness of caudal or lumbar epidural blockade in low back surgery [3–5]. Kundera et al. [3] added epidural morphine before or soon after surgery and found that the former, namely, preemptive analgesia, gave significantly better postoperative pain relief. Sekar et al. reported that injection of a cocktail of 0.5% bupivacaine and tramadol into the sacral space provided significant analgesic effect for as long as 24 h postoperatively [4]. They used other medications [e.g., nonsteroidal anti-inflammatory drugs (NSAIDs) [4] or nonopioid analgesics [5]) in addition to or without local anesthetics [3] in the previous studies, and the long-lasting analgesic effect might be due to pharmacological action of the additive rather than preemptive analgesic effect. We evaluated the preemptive analgesic effect of bupivacaine alone, as caudal-block agent, by observing patients' pain level >48 h after surgery. This period is far longer than the pharmacokinetic effect period of bupivacaine and could suggest preemptive analgesic effect of bupivacaine injected caudally. Our results revealed that patients in the blocked group showed significantly lower VAS scores in comparison with patients in the control group for 3 days. Taking this into consideration, previous studies with additives also might have gained longer-lasting effect due to local anesthetic.

We used fentanyl IV PCA in all patients. Although fentanyl is an analgesic drug with narcotic effect, we thought it reasonable to apply this agent to our elderly patients because of its features: shorter duration (owing to redistribution pharmacokinetics) and quicker onset than morphine, and lack of dependence on renal excretion [11]. Furthermore, access to the bolus button avoided the need for NSAIDs or other analgesic rescue drugs, which made comparison between groups easier. It may be reasonable to believe that prolongation of the analgesic effect of caudal blockade can reduce fentanyl consumption and help avoid cognitive decline. On the other hand, there is a report suggesting that inappropriate pain control in older surgical patients can cause confusion [1, 2]. Accordingly, our patients in the study group showed higher MMSE scores by receiving better pain control.

Starting exercise earlier encourages postoperative ADL recovery. In our study, time to beginning of walking exercise was 61.9 (7.6) h in group B and 70.2 (14.3) h in group C patients ($p = 0.0133$), but there was no significant difference in MMSE score on postoperative days 2 and 3. As VAS score showed significant difference between groups, exercise in group B patients could be easier. Therefore, beginning of walking exercise may depend on postoperative analgesic status rather than recovery of cognitive function.

In low back surgery, it is not generally thought that early rehabilitation adds to the danger of re-operation. Our hospital employed the clinical pass of low back surgery facilitating early rehabilitation, and our study protocol was designed according to that pass. Though preoperative/postoperative symptoms of motor paralysis would lead to rehabilitation limitation, we did not include patients with motor deficit of the lower extremities. Fortunately, none of our patients showed such symptoms after surgery.

There are still many factors affecting when rehabilitation begins, and postoperative pain, psychiatric status, and cognition, in particular, are considered to play important roles. In this study, we evaluated the status of postoperative pain and cognition, and our results showed no correlation between deterioration of MMSE score and time to ambulate or supplemental fentanyl doses. However, psychiatric status was not included in the measurement. Patient anxiety regarding the surgical wound and postoperative recovery course might delay rehabilitation. Although we did not evaluate the level of anxiety in the postoperative period, we consider that mental condition becomes a limiting factor for rehabilitation. Further study is needed to clarifying whether or not postoperative anxiety delays rehabilitation.

Epidurogram findings and spread of epidural anesthesia using an identical volume of an agent show good correlation [12, 13]. Results of our study showed that 15.5 ml blocked 12 ± 1 segment (from Th11 to S5). Therefore, our dosage of 0.5% bupivacaine (10 ml $\times$ height) was considered reasonable for blocking the sensory nerves between L1 and L5. Although intraoperative requirements of fentanyl were similar in both groups, sevoflurane requirements were less in group B than in group C patients. That was considered to be elicited by attenuation of nociceptive stimuli from the surgical field due to epidural bupivacaine [14].

In conclusion, caudal blockade as preemptive analgesia provided earlier beginning of walking exercise. This was elicited by beneficial effects of caudal blockade, reducing requirements for anesthetics and level of postoperative pain intensity, as well as providing better recovery of cognitive function. As caudal blockade is a safe and simple technique in the patients without hematological abnormalities, it will be used widely.

References

1. Fong HK, Sands LP, Leung JM. The role of postoperative analgesia in delirium and cognitive decline in elderly patients: a systematic review. Anesth Analg. 2006;102:1255–66.
2. Duggleby W, Lander J. Cognitive status and postoperative pain: older adults. J Pain Symptom Manage. 1944;9:19–27.
3. Kundra P, Gurnani A, Bhattacharya A. Preemptive epidural morphine for postoperative pain relief after lumbar laminectomy. Anesth Analg. 1997;85(1):135–8.
4. Sekar C, Rajasekaran S, Kannan R, Reddy S, Shetty TAP, Pithwa YK. Preemptive analgesia for postoperative pain relief in lumbosacral spine surgeries: a randomized controlled trial. Spine J. 2004;4:261–4.
5. Kakiuchi M, Abe K. Pre-incisional caudal epidural blockade and the relief of pain after lumbar spine operations. Int orthop. 1997;21(1):62–6.
6. Folstein MF, Folstein SE, McHugh PR. "Mini-Mental State" a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975;12:189–98.
7. Fragen RJ, Dunn KL. The minimum alveolar concentration (MAC) of sevoflurane with and without nitrous oxide in elderly versus young adults. J Clin Anesth. 1996;8:352–6.
8. Woolf CJ, Chong MS. Preemptive analgesia-treating postoperative pain by preventing the establishment of central sensitization. Anesth Analg. 1993;77:362–79.
9. Beilin B, Bessler H, Mayburd E, Smirnov G, Denkel A, Yardeni I, et al. Effect of preemptive analgesia on pain and cytokine production in the postoperative period. Anesthesiology. 2003;98:151–5.
10. Hong JY, Lim KT. Effect of preemptive epidural analgesia on cytokine response and postoperative pain in laparoscopic radical hysterectomy for cervical cancer. Reg Anesth Pain Med. 2008;33(1):44–51.
11. Grass JA. Patient-controlled analgesia. Anesth Analg. 2005;101: S44–61.
12. Yokoyama M, Hanazaki M, Fujii H, Mizobuchi S, Nakatsuika H, Takahashi T, et al. Correlation between the distribution of contrast medium and the extent of blockade during epidural anesthesia. Anesthesiology. 2004;100:1504–10.
13. Burn JM, Guyer PB, Langdon L. The spread of solutions injected into the epidural space. A study using epidurograms in patients with the lumbosciatic syndrome. Brit J Anaesth. 1973;45:338–45.
14. Ishiyama T, Kashimoto S, Oguchi T, Yamaguchi T, Okuyama K, Kumazawa T. Epidural ropivacaine anesthesia decreases the Bispectral Index during the awake phase and sevoflurane general anesthesia. Anesth Analg. 2005;100:728–32.