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Significance of patient-controlled analgesia in combination with continuous epidural block for patients who underwent posterior lumbar surgery

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Abstract The purpose of the study was to evaluate the efficiency of patient-controlled analgesia (PCA) combined with continuous epidural block in patients who underwent lumbar spine surgery. In group 1 (postoperative PCA group), 23 patients were administered postoperative continuous epidural block in combination with analgesics, which was self-regulated by the patient using a device. In contrast, the 22 patients in group 2 (control group) received suppositories or intramuscular injections of analgesics on request. The following factors were compared between the two groups: pain relief according to the visual analog scale for pain assessment, the frequency of administration of analgesics, and side effects of the postoperative analgesia. The patients in group 1 had more satisfactory relief of pain according to the visual analog scale for pain assessment and needed suppositories and intramuscular injection of analgesics less frequently on the 1st, 2nd, and 3rd postoperative day. The time spent by nurses on pain management in group 1 was less than that in group 2. No patient had any serious complications in either group. In conclusion, the present patient-controlled method combined with postoperative continuous epidural block could decrease the intensity of postoperative pain and the amount of time spent by nurses on the administration of postoperative analgesics after lumbar spine surgery.

Key words Postoperative analgesia · Lumbar spine · Patient-controlled analgesia

Introduction

A contemporary clinical study on postoperative pain control has shown that intramuscular narcotic injection on the patient's demand, which is the most common management method of postoperative pain, results in severe unrelieved pain in nearly half of all operated patients, and satisfactory analgesia is obtained in no more than one-third of the patients [18]. Although Bennett et al. first presented patient-controlled analgesia (PCA) as a concept of postoperative pain relief in 1982 [3], this method has not become widely used as a preventative method for postoperative pain. This is probably due to the fact that the patient-controlled module consisted of an infusion pump electronically connected to a timing device, which was too complicated and too heavy for patients who had undergone surgery. The postulated importance of pre-emptive blockade by epidural anesthesia for patients who undergo thoracic or abdominal surgery has been assessed [13, 21, 22]. Regarding surgery of the extremities, clinical evidence shows that persistent pain comes from the surgical wound with nearly the same intensity as in a hysterectomy or gastrectomy [5]. Recently, the importance of pre- and postoperative pain relief of the extremities has been assessed [2, 7, 10, 11, 14]. However, only a few studies have attempted to evaluate the effects of postoperative pain management using PCA for lumbar degenerative disease

Table 1 The method of operation and the number of levels operated in group 1 and group 2

There were no significant differences in the data between the two groups

Operation method	Group 1 (postoperative PCA, n = 23)		Group 2 (control, n = 22)	
	No. of patients	Average no. of levels operated	No. of patients	Average no. of levels operated
Fenestration and Discectomy	14	1.36	7	1.0
Laminotomy	1	2.0	5	2.0
Laminectomy	8	3.25	10	3.1

[7, 15]. The purpose of the present study was to evaluate the efficiency of blocking the noxious stimulation from the operated lumbar region by epidural PCA combined with continuous epidural block, and to clarify whether this management for postoperative pain could decrease the intensity of postoperative pain and the amount of time spent by nurses on the administration of postoperative analgesics.

Patients and methods

Patients who underwent lumbar posterior decompressive surgery between November 1994 and January 1996 were assigned to two groups. In group 1 (23 patients), postoperative PCA was used in combination with continuous epidural analgesia. Patients in group 2 (n = 22) received conventional treatment for postoperative pan. The surgical method employed was lumbar fenestration and discectomy for lumbar disc herniation, and lumbar laminectomy or laminotomy for degenerative spinal stenosis (Table 1). The control patients (group 2) were matched to the patients who underwent postoperative PCA (group 1) according to the number of levels operated, age, and gender. In both groups, general anesthesia was induced with thiopental (3 mg/kg) and maintained with N_2O/O_2 and sevofluren. Muscle relaxation was achieved with pancronium (0.1 mg/kg). No additional analgesics were used before or during operation in either group.

In the method of postoperative pain management administered to the patients in group 1 (Fig. 1), an epidural catheter was introduced through an 18-gauge needle inserted 2–3 cm from the lumbar incision just before wound closure. The tip of the epidural catheter was placed about 2 cm cranially from the upper edge of the laminectomy, and 39 ml of 2% lidocaine containing 0.2 mg buprenorphine (1 ml) was placed in a balloon reservoir (DIB International, Tokyo), connected to a patient-controlled module (DIB International), which was used for intermittent epidural delivery of analgesics. By pressing the plastic bag (3 ml in internal cubic volume), the patients in group 1 were able to administer the analgesics (a single dose: 3 ml of 2% lidocaine with 0.015 mg buprenorphine) by themselves for a total of 13 times. The patient could not perform immediate repetitive administration of the 3 ml of analgesics, since the time required for filling the plastic bag is 55 min with this system. For the infusion of continuous epidural block, 39 ml of 0.25% bupivacaine was used in combination with 0.2 mg buprenorphine. The injection speed of the drug solution of the epidural analgesia was 0.83 ml/h. Continuous epidural block was started just before wound closure.

For relief of postoperative pain for group 2, a traditional method was employed. A diclofenac sodium suppository (50 mg) was given initially, followed by a fixed-dose intramuscular injection of 15 mg pentazocine in combination with 25 mg hydroxyzine hydrochloride. The administration of suppositories and intramuscular injection was performed by nurses in response to the demands of the patient. Informed consent for the study was obtained from all the patients.

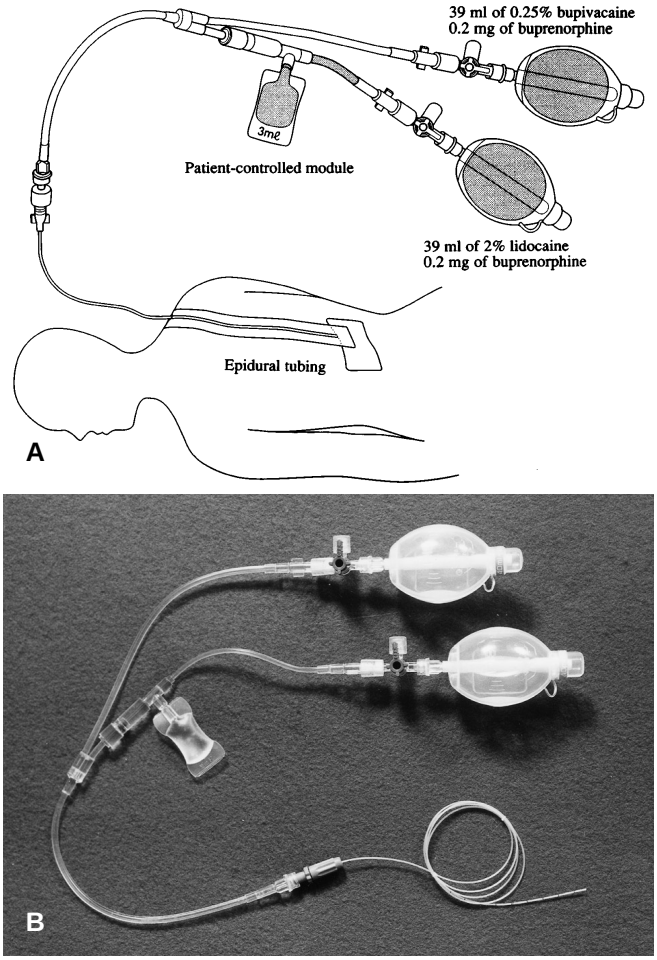

Fig. 1A, B Schematic drawing of the management of postoperative pain after lumbar spine surgery in group 1, the patient-controlled analgesia (PCA) group: **A** schematic drawing, **B** set-up of devices. Continuous epidural block is given with a balloon infusor (DIB International, Tokyo) in which 39 ml of 0.25% bupivacaine in combination with 0.2 mg buprenorphine is administered at a speed of 0.83 ml/h. A patient-controlled module (PCM, DIB International) is used for intermittent epidural delivery of drug solution on the patient's request. When the patient presses a plastic bag of the PCM, 3 ml of 2% lidocaine containing 0.015 mg of buprenorphine is epidurally released in a single dose. The PCM is supplied the analgesic solution from a balloon reservoir containing 39 ml of 2% lidocaine and 0.2 mg buprenorphine (1 ml). The patient cannot perform repetitive administration of 3 ml analgesics because the time necessary for filling the plastic bag is 55 min with this system

The visual analog scale (VAS) for pain assessment [4] was used to evaluate the intensity of postoperative pain at three time points, 12, 24, and 48 h after the completion of surgery. The pain score was ranked on a scale of 0–10, with 0 indicating no pain and 10 the worst possible pain. The mean pain scores in each group at the three points were compared. The frequency with which the nurse administered analgesics in response to the demand of the patients in each group was compared for three periods: 0–12, 12–24 and 24–48 h after the completion of surgery. In addition, the presence of nausea, vomiting, pruritus, eruption, motor blockade, or a sensory level to pinprick were assessed and complications and side effects in the two groups were registered.

A questionnaire survey on the performance and satisfaction of the nurses in relation to the two different means of the management of postoperative pain was given to 18 registered nurses in the orthopedic ward. Information on the satisfaction of the patients in group 1 with the use of PCA in combination with continuous epidural analgesia was also sought.

Demographic data, VAS pain intensity score, and the frequency of treatment for postoperative pain were statistically analyzed by *t*-tests, Welch's tests, or a chi-square test. $P < 0.05$ was considered statistically significant in all tests.

Results

Pain assessment

There were no significant differences between the two groups with regard to age, gender, body weight, body height, intraoperative blood loss, or duration of surgery. The mean pain score of both groups was highest at 12 h after operation (group 1: 3.9; group 2: 5.27), decreasing after that point. Comparison of the pain scores at 24 h and 48 h after operation revealed that the mean VAS score of group 1 decreased from 2.85 to 2.4 and that of group 2 decreased from 5.14 to 3.18. There were significant differences between the two groups with regard to the overall level of pain assessed by the VAS score for the three points after surgery ($P < 0.01$ or $P < 0.05$; Fig. 2).

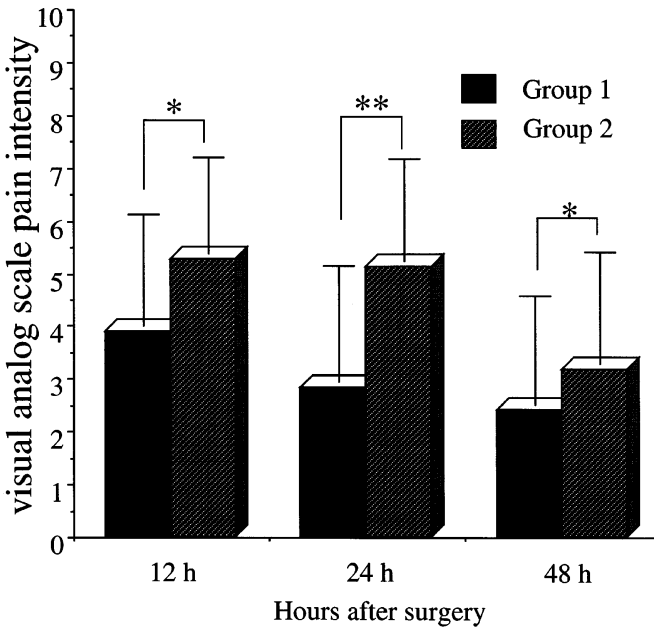

Fig. 2 Postoperative pain intensity as assessed by visual analog scale (VAS): the mean scores of postoperative pain intensity by VAS for groups 1 (postoperative PCA group) and 2 (control group). There were significant differences between the two groups with regard to the overall level of pain for the three points after surgery (*$P < 0.05$; **$P < 0.01$)

Frequency of analgesic administration by nurses and PCA administration by patients

The frequency of treatment other than PCA for relieving pain on patient demand decreased over the three periods in accordance with the decrease of the VAS score. The mean number of times that the analgesic was administered to the patients in group 1 was 0.04 in the period 0–12 h after operation, 0.13 at 12–24 h, and 0.04 at 24–48 h. The frequency for requiring analgesics in group 1 during each period was significantly lower ($P < 0.01$, Fig. 3) than in group 2 (0–12 h: 1.55; 12–24 h: 1.14; 24–48 h: 1.55 on average.

The frequency of the use of PCA in group 1 was 8.44 times in the period 0–12 h after operation, 4.06 times at 12–24 h, and 2.44 times at 24–48 h on average. The overall use of PCA was 13.7 times on average (range: 2–27).

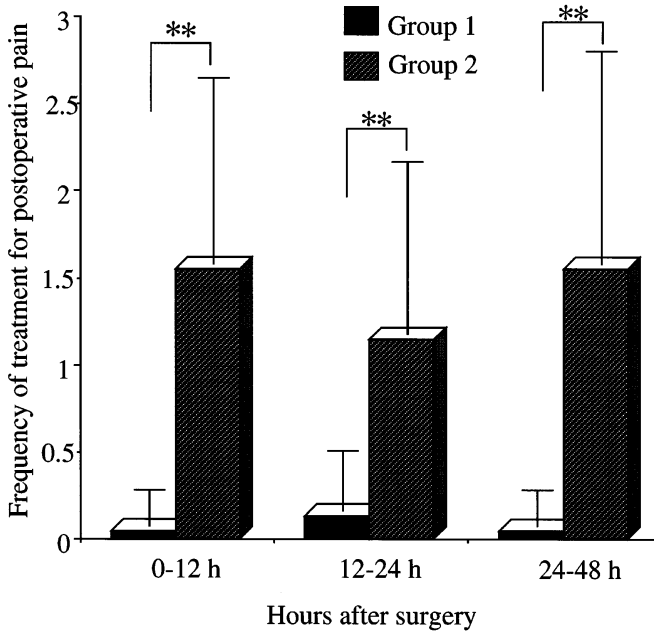

Fig. 3 Frequency of analgesic administration. The number of times the analgesic was administered by nurses to the patients in group 1 (postoperative PCA group: average of 0.21 times in total) was significantly smaller than that to the patients in group 2 (control group: average of 4.24 times in total; **$P < 0.01$)

Complications and side effects

No patient had nausea, vomiting, or urinary retention in either group. In group 1, there was no case of respiratory distress, venous thrombosis, or subarachnoidal block by the dural puncture. Motor blockade, or a sensory disturbance was also not observed.

Questionnaire for nurses

All the 18 registered nurses in the orthopedic ward responded to the questionnaire. Twelve (67%) of them stated that PCA was efficient pain relief for the patients, since they could manage postoperative pain by themselves whenever they wished. Four (22%) of 18 nurses believed that PCA was efficient for both patients and nurses. Thus, 16 (89%) of 18 nurses considered that PCA was more useful than conventional postoperative pain management. Twelve (67%) of 18 nurses believed that a single dose of PCA provided less relief of pain than a diclofenac sodium suppository; however, the combination of continuous epidural analgesia and repetitive self-administration enhanced the efficacy of pain relief.

Patient satisfaction in group 1

Twenty (87%) of 23 patients in group 1 reported that PCA relieved pain effectively. However, 6 (26%) of 23 patients reported that it was a little difficult to push the plastic bag.

Discussion

Regarding the management of postoperative pain following lumbar spine surgery, Marcaine infiltration to the paravertebral muscle [17, 20], intraoperative dexamethasone irrigation [8], and epidural morphine administration with or without steroid have been reported [9, 15]. However, postoperative complications related to the use of narcotic analgesics or steroids, such as oversedation, respiratory depression, ileus, and urinary retention cannot be eliminated [7, 9, 15].

Recently, in a prospective controlled study on postoperative pain management after joint replacement and spinal surgery, Colwell and Morris recommended PCA from the viewpoint of patient satisfaction, time saving for nurses, and the cost of pain management [7]. However, it is necessary for the patient to keep the intravenous line for 3 days following operation in order to deliver narcotic agents. With the present method of epidural PCA combined with continuous epidural block, there is no need for an intravenous line and there were significant differences between the PCA and control groups with regard to the pain score by VAS and the frequency of pain care by the nursing staff during the three postoperative periods. In Japan, PCA using intravenous injection of narcotics faces formidable problems due to legal regulation. Thus, it is not easy to perform a comparative study between patient-controlled epidural anesthesia and patient-controlled intravenous narcotics injection.

In postoperative analgesia after lumbar spine surgery, the combination of epidural PCA and continuous epidural block may have some advantages because an epidural catheter can be positioned easily and with certainty through the operative field and a direct effect on the noxious stimulation may decrease the amount of analgesics required. There are other common advantages of postoperative PCA. The nursing staff can focus on other factors of postoperative patient care and management rather than on the task of relieving postoperative pain. In addition, as there is only a short time lapse from the demand of the patient to the actual relieving of pain, from the viewpoint of the emotional aspects of acute pain, the present patient-controlled system may help to minimize the emotional phenomena of acute pain such as fear and anxiety. Patients are therefore likely to use the amount of PCA that is appropriate to their actual needs, with the appropriate sum total, thus avoiding an overdose of analgesics [3].

In a previous study among patients with extremity trauma [14], 0.2 mg buprenorphine in combination with 39 ml of 0.25% bupivacaine, which was continuously injected into the epidural space at a rate of 1.67 ml/h, achieved adequate analgesia when supplemented with the subcutaneous PCA system. Regarding the PCA system, 3 ml of saline containing 0.4 mg buprenorphine was placed in a balloon reservoir, connected to a patient-controlled module, which was used for intermittent subcutaneous delivery of analgesics. Although there was no case of respiratory distress, venous thrombosis, or subarachnoidal block by the dural puncture, 4 of 46 patients had nausea or vomiting, 2 of 46 patients had urinary retention, and 1 had incorrect insertion of a catheter into the epidural vein. Thus, in the present study, the injection speed to the epidural space was reduced to half of that in the previous study. Incorrect insertion of a catheter was completely avoidable due to intraoperative direct insertion. As a result, these side effects were eliminated.

The balloon infusor that we chose for the continuous epidural block and epidural PCA is very simple, inexpensive and acts precisely. The injection speed of the balloon infusor is 0.83 ml/h or 3.33 ml/h for epidural block and refilling of PCA plastic bag, respectively. The factor that determined the intensity necessary to block the noxious stimulation was dependent upon the amount of local anesthetic, which was calculated from the volume multiplied by concentration of the local anesthetic [6]. In the present study, 0.2 mg buprenorphine in combination with 39 ml of 0.25% bupivacaine, which was continuously injected into the epidural space at a rate of 0.83 ml/h, achieved adequate analgesia when supplemented with the epidural PCA system, without serious side effects.

It is advisable in the management of postoperative pain to administer the analgesic before the patient experiences pain [12]. Transduction and modulation of the noxious stimulation are the neural pathways for pain sensation [19]. Postoperative pain of the spine after lumbar surgery is reported to be as severe as that following intrathoracic and intra-abdominal surgery [5]. This is partly due to bouts of severe pain caused by reflex spasm of the paravertebral muscle, occurring after laminectomy [5]. In order to prevent prolonged postoperative pain, aggressive control of postoperative pain may be recommended, especially in multiple back operation patients from the viewpoint of the prevention of a nociceptive experience and the phenomenon of pre-emptive analgesia [1, 16, 23]. As a result, the alleviation of postoperative pain is beneficial for both patients and medical staff. In conclusion, the present epidural PCA, which was combined with continuous epidural block, is an effective and safe method for the management of postoperative pain after lumbar spine surgery.

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