Comparison of Continuous Epidural Infusion and Intermittent Bolus Epidural Injection of Local Anesthetics for Postoperative Pain Relief

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(Key words: portable infusor, postoperative pain, mepivacaine, epidural analgesia, upper abdominal surgery)

Intermittent epidural administration of mepivacaine for relieving postoperative pain have been widely used in our Department. This procedure occasionally causes hypotension in patients after administration and requires frequent monitoring of patients by a nursing staff for that reason. Intermittent bolus administration thus charges both nursing personnel and physicians much time and effort in looking after the patient in a recovery room or an intensive care unit. Continuous epidural infusion of local anesthetics is known to provide a favorable relief of pains from cancer, herpes zoster and other severe non-malignant diseases. Our observations so far have indicated that such continuous infusion offered effective control of pains, and that the pain-free period after infusion lasted longer than bolus administration.

In this study we evaluated the efficacy of continuous epidural infusion of mepivacaine, by comparing it with intermittent bolus administration of the same local anesthetic during the postoperative period.

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J Anesth 5:419–423, 1991

Subjects and Methods

We studied 18 patients scheduled for an elective upper abdominal operation under general anesthesia. Approval was obtained from the institutional committee on clinical investigations, and informed consent was obtained from every patient studied. Every patient received epidural catheterization prior to surgery. Prior to induction of anesthesia, the adequacy of the level of analgesia was confirmed with a pin-prick test. Anesthesia was maintained with nitrous oxide, oxygen, enflurane supplemented with epidural analgesia with 20 $mg \cdot ml^{-1}$ mepivacaine.

The patients were randomly allocated to two groups: Group 1 (n = 10) received continuous epidural infusion of 10 $mg \cdot ml^{-1}$ mepivacaine with a portable infusor, and Group 2 (n = 8) received intermittent bolus administration of 10 $mg \cdot ml^{-1}$ mepivacaine epidurally starting immediately after surgery till 72 hrs postoperatively. In Group 1, we used a Baxter infusor® (Baxter limited, Tokyo), which is a disposable, portable and nonelectronic device designed to infuse a medication at a fixed rate of 2 $ml \cdot hr^{-1}$. Continuous infusion was initiated when the patient was confirmed fully awake at the end of the operation. In Group 2, 3 ml of

Table 1. Characteristics of patients studied

	Group-1	Group-2
Patient number	10	8
Age (yrs)	58.9 ± 11.1	63.4 ± 9.6
Weight (Kg)	59.1 ± 10.8	60.5 ± 8.3
Height (cm)	159 ± 8.9	162 ± 10.9
BSA (m^2)	1.60 ± 0.16	1.64 ± 0.16
Male : Female	6 : 4	5 : 3
Operation time (min)	274 ± 90	250 ± 114
Total doses of mepivacaine during operation	18.6 ± 2.8	17.7 ± 2.8
Duration from the last administration (min)*	50.5 ± 5.5	50.8 ± 9.3
Dose of the last administration of mepivacaine	3.2 ± 0.4	3.2 ± 0.3
Epidural puncture		
Th 9–10	6	8
Th 10–11	3	0
Th 11–12	1	0
Operation		
Cholecystectomy	2	3
Subtotal gastrectomy	5	4
Total gastrectomy	1	1
Ileus reduction	2	0

All values represent mean ± SE. Group 1 received continuous epidural infusion of mepivacaine; Group 2 received intermittent epidural bolus administration of mepivacaine. *Duration (min) from the last administration of mepivacaine during the operation to the initiation of postoperative epidural administration.

10 $mg \cdot ml^{-1}$ mepivacaine was administered at intervals of 4 hrs. Buprenorphine, 0.2 mg, was administered intramuscularly as a supplemental analgesic, whenever the patient complained of severe pain during the study period.

Verbal rating scale and the amount of supplemental buprenorphine were measured to evaluate the efficacy of both methods every 12 hrs until 72 hrs postoperatively. Verbal rating scale was classified into four categories: "Excellent" no pain when coughing or breathing deeply; "Good" mild pain when coughing or moving; "Fair" moderate pain on the bed-rest without coughing or moving "Poor" sever pain on the bed-rest.

Statistical analysis was performed using a one-way analysis of variance, Wilcoxon single rank test, and Mann-Whiteny U test. A P value of < 0.05 was considered statistically significant.

Results

Table 1 summarizes the patient characteristics of both groups. There was no significant difference between the two groups in regard to the mean age, weight, height, body surface area, and sex ratio. Also there was no significant difference in regard to total doses of mepivacaine administered, duration from the last epidural administration of mepivacaine during operation to the initiation of postoperative epidural injection, dose of the last epidural injection, the site of epidural puncture, mean length of operation, and type of operation performed between the two groups.

Results of evaluations made every 12 hrs are shown in Figure 1. During the first 12 hrs, the distribution of verbal rating scale

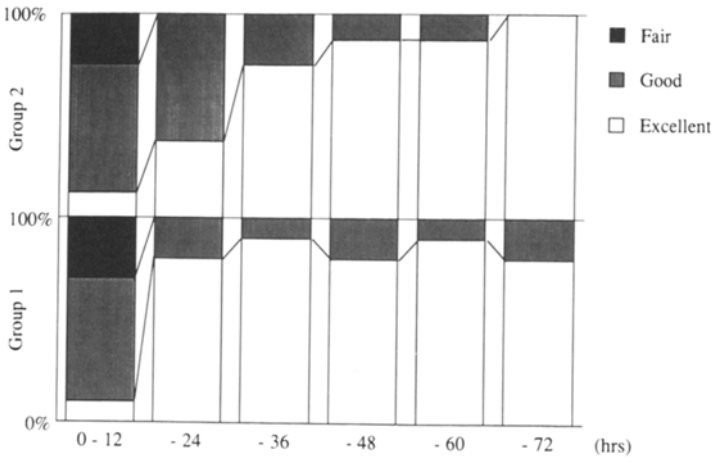

Fig. 1. Distribution of verbal rating scores in group 1 and group 2 at an interval of 12 hrs until 72 hrs postoperatively.

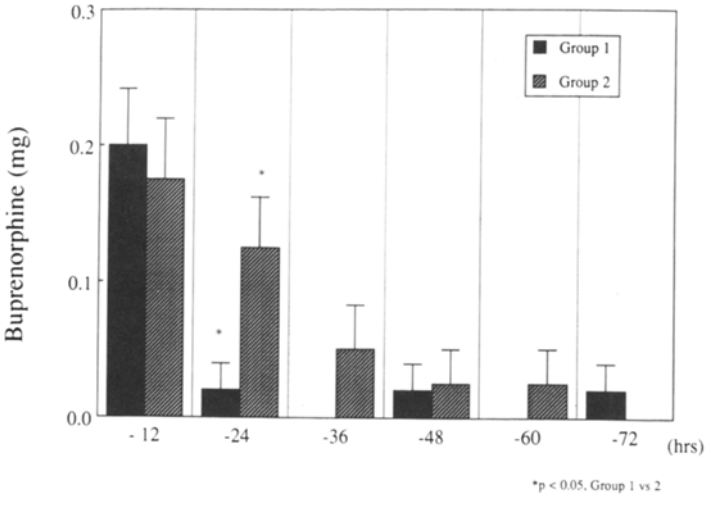

Fig. 2. Amounts of supplemental buprenorphine at an interval of 12 hrs until 72 hrs postoperatively.

All values represent mean ± SE. *represents a significant difference between both groups ($P < 0.05$).

in Group 1 was almost the same as that in Group 2. During the next 12 to 24-hour period, the patients rated "Excellent" in Group 1 (80%) tended to be greater in number than those in Group 2 (37.5%, p = 0.06). But during the 24 to 72-hour period, there was no difference between two groups in regard to the distribution of verbal rating scale (fig. 1). The amount of buprenorphine administered in Group 1 was significantly less than that in Group 2 during the 12 to 24-hour period (fig. 2). The amount of buprenorphine used during the first 12 hrs was significantly large compared with any other periods in Group 1. In Group 2, the amount of buprenorphine used both during the first 12-hour and the next 12 to 24-hour period were significantly large compared with other periods, but there was no significant difference between the first 12-hour and the 12 to 24-hour period. No complication was noted in either group.

Discussion

Epidural analgesia performed with local anesthetics and/or narcotics has been a common method of alleviating postoperative pains. Intermittent epidural administration of local anesthetics provides patients with adequate analgesia postoperatively. This technique requires frequent reinjection because pain relief obtained is brief. It is also associated with hypotension. Pa-

tients so treated have to be observed closely during the period of 15 to 30 min after the administration by a nursing personnel. Continuous epidural infusion of morphine or a combination of morphine and bupivacaine has been reported to provide excellent postoperative pain relief[1]. Also continuous infusion of fentanyl has been reported to be effective for postoperative pain relef[2]. If continuous epidural infusion of local anesthetics could provide adequate relief of postoperative pains without complications, this method would be superior to the bolus administration for postoperative pain relief.

Our results revealed that continuous epidural infusion of 10 $mg \cdot ml^{-1}$ mepivacaine was superior to bolus injection in alleviating postoperative pains during the 12 to 24-hour period. During the first 12-hour period, no difference was seen between the two methods in the distribution of verbal rating scales or in the amount of supplemental analgesic. The supplemental analgesic used in this period was significantly greater in dose than in any other periods. A continuous infusion rate of 2 $ml \cdot hr^{-1}$ epidurally was not adequate to provide necessary pain relief in this period. In other words, this was the most painful period for the patients to undergo upper abdominal surgery, an infusion rate higher than 2 $ml \cdot hr^{-1}$ of mepivacaine is likely to be need to provide adequate pain relief. Logas et al.[1] reported that the immediate postoperative 8 hrs was the most painful of 72-hour postoperative periods according to pain score, and a combination of bupivacaine and morphine infused at the rate of 3–4 $ml \cdot hr^{-1}$ provided excellent postoperative pain relief. Takahashi, et al.[3] also reported that 0.25% bupivacaine at a rate of 6 $ml \cdot hr^{-1}$ provided 6 out of 11 patients adequate pain relief during the postoperative 48-hour period.

The Baxter infusor® is a disposable, non-electronic device having an ability to deliver infusion at a constant fixed rate. It was originally designed for administration of chemotherapeutic agents. As the viscosity of local anesthetics differs, we earlier evaluated the flow rate of 10 $mg \cdot ml^{-1}$ mepivacaine of this device, by attaching it to the outlet of the epidural catheter, and also evaluated the safety of this infusor by measuring the serum level of mepivacaine in patients[4]. We reported that the measured flow rates of 10 $mg \cdot ml^{-1}$ mepivacaine, prefixed at 2 $ml \cdot hr^{-1}$ type, were 1.87 $ml \cdot hr^{-1}$ at 28°C, and 2.14–2.15 $ml \cdot hr^{-1}$ at 33°C, and the maximal level of serum mepivacaine was 1.129 ± 0.439 $\mu g \cdot ml^{-1}$ during a 72-hour period[4]. We, as well as other researchers[4,5], thus confirmed the safety of this device as used at a prefixed flow rate. It has been extensively used for administration of local anesthetics, narcotics and analgetics epidurally, intravenously, or subcutaneously[2,6,7]. We encountered no instance of complications attributable to this portable infusor during our studies.

We conclude that continuous epidural infusion of 10 $mg \cdot ml^{-1}$ mepivacaine at a rate of 2 $ml \cdot hr^{-1}$ was more effective than intermittent bolus administration for postoperative pain relief purposes during the 12 to 24-hour period, while in the immediate 12-hour period either method failed to produce the expected results. From 12 to 72-hour period postoperatively a continuous infusion of 10 $mg \cdot ml^{-1}$ mepivacaine helped to reduce the dose of supplemental analgesics. Patients in the first 12-hour period after operation seemed to require an increased flow rate of local anesthetics.

(Received Nov. 8, 1990, accepted for publication Mar. 7, 1990)

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