Epidural Administration and Analgesic Spread: Comparison of Injection with Catheters and Needles

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This study was designed to investigate differences in epidural analgesic spread between catheter and needle injections in 48 patients with comparable physical characteristics. The spread of analgesia in the catheter injection group with a 0.24 ml·sec^{-1} injection rate (n=16) was 16.8 ± 1.5 spinal segments and that in the needle injection group at the same injection rate (n=16) was 12.5 ± 1.8 spinal segments ($P < 0.01$). Needle injection at the faster rate of 1.2 ml·sec^{-1} (n=16) produced a significantly greater spread of analgesia than with the 0.24 ml·sec^{-1} rate through the needle (16.2 ± 1.6 vs 12.5 ± 1.8 spinal segments, $P < 0.01$). Thirteen of 16 patients receiving the fast needle injection complained of back compression or discomfort during the injection.

The injection through an epidural catheter and the fast (1.2 ml·sec^{-1}) injection through a needle produced extensive and equivalent epidural analgesic spread. However, because of patient discomfort with fast injection through the needle, the authors conclude that when using continuous epidural anesthesia, the initial injection of local anesthetic should be administered through the epidural catheter not the needle. (Key words: epidural, lidocaine)

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It is well known that several factors determine the spread of epidural analgesia with local anesthetics, including age, height and position of patients[1–6], and volume of anesthetics[2–4,7].

The present wide spread use of epidural analgesia would be impossible without continuous catheter techniques for prolonging blockade. However, most of investigators had studied the epidural spread of local anesthetics when administered through a needle but not through a catheter[1–8].

The aim of this study was to compare the effect of needle versus catheter injection on the epidural spread of a local anesthetic. Results will be discussed in terms of the optimal method for initial epidural drug administration.

Materials and Methods

Forty eight patients, who were scheduled for elective gynecologic surgery with lumbar epidural anesthesia, were selected for this study. The protocol was approved by the ethics committee of our institute and in-

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Table 1. Patient physical characteristics

Group	n	Sex	Age (yr old)	Body Weight (kg)	Height (cm)
I	16	F	43.3 ± 5.0	53.5 ± 6.8	153.2 ± 5.9
II	16	F	43.4 ± 5.3	52.1 ± 6.1	151.9 ± 4.9
III	16	F	43.4 ± 4.9	54.9 ± 4.8	153.4 ± 5.2

All values are means ± SD.

formed consent was obtained from each patient. All patients were ASA physical status I, and were free from neurologic disease, local infection, sepsis and bleeding abnormalities. Premedication with 100 mg of hydroxyzine hydrochloride and 0.5 mg of atropine sulfate was administered by intramuscular injection 30 min before arrival in the operating room. A 16-gauge intravenous cannula was placed for infusion of lactated Ringer's solution, and a blood pressure cuff and ECG electrodes were applied. Following sterile preparation and draping of each patient in the right lateral decubitus position, lidocaine (1%, 2–3 ml) was injected subcutaneously and intradermally at the L1–2 intervertebral space. The epidural space was identified with a 17-gauge Tuohy needle cephalad by a midline approach. Entry of the needle point into the epidural space was confirmed by the hanging drop method and loss-of-resistance technique with an air-filled syringe. In group I, an 18-gauge epidural catheter (Portex) was inserted through the needle and 2–3 cm of catheter was placed in the epidural space.

Following identification of the epidural space, 2 ml of 2% lidocaine with freshly added epinephrine (1:200,000) was injected as the test dose through the epidural catheter (Group I) or through the needle (Group II and III). After 2 min, if there was no evidence of inadvertent subarachnoid or intravenous injection of the drugs, 12 ml of the remaining anesthetic solution was injected according to the following three protocols:

(1) Group I (n=16): The injection through an 18-gauge epidural catheter was made at a rate of 0.24 $ml \cdot sec^{-1}$.
(2) Group II (n=16): The injection through a Tuohy needle was made at a rate of 0.24 $ml \cdot sec^{-1}$.
(3) Group III (n=16): The injection through a Tuohy needle was made at a rate of 1.2 $ml \cdot sec^{-1}$.

Immediately after the epidural injection, each patient was placed in the supine position. The spread of analgesia was determined in 2 min intervals for 20 min. The onset of analgesia was observed by noting the loss of sharpness of pinprick, and the arithmetic mean of the analgesic level on each side was determined using a segmental dermatome chart, according to Foerster's dermatome map[9]. Epidural dose requirement to block one spinal segment was calculated by 14 ml/(segment numbers of analgesia). Arterial blood pressure and heart rate were measured and recorded in 2 min intervals.

Data were analyzed for statistical significance using analysis of variance (ANOVA), followed by Student's t test. P values of 0.05 or less were regarded as statistical significant. Data were expressed as means ± S.D.

Results

There were no significant differences in age distribution, body weight or height in the three groups of patients (table 1).

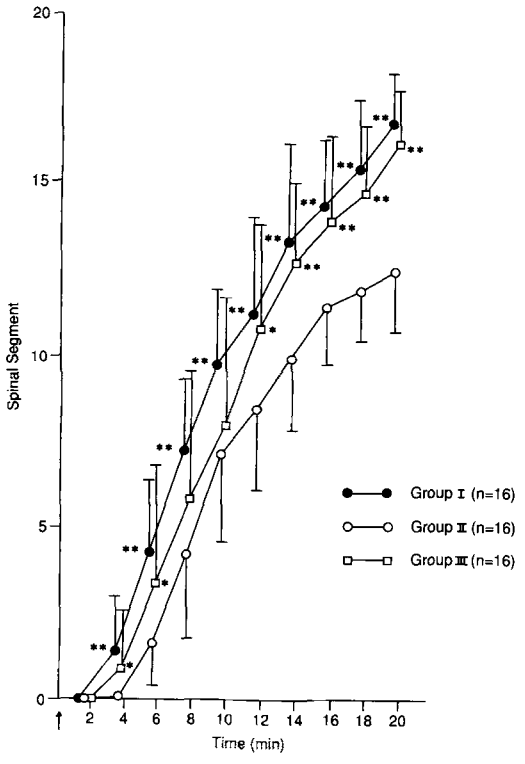

Fig. 1. Spinal segments of epidural analgesia.

Injection time is denoted by the arrow at time zero. Vertical brackets represent the S.D. of the means.

$^{*}P < 0.05$, $^{**}P < 0.01$ statistically significant difference compared with Group II.

Analgesic latency, as defined by the time required for loss of sharpness of pinprick, was 5.2 ± 1.3, 6.7 ± 1.5 and 6.3 ± 1.7 min in Groups I, II and III, respectively. The latency in Group I was significantly shorter than that in Group II. Spread of epidural analgesia is shown in figure 1. Analgesic spread in Group I was more extensive than that in Group II with the difference becoming significant at 4 min and thereafter ($P < 0.01$). Twenty minutes after drug administration, analgesic spread was 16.8 ± 1.5 spinal segments in Group I and 12.5 ± 1.8 spinal segments in Group II ($P < 0.01$). Analgesic spread in Group III was significantly more extensive than that in Group II at 4, 6 and 12 min and thereafter ($P < 0.05$). Twenty minutes after drug administration, analgesic spread was 16.2 ± 1.6 spinal segments in Group III ($P < 0.01$, compared with that in Group II). The epidural dose requirements to block one spinal segment in Group I was 0.4 ± 0.1 ml, and the corresponding value for the Group II was 1.1 ± 0.2 ml and that for the Group III was 0.9 ± 0.1 ml. (The value for the Group II was significantly different from Group I and III, $P < 0.01$). The analgesic spread difference between Group I and III was not significant.

There was no difference in the amount of intravenous fluid between the groups. Hypotension (below 70% of control systolic blood pressure) was observed in 3, 0 and 2 cases in Group I, II and III, respectively.

Thirteen of the 16 patients receiving the faster needle injection (Group III) complained of back compression or discomfort during the injection, whereas no one in the catheter and slow needle injection groups (Groups I and II) had similar complaints.

Discussion

The present study demonstrated that the injection through an epidural catheter and the fast injection through a needle produced more extensive epidural analgesic effect than the slow injection through the needle. Physical characteristics including sex, age, height and body weight were standardized, therefore, we assume that the status of the epidural space was comparable among groups.

There was a significant difference in the spread of analgesia between the catheter group and the needle group at the same injection rate. The spread of analgesia in Group I was about 4 spinal segments greater than that in Group II. A Portex epidural

catheter has three side holes close to the tip. The local anesthetic would be distributed to three directions in the epidural space from the fine holes. In contrast to catheter injection, injection through a needle at the same injection rate did not appear to spread the local anesthetic as effectively in the epidural space.

Complications associated with epidural catheterization include malposition[10], epidural venous cannulation[11,12], subarachnoid cannulation[13,14] and subdural cannulation[15]. When initial injection is done through a catheter, it is possible to ensure that the injection has not been made into an undesirable space. On the other hand, however, when initial injection through a needle followed by epidural catheterization for prolongation of blockade, there is no certaints for the second injection through the catheter. When the second injection through the catheter in the needle group is inadvertent, it is impossible to continue the epidural anesthesia. Moreover, the local anesthetic previously administered through the needle may conceal trauma to neural tissue during catheter placement[16].

Erdemir et al.[7] reported that fast injection (1 $ml \cdot sec^{-1}$) was found to produce slightly higher analgesic levels (only 0.7 dermatome higher) than slow injection (0.33 $ml \cdot sec^{-1}$). However, they did not discuss the physical characteristics of the patients. We, in this study, compared injection rates in patients with comparable physical characteristics and used faster and slower injection rates (1.2 and 0.24 $ml \cdot sec^{-1}$) than those in Erdemir's study. The faster injection rate produced a significant increase in analgesic spread, but was associated with increased patient discomfort and complaints.

The results of the present study indicate that greater analgesic spread may be achieved when local anesthetic is administered through an indwelling epidural catheter rather than a Tuohy needle. Increasing the flow rate through the needle will increase spread but may also be associated with patient discomfort. We, therefore, conclude that when using continuous epidural anesthesia, the initial injection of local anesthetic should be administered through the epidural catheter not the needle.

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