Brief Reports

Epidural saline solution prior to local anaesthetic produces differential nerve block

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Purpose: The loss-of-resistance technique is generally used to identify the epidural space usually with normal saline. However, the effect of epidural saline on anaesthetic spread has not been demonstrated. The purpose of this study was to determine whether epidural saline affected the anaesthetic level and the quality of analgesia.

Methods: Seventy patients undergoing upper abdominal surgery received thoracic epidural anaesthesia combined with general anaesthesia. The patients were randomly allocated into three groups using epidural saline volumes of 1, 5, or 10 ml. Ten minutes after epidural injection of 12 ml mepivacaine 1%, the dermatome levels of hypaesthesia for cold and pinprick were determined by an individual blinded to the amount of saline administered.

Results: The levels of hypaesthesia for cold sensation were not different among the three groups (23 [14-44] total bilateral dermatomes blocked with 1 ml saline, 22 [16-41] dermatomes with 5 ml, and 24 [10-36] dermatomes with 10 ml (median [range])). However, the larger volume of saline produced decreased spread of hypaesthesia for pinprick (22 [4-41] dermatomes blocked bilaterally for 1 ml vs 16 [8-24] dermatomes for 10 ml group, $P < 0.004$).

Conclusion: Our results suggest that a large volume of saline solution injected in the epidural space to elicit loss-of-resistance dilutes the local anaesthetic solution, resulting in reduced spread of the block to pinprick.

Objectif : La technique de perte de résistance, utilisée surtout avec une solution physiologique salée, est généralement employée pour identifier l'espace péridural. Cependant, l'effet du soluté péridural sur l'extension anesthésique n'a pas été démontré. Le but de la présente étude était de déterminer si la solution péridurale a un effet sur le niveau et la qualité de l'anesthésie.

Méthode : Soixante-dix patients devant subir une chirurgie abdominale basse ont reçu une anesthésie péridurale thoracique combinée à une anesthésie générale. Les patients ont été répartis de façon aléatoire en trois groupes, selon l'utilisation de solutions péridurales dont les volumes étaient de 1, 5 ou 10 ml. Dix minutes après l'injection péridurale de 12 ml de mépivacaïne 1 %, les niveaux d'hypesthésie au froid (dermatome) ou à la piqure, ont été déterminés par un observateur qui ne connaissait pas le volume de solution administré.

Résultats : Les niveaux d'hypesthésie à la sensation du froid n'ont pas été différents d'un groupe à l'autre (23 [14-44] dermatomes bilatéraux bloqués avec 1 ml de solution, 22 [16-41] dermatomes avec 5 ml et 24 [10-36] dermatomes avec 10 ml ([intervalle] médian)). Toutefois, le plus grand volume de solution a produit une plus faible extension de l'hypesthésie à la piqure (22 [4-41] dermatomes bloqués bilatéralement avec 1 ml vs 16 [8-24] dermatomes avec 10 ml, $P < 0,004$).

Conclusion : Nos résultats suggèrent qu'un grand volume de solution salée injecté dans l'espace péridural, pour permettre d'utiliser la technique de perte de résistance, dilue la solution anesthésique locale, ce qui résulte en une extension réduite du blocage de la sensibilité à la piqure.

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SUDDEN loss of resistance (LOR) is characteristic of the epidural needle advancing into the epidural space through the Ligament flavum. A small amount of saline solution from the syringe is usually injected into the epidural space. Occasionally, large volumes are inadvertently injected, particularly when positioning of the epidural catheter is difficult. Although some studies have shown that the spread of epidural anaesthetics was independent of the volume injected,^{1,2} others have not. The purpose of this study was to determine whether the volume of injected epidural saline affected the level and quality of anaesthesia.

Methods

Seventy patients undergoing upper abdominal surgery who gave informed consent were enrolled in the study. This protocol was approved by our hospital's investigation committee on ethics.

Epidural puncture was performed in the left lateral position at the T₇₋₈ level of the intervertebral space using a 17G Tuohy needle by a paramedian approach with the LOR method using normal saline solution. Patients were randomly assigned to one of three groups according to the volume of saline volume injected epidurally; 1 ml, 5 ml or 10 ml. One of the three different volumes was injected into the epidural space after demonstrating LOR. Then, an epidural catheter was placed in the epidural space 3 cm cephalad to the epidural tap. After confirming negative aspiration of cerebrospinal fluid and blood, 2 ml mepivacaine 1% were injected as a test dose. Patients were turned to the supine horizontal position. Ten minutes after injection of the test dose, we confirmed again that the epidural catheter was not in the subarachnoid space by assessing the degree of motor blockade and enquiring about leg numbness. Thereafter, 12 ml mepivacaine 1% were administered over 30 sec through the epidural catheter as a main dose. Ten minutes after mepivacaine 1%, the anaesthetist, who was blinded to the amount of saline administered, assessed the spread of hypaesthesia to cold and a pain using an alcohol swab and a pinprick, respectively (above the 2nd sacral dermatome). The extent of the hypaesthesia was expressed as the total number of dermatomes from each side because bilateral block level was not always the same.

Lactated Ringer's solution was administered at 10 ml·hr⁻¹ during the procedures. Arterial pressure and heart rate were determined automatically every five minutes, and arterial oxygen saturation was continuously monitored by pulse oximetry. When the systolic pressure decreased to 80 mmHg or to < 70% of the baseline pressure, 1 mg etilefrine *iv*, a sympathomimetic vasoconstrictor, was administered.

After these procedures, general anaesthesia was induced with thiopentone or propofol and the anaesthesia was maintained by nitrous oxide and sevoflurane or propofol-fentanyl combined with epidural anaesthesia. Anaesthesia was adequate in all patients for surgery and there were no serious complications.

Differences between all variables in the three groups were tested using Kruskal-Wallis tests, followed by Mann-Whitney U-tests. Results are expressed as mean $\pm$ SD.

Results

Of the 70 patients enrolled in the study, epidural catheters could not be inserted in five. In three, there were no hypaesthetic levels for cold sensation and pinprick. In two patients, catheters were suspected to have been placed into the subarachnoid space. Therefore, 60 patients were analyzed. There were no significant differences in patient age, height or weight among the groups (Table I). The total number of dermatomes of hypaesthesia for cold sensation were not different among the groups (Table II). However, the total number of dermatomes of hypaesthesia to pinprick in the 1 mL group was more than that in the 10 mL group (Table II). The differences between the total number of dermatomes of hypaesthesia for cold sensation and pinprick in the 1 mL and 5 mL groups were less than that in the 10 mL (Figure 1).

TABLE I Characteristic of patients assigned to the three groups (mean $\pm$ SD).

Characteristic <i>n</i>	Group		
	1 ml group 20	5 ml group 20	10 ml group 20
Age (yr)	61 $\pm$ 11	61 $\pm$ 10	61 $\pm$ 10
Height (cm)	161 $\pm$ 9	162 $\pm$ 6	164 $\pm$ 7
Weight (kg)	60 $\pm$ 13	55 $\pm$ 8	59 $\pm$ 9

P: NS.

TABLE II The number of hypaesthesia dermatomes for cold and pinprick stimulus (median [range])

	Group		
	1 ml group	5 ml group	10 ml group
hypaesthesia level for cold	23 [14-44]	22 [16-41]	24 [10-36]
hypaesthesia level for pinprick stimulus	22 [4-41]*	19 [10-33]	16 [8-24]

Hypaesthesia segments were calculated above the 2nd sacral dermatome.

The number was total segments or both right and left hypaesthesia.

* $P = 0.004$ vs 10 ml group

Discussion

Our principal findings were that the hypaesthetic level to cold was independent of the volume of saline used, whereas the hypaesthetic level to pain was attenuated in proportion to the saline volume.

The volume-anaesthesia relationships for epidural anaesthesia were originally reported by Bromage.³ He assumed that the epidural volume-anaesthesia relationship was linear and doubling the epidural volume would double the number of spinal segments blocked. However, Grundy *et al.*⁴ found that a stepwise increase in volume of bupivacaine resulted in a relatively small spread of anaesthetic effect. Park *et al.*⁵ also reported that there were only small differences in spread with 10, 15, 20 ml lidocaine. In addition, no correlation between the volume and the effect was reported by Duggan *et al.*¹ or Paul *et al.*² Our finding of no difference in cold sensation block among three groups was consistent with these reports. The relationship between epidural saline and spread of the subsequent anaesthetic has been reported by Iwama⁶ who showed that a larger volume of saline using LOR caused a greater extent of hypaesthesia. His findings are inconsistent with our results.

We considered the influence of increased epidural pressure by the volume of saline on the hypaesthetic level because Usubiaga⁷ suggested that block height was related to generated epidural pressure after injection. However, we injected the local anaesthetic ten minutes after injecting saline into the epidural space. Although the pressure was maximum at the end of the injection and pressure can affect the spread of the solution, the pressure

decreases to a plateau within a few minutes.⁸ Therefore, it is unlikely that this affected the spread of hypaesthesia.

The mechanisms underlying the differential nerve block elicited by the large volume saline group were considered. Differential nerve block is a well recognised characteristic of subarachnoid anaesthesia. Green⁹ suggested that differential nerve block in spinal anaesthesia may be due to progressive dilution of the anaesthetic by the cerebrospinal fluid so that its concentration decreases as the distance from the injection site increases. At the initial phase of epidural block, a similar but narrow zone of differential nerve block may exist for five to ten minutes. However, once epidural anaesthesia is established, the discriminatory level of cold sensation and pinprick stimuli coincides exactly.¹⁰ A large volume of saline in the epidural space also dilute the local anaesthetic and thus produced differential nerve block. The short interval between the local anaesthetic injection and the assessment of block levels may also contribute to the occurrence of the differential blockade.

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FIGURE Difference of dermatome levels, total bilateral, between hypaesthesia for cold sensation and pinprick. The upper level of each bar represents the median in each group. The difference of dermatomes between two hypaesthesia levels was greater in the 10 mL than with the 1 mL and 5 mL groups. # $P < 0.01$ vs 10 mL group.