Toshiyuki Okutomi MD,
Sumio Hoka MD

Saline - anesthetic interval and the spread of epidural anesthesia

Purpose: To examine the effect of modifying the interval between administration of saline used during the loss of resistance (LOR) method and local anesthetic on epidural anesthetic level and its quality.

Methods: Seventy-three patients who received thoracic epidural anesthesia were randomly allocated into three groups; the 2, 5 and 10 min groups, according to the interval between the administration of saline and 8 ml mepivacaine 1.5%. Fifteen minutes after the mepivacaine injection, the dermatome level of hypesthesia was determined by an individual blinded to the interval.

Results: When the saline-anesthetic interval was prolonged, the hypesthetic levels for coldness and pinprick were decreased. The number of spinal segments with hypesthesia for coldness were 15 [12-20]#, 12.5 [10.5-22.5]## and 10.5 [6.5-15.5]### in the 2, 5 and 10 min groups, respectively (median [range], # $P < 0.05$ vs the 5 min group, ## $P < 0.05$ vs the 10 min group, ### $P < 0.05$ vs the 2 min group). The number of spinal segments with hypesthesia for pinprick were 13.5 [11-18]#, 11 [7.5-20.5]## and 10 [5.5-13]### in the 2, 5 and 10 min groups, respectively. There were differences in all groups between the number of segments with hypesthesia for coldness and pinprick elicited.

Conclusion: The interval between the administration of saline and local anesthetic alters the anesthetic level and quality of epidural analgesia.

Objectif : Examiner l'effet de la modification de l'intervalle entre l'administration de solution salée et d'anesthésique local sur le niveau anesthésique péridural et ses caractéristiques, lorsqu'on utilise la méthode de perte de résistance (PDR).

Méthode : Soixante-treize patients qui ont reçu une anesthésie péridurale thoracique ont été répartis au hasard en trois groupes de 2, 5 et 10 min, selon l'intervalle entre l'administration de la solution salée et de 8 ml de mepivacaine à 1,5 %. Quinze minutes après l'injection de mepivacaine, le niveau du dermatome atteint d'hypoesthésie a été déterminé par une personne qui ne connaissait pas la durée de l'intervalle.

Résultats : Quand l'intervalle solution salée-anesthésique était prolongé, les niveaux hypoesthésiques des sensations de froid et de piquûre ont été abaissés. Le nombre de segments médullaires qui présentaient de l'hypoesthésie au froid ont été de 15 [12-20]#, 12,5 [10,5-22,5]## et de 10,5 [6,5-15,5]### dans les groupes de 2, 5 et 10 min, respectivement, (médiane [étendue], # $P < 0,05$ vs le groupe de 5 min, ## $P < 0,05$ vs le groupe de 10 min, ### $P < 0,05$ vs le groupe de 2 min). Le nombre de segments médullaires atteints d'hypoesthésie à la piquûre ont été de 13,5 [11-18]#, 11 [7,5-20,5]## et de 10 [5,5-13]### dans les groupes de 2, 5 et 10 min, respectivement. Il y a eu des différences entre tous les groupes quant au nombre de segments atteints d'hypoesthésie provoquée au froid et à la piquûre.

Conclusion : L'intervalle entre l'administration d'une solution salée et d'un anesthésique local modifie le niveau anesthésique et la qualité de l'analgesie péridurale.

From the Department of Anesthesiology, Kitasato University School of Medicine, 1-15-1 Kitasato, Sagami-hara, Kanagawa 228-8555, Japan.
Address correspondence to: Toshiyuki Okutomi MD, Phone: +81-427-78-8616; Fax: +81-427-78-9427.
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THERE is no consensus as to whether air or saline is preferable for the loss of resistance (LOR) technique. Some authors have suggested that the use of air is a major risk.^{1,2} Recent studies showed that a large saline solution inadvertently injected into the epidural space, particularly when it is difficult to place the epidural catheter, modulates the spread of local anesthetic and its quality.^{3,4} The extent of the effect of saline on the spread of local anesthetic may be influenced, not only by the volume of saline or the concentration of local anesthetic, but also by the interval between the saline used during the LOR method and the local anesthetic administration. The purpose of this study is to examine the effect of the interval on epidural anesthetic levels and its quality.

Methods

The study protocol was approved by our hospital's investigation committee on ethics. The study was single-blinded clinical trial. Seventy three patients undergoing upper abdominal surgery were enrolled after giving informed consent.

All patients enrolled in this study were randomly divided into three groups according to the interval between the administration of saline, used during the LOR technique, and mepivacaine; the 2 min, 5 min and 10 min groups. Randomization was performed by dividing the last two figures of the patients' identification (ID) numbers by three. Those patients whose figures were divisible were allocated to the 2 min group, while the patients whose ID divided by three with one left over were allocated to the 5 min group, and with two left over were allocated to the 10 min group.

Each patient received 5-15 mg diazepam *po* as the premedication. Intravenous access was obtained in all patients. They were placed in the left lateral position on a horizontal operating table. Epidural puncture was performed aseptically by an attending anesthetist at the T₇₋₈ level of the intervertebral space using a reusable 17G winged Tuohy needle (47B-1170, Hakko-Shouji Co., Tokyo, Japan) by a paramedian approach with the LOR to air using no more than 1 ml. The epidural catheter (Epineed EN-C1795, Terumo Co. Tokyo, Japan) was kept in place in the epidural space 3 cm cephalad from the epidural tap. After confirming negative aspiration of cerebrospinal fluid and blood, 2 ml mepivacaine 1% were injected in the left lateral position as a test dose to confirm correct epidural catheter placement. Patients were turned to the supine horizontal position. Three minutes after injection of the test dose, 8 ml saline solution were administered for 30 sec through the epidural catheter.

After one of three different intervals, we confirmed that the epidural catheter had not been placed in the subarachnoid space or blood vessels by assessing the degree of motor blockade and asking the patient if there was numbness in their legs. Then, 8 ml mepivacaine 1.5 % were administered for 30 sec through the epidural catheter with the patient in the supine horizontal position.

Fifteen minutes after the mepivacaine injection, assessment of the spread of hypesthesia to cold and pain on both sides of the body according to a dermatomal chart (above the 2nd sacral dermatome), using cotton soaked in rubbing alcohol and pinprick, was performed by an individual blinded to the interval between the saline and mepivacaine administration to determine the sensory blockade. The extent of the hypesthesia was calculated as the average dermatome of both sides if the block levels for both sides were not the same.

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

After these procedures, general anesthesia was induced with thiopental or propofol and the was maintained by nitrous oxide and sevoflurane or propofol-fentanyl combined with epidural anesthesia. Vecuronium was used as the muscle relaxant. Anesthesia was adequate in all patients for upper abdominal surgery and there were no serious complications.

Differences between all variables among the three groups were tested using Kruskal-Wallis tests, followed by Mann-Whitney U-tests. The differences between the number of segments with hypesthesia for coldness and pinprick were tested using Wilcoxon tests. A *P* value < 0.05 was considered significant. Results are expressed as mean ± SD for characteristic data of patients and median [range] for anesthetic level.

TABLE Characteristic of patients assigned to the three groups (mean ± SD).

Characteristic	2-min	Group 5-min	10-min
n	23	23	23
Sex (M/F)	17 / 6	17 / 6	14 / 9
Age (yr)	59 ± 11	62 ± 14	60 ± 12
Height (cm)	161 ± 8	160 ± 10	160 ± 9
Weight (kg)	62 ± 10	57 ± 10	55 ± 10

P: NS

Results

Of the 73 patients, one had failure of catheter placement because of obesity and three had heavy premedication. Nobody showed a blood or a spinal tap. Therefore, 69 patients in total, 23 in each group were studied. There were no differences in age, height, or weight among the three groups (Table). The number of spinal segments with hypesthesia for coldness in the 2 min, 5 min and 10 min groups were 15 [12-20]#, 12.5 [10.5-22.5]## and 10.5 [6.5-15.5]###, respectively (median [range], # $P < 0.05$ vs the 5 min group, ## $P < 0.05$ vs the 10 min group, ### $P < 0.05$ vs the 2 min group) (Figure). The number of spinal segments with hypesthesia for pinprick in the 2 min, 5 min and 10 min groups were 13.5 [11-18]#, 11 [7.5-20.5]## and 10 [5.5-13]###, respectively (Figure 1). Differences between the number of segments with hypesthesia for coldness and pinprick were elicited in each group (Figure).

Discussion

Our principal finding was that the number of segments with hypesthesia for cold and pinprick after 8 ml mepivacaine 1.5% administration was dependent on the interval between the administration of saline solution, used during the LOR method, and local anesthetic. As the interval became longer there were fewer segments of hypesthesia to cold or pinprick. It is possible that unexpected spread of local anesthetic may occur when it is difficult to place the epidural catheter, and a larger volume of saline is inadvertently injected into the epidural space. The difference for hypesthetic segment between 2 min and 10 min intervals between the saline and the mepivacaine administrations was 3-4 segments.

Although the mechanism causing different hypesthetic levels is unknown, it is possible that, with time, that 8 ml of saline changes the epidural pressure gradient, affecting the spread of the following local anesthetic. Usubiaga *et al.*⁵ suggested that the segmental block level relates to generated epidural pressure after injection. However, Husemeyer and White⁶ found no correlation between the epidural pressure and the extent of epidural anesthesia, and Hirabayashi *et al.*⁷ reported that the lower the epidural pressure, the wider the spread of epidural anesthesia. These inconsistent results may be explained partly by the differences in epidural pressure measurements at different moments during and after the local anesthetic injection, using different local anesthetic solutions. In this study, we injected local anesthetic two to ten minutes after saline into the epidural space. Since the elevated pressure is maximum at the end of the injection and the pressure decreases to a plateau in less than a few minutes,⁷⁻⁹ the pressure generated by the injected solution could influ-

FIGURE The number of dermatomes for hypesthesia for cold stimulation and pinprick in three groups of different intervals between the saline and 8 ml mepivacaine 1.5% administrations. The upper level of each bar represents the average segment in each group. Closed circle: the number of dermatomes for hypesthesia for cold sensation in each patients; open circle: the median of the number of dermatomes for hypesthesia for cold sensation in each group. Closed diamond: the number of dermatomes for hypesthesia for pinprick stimulus in each patient; open diamond: the median of the number of dermatomes for hypesthesia for pinprick stimulus in each group. * $P < 0.05$ vs the number of dermatomes for hypesthesia for pinprick in the same group. † $P < 0.05$ vs the number of dermatomes for hypesthesia for cold stimulation or pinprick stimulus in the 5 min group. ‡ $P < 0.05$ vs the number of dermatomes for hypesthesia for cold stimulation or pinprick stimulus in the 10 min group. § $P < 0.05$ vs the number of dermatomes for hypesthesia for cold stimulation or pinprick stimulus in the 2 min group.

ence the spread of the solution depending on the interval between the saline solution and the local anesthetic administrations.

It is possible that local anesthetic diluted by saline causes a differential nerve block because different concentrations of local anesthetic agents may block different types of nerve fibres. The smallest fibres, sympathetic fibres and those transmitting temperature discrimination, are more sensitive than those transmitting pain. This phenomenon is a well known characteristic in subarachnoid anesthesia. Green¹⁰ suggested that this may be due to the progressive dilution of anesthetic by the cerebrospinal fluid so that its concentration decreases as the distance from the injection site increases, resulting in a zone in which only temperature discrimination is impaired while pinprick sensation is intact. When a large volume of saline is injected into the

epidural space, it may dilute a local anesthetic as if it were the cerebrospinal fluid. Our results showed that differential nerve block was elicited in all groups, independently of the interval between the saline and the local anesthetic administration.

In this study, air was used to test the loss of resistance during epidural puncture. There is no consensus as to which is better for the loss of resistance technique, air or saline. We used air, <1 ml because to avoid the loss of saline as the epidural needle passed through the various tissues before entering the epidural space. Barros¹¹ concluded that 2 ml or less of air does no harm. No subjects in our study had any complications.

In conclusion, the interval between saline solution used for the LOR method and 8 ml mepivacaine 1.5% administrations altered the number of segments with hypesthesia for coldness and pinprick.

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