# Epidurally Administered Halothane Vapor Potentiates Mepivacaine-induced Epidural Anesthesia : A Report of 10 Cases

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Inhalational agents have some action to the spinal cord[1,2]. It is conceivable that epidurally administered inhalational agent may induce anesthesia similar to the epidural anesthesia induced by local anesthetics. A search for literature failed to find such reports. Because some advantages were expected as we discuss later, we first administered a small amount and obtained an encouraging response. Therefore, we undertook a somewhat more systematic study. This is a report of the first 10 patients who received this type of anesthesia.

## Methods

Ten patients who underwent intraabdominal procedure and who received anesthesia under this protocol were studied. Their ages, body sizes are given in table 1 together with the results. Five patients are males and five are females. Four out of these 10 underwent subtotal or total gastrectomy with lymphnodes dissection.

Epidural space was identified with the ordinary "loss-of-resistance" method and by inserting a catheter 10 cm beyond the tip of the needle. The catheter was subsequently pulled back so that approximately 5 cm remained in the epidural space. The places of insertion were between Th8 and L1. Three ml of 1% mepivacaine were administered. General anesthesia was induced with an appropriate amount of thiopental, an endotrachal tube was placed in the trachea, and the patient received nitrous oxide (66%) and low concentration of enflurane. Then the first dosis of epidural halothane was given.This was repeated twice more at 10 min intervals. After that, halothane vapor was administered every 30 min to every 60 min. If a repeated administration of halothane appears not to be anesthetizing the patient properly, a small amount of mepivacaine was administered. Usually 2 to 4 mg of pancuronium was given at the initiation of surgery, and a small increment was added as judged necessary for surgical procedure. We made some effort to reduce the concentration of enflurane, amount of mepivacaine and/or the addition of pancuronium, but we always aimed at stabilizing the circulatory condition, and at achieving good surgical condition. Hypertension, when it occurred, was treated by either deepening the enflurane or by adding mepivacaine.

Halothane vapor was prepared by drawing air or nitrous oxide into a 50 ml glass syringe in which a few ml of liquid halothane had been placed in advance. The anesthetist's hand supplied some heat, but the vaporization was done essentially at room temperature. The concentration was not measured but it was assumed that the vapor was close to full saturation at room

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**Table 1.** Results from 10 patients studied and the control group

| pt | age | heig | weig | time | mepi | me/t | halo | ha/t | panc | pan/t | enfl | enf/t | wake |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| unit | year | cm | kg | min | mg | mg/m | ml | ml/m | mg | mg/m | %min | % | min |
| 1 | 43 | 156 | 51 | 260 | 340 | 1.3 | 300 | 1.15 | 5 | 0.01 | 79 | 0.3 | 0 |
| 2 | 49 | 165 | 68 | 230 | 20 | 0.08 | 300 | 1.3 | 4 | 0.01 | 145 | 0.63 | 9 |
| 3 | 74 | 152 | 58 | 145 | 140 | 0.96 | 120 | 0.82 | 2 | 0.01 | 25 | 0.17 | 0 |
| 4 | 78 | 140 | 37 | 200 | 160 | 0.80 | 210 | 1.05 | 4 | 0.02 | 70 | 0.35 | 20 |
| 5 | 60 | 157 | 49 | 615 | 270 | 0.43 | 1100 | 1.78 | 11 | 0.01 | 170 | 0.27 | 0 |
| 6 | 52 | 150 | 44 | 75 | 70 | 0.93 | 160 | 2.13 | 2 | 0.02 | 0 | 0.00 | 0 |
| 7 | 78 | 156 | 44 | 100 | 180 | 1.80 | 60 | 0.60 | 2 | 0.02 | 7 | 0.07 | 0 |
| 8 | 48 | 165 | 66 | 175 | 240 | 1.37 | 265 | 1.51 | 6 | 0.03 | 80 | 0.45 | 0 |
| 9 | 43 | 160 | 50 | 145 | 160 | 1.10 | 400 | 2.75 | 4 | 0.02 | 24 | 0.16 | 0 |
| 10 | 66 | 150 | 60 | 460 | 510 | 1.10 | 1010 | 2.19 | 2 | 0.002 | 139 | 0.30 | 0 |
| mn | 59 | 155 | 52.7 | 241 | 209 | 0.98 | 393 | 1.53 | 4.2 | 0.015 | 73.9 | 0.27 | 2.9 |
| cont | 59 | 157 | 53.6 | 258 | 567 | 2.49 | 0 | 0 | 5.5 | 0.020 | 130.4 | 0.46 | 20.8 |

*halo indicates halothane vapor administered into epidural space.

**enf indicates enflurane administered together with nitrous oxide via endotrachal tube. It is expressed as the product of concentration and time (in min). enf/t is the concentration of enflurane averaged over the anesthesia time.

***wake indicates the time required for patients to wake up. Except cases 2 and 4, it was virtually instantaneous.

****Case 6 woke up, but required artificial ventilation for 35 min post-op.

temperature (21 to 24 degree in Celsius). As a standard, 40 ml of this mixture was administered, but a smaller increment was used when judged it to be appropriate.

Another group of 10 patients whose profiles are similar to the study group except that they received conventional epidural anesthesia using mepivacaine combined with general anesthesia. This was treated as the control group, althouth it is not a blind "control" nor do we consider this to be a controlled study.

## Results

Table 1 indicates the results of these 10 cases. In essence, a patient of 155 cm of height and 53 kg of weight underwent intra-abdominal procedure of 4 hours duration under nitrous oxide and enflurane (0.27%) combined with epidural anesthesia achieved with 1 mg/min of mepivacaine and 1.5 ml/min of halothane vapor. The total amount of pancuronium administered was 4.2 mg. In the bottom of the table, similar mean values from the control group are shown. Age, height, weight and anesthesia time are all similar, while the mean concentration of enflurane, amount of mepivacaine given per minutes and the amount of pancuronium were less in the study group than in the control group. Time required for awaking is shorter in the study group. These differences are all statistically significant.

## Discussion

The practical aim of this investigation is two-folds. One is to achieve epidural anesthesia more quickly. The diffusivity of the inhalational agents is conceivably better than ordinary local anesthetics, because the formers diffuse in the gas phase while the latters have to diffuse in liquid environment. With the current study, we could not substantiate this presumption; we did not observe the initiation of anesthesia carefully, and we did not obtain an impression of its onset being substantially faster. Furthermore, in the preliminary studies, when we injected halothane vapor into epidural space of awake patients, they occasionally experienced some pain.

This may partly be due to pressure or volume effect but it appears, at least in some patients, that halothane vapor itself causes pain. In the spinal cat preparation, deJong observed a short stimulative phase of halothane anesthesia in the dorsal horn neuron[2]. The mechanism is not known, but this finding may be related to the "burning" sensation which some patients experienced.

The second aim was to reduce the toxicity of local anesthetics especially when a large amount was required. In the epidural anesthesia using local anesthetics a clinically required dosis and the toxic dosis are close to each other. We occasionally observe light toxic reaction after a prolonged surgery. With the inhalational agents this problem is self-limiting because it will be eliminated from the lung via expired gas. It is premature to draw any conclusion on this presumption, but we at least have not observed any finding suggesting to the contrary.

We had one complication which was likely due to this method. One patient had some degree of subcutaneous emphysema. He received the second largest volume of halothane vapor (1010 ml) with air as carrier gas. This apparently caused no other problems, however, and emphysema resolved altogether next day. We subsequently made rules that nitrous oxide be used as carrier gas and that total amount of administration be held not more than 500 ml. We have not observed a similar problem since then.

One may argue that a similar anesthesia may be achieved with the same level of enflurane and similar doses of pancuronium and mepivacaine without using epidural halothane. There is no way to refute this definitely until we prove otherwise in a controlled study or in a more convincing method.

We presume that halothane vapor administered to the epidural space works on the spinal cord, with no sound evidence. One may argue that it may be working on the brain after being carried by the cerebro-spinal fluid. We wish to leave this question open until more data are obtained.

We have not had any complication except the above mentioned subcutaneous emphysema. It is obviously too early to conclude that this method is entirely safe.

A few points may deserve comments. As mentioned earlier, injection of halothane vapor into epidural space causes pain in awake patients. If a small amount of mepivacaine (2 to 3 ml of 1% solution), then halothane seldom causes any pain. This is one reason why we made a rule to administer 3 ml of mepivacaine. The hypotensive effect of halothane vapor appears to be less predictable than that of mepivacaine. We do not intend to insist that the hypotension is less with halothane than with mepivacaine. That remains to be studied. A similar statement may be made with the abdominal relaxation. With this method, the abdominal relaxation appears to be better compared with no epidural halothane. Again, for the definite results, it has to be studied.

A sterile injection of halothane vapor was not easy. We made some efforts to keep it clean, but it was certainly less than ideal. The amount of halothane vapor may appear to be large, but as liquid halothane it is a minute amount. For 4 hour anesthesia, we gave 360 ml of 30% halothane vapor, which is about 120 ml of pure halothane vapor. Since 1 ml of liquid halothane makes 240 ml of gas, the amount of halothane required is 0.5 ml of liquid halothane. By this calculation, we can be certain that halothane so administered is working differently from the ordinary inhalationally administered halothane. This does not negate the possibility that epidural halothane may affect the brain or the nerve roots as well as the spinal cord.

Whether this technique may eventually prove useful or not remains to be studied. For the moment, we might be satisfied with the fact that halothane vapor may be administered into epidural space potentiating mepivacaine with no obvious ill effects.

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## References

1. Somjen G: Effects of anesthetics on spinal cord of mammals. Anesthesiology 28:135–143, 1967
2. DeJong RH, Robles R, Morikawa K: Action of halothane and nitrous oxide on dorsal horn neurons ("The spinal gate"). Anesthesiology 31:205–212, 1969