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Rapid induction with 7% sevoflurane inhalation—not the single-breath method

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Abstract: The usefulness of the rapid anesthesia induction method with 7% sevoflurane, not the single-breath method, was investigated in 88 patients with ASA physical status 1. Anesthesia was induced with 3 l·min^{-1} nitrous oxide in 3 l·min^{-1} oxygen and sevoflurane 7% for 3 min (group A), 7% for 5 min (group B), 7% for 7 min (group C), and 5% for 7 min in conventional induction (group D). There were 22 patients in each group. Each sevoflurane concentration was given at the same time as the start of nitrous oxide inhalation except for group D. The changes in blood pressure and heart rate were the smallest in group A. The time for the loss of consciousness was shorter in groups A (47.2 s), B (44.9 s), and C (49.8 s) than in group D (73.4 s). During induction, body movements were seen in 18.2% in group A and 13.6% in the other 3 groups, but no other complications such as coughing, breath holding, or laryngospasm were seen in any group. In conclusion, the anesthesia induction method with 3 min of 7% sevoflurane inhalation was useful for rapid induction.

Key words: Rapid induction, Inhalation anesthetics, Sevoflurane

Introduction

Sevoflurane is used for conventional inhalation induction of anesthesia because of its low irritability to the airways. It is also used for the vital capacity rapid inhalation induction of anesthesia (single-breath method) [1]. The conventional induction was said to require more time for induction than the single-breath method [1], but the latter method needs the patient's cooperation. We investigated the usefulness of the rapid inhalation induction of anesthesia for 3 min, without single breath, using a higher concentration of sevoflurane (7%) than the conventional method (5%).

Materials and methods

This study was approved by the ethics committee of our hospital and oral informed consent was obtained from all patients after the nature of the study was explained to them. Eighty-eight patients scheduled to undergo elective surgery, aged 35 to 70 years with ASA physical status 1, were randomly divided into four groups of 22 patients each.

All patients were premedicated with atropine 0.01 mg·kg^{-1} i.m. and midazolam 0.05 mg·kg^{-1} i.m. 15 min before induction of anesthesia. Before induction of anesthesia, all patients received 100% oxygen for 3 min, and vecuronium 1 mg was administered for neuromuscular blockade. Anesthesia was induced with 3 l·min^{-1} nitrous oxide in 3 l·min^{-1} oxygen and sevoflurane 7% for 3 min (group A), 7% for 5 min (group B), 7% for 7 min (group C), and 5% for 7 min (group D). Each sevoflurane concentration was given at the same time as the start of nitrous oxide inhalation in groups A, B, and C. In group D, conventional inhalation induction was performed with the gradual increase of sevoflurane concentration, but in 45 s 5% was obtained. These concentrations of sevoflurane were determined by the dial setting of the vaporizer, PPV Σ 7% (Penlon, Abingdon UK), which was checked with a gas monitor (Anesthetic Agent Monitor 303, ATOM, Tokyo, Japan). Vecuronium 7 mg was given when patients reached loss of consciousness (LOC) and tracheal intubation was performed 1 min after an intratracheal spray with 4% lidocaine 2 ml, which was performed 2, 4, and 6 min after the start of sevoflurane inhalation in groups A, B, C, and D, respectively. After the intubation, anesthesia was maintained with 0.5%

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sevoflurane and 3 l·min^{-1} nitrous oxide in 2 l·min^{-1} oxygen for 5 min. No surgical stimulation was given in this period. Thereafter, anesthesia was maintained with sevoflurane 1.0% to 2.0% and nitrous oxide in oxygen. Blood pressure, heart rate, and end-tidal sevoflurane concentration were monitored during the study.

The time until LOC was determined as the time between the start of sevoflurane inhalation and the time of the disappearance of response to verbal commands. The induction time was determined as the time between the start of induction and intubation. During induction, complications such as coughing, laryngospasm, breath holding, and body movement were checked. On the next morning, patients were asked whether they would be willing to submit to the same induction method again.

Data are expressed as mean ± standard deviation (SD), but in the figures they are presented as mean ± standard error (SE). Statistical analyses were performed with the chi-square test and the Kruskal-Wallis test for differences among the groups and with the Wilcoxon signed-rank test for intragroup differences. A P value less than 0.05 was considered statistically significant.

Results

The backgrounds of the patients were not significantly different among the four groups (Table 1).

Blood pressure decreased significantly after the start of sevoflurane inhalation in all groups. The decrease rate was maximal at 2–3 min after the start of inhalation in groups A, B, and C and at 5 min in group D. There was no statistically significant difference among the four groups except for the value at 6 min between groups C and D. After intubation, blood pressure increased significantly compared to the preinduction values in groups C and D (Fig. 1).

Heart rate increased significantly before induction in groups B, C, and D, and after intubation in all groups. It decreased to the preinduction level the fastest in group A (Fig. 2).

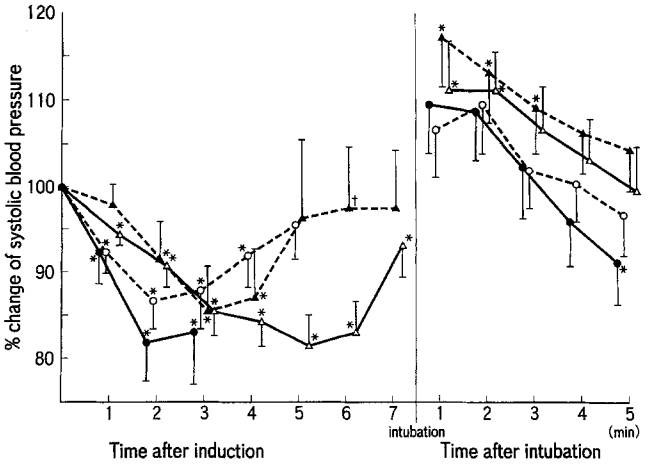

Fig. 1. Blood pressure changes after induction. *Closed circles*, group A; *open circles*, group B; *closed triangles*, group C; *open triangles*, group D. *Bars* indicate mean ± SE. * $P < 0.05$ *vs* preinduction value + $P < 0.05$ *vs* group D

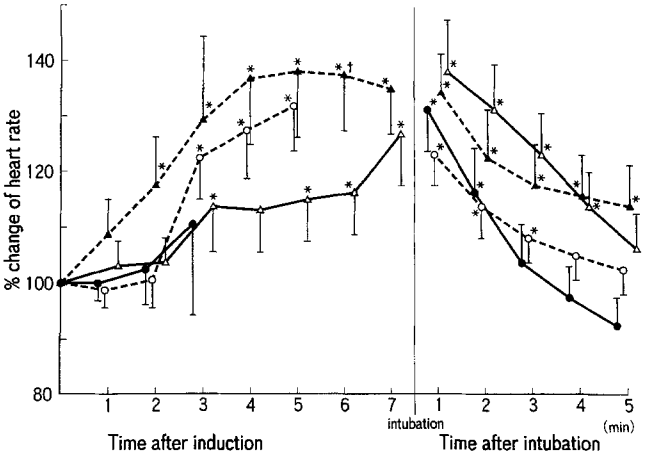

Fig. 2. Heart rate changes after induction. *Closed circles*, group A; *open circles*, group B; *closed triangles*, group C; *open triangles*, group D. *Bars* indicate mean ± SE. * $P < 0.05$ *vs* preinduction value, + $P < 0.05$ *vs* group D

The end-tidal sevoflurane concentration rose quickly to about 6% and continued at this level until intubation in groups A, B, and C. It was 3.5% to 4.0% in group D (Fig. 3).

Table 1. Backgrounds of patients

	Group A	Group B	Group C	Group D
Age (years)	52.3 ± 11.5	53.9 ± 11.3	48.5 ± 10.1	58.4 ± 9.3
Male/Female	12/10	10/12	12/10	14/8
Body Weight (kg)	59.4 ± 8.9	54.8 ± 3.4	60.7 ± 8.5	56.3 ± 8.8
Duration of anesthesia (min)	290 ± 134	237 ± 35	265 ± 146	295 ± 112
Duration of operation (min)	213 ± 117	167 ± 35	192 ± 138	215 ± 107

Mean ± SD.

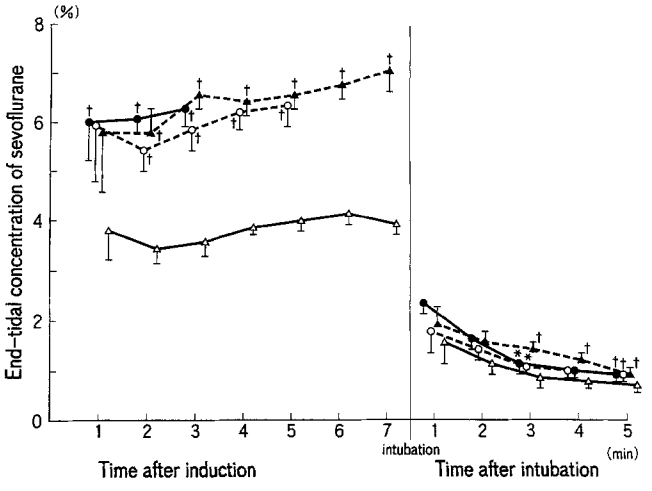

Fig. 3. End-tidal sevoflurane concentrations after induction. *Closed circles*, group A; *open circles*, group B; *closed triangles*, group C; *open triangles*, group D. *Bars* indicate mean ± SE. * $P < 0.05$ *vs* group C, + $P < 0.05$ *vs* group D

The time until LOC was 47.2 ± 8.2 s in group A, 44.9 ± 13.4 s in group B, 49.8 ± 10.5 s in group C, and 73.4 ± 30.5 s in group D. Group D took significantly longer than the other three groups until LOC.

The complications are shown in Table 2. No complications other than body movements were seen in any group. All patients, except for two in group D, stated that they would be willing to submit to the same induction method again.

Discussion

Sevoflurane has a low blood gas partition coefficient [2], which enables the rapid rise in the alveolar concentration, and the pleasant odor in sevoflurane makes it a suitable agent for inhalation induction. In conventional inhalation induction, we ordinarily use 5% sevoflurane for about 7 min, therefore we used these conditions for group D as a control.

Rapid inhalation induction was first reported by Ruffle et al. [3] with halothane. They said the single-breath method was safe, effective, and acceptable to patients, but their study was performed on volunteers and they were not intubated. Therefore, it was not evaluated under actual clinical conditions. Furthermore, we do not want to use halothane for routine practice due to its hepatotoxicity in repeated use.

Regarding isoflurane, Lamberty and Wilson. [4] reported that a single breath of 2% isoflurane with 66% nitrous oxide in oxygen was acceptable for patients. This was very surprising, however, because in our experience conventional inhalation induction with isoflurane has more complications such as coughing or breath holding, and inhalation of high concentrations causes more complications than the conventional method. Loper et al. [5] used fentanyl in the single-breath induction with isoflurane to overcome the complications caused by the pungent odor and irritability to the airways [6].

We think that sevoflurane is best for rapid inhalation induction, but, with the single-breath method, the patient's cooperation is needed to do a vital capacity breath and the anesthetic circuit must be filled with gases before induction. The time for anesthesia induction in the single-breath method is not as short as that in the conventional method. Yurino et al. [1] and Fukuda et al. [7] reported the time until LOC as the induction time, but this definition of induction time is not the one we used. The induction time that we determined was 5 min in Yurino's report [1] and was not clearly stated in Fukuda's report [7], which suggested about 5 min or more. The induction time was shorter in our group A than in the single-breath method [1,7]. Moreover, the time until LOC in our groups A, B, and C was shorter than in our group D and in the single-breath method by Yurino et al. [1], and it was the same as that of the single-breath method with 7% sevoflurane in Fukuda's report [7]. The shorter time until LOC is preferable from the patients' point of view. In our group D, two patients did not want to submit to the same induction method again because they retained consciousness for a long time.

In our group A, complications were slightly higher than by the single-breath method as reported by Yurino et al. [1], but all were body movements which posed no risk to the patient.

Table 2. Complications during induction

	Group A	Group B	Group C	Group D
Body movement during induction	4/22 (18.2%)	3/22 (13.6%)	3/22 (13.6%)	3/22 (13.6)
Body movement during intubation	2/22 (9.1%)	0	0	0
Coughing	0	0	0	0
Laryngospasm	0	0	0	0
Breath holding	0	0	0	0

The present study showed that the end-tidal sevoflurane concentration rose quickly in 1 min and continued at the same level for 3–7 min. The rapid rise in the end-tidal sevoflurane concentration might be due to the low blood gas partition coefficient [2].

Blood pressure decreased and again recovered before induction in groups B, C, and D. In response to the recovery in blood pressure, heart rates increased in the three groups. The reason for this was thought to be that sevoflurane extended vascular beds, which might stimulate the compensatory increase in heart rate. This increase in heart rate causes an increase in cardiac output, which is followed by blood pressure recovery. In group A, this mechanism did not operate. Group A had the smallest change in blood pressure and heart rate, which suggested that group A experienced the best induction method in all 4 groups.

In conclusion, rapid inhalation induction with 3 min 7% sevoflurane inhalation was useful for ASA physical status 1 patients because this method had the smallest circulatory change, the shortest induction time, and the same level of complications as in all discussed groups.

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