Effects of Nitrous Oxide on Single Breath Induction with Enflurane

Simon J ROWBOTTOM, Hidekazu YUKIOKA and Mitsugu FUJIMORI

A single vital capacity breath method of inhalational induction using 4% enflurane in 67% nitrous oxide (group I) or 100% oxygen (group II) was studied in 30 patients. Nitrous oxide accelerated induction time (71 (22 SD) seconds in group I versus 136 (29 SD) in group II, $P =< 0.01$) and was associated with a decreased incidence of excitement and respiratory disturbance ($P =< 0.05$). There were no significant differences between groups in systolic blood pressure, heart rate or arterial oxygen saturation. The technique was acceptable to 87% in group I and 33% in group II ($P =< 0.02$). (Key words: anesthetic technique, induction anesthetics, volatile, enflurane, nitrous oxide)

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In studies of rapid inhalational induction of anesthesia using a single vital capacity breath (VCB) technique with a voluntary breath-hold only halothane and isoflurane, either in oxygen alone or in nitrous oxide have been used[1–5].

The place of nitrous oxide in this technique remains to be determined. Though it is relatively insoluble, it cannot be administered in sufficient concentration to reliably pass through the excitement stage. Consequently it may cause excitement with respiratory disturbance and hypoxemia before the accompanying less soluble volatile agent produces anesthesia[6]. We investigated the effects of nitrous oxide of a single VCB method of induction using enflurane.

Methods

30 consecutive adult patients (ASA I or II) presenting for elective surgery were studied. Group I patients received a single breath induction technique using 4% enflurane in 67% nitrous oxide and oxygen and group II patients received 4% enflurane in 100% oxygen. Groups were studied consecutively.

All patients were premedicated with atropine 0.01 $mg \cdot kg^{-1}$ im and secobarbital 2 $mg \cdot kg^{-1}$ im 60–90 min pre-operatively. In the anesthetic room patients were instructed to breathe out maximally to room atmosphere and then inhale maximally from the anesthetic system and hold their breath for as long as comfortably possible before resuming spontaneous respiration. Following loss of consciousness inspired anesthetic concentrations were maintained for a further 3–5 min. Anesthetic was delivered by a Drager vaporizer into a Drager Narkomed IIA circle system with a 2 l reservoir bag using a fresh gas flow rate of 6 $l \cdot min^{-1}$. Before each case, the circle system was primed with the appropriate anesthetic mixture using a calibrated Capnomac (Datex).

Patient monitoring included a pre-cordial stethoscope, continuous ECG (Hewlett Packard), automatic non-invasive blood pressure monitor (Nihon-Colin), pulse oximeter

Department of Anesthesiology and Intensive Care Medicine, Osaka City University Medical School, Osaka, Japan

Address reprint requests to Dr. Yukioka: Department of Anesthesiology and Intensive Care Medicine, Osaka City University Medical School, 1-5-7 Asahi-machi, Abeno-ku, Osaka, 545 Japan

Table 1. Patient details

		Group I (n = 15)	Group II (n = 15)
Age (years)		39 (8)	40 (12)
Weight (kg)		57 (9)	58 (10)
Sex	Female	13	11
	Male	2	4

mean (SD)

Table 2. Breath-hold and induction times

	Group I	Group II
Breath-hold time (s)	43 (24)	34 (21)
Induction time (s)	71 (22)	136 (29)*

*$P =< 0.01$ mean (SD)

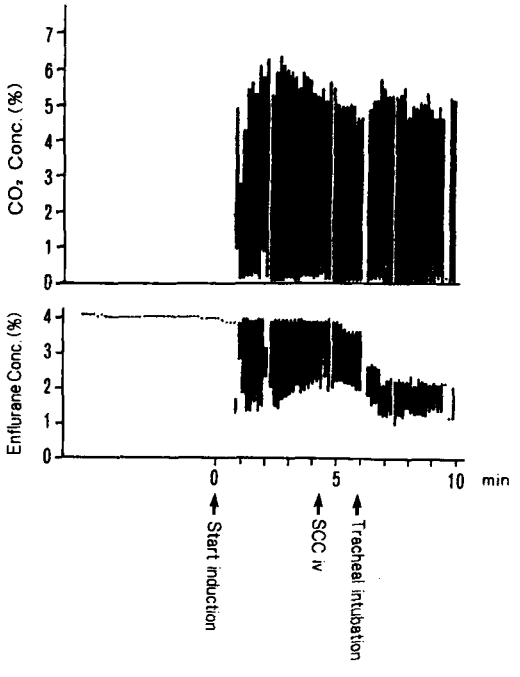

Fig. 1a. O_2/N_2O/Enflurane

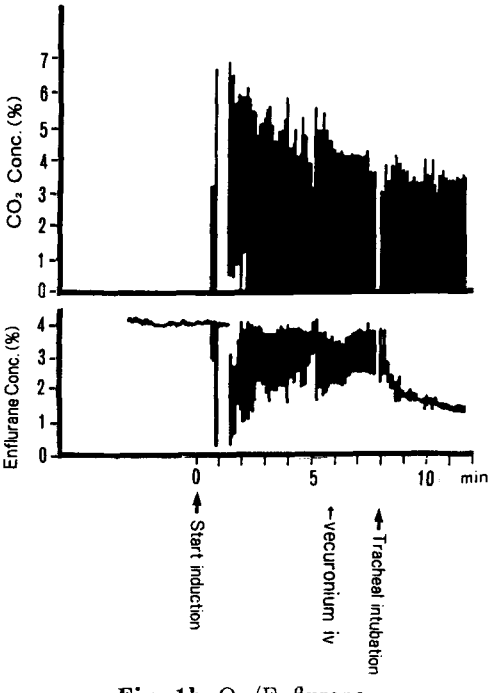

Fig. 1b. O_2/Enflurane

Fig. 1. Inspiratory and end-tidal CO_2 and enflurane concentrations SCC – succinylcholine.

(Datex Satlite), and continuous inspired and end-tidal carbon dioxide and enflurane concentrations – via the face-mask angle piece – (Datex Capnomac).

Loss of consciousness was defined as the loss of response to eyelash reflex and verbal command (eye opening). Induction time was recorded as the interval between the start of the first conventional breath or vital capacity breath and loss of consciousness. Signs of excitement during induction – movement of the head or limbs – were noted.

The length of the breath-hold and induction time were recorded. Heart rate, blood pressure and arterial oxygen saturation were measured at one minute intervals from the start of induction. The maximum end-tidal CO_2 concentration at any time during induction and at the end of the breath-hold were recorded. The incidence of excitement or ECG arrhythmias at any time were noted. All recordings were made by an independent observer. After recovery from anesthesia the patients' opinion of the technique was sought.

Statistical analysis of data was performed using an unpaired t-test or Chi-squared with Yates' correction where appropriate.

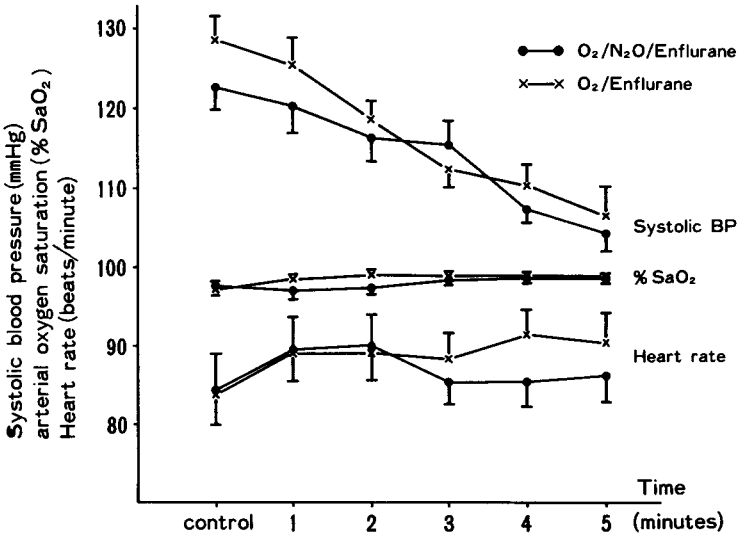

Fig. 2. Hemodynamic changes and arterial oxygen saturation during induction (mean SEM).

SEM are shown in one direction only.

Table 3. Incidence of movement and coughing

	Group I	Group II
Movement	2 (13%)	10 (67%)*
Coughing	1 (7%)	2 (13%)

*$P =< 0.05$

Results

Patient details are given in table 1. The groups did not differ significantly. Induction and voluntary breath-hold times are shown in table 2. Mean induction time in group I was 71 (22 SD) seconds and 136 (29 SD) seconds in group II. The difference was significant ($P =< 0.01$). Breath-hold time for the VCB maneuver ranged from 18–102 seconds in group I and from 10–120 seconds in group II.

Figure 1 illustrates typical recordings of end-tidal CO_2 and enflurane concentrations during induction for the two groups. End-tidal enflurane concentration increased more rapidly in group I patients.

Figure 2 shows the hemodynamic changes and arterial oxygen saturation associated with induction. There were no significant differences between groups in any of the parameters at any of the times indicated. Systolic blood pressure at 5 min was 85% and 83% of control in groups I and II respectively.

The incidence of movement (table 3) was significantly greater in group II ($P =< 0.05$) and tended to be more pronounced and last longer. Though the incidence of coughing tended to be lower in group I, the difference was not statistically significant. 6 patients in group II had additional, secondary periods of breath-holding after resuming spontaneous ventilation following the initial voluntary breath-hold of the VCB maneuver but none in group I.

There were no arrhythmias during induction in either group. There were no significant differences between groups in mean end-tidal CO_2 concentrations at the end of the VCB breath-hold (40 (6 SD) mmHg in group I, 39 (3 SD) mmHg in group II) or in the maximum end-tidal CO_2 concentration during induction (44 (5 SD) mmHg in group I and 46 (5 SD) mmHg in group II).

Table 4 describes the patient questionaire and results. There were no statistical differences between groups regarding the smell of gas, recollection of the VCB or subsequent events. 87% of patients in group I and 33% in group II were prepared to have the same technique again. The difference was significant ($P =< 0.02$).

Table 4. Patient questionaire

	Group I		Group II	
	Yes	No	Yes	No
a) was the smell of gas pleasant?	4		6	
..... unpleasant?	11		9	
b) did you remember the first breath?	11	4	10	5
c) ..... anything after this?	8	7	4	11
d) would you have this technique again?	13	2	5	10*

*$P =< 0.02$

Discussion

The study has shown that in a single VCB induction technique using 4% enflurane, nitrous oxide reduces induction time and the incidence of excitement. The cardiovascular changes observed were similar to those in previous studies[1,3]. A maximum of 4% enflurane was used in accordance with the distributors recommendations (Dinabbott, Japan).

The additional pharmacological and second gas effects[7] of nitrous oxide permitted a smoother induction which was not significantly associated with signs of excitation – movement, respiratory upset (coughing and secondary periods of breath-holding) or arterial hypoxemia. This is at variance with previous observations in unpremedicated patients in whom rapid induction with enflurane in nitrous oxide or oxygen alone was accompanied by a high incidence of excitement, breath-holding and poor airway patency[8,9]. Any movement of the head or limbs – and not just gross movement – was used as a strict and sensitive criteria to indicate excitement. The use of premedication in the present study may account for our observations.

Enflurane in 100% oxygen alone cannot be recommended for single VCB induction: induction time was slow and patient acceptability low. The relatively high MAC value of enflurane in oxygen limits the speed at which anesthesia is achieved despite its low solubility. However, 4% enflurane in nitrous oxide compares favorably with 4% halothane in nitrous oxide in terms of induction time and acceptability (mean induction time 83s and 91% acceptability for halothane)[1].

Although both groups commented unfavorably on the pungency of enflurane, 87% in group I were prepared to repeat the technique compared with 33% in group II. However, in the present study there was no difference between the two groups in the recall of the VCB or subsequent events despite differing times to loss of consciousness. Previous authors[1–3] have commented that the acceptability of this technique may be related to the early onset of amnesia before the apparent loss of consciousness, though the mechanism for this is not explained. Our result is difficult to understand.

In summary, nitrous oxide accelerates induction time, reduces excitement and potential respiratory upset in a single VCB induction technique with enflurane.

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