Recovery Profile and Patient Satisfaction After Ambulatory Anesthesia for Dental Treatment—A Crossover Comparison Between Propofol and Sevoflurane

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The purpose of this study was to determine which anesthetic was preferable for ambulatory anesthesia: propofol alone or sevoflurane alone. A crossover study was performed to compare the recovery profile and patient satisfaction after 2 anesthesia methods. Twenty healthy patients with severe anxiety toward dental treatment undergoing 2 sessions of day-case dental treatment received either propofol or sevoflurane anesthesia. The order of these methods was randomized. The depths of anesthesia were kept constant using bispectral index (BIS) monitoring. Observations on recovery profiles were performed in the emergence phase, in the recovery phase, and 24 hours after discharge. Patient satisfaction and preference were obtained by a questionnaire. Most of the recovery profiles in the emergence phase such as time to eye opening to respond to verbal command, time to BIS ≥ 75 , and time to extubation were shorter in the sevoflurane group than in the propofol group. All recovery profiles in the recovery phase showed no differences between the 2 groups. Based on the subject's satisfaction and preference, propofol was evaluated as a better anesthetic for ambulatory anesthesia than sevoflurane. Higher patient satisfaction and a greater preference for future dental treatment were revealed for propofol anesthesia. Propofol may be more suitable for ambulatory anesthesia for dental treatment.

Key Words: Ambulatory anesthesia; Recovery profile; Patient satisfaction; Propofol; Sevoflurane.

Anesthetics used for ambulatory anesthesia should have the following characteristics: smooth and rapid induction, easily controllable depth of anesthesia in the maintenance phase, rapid emergence and recovery from anesthesia, and few adverse reactions

after general anesthesia.¹ Two anesthetics currently used for ambulatory anesthesia are propofol and sevoflurane. Emergence from propofol anesthesia is rapid because the context-sensitive half-time is less than 30 minutes² even after 5-hour continuous infusion. Emergence from sevoflurane anesthesia is also rapid,³ as seen from the blood-gas distribution coefficient at 0.65 and tissue-gas partition coefficient at 1.1 for major tissues other than fat. Many studies have compared the recovery profiles following propofol and sevoflurane anesthesia, and

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systematic reviews have also been published.^{4,5} In each study, however, other drugs such as opioid analgesics and/or nitrous oxide were combined during maintenance of anesthesia, and there are no studies for adult subjects comparing the recovery profile from anesthesia maintained with these anesthetics alone. In addition, because the previous studies divided subjects into subgroups by anesthesia method, individual differences might have influenced the recovery profile. We therefore performed a crossover study to determine which was more preferable for ambulatory anesthesia between propofol and sevoflurane based on the comparison of the recovery profile and patient satisfaction after anesthesia.

METHODS

Subjects

This study was approved by the Ethics Review Board of Tokyo Dental College Ethics Committee (approval number 267). Subjects were 20 patients scheduled to undergo dental treatment 2 or more times under general anesthesia because of extensive dental needs and severe anxiety towards dental treatment. All subjects received general anesthesia for dental treatment for the first time. All subjects gave written informed consent. Subjects received either propofol anesthesia or sevoflurane anesthesia. The order of these methods was randomized. All patients were classified as ASA physical status I or II. Alcoholics, drug-dependent individuals, obese patients with a body mass index of 26 or more, and pregnant women were excluded.

Anesthesia Method

No preanesthetic medication was administered. Anesthesia was started at 9:00 AM in both groups. On arrival in the outpatient clinic, standard monitoring equipment including body temperature, electrocardiograph, heart rate, noninvasive blood pressure, arterial oxygen saturation, inspired oxygen, and end-tidal concentration of carbon dioxide was applied. A bispectral index (BIS) monitor (BIS MONITOR Model A-2000, Aspect Medical Systems) was also used. A venous line was established in the left cephalic vein and acetated Ringer solution (Veen F, Kowa Company Ltd) was infused at a rate of approximately 100 mL/h.

In the propofol group, anesthesia was induced with propofol (1% Diprivan injection kit, AstraZeneca) under

inhalation of 100% oxygen at 6 L/min, using a TCI pump (Terufusion TCI syringe pump TE-371, TERUMO Corporation) with predicted effect site concentration at 3.5 µg/mL. In the sevoflurane group, anesthesia was induced with 3% sevoflurane (Sevofrane, Abbott Japan Co, Ltd) using a face mask with supplemental oxygen at 6 L/min. Nasotracheal intubation was facilitated with 0.6 mg/kg rocuronium bromide (Eslax intravenous solution, Schering-Plough) for both groups.

During anesthesia, predicted effect site concentration of propofol and inhaled concentration of sevoflurane were adjusted to maintain BIS value at 40–60 under inhalation of oxygen at 1 L/min and air at 3 L/min. Artificial ventilation was performed using a ventilator (Acoma Ventilator PRO-Vmk II, Acoma Co, Ltd) to maintain end-tidal concentration of carbon dioxide at 35–40 mm Hg. When bucking or body movement occurred during anesthesia, the concentration of anesthetic was increased by approximately 0.2 µg/mL for propofol and 0.5% for sevoflurane. In the case of further body movement, 0.2 mg/kg rocuronium bromide was administered. Local anesthesia for deep dental caries restoration, pulpectomy, and tooth extraction with appropriate doses of 2% lidocaine hydrochloride solution containing epinephrine at 12.5 µg/mL (1 : 80,000) was used. After discontinuation of the anesthetics, controlled ventilation was continued until spontaneous respiration was resumed. We did not require reversal of neuromuscular blockade in either group. Patients were extubated after confirmation that tidal volume had returned to 4 mL/kg, the patient was responsive to commands, and recovery of swallowing reflex was sufficient. Subjects who received pulpectomy and/or tooth extraction took 120 mg of loxoprofen sodium or 50 mg of diclofenac sodium at discharge.

Observational Period and Indices

Observation was performed in the emergence phase, in the recovery phase, and 24 hours after discharge. The emergence phase was defined as the period from discontinuation of the anesthetics until extubation, and observations made during this interval were time to restoration of spontaneous respiration, time to eye opening, time to respond to verbal command, time to BIS $\geq$ 75, and time to extubation. The recovery phase was defined as the period from extubation until hospital discharge. During this phase, Aldrete score⁶ and Modified Post Anesthesia Discharge Scoring System⁷ were calculated every 5 minutes to obtain the time until each score reached $\geq$ 9. A trained observer asked

Table 1. Patient Characteristics*

No.	20
Age (y)	35.1 ± 9.3
Gender (male : female)	13 : 7
Height (cm)	168.8 ± 9.2
Weight (kg)	62.2 ± 15.0
BMI (kg/m ²)	21.6 ± 3.9

* BMI indicates body mass index.

subjects every 10 minutes whether he/she could stand up after Modified Post Anesthesia Discharge Scoring System score had reached ≥ 9 . If subjects could stand up without swaying, then the observer asked them to take 5 steps forward and backward. Time to independent walking was thus determined. Discharge time was measured based on Clinical Discharge Criteria.⁷ Findings for 24 hours after discharge were obtained by telephone, based on a questionnaire given to patients at discharge. After the second dental treatment under general anesthesia was completed, patients were asked which anesthetic they would choose for any future dental treatment under general anesthesia. The time frame was about 2 weeks between the 2 anesthetics. Obtained data were analyzed by other researchers who did not observe the anesthesia and recovery process.

Statistical Analysis

The χ^2 test was used to analyze occurrence of nausea and/or vomiting and telephone interview answers about preferred anesthetic in the future. Anesthetic time data and time to resume normal activities were analyzed using Student's *t* test for paired samples. Time to eye opening

and patient satisfaction were analyzed using Wilcoxon signed-rank sum test because these data were not normally distributed. All values were represented as mean $\pm$ SD. A *P* value less than .05 was considered as statistically significant.

RESULTS

Patient characteristics are shown in Table 1. Although there were no differences in duration of treatment, type of dental treatment, patients who received dental treatment with local anesthesia, total dose of local anesthetic, duration of anesthesia, or crystalloid transfusion volume between the 2 groups, the number of patients who received additional rocuronium bromide and the total dose of rocuronium bromide were greater in the propofol group than in the sevoflurane group. Predicted effect site concentration of propofol was 3.8 ± 0.5 $\mu\text{g/mL}$ and end-tidal concentration of sevoflurane was $1.8 \pm 0.3\%$ during anesthesia (Table 2). The time to BIS ≥ 75 , time to eye opening, and time to extubation were shorter in the sevoflurane group than in the propofol group, whereas time to restoration of spontaneous respiration was similar in both groups (Table 3). There were no differences in Aldrete score, Modified Post Anesthesia Discharge Scoring System score, time to independent walking, or time to discharge between the 2 groups. The incidence of nausea in the recovery phase in the sevoflurane group was 15%, but there were no incidents of vomiting (Table 4). Intravenous metoclopramide was used for management of nausea where indicated. There were no incidents of nausea or vomiting in the propofol group.

Table 2. Data in Perianesthetic Period

	<i>Propofol</i>	<i>Sevoflurane</i>	<i>P Value</i>
Duration of treatment (min)	241 ± 49	229 ± 50	.471
Dental treatment with local anesthesia (No.)	15	15	1.000
Type of dental treatment (No. of teeth)			
Restorative treatment without local anesthesia	0.60 ± 0.94	1.4 ± 2.06	.303
Restorative treatment with local anesthesia	0.35 ± 0.59	0.1 ± 0.31	.111
Pulpectomy with local anesthesia	0.25 ± 0.44	1.45 ± 3.11	.089
Root canal treatment without local anesthesia	2.15 ± 3.50	0.8 ± 0.77	.333
Prosthetic treatment without local anesthesia	1.75 ± 2.15	2.75 ± 3.64	.387
Tooth extraction with local anesthesia	0.55 ± 1.20	0.4 ± 0.82	.743
Duration of anesthesia (min)	283 ± 46	269 ± 54	.393
Total fluid volume (mL)	453 ± 116	453 ± 134	1.000
Patients who received additional rocuronium bromide (No.)	16*	10	.046
Total dose of rocuronium bromide (mg)	68 ± 18*	48 ± 15	.001
Total dose of local anesthetic (mL)	2.7 ± 1.9	3.0 ± 2.3	.557
Mean anesthetic concentration			
Sevoflurane (end-tidal, %)	—	1.8 ± 0.3	
Propofol (effect-site concentration, $\mu\text{g/mL}$)	3.8 ± 0.5	—	

* *P* < 0.05.

Table 3. Emergence Phase After End of Anesthesia*

	Propofol	Sevoflurane	P Value
Spontaneous respiration (s)	242 ± 210	147 ± 127	.102
BIS ≥ 75 (s)	653 ± 521	387 ± 193†	.026
Eye opening (s)	861 ± 650	469 ± 200†	.008
Extubation (s)	920 ± 537	595 ± 186†	.016

* BIS indicates bispectral index.

† $P < 0.05$.

On telephone questioning approximately 24 hours later, there was no difference in time to first meal and fluid between 2 groups, and neither nausea nor vomiting was reported in either group. Based on the subjects' satisfaction and preference, propofol was evaluated as a better anesthetic for ambulatory anesthesia than sevoflurane (Table 5). The main reasons for the selection of a preferred anesthetic in the future are shown in Table 6.

DISCUSSION

This study compared the recovery profiles from ambulatory anesthesia for dental treatments and patient satisfaction between propofol and sevoflurane when used alone to induce and maintain anesthesia given to the same subjects. We obtained the following results: (a) The time to emergence was shorter with sevoflurane anesthesia than with propofol anesthesia, but there was no difference in time to full recovery. (b) Propofol anesthesia is preferred over sevoflurane anesthesia in terms of both patient satisfaction and patient preference for future anesthesia.

This study was characterized by the following: (a) Each subject underwent both anesthesia methods. (b) No coadministered drugs such as nitrous oxide and/or opioid analgesics were used to maintain general anesthesia as these may affect the recovery process. (c) BIS monitoring was used to maintain a constant depth of anesthesia, as it has been reported that BIS monitoring was useful to predict fast-tracking of outpatients.⁸ (d) A local anesthetic was administered at the treatment site to inhibit peripheral nociceptive stimulus.

All previous studies comparing the recovery processes of propofol and sevoflurane anesthesia were performed under concomitant use of analgesics, including nitrous oxide,^{9,10} fentanyl,^{11,12} remifentanyl,^{13–16} and alfentanil.¹⁷ However, these studies indicated inconsistent findings that emergence from sevoflurane anesthesia was faster than from propofol anesthesia when either nitrous oxide or remifentanyl was coadministered,⁹ or that there was no difference between these agents.^{1,10,13,15} There are some studies that report that emergence from propofol anesthesia is

Table 4. Recovery Phase After Extubation*

	Propofol	Sevoflurane	P Value
Aldrete score ≥ 9 (min)	13 ± 8	11 ± 4	.499
MPADSS score ≥ 9 (min)	52 ± 30	54 ± 30	.855
Time to independent walking (min)	69 ± 32	73 ± 37	.484
Incidence of nausea and vomiting (No.)†			
0	20	17	.072
1	0	3	
2	0	0	
Time to hospital discharge (min)	169 ± 45	176 ± 48	.531

* MPADSS indicates Modified Post Anesthesia Discharge Scoring System.

† Score 0 = patients without nausea and vomiting; score 1 = patients who had nausea at least 1 time but no vomiting; score 2 = patients who had vomiting at least 1 time.

faster than from sevoflurane anesthesia.^{18,19} The time to recovery has also been inconsistent among previous studies. Full recovery to discharge from propofol anesthesia was faster than from sevoflurane anesthesia when nitrous oxide was coadministered.¹⁰ However, there was no difference in early recovery variables (eg, time to eye opening or sitting up) between propofol anesthesia with nitrous oxide and sevoflurane anesthesia with nitrous oxide.¹⁰ When remifentanyl was coadministered, no difference was observed between the 2 anesthetics.^{13–16} In our current study, emergence from sevoflurane-only anesthesia was faster, but there was no difference in the time to full recovery.

Patient satisfaction is one recent criterion proposed to evaluate the quality of general anesthesia. Patient satisfaction after general anesthesia is affected by several factors, including intraoperative emergence during anesthesia, postoperative pain, nausea and vomiting, urinary bladder catheterization, clarity of wakefulness, and other postoperative factors.²⁰ In this study, intravenous fluid was given as slowly as possible to avoid catheterization to the urinary bladder. In previous studies, patient satisfaction was greater after propofol anesthesia than after sevoflurane anesthesia, despite several concomitant analgesics and different evaluation methods,^{10,14} or there was no difference.^{12,13,17} Luntz and colleagues¹⁴ reported that the reasons for lower patient satisfaction in sevoflurane anesthesia included discomfort at induction, contact and odor of the mask, and nausea and/or vomiting at a later date. However, in this study, the telephone interview 24 hours after discharge showed that 15% of the subjects were dissatisfied with the smell of sevoflurane, and there were no complaints of nausea and/or vomiting or postoperative pain. In general, evaluation of patient satisfaction is scored in multiple ways, with many using the visual analogue scale. This

Table 5. Interview by Telephone on First Day After Discharge

	<i>Propofol</i>	<i>Sevoflurane</i>	<i>P Value</i>
Nausea and vomiting (No.)	0	0	
Time to first fluid intake (min)	225 ± 101	236 ± 68	.724
Time to first eating (min)	384 ± 223	428 ± 276	.593
Patient satisfaction score (0–100)*	87 ± 14†	71 ± 28	.003
Patient preference for future anesthesia (No.)	16†	4	.0001

* Satisfaction score was measured on visual analogue scale.

† $P < 0.05$.

study also used the visual analogue scale, and the results indicated that patient satisfaction was greater after propofol anesthesia than after sevoflurane anesthesia. Patient satisfaction in the previous studies was evaluated by comparing pooled groups of subjects receiving either sevoflurane anesthesia or propofol anesthesia. However, in this crossover study, we believe that the results express subjective satisfaction more accurately.

According to the previous reports, when patients were asked at 24 hours¹ and 48 hours¹³ after surgery which general anesthetic, whether mainly various inhalation anesthesia or propofol-based anesthesia, they would prefer at future surgery, almost all patients selected the same anesthetic.¹³ However, in other previous studies, another anesthesia method was requested by 22% of patients who received tidal breathing induction with sevoflurane,¹⁴ and even 7 days after surgery, by 43% of patients who received sevoflurane with nitrous oxide.²¹ Patients with severe anxiety against dental treatments, like the subjects in this study, probably need general anesthesia for future dental treatment. Selection of a preferred anesthetic is important for such patients, and 80% of the subjects in this study selected propofol as their preferred anesthetic. There was a trend toward an increased incidence of nausea in the recovery phase in the sevoflurane group only, with 3 subjects experiencing nausea without vomiting ($P = .072$). Furthermore, 5 subjects claimed an uncomfortable sensation, such as feeling sluggish, and 9 of them claimed fatigue after sevoflurane anesthesia. This result might contribute to the preference of propofol for ambulatory anesthesia.

Table 6. Main Reasons for the Selection of a Preferred Anesthetic in the Future

	<i>Propofol</i> (<i>n</i> = 16)	<i>Sevoflurane</i> (<i>n</i> = 4)
Comfortable	2	2
Discomfort after sevoflurane anesthesia	5	—
Fatigue after sevoflurane anesthesia	9	—
Pain on injection by propofol anesthesia	—	2

One drawback of our study is that propofol anesthesia provides less muscle relaxation, which leads to an easier occurrence of bucking or body movement during dental treatment. Thus, the number of patients who received additional rocuronium bromide and the total dose of rocuronium were greater in the propofol group than in the sevoflurane group. Repetitive administration of a short-acting muscle relaxant may extend treatment time. It should be considered to study a continuous infusion of muscle relaxants and/or opioid antagonists in future treatments.

With respect to sample size, for a significance level of $\alpha = .05$ and a statistical power of .8, given that the expected difference between the propofol group (0.8) and the sevoflurane group (0.2) as to which patients might select for future dental treatment was 0.6, the needed sample size was 20, which suggested that the sample size in this study was adequate.

In conclusion, we performed a crossover study on the recovery profiles after ambulatory anesthesia with propofol alone and with sevoflurane alone. There was no difference in time to discharge between the 2 groups and no complications were reported 24 hours after general anesthesia in either group. Higher patient satisfaction and a greater preference for future dental treatment with propofol anesthesia were found. We conclude that propofol may be more suitable for ambulatory anesthesia for dental treatment where patient satisfaction is a higher priority.

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