Is the Bispectral Index Useful in Predicting Fast-Track Eligibility After Ambulatory Anesthesia with Propofol and Desflurane?

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This study was designed to test the hypothesis that outpatients with higher electroencephalographic (EEG) Bispectral Index (BIS) values at the end of anesthesia achieve a modified Aldrete score of 10 and satisfy fast-track eligibility criteria more rapidly after ambulatory surgery. Sixty consenting women undergoing laparoscopic tubal ligation procedures were studied. After premedication with midazolam 2 mg IV, anesthesia was induced with propofol 2 mg/kg IV, fentanyl 1.5 μg/kg IV, and succinylcholine 1 mg/kg IV and was initially maintained with either desflurane 4% (n = 31) or a propofol infusion 100 $\mu g \cdot kg^{-1} \cdot min^{-1}$ (n = 29), in combination with nitrous oxide 65% in oxygen. Subsequently, the inspired desflurane concentrations (2%–6%) and propofol infusion rates (50–150 $\mu g \cdot kg^{-1} \cdot min^{-1}$ were varied to maintain a clinically acceptable depth of anesthesia. The average BIS value during the 3-min interval immediately before the discontinuation of the maintenance anesthetics was recorded. Emergence times and modified Aldrete scores were assessed from the end of anesthesia until patients were considered fast-track–eligible. The BIS values at the end of anesthesia were significantly correlated with the time to reach fast-track eligibility in both the desflurane (r = −0.68) and propofol (r = −0.76) groups. We concluded that the EEG-BIS value at the end of anesthesia is useful in predicting fast-track eligibility after laparoscopic tubal ligation procedures with either a desflurane- or propofol-based anesthetic technique. **Implications:** In outpatients receiving either desflurane and propofol anesthesia for laparoscopic tubal ligation surgery, the times to achieve criteria for bypassing the recovery room (i.e., fast-tracking) correlated with the electroencephalographic-Bispectral Index values at the end of anesthesia.

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The electroencephalographic (EEG) Bispectral Index (BIS) is a simple, user-friendly monitor of the depth of hypnosis (1,2). Recent articles describe the use of the BIS monitor as a guide for titrating the administration of propofol or desflurane during general anesthesia (3,4). When higher BIS values were maintained during the intraoperative period, patients experienced a more rapid emergence from propofol (3) and desflurane (4) anesthesia.

The availability of rapid-onset, short-acting anesthetics has also facilitated early recovery (5–7), and may allow outpatients undergoing general anesthesia to bypass the phase I postanesthesia care unit (PACU) after ambulatory surgery, a process known as "fast-tracking" (8). For patients to be candidates for direct transfer from the operating room (OR) to a phase II recovery unit, they must rapidly achieve PACU discharge criteria after anesthesia. Song et al. (9) reported that a higher percentage of outpatients receiving desflurane for maintenance of anesthesia fulfilled the criteria for PACU discharge on arrival in the PACU (i.e., fast-track eligibility) compared with patients whose anesthesia was maintained using propofol.

We hypothesized that outpatients with higher BIS values at the end of general anesthesia with either desflurane or propofol would more rapidly achieve criteria for fast-tracking after ambulatory surgery. Therefore, we designed a prospective, randomized study to test the hypothesis that the time from discontinuation of anesthesia until the patient is judged fast-track–eligible after desflurane and propofol anesthesia correlates with the BIS values at the end of the surgery.

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Methods

After obtaining institutional review board approval and written, informed patient consent, 60 ASA physical status I and II female outpatients scheduled for laparoscopic tubal ligation surgery were randomly assigned to one of two anesthetic treatment groups based on a computer-generated table of random numbers. Patients were excluded from the study if they had a known neurologic, cardiovascular, or metabolic disease; impaired renal or hepatic function; a body weight >100% above the ideal; or a history of alcohol or drug abuse.

On arrival in the OR, routine monitors were applied for recording heart rate (HR), mean arterial pressure (MAP), and oxygen saturation (Spo_2). The two-channel EEG-BIS value was obtained by using a four-lead EEG monitoring device (Model 1050 with software version 3.124; Aspect Medical Systems, Natick, MA), with the four cutaneous electrodes positioned over the outer malar bones, midline on the forehead, and adjacent to the center electrode. After premedication with midazolam 2 mg IV, anesthesia was induced with propofol 2 mg/kg IV, fentanyl 1.5 μg/kg IV, and succinylcholine 1 mg/kg IV. After tracheal intubation, anesthesia was initially maintained with either desflurane 2%–6% (desflurane group) or a propofol infusion 50–150 $\mu g \cdot kg^{-1} \cdot min^{-1}$ IV (propofol group), in combination with nitrous oxide 65% in oxygen. All patients were mechanically ventilated to maintain an end-tidal carbon dioxide (CO_2) concentration of 32–36 mm Hg. Intermittent bolus doses of mivacurium 0.04 mg/kg IV were administered to maintain adequate muscle relaxation. Supplemental doses of fentanyl 25–50 μg IV were given to treat persistent increases in HR (>100 bpm) or MAP (>20% of the preanesthesia baseline) values despite the administration of desflurane 6% (inspired) or propofol 150 $\mu g \cdot kg^{-1} \cdot min^{-1}$. All anesthesia providers were instructed to titrate the maintenance anesthetic using standard clinical indicators, and they were blinded to the BIS values by facing the BIS monitor away from their line of sight. Approximately 10–15 min before the end of surgery, all patients received ketorolac 30 mg IV and droperidol 0.625 mg IV as prophylactic analgesic and antiemetic medication, respectively. All maintenance anesthetics were discontinued after the skin closure.

The EEG-BIS value was recorded at 5-min intervals during the maintenance period, and the average BIS value during the 3-min interval immediately before the discontinuation of the anesthetic drugs were noted. Recovery times were determined at 1-min intervals after discontinuation of the maintenance anesthetics by one of the investigators (DS), including the time to awakening (i.e., opening eyes in response to a verbal command), tracheal extubation, and orientation to person and place, as well as the time to achieve a modified Aldrete score of 10 (10). Patients were judged to be fast-track–eligible when they achieved a modified Aldrete score of 10 without complaints of moderate to severe pain on a 4-point verbal pain scale (0 = none, 1 = mild, 2 = moderate, or 3 = severe) or intractable nausea or vomiting (lasting >2 min). Subsequently, patients were assessed at 15-min intervals until they were determined to be "home-ready" (i.e., had achieved criteria for discharge home) (11).

A power analysis (α = 0.05, β = 80%) performed before the study suggested that 29 patients were required in each group to detect a 30% difference in the times from discontinuation of anesthesia to fast-track eligibility (assuming that the mean time from discontinuation of anesthesia to the patient achieving an Aldrete score of 10 was 15 ± 6 min) (9). The correlation between the BIS values at the end of anesthesia and the times to fast-track eligibility was analyzed using linear regression. Recovery times and fast-track eligibility times were also analyzed using unpaired Student's *t*-test. Data are expressed as mean values ± SD, and *P* values < 0.05 were considered statistically significant.

Table 1. Demographic Characteristics, Duration of Anesthesia and Surgery, and Intraoperative Values

	Desflurane	Propofol
n	31	29
Age (yr)	27 ± 6	26 ± 5
Weight (kg)	69 ± 14	63 ± 10
ASA physical status (I/II)	19/12	22/7
Duration of anesthesia (min)	69 ± 24	67 ± 19
Duration of surgery (min)	40 ± 16	43 ± 21
Intraoperative MAP (mm Hg)	92 ± 11	96 ± 14
Intraoperative HR (bpm)	75 ± 9	74 ± 10
Intraoperative BIS (U)	41 ± 11	46 ± 9
End-tidal concentration of desflurane at the end of anesthesia (%)	2.7 ± 1.2	NA
Infusion rate of propofol at the end of anesthesia ($\mu g \cdot kg^{-1} \cdot min^{-1}$)	NA	53 ± 20
BIS at the end of anesthesia (U)	59 ± 19	60 ± 14

Values are mean ± SD or *n*.
MAP = mean arterial pressure, HR = heart rate, NA = not applicable.

Results

The two treatment groups were comparable with respect to demographic characteristics, ASA physical status, duration of surgery and anesthesia, and the intraoperative HR, MAP, and BIS values (Table 1). Although there was no significant difference in the BIS value at the end of anesthesia in the two treatment groups, the average times from discontinuation of anesthesia to awakening (7 ± 6 vs 4 ± 2 min), orientation (12 ± 6 vs 9 ± 3 min), and fast-track eligibility

Table 2. Recovery Times After Anesthesia and Spo_2 on Arrival in the PACU

	Desflurane	Propofol
Awakening (min)	4 ± 2	7 ± 6*
Leaving operating room (min)	10 ± 4	11 ± 5
Orientation (min)	9 ± 3	12 ± 6*
Spo_2 values on arrival in PACU (%)	96 ± 2	95 ± 2
Fast-track eligibility (min)	10 ± 3	13 ± 4*
Home-readiness (min)	146 ± 59	134 ± 48

Values are mean ± SD.
PACU = postanesthesia care unit.
$P < 0.05$ compared with the control group.

(13 ± 4 vs 10 ± 3 min) were all significantly longer in the propofol group ($P < 0.05$) (Table 2). The BIS values at the end of anesthesia in the two treatment groups significantly correlated with the time to reach fast-track eligibility after both desflurane ($r = -0.68$) and propofol ($r = -0.76$) (Fig. 1). All patients with BIS values >75 at the end of anesthesia achieved fast-track eligibility within 10 min, whereas none of the patients with BIS values <45 were fast-track–eligible in <10 min. There was no correlation between the BIS values at the end of anesthesia and the times to home-readiness or actual discharge home.

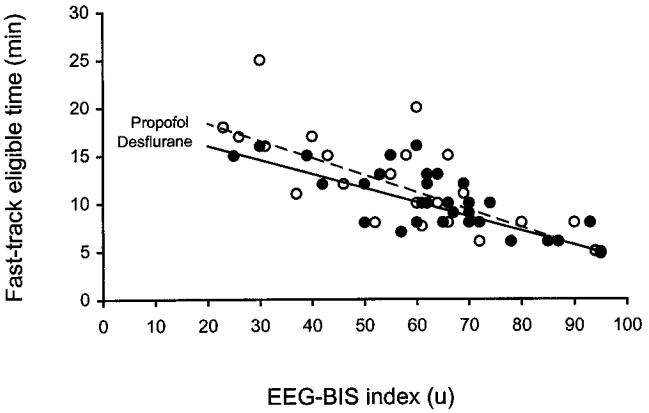

Figure 1. The correlation between the time to achieve fast-track eligibility and the electroencephalogram (EEG)-Bispectral Index (BIS) values at the end of anesthesia for the propofol (○) and desflurane (●) groups.

Discussion

Patients in both the desflurane and propofol groups experienced a rapid emergence from general anesthesia. As reported previously (9), patients receiving desflurane were awake more quickly and achieved fast-track eligibility significantly earlier than those receiving propofol, although there was no difference between the two groups with respect to their average BIS values at the end of anesthesia. This finding suggests that earlier recovery from desflurane is not simply due to a higher BIS value at the end of anesthesia. Thus, the BIS value per se may have less to do with the time to achieving fast-track eligibility than with the pharmacologic profile of the maintenance anesthetic.

We found a significant correlation between the BIS values at the time the maintenance anesthetics were discontinued and the time to reach fast-track eligibility with both desflurane and propofol. More importantly, all of the patients with a BIS value >75, and none of the patients with a BIS value <45, were fast-track–eligible within 10 min after discontinuation of the maintenance anesthetics. As a result of interpatient variability, there was no correlation between the BIS value and the time to achieve fast-track eligibility in patients with BIS values in the range of 45–70. These data suggest that when using either desflurane or propofol for maintenance of general anesthesia, targeting a higher BIS value at the end of anesthesia will lead to a faster emergence and shorter time to achieving fast-track criteria.

One may criticize the use of the modified Aldrete scores for determining fast-track eligibility because it does not reflect all the key elements of the early recovery process (12). We chose to use the Aldrete criteria because it is commonly used to determine when patients are eligible for discharge from the PACU. A better criteria for determining fast-track eligibility would also include an assessment of pain and emetic symptoms (12). Although the clinical significance of a 3-min difference in the times to achieving fast-track eligibility between the desflurane and propofol groups may be questioned, even small differences in times to awakening and orientation may translate into significant cost-savings if more patients are able to bypass the PACU and be transferred directly to the less labor-intensive phase II recovery area after general anesthesia (8).

In conclusion, outpatients with high BIS values (>75) at the end of propofol or desflurane anesthesia more rapidly achieved PACU discharge criteria and fast-track eligibility after ambulatory surgery.

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