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Bispectral index-guided desflurane and propofol anesthesia in ambulatory arthroscopy: comparison of recovery and discharge profiles

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Abstract In this prospective, randomized study we compared the recovery profiles of bispectral index (BIS)-guided anesthesia regimens with desflurane or propofol in ambulatory arthroscopy. Fifty ASA I–II adult patients who underwent knee arthroscopy were randomized to receive desflurane (D) or propofol (P) infusion accompanied by remifentanil and nitrous oxide during maintenance, titrated to maintain a bispectral index value between 50 and 60. Initial awakening, fast-track eligibility, and home readiness as well as intraoperative hemodynamics, were compared. The groups did not differ with respect to demographics, duration of operation, or intraoperative vital signs. Although the times for initial awakening parameters were shorter in group D, the differences between the groups were not significant. The time needed for the White fast-track score to reach 12 was shorter in group P than group D (9 ± 3.5 min vs 12.5 ± 5.3 min). However, home readiness did not differ significantly between the groups. Desflurane is an alternative to propofol for BIS-guided ambulatory anesthesia. Using desflurane in combination with opioid analgesics blunted its rapid emergence characteristics, and the higher frequency of emetic symptoms with desflurane diminished the success of its fast-track eligibility.

Key words Outpatient anesthesia · Bispectral index · Fast-track · Desflurane · Propofol

Due to developments in surgical and anesthetic techniques, the use of outpatient surgery has increased dramatically in recent years. Desflurane, a volatile agent that has a very low blood-gas partition coefficient, providing rapid emergence from anesthesia, has become an attractive choice for outpatient surgery [1]. Similarly, propofol is often used in outpatient anesthesia due to its rapid and favorable recovery characteristics [2].

The introduction of bispectral index (BIS) monitoring in daily practice has enabled the clinician to quantify the hypnotic and sedative effects of anesthetic agents on the central nervous system [3]. BIS-guided anesthetic titration secures the principal goal of outpatient anesthesia by facilitating the recovery process, due to reductions in hypnotic requirements [4,5].

The purpose of the present prospective, randomized study was to compare the recovery profiles of BIS-guided anesthesia regimens with either desflurane or propofol in outpatients undergoing arthroscopic knee surgery.

Power analysis ($\alpha = 0.05$ and $\beta = 0.1$) suggested that a sample size of 22 patients per group was needed to detect a 30% reduction in time needed for the White fast-track score (White and Song [6]) to reach 12. After we had obtained institutional review board approval and informed consent, 50 unpremedicated outpatients, aged between 18 and 65 years, American Society of Anesthesiologists (ASA) I–II status, undergoing arthroscopic knee surgery were enrolled in this study. Routine monitoring of ECG, pulse oximetry, and noninvasive blood pressure was established before the induction of anesthesia. Electrodes were applied to each patient's forehead for monitoring the BIS of the electroencephalogram (A-2000 BIS monitor; Aspect Medical Systems, Natick, MA USA).

Following preoxygenation of at least 2 min, anesthesia was induced with 0.5–1 $\mu g \cdot kg^{-1}$ remifentanil and 2–3 $mg \cdot kg^{-1}$ propofol. Following laryngeal mask airway (LMA) insertion, which was facilitated by the use of 0.1 $mg \cdot kg^{-1}$ atracurium, patients were randomly allocated to two study groups according to the numerical order of a computer-generated randomization list. Group D (n = 25), received desflurane and a remifentanil infusion of 0.05–0.2 $\mu g \cdot kg^{-1} \cdot min^{-1}$ for maintenance of anesthesia. In group P (n = 25), desflurane was replaced by propofol infusion. Propofol infusion was started with 10 $mg \cdot kg^{-1} \cdot h^{-1}$, and the initial inspired desflurane concentration was 3%. Then each anesthetic was titrated to maintain a BIS value between 50 and 60.

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BIS was inspected continuously, and the propofol infusion rate and the inspired desflurane concentration were adjusted by 50% if the BIS value was out of the targeted range for more than 60 s. The lungs were ventilated with 60% nitrous oxide in oxygen to an end-tidal concentration of CO_2 between 32 and 38 mmHg. Additional atracurium boluses of 5 mg were given if peak airway pressure increased by 30% or coughing occurred. Esophageal temperature was recorded throughout the study, and normothermia was maintained with a forced warm-air device (Warm Touch Patient Warming System; Tyco Healthcare, Gosport, UK).

Mean arterial pressure (MAP) and heart rate (HR) differing by ±25% from the baseline values were initially treated by changing the rate of remifentanil infusion in $0.05\,\mu g \cdot kg^{-1} \cdot min^{-1}$ steps. Hypotension or bradycardia unresponsive to remifentanil manipulation were treated with 5 mg ephedrine or atropine $10\,\mu g \cdot kg^{-1}$, respectively. The incidences of hemodynamic events and treatment modalities were recorded.

HR, MAP, peripheral oxygen saturation ($S_{P_{O_2}}$) and BIS values were recorded before anesthesia induction, after LMA insertion, after incision, and every 5 min throughout the operation. All patients received both analgesic and antiemetic prophylaxis with intramuscular diclofenac sodium (75 mg) and intravenous dexamethasone (4 mg) 15 min before surgery. At the end of the surgical procedure, the surgeon instilled 20 ml bupivacaine 0.25% into the knee joint. Postoperative nausea and vomiting was treated with 10 mg metoclopramide, intravenously. The incidence of postoperative nausea and vomiting was recorded. Hypnotic agents and remifentanil were discontinued on removal of the arthroscope, and the time required for eye-opening with a verbal command, and the LMA extraction time and the time required for full patient orientation (orientation to place, to person, and to time) were recorded. The time needed for the White fast-track score [6] to reach 12 was also recorded. This scoring system takes into consideration pain and emetic symptoms, as well as Aldrete's assessments of consciousness, physical activity, and hemodynamic and respiratory stability. These early recovery assessments were made at 1-min intervals by the same anesthesia resident, who was blinded to the study groups. Time to home readiness was judged by a nurse anesthetist, at 5-min intervals, in the recovery room. The criteria for home readiness include that the patient be awake and alert, have stable vital signs (systemic blood pressure and heart rate within 20% of preoperative values) upon sitting, be able to take fluids by mouth and to void, and to be experiencing no or minimal incisional pain.

Data values are expressed as means ± SD or percentages. Sex, ASA status, and incidence of nausea and vomiting were compared with the χ^2 or Fisher's exact test. The rest of the data were analyzed using the unpaired Student's *t*-test. Statistical significance was assumed for $P < 0.05$.

Characteristics of patients in the two groups are summarized in Table 1. HR, MAP, SpO_2, and BIS values did not demonstrate statistically significant differences between the two groups at any of the measurement intervals. None of the patients demonstrated hypotensive or bradycardic episodes needing vasoactive drug therapy. The remifentanil infusion rate was adjusted in 14 patients (56%) in group D and in 15 patients (60%) in group P ($P = 0.8$), but none of the patients required discontinuation of remifentanil. Three (12%) patients in group D, but none of the patients in group P complained of postoperative nausea ($P = 0.2$).

Although the times were shorter in group D, the time required for eye-opening with a verbal command, the LMA extraction time, and the times required for full patient orientation did not demonstrate statistically significant differences between the groups (Table 2). The time needed for the White fast-track score to reach 12

Table 1. Demographic characteristics, duration of surgery, and dosages of anesthetic drugs

	Desflurane ($n = 25$)	Propofol ($n = 25$)	*P*
Age (years)	43 ± 14	40 ± 13	NS
Sex (M/F)	14/11	13/12	NS
ASA status (I/II)	20/5	19/6	NS
Weight (kg)	81 ± 13	76 ± 12	NS
Height (cm)	171 ± 9	168 ± 9	NS
Duration of surgery (min)	50 ± 15	52 ± 18	NS
Propofol (mg)	161 ± 22	511 ± 43	<0.0001
Desflurane concentration (ET%)	3.6 ± 0.9	NA	
Remifentanil (μg)	765 ± 36	744 ± 41	NS
Atracurium (mg)	9.72 ± 1.9	9.42 ± 1.8	NS

NS, Nonsignificant; NA, not assessed

Table 2. Recovery profiles

	Desflurane ($n = 25$)	Propofol ($n = 25$)	P
Eye-opening (min)	6 ± 2.2	6.6 ± 2.8	NS
LMA extraction (min)	6.4 ± 2.6	6.9 ± 2.6	NS
Orientation to place (min)	7.2 ± 2.5	7.9 ± 3	NS
Orientation to person (min)	7.5 ± 2.4	7.8 ± 2.8	NS
Orientation to time (min)	7.8 ± 2.6	8.3 ± 3.1	NS
Fast-track score >12 (min)	12.5 ± 5.3	9 ± 3.5	0.02
Home readiness (min)	87 ± 28	88 ± 30	NS

NS, Nonsignificant

Table 3. Recovery profiles in previous studies

Desflurane vs propofol	Number of patients	Anesthetic titration	Eye-opening time (min)	Orientation time (min)	Fast-track eligibility (min)	Home readiness (min)
Van Hemelrijch et al. [1], 1991	23 vs 23	Clinical signs	5.1 vs 7.3	8 vs 9.8	NA	204 vs 199
Lebenbom–Mansour et al. [12], 1993	14 vs 16	Clinical signs	7.7 vs 10	10.3 vs 8.6	NA	162 vs 109
Eriksson and Korttila [11], 1996	31 vs 30	Clinical signs	4.3 vs 5.1	6.5 vs 6.4	NA	109 vs 110
Apfelbaum et al. [10], 1996	20 vs 20	Clinical signs	6.2 vs 15*	8.2 vs 19*	NA	81 vs 70*
Coloma et al. [14], 2001	9 vs 11	BIS	5 vs 8	9 vs 13	16 vs 7	114 vs 131
Tang et al. [9], 2001	40 vs 35	BIS	6 vs 4*	6 vs 4*	11 vs 13	32 vs 37

*Statistically significant differences between groups
NA, not assessed

was shorter in group P than in group D (9 ± 3.5 min vs 12.5 ± 5.3 min respectively; $P < 0.02$; Table 2). Those group D patients who suffered postoperative nausea and vomiting (PONV) needed a longer time (20, 22, and 25 min) for the White fast-track score to reach 12. However, time to home readiness did not differ significantly between the groups (Table 2). Patients with PONV did not need a longer time to be ready for home.

This study demonstrated that BIS-guided anesthesia maintenance with desflurane or propofol produced similar recovery profiles in outpatients undergoing arthroscopic knee surgery. The longer time to reach fast-track score eligibility with desflurane was due to the postoperative nausea observed in three patients.

In addition to its support in speeding up early recovery, BIS monitoring was utilized to ensure that anesthetic levels were equal during the maintenance of anesthesia in the two groups in the present study. We targeted a BIS value between 50 and 60 because this level has been to be reported safe in regard to a low probability of intraoperative recall and a high probability of unresponsiveness during surgery [7,8].

Hemodynamic stability was satisfactorily provided by the equal anesthetic levels of each of the maintenance regimens, which were used in combination with remifentanil infusion. Despite achieving approximately 10% faster eye opening, LMA extraction, and full patient orientation times with desflurane, we could not demonstrate statistically significant differences in the early recovery profiles of propofol and desflurane anesthesia. This finding is contrary to the data reported by Tang et al. [9], who compared BIS-guided propofol and desflurane maintenance during office-based anesthesia. They demonstrated that desflurane facilitated a faster emergence from anesthesia compared to propofol (4 vs 6 min for both eye-opening and orientation). In that study, the authors employed a protocol similar to ours and adjusted the anesthetics to maintain a BIS value between 55 and 65, but none of their patients received opioid analgesics or muscle relaxants in the perioperative period. In an earlier study [10], in which depth of anesthesia was judged by hemodynamic variables, desflurane also provided faster emergence from opioid-free anesthesia. On the other hand, several clinical trials [1,11,12] could not demonstrate statistically significant differences in initial awakening parameters between propofol and desflurane anesthesia, guided by standard clinical signs (Table 3). Opioid

analgesics and muscle relaxants were employed during anesthetic induction and maintenance in these trials [1,11,12], as they were in the present study. We speculate that using desflurane in combination with opioid analgesics and muscle relaxants is the major factor which blunts its rapid emergence characteristics.

In 1999, White and Song [6] evaluated a new scoring system for fast-tracking after outpatient anesthesia; the system combines postoperative pain and emesis assessment with the essential elements of the modified Aldrete's scoring system [13]. They proposed that outpatients could be transferred to the step-down unit when they achieved a score of 12 on this new scoring system. In the present study, we observed that patients became eligible for fast-track earlier with propofol than with desflurane (12.5 vs 9 min) when we used those criteria. Although the difference in PONV incidence between the groups was statistically insignificant, we speculate that PONV episodes in three patients after desflurane anesthesia gave rise to the delay in fast-track eligibility with desflurane. Contrary to our findings, Tang et al. [9] reported earlier fast-track eligibility with opioid-free anesthesia using desflurane compared with propofol (11 vs 13 min). In contrast to those finding, using remifentanil in the present study probably intensified the emetogenic potential of desflurane. Furthermore, Tang et al. [9] used a triple antiemetic regimen instead of prophylaxis with a single agent. The discrepancy between the results of their study and ours indicates the importance of PONV prophylaxis in patients to be anesthetized with desflurane, even in outpatients undergoing nonemetogenic procedures.

Time to home readiness was comparable in our desflurane and propofol groups despite the differences in fast-track eligibility. Previous studies, using either BIS-guided [9,14] or clinically guided [1,11] anesthetic maintenance, were not able to find an advantage of one drug over the other in the assessment of late recovery endpoints (Table 3).

We conclude that desflurane is an alternative to propofol for BIS-guided ambulatory anesthesia. However, using desflurane in combination with opioid analgesics blunted its rapid emergence characteristics, and the higher frequency of PONV diminished the success of its fast-track eligibility.

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