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Neurologic State and Psychomotor Function Following Anesthesia for Ambulatory Surgery

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Rapidly mounting in-hospital costs have increased the need for alternative approaches to patient care. This problem has given impetus to the development of ambulatory surgery.[1,2] Most ambulatory patients are discharged just a few hours after anesthesia and surgery and after receiving significant amounts of barbiturates, tranquilizers, narcotics, and inhaled anesthetics. A major concern, therefore, is the patient's neurologic state and psychomotor function at the time of discharge.

We were interested in developing guidelines for discharge in the ambulatory surgical unit that were based on objective tests, rather than subjective clinical impressions. We also were interested in determining whether isoflurane was superior to enflurane because of its lower blood/gas partition coefficient and alleged shorter induction and emergence times.[3]

METHOD

After obtaining approval from the institutional committee on scientific activities and informed consent from the patients, 120 ASA class I patients were studied. Diazepam, 0.08 mg/kg, was administered iv about 5 min before the patient was taken into the operating room. After administration of thiopental 4 mg/kg iv, each patient was assigned to a fentanyl, enflurane, or isoflurane group. Randomization was achieved by adding one patient at a time to each of the study groups. The fentanyl group (40 patients) received fentanyl, 2 μg/kg iv, shortly before thiopental, and anesthesia was maintained with nitrous oxide 70% in oxygen. The enflurane and isoflurane groups (40 patients each) received equipotent concentrations of the respective inhaled anesthetic: initially two MAC (3.4% and 2.6%, respectively) inspired concentration with nitrous oxide 50% and oxygen, until the end-tidal concentration reached one MAC (1.7% and 1.3%, respectively) and then one MAC inspired concentration until surgery was completed. The end-tidal concentration of the inhaled anesthetic was monitored continuously by a quartz crystal transducer. All patients received intermittent doses of 20–30 mg of succinylcholine iv to facilitate positive-pressure ventilation and maintain the end-tidal P_{CO_2} in the normal range.

An investigator, blind to the identity of the anesthetic drug, gave each patient the following psychomotor tests preoperatively and 1 and 2 h after anesthesia: response time test,[4] modified tapping test (eye–hand coordination),[5] and visualization test (the ability to anticipate the outcome of an object manipulated in space).[6] The equipment for the response time and modified tapping tests was improvised and made from pieces easily available in the operating room: two rubber bulbs connected by a y piece to a pressure transducer, which was, in turn, attached to a pressure monitor and to a paper chart recorder. When testing response time, the investigator held one bulb in his hand and the patient held the other. The investigator gave the patient visual signals by pressing his bulb and producing spikes on the screen. The patient was instructed to watch the monitor's screen and respond to each visual signal by pressing his bulb. All signals and responses were recorded on paper, running at the rate of 25 mm/s. The patient's response time was calculated from the distance between the tester's signal and the patient's response.

To perform the modified tapping test, the same equipment was used, as described above (fig. 1). The patient was instructed to use one hand (the right hand in a right-handed patient or the left hand in a left-handed patient) and press the bulbs one at a time, alternatingly as fast as he could. Each time the patient pressed a bulb, a spike appeared on the screen, which was recorded on paper. The patient's score was calculated by adding the total number of spikes recorded in a 10-s testing period.

For the visualization test the patient was given 3 min to trace lines in a maze and mark as fast as he could where the lines end. The patient's score was equal to the sum of the correct markings.

The time to first response after anesthesia and the arousal scores at 20 and 40 min after anesthesia were

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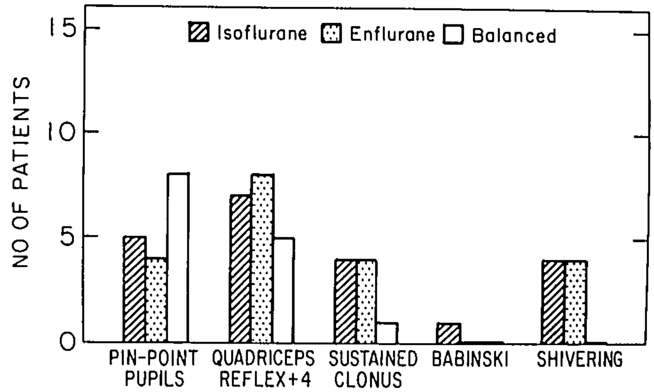

FIG. 1. The incidence of postanesthesia abnormal neurologic signs in the study groups. There were no statistical differences between groups.

determined as described by Rosenberg *et al.*[7] The patients also were assessed neurologically before and after anesthesia and the size of pupils and the presence of hyperactive patellar reflex, sustained ankle clonus, Babinski reflex, and shivering were noted. The arousal state and the psychomotor scores were analyzed by a multigroup analysis of variance and intragroup comparisons; the incidence of abnormal neurologic signs was analyzed by the chi-square test. A P value less than 0.05 was considered significant.

RESULTS

The results are summarized in tables 1–3. The surgical procedures included dilatation and curettage (92 patients), varicocelectomy (seven patients), suspension laryngoscopy (four patients), breast biopsy (three patients), testicular biopsy (three patients), vulvar lesion excision (three patients), circumcision (two patients), colposcopy (two patients), laparoscopy (one patient), lymph node biopsy (one patient), hymenectomy (one patient), and lipectomy (one patient). There were no differences in mean body weight and mean duration of surgery between the groups. The mean age was significantly higher in the isoflurane group. The mean ± standard deviation of total succinylcholine given in the isoflurane, enflurane, and nitrous oxide–fentanyl groups was 38 ± 16, 35 ± 15, and 38 ± 13 mg, respectively (statistically insignificant differences).

TABLE 1. Sex, Age, and Weight Distribution (Mean Standard Deviation) in the Three Study Groups

Group	Sex F/M	Age in Years	Wt. in Kg	Duration of Anesthesia (min)
Fentanyl	39/1	30 ± 7	63 ± 19	14 ± 8
Enflurane	35/5	33 ± 8	66 ± 19	16 ± 8
Isoflurane	31/9	38 ± 10*	64 ± 17	12 ± 8

* $P < 0.001$ when compared with the fentanyl and enflurane groups.

TABLE 2. The Time to First Response and the Arousal Scores at 20 and 40 Min after Anesthesia

Group	Time to First Response (min)	Arousal Score after 20 Min	Arousal Score after 40 Min
Fentanyl	3.6 ± 2.6*	2.4 ± 0.5†	2.9 ± 0.3
Enflurane	8.8 ± 2.4	2.0 ± 0.4	2.7 ± 0.5
Isoflurane	9.4 ± 4.8	2.0 ± 0.7	2.7 ± 0.4

* $P < 0.001$, †$P < 0.05$ when compared with the enflurane and isoflurane groups.

The time to first response after anesthesia was the shortest and the arousal score at 20 min after anesthesia was the best in the fentanyl–nitrous oxide group. There were no differences between the enflurane and isoflurane groups at 20 min after anesthesia, and there were no differences between the three groups at 40 min after anesthesia.

The psychomotor tests were abnormal in all groups at 1 h after anesthesia (significantly more so in the enflurane group) and near normal in all groups at 2 h after anesthesia. Abnormal neurologic signs during recovery were seen in all three groups (fig. 1); there were no statistical differences between the groups.

DISCUSSION

Volatile anesthetic drugs, tranquilizers, narcotics, and barbiturates produce prolonged abnormalities in psychomotor function.[5–10] These observations are of particular concern in ambulatory surgery because of the early discharge of patients and the absence of postoperative nursing care that is normally provided to inpatients.

Our findings indicate that 20 minutes after anesthesia, the patients in the fentanyl–nitrous oxide group were more awake than patients in the groups that had inhaled anesthesia, but at 40 min after anesthesia all patients were equally awake. The earlier recovery from fentanyl nitrous-oxide possibly could be due to a lighter level of anesthesia in this group. Fentanyl in higher doses possibly may be associated with longer recovery time.

There were no significant differences among the groups in psychomotor scores at 1 and 2 h after anesthesia, except for slightly lower scores in the enflurane group. All patients were at or near their preoperative performance level 2 h after anesthesia. Our expectation that recovery from isoflurane would be significantly faster than recovery from enflurane did not materialize. The length of the surgical procedures in this series probably was too short to uncover a significant difference in recovery rate between the two anesthetics.

The correlation between postoperative psychomotor scores and the return of skills to perform daily tasks such as driving, using tools, and making decisions, has not been studied. However, in our patients the return at 2

TABLE 3. Visualization, Response Time, and Modified Tapping Test Scores, in Per Cent of Preanesthesia Values, 1 and 2 after Anesthesia

Group	Visualization after:		Response Time after:		Modified Tapping after:	
	1 HR	2 HR	1 HR	2 HR	1 HR	2 HR
Fentanyl	74 ± 27*	95 ± 10	112 ± 11*	104 ± 9	88 ± 10*	96 ± 9
Enflurane	72 ± 17*	92 ± 10†	111 ± 18*	104 ± 5*	86 ± 9*	94 ± 6*
Isoflurane	75 ± 21*	97 ± 5	111 ± 11*	102 ± 4	87 ± 10*	98 ± 3

* $P < 0.001$ and † $P < 0.03$ when compared with preanesthesia values.

h after anesthesia of response time, eye–hand coordination, and ability to anticipate the outcome of an object manipulated in space suggests sufficient recovery of essential skills for safe discharge in the company of an adult.

Our patients received diazepam and thiopental, which have significant depressing effect on psychomotor function.[6,8,10,12] This probably contributed to the postanesthesia psychomotor depression that we observed. However, since similar doses were used in all patients, we believe that this did not bias our results.

In summary, ambulatory patients following fentanyl–nitrous oxide, enflurane, or isoflurane anesthesia were equally awake at 40 minutes after anesthesia and their psychomotor function scores were similar and close to the preoperative values at 2 h after anesthesia.

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