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General Anesthesia for Morbidly Obese Patients — An Examination of Postoperative Outcomes

Randall C. Cork, M.D., Ph.D., Robert W. Vaughan, M.D.,† John B. Bentley, M.D.,‡*

Specific postoperative outcomes were assessed in 67 morbidly obese subjects who received general anesthesia for gastric stapling. Each patient was randomly assigned to receive N_2O:O_2 combined with fentanyl (n = 20), enflurane (n = 24), or halothane (n = 23). Time from last skin stitch until the patient opened eyes on command was significantly less for the fentanyl group (3.0 ± 0.7 min) than for the enflurane group (13.2 ± 1.9 min) or the halothane group (17.4 ± 2.9 min) with $P < 0.05$. However, no significant differences in time from last skin stitch to extubation were noted among the fentanyl (16.2 ± 7.4 min), enflurane (15.2 ± 1.6 min), and halothane (21.6 ± 5.8 min) groups ($P > 0.05$). Recovery room (RR) admission temperatures were similar for the three groups: fentanyl, 36.1 ± 0.1° C; enflurane, 35.7 ± 0.2° C; and halothane, 36.0 ± 0.1° C ($P > 0.05$). Total RR time was not significantly different: fentanyl, 108 ± 6 min, enflurane, 118 ± 4 min; and halothane, 112 ± 10 min ($P > 0.05$). In addition, no difference in RR and 24-hour postoperative narcotic (meperidine) requirements was demonstrated among the anesthetic groups. These data suggest that increased lipid solubility of volatile anesthetics (halothane or enflurane) produces neither delayed awakening nor prolonged recovery time in morbidly obese subjects. Considering the early (24 hour) postoperative outcomes studied, there is little to commend one general anesthetic technique over another in the obese subset of the population. (Key words: Analgesia: postoperative. Anesthetics, volatile: enflurane; halothane. Anesthetics, intravenous: fentanyl. Complications: obesity. Oxygen: tension. Recovery.)

THE IDEAL GENERAL ANESTHETIC for morbidly obese patients remains controversial. The relative benefits of fixed (intravenous) compared to volatile (inhalation) agents have been argued. Fisher *et al.*[1] suggest that uptake and storage of volatile agents in adipose reserves of a morbidly obese patient result in prolonged anesthetic recovery. Hamm and Koehler[2] agree, and recommend fixed agents for anesthetic management of obese patients. No clinical data to justify this recommendation have been reported. Therefore, a randomized, prospective clinical study was designed to compare relative clinical postoperative anesthetic outcomes among anesthetic agents in morbidly obese patients.

* Assistant Professor.
† Associate Professor.
‡ Research Associate.

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Address reprint requests to Dr. Randall C. Cork.

Methods

Fentanyl, enflurane, or halothane were randomly assigned to patients scheduled for elective gastric stapling.

Sixty-seven patients were studied, 12 male and 55 female. Descriptive characteristics were as follows (mean ± SEM): age, 38 ± 1 year; weight, 126 ± 3 kg; and height, 166 ± 1 cm. After random assignment, the fentanyl group included 20 patients, the enflurane group 24 patients, and the halothane group 23 patients (table 1). No significant differences among the three groups were noted with respect to age, weight, height, body mass index, or body surface area.

In addition to the randomly assigned agent, the patients in each group received nitrous oxide: oxygen (60:40) and pancuronium bromide during surgery.

All patients were seen the evening prior to surgery. During this visit, informed consent, as approved by the University of Arizona Health Sciences Center Human Subjects Committee, was given for both the planned general anesthetic agent and for the study protocol. Also, a digit span test was administered in the manner described by Botwinick and Storandt[3] to serve as an index of attention and concentration. In this test each patient was asked to repeat a series of digits read to them. Each time the digit series was recited correctly, the test was repeated with a new series of digits that included one more digit than the previous series. This sequence was continued until the patient missed two digit series of identical length or until nine sequential digits had been repeated correctly. Patients were scored by the length of the longest series of numbers which could be recalled accurately.

One hour prior to operation, each patient received diazepam (15 mg) and Maalox® (30 ml) by mouth, and glycopyrrolate (0.3 mg) intramuscularly. Anesthetic induction sequence included gallamine (20 mg), preoxygenation (3–5 min), sodium thiopental (400–950 mg), succinycholine (120–180 mg), cricoid pressure, and placement of a cuffed endotracheal tube. Pancuronium bromide (6–9.5 mg) was utilized for muscle relaxation, and ventilation was controlled to maintain Pa_{CO_2} at 40 ± 5 torr. Those patients receiving intravenous fentanyl, were given a dose of 250 + 5 ×

(BMI§—30) μg. This dosage schedule was selected on the basis of our prior clinical experience with this population and with the intention of providing a standard narcotic dose based on degree of obesity. In addition, those patients receiving fentanyl were administered incremental doses of sodium thiopental (25–50 mg) as needed to maintain anesthesia. Patients receiving enflurane or halothane were given concentrations of volatile anesthetic based on the anesthesiologist's clinical impression of depth of anesthesia required to match surgical stimulus. End-tidal concentrations of halothane or enflurane were determined by gas chromatography for subsequent minimum alveolar concentration (MAC)-hour calculation.

When suturing of abdominal muscle fascia was completed, each patient received neostigmine (5 mg) and atropine (2 mg), and the volatile agent (enflurane or halothane) was discontinued. Subsequent discontinuance of nitrous oxide in all patients occurred at the time of the last skin stitch. The time at which the patient first opened his eyes on command and time of extubation were recorded. Extubation criteria included: sustained tetanus (50 Hz) for 5 s; opening eyes on command; and maintaining head lift for 5 s. Adequacy of ventilation has been shown to be strongly correlated with sustained tetanus,[4] and the head-lift test is an even more sensitive index of neuromuscular blockade.[5] These tests were continuously administered until the patient was extubated. Patients were transferred to the recovery room (RR) in the semi-recumbent position. Supplemental oxygen was provided during the transport.

Each patient's tympanic membrane temperature was recorded on RR admission. Patients were maintained in the semi-recumbent position and administered supplemental oxygen ($F_{I_{O_2}} = 0.4$) by ventimask. Arterial blood gases were drawn. All subjects received intravenous meperidine in the RR and during the subsequent 24-hour period as needed for pain. Pain assessment was based on the judgment of the patient's nurse, who was not blind to the type of anesthetic administered. All patients were assessed for discharge from the RR by the same anesthesiologist (R.V.), who was not blind to the type of anesthetic administered. Criteria for transfer included stability of vital signs, no evidence of hypoxemia, hypercarbia, or acidosis from arterial blood gases ($F_{I_{O_2}} = 0.4$), plus patient alertness and orientation. The digit-span test was repeated when each patient was judged eligible for transfer.

All patients were monitored in the intensive care unit for 24 hours after surgery. At the end of this time period, measured variables included arterial blood gases ($F_{I_{O_2}} = 0.4$; patient semi-recumbent); the digit-span test; and 24-hour postoperative narcotic requirements. Analysis of variance and the Student t test for grouped data and for paired data were employed. The Bonferroni modification of the Student t test[6] was used when multiple comparisons were made. Significance was defined at $P < 0.05$.

§ BMI = body mass index = wt (kg)/ht² (m²)

TABLE 1. Patient Characteristics (Mean ± SEM) by Anesthetic Agent

	Fentanyl (n = 20)	Enflurane (n = 24)	Halothane (n = 23)
Age (yrs)	36 ± 2	38 ± 2	39 ± 2
Weight (kg)	128 ± 5	123 ± 5	127 ± 4
Height (cm)	165 ± 2	166 ± 2	167 ± 2
BMI (kg/m²)*	47 ± 2	45 ± 2	45 ± 1
BSA (m²)†	2.28 ± 0.04	2.25 ± 0.04	2.30 ± 0.04

* BMI = body mass index (weight/height²).
† BSA = body surface area.

Results

Postoperative clinical comparisons are summarized in table 2. Anesthesia time was significantly longer for the fentanyl group than for the enflurane or halothane group ($P < 0.05$). MAC-hour exposure for the halothane group was greater than that for the enflurane group ($P < 0.05$) despite no significant difference in anesthesia time. The total amount of sodium thiopental administered to patients in the fentanyl group was almost twice that given to either the enflurane or halothane group ($P < 0.05$). At-

TABLE 2. Comparison of Postoperative Clinical Variables (Mean ± SEM) Among Anesthetic Agents

	Fentanyl (n = 20)	Enflurane (n = 24)	Halothane (n = 23)
Anesthesia time (min)	159 ± 10*	134 ± 7	129 ± 5
MAC-hrs	——	1.38 ± 0.09	1.80 ± 0.13*
Sodium thiopental (mg)	920 ± 72*	511 ± 25	527 ± 19
Attention and concentration			
Digits Span			
Preoperative	6.5 ± 0.3	7.4 ± 0.3	7.3 ± 0.3
Recovery room	6.6 ± 0.3	7.4 ± 0.3	7.2 ± 0.3
24-Hrs post-operative	6.8 ± 0.3	7.4 ± 0.3	7.3 ± 0.2
Recovery room admission temperature (°C)	36.1 ± 0.1	35.7 ± 0.2	36.0 ± 0.1
Total recovery room time (min)	108 ± 6	118 ± 4	112 ± 10

* Significantly different at $P < 0.05$ among anesthetic agents.

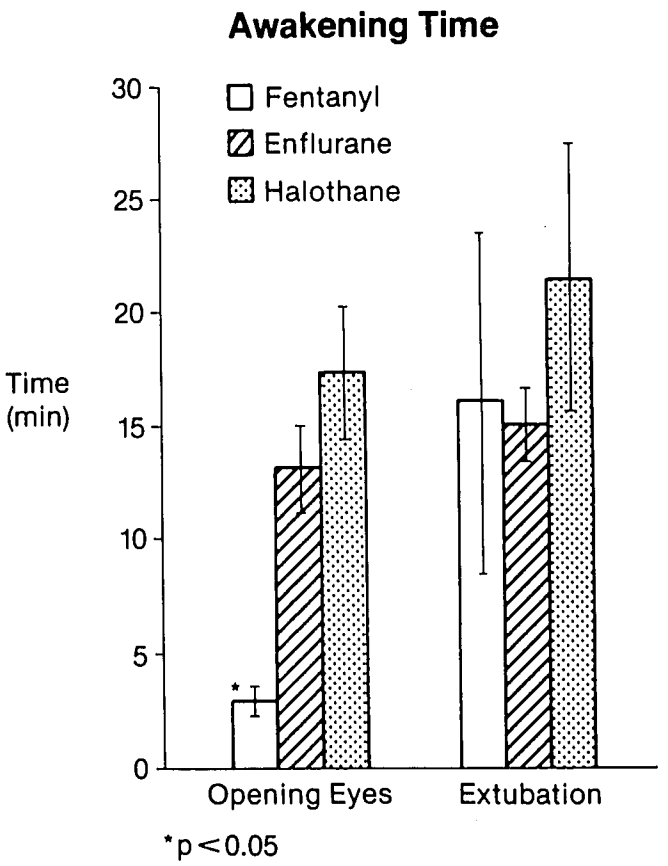

FIG. 1. Awakening time as measured by time from last skin stitch until opening eyes on command and by time from last skin stitch until extubation. Extubation criteria were the following: sustained tetanus for 5 s; opening eyes on command; and maintaining head lift for 5 s.

tention and concentration, as measured by the digit-span test, did not differ significantly among the three groups. Also, there was no significant difference between the preoperative digit-span score and either the recovery room or 24-hour postoperative score in any of the three groups.

Time from the last skin stitch until the patient opened eyes on command was significantly less for the fentanyl group ($P < 0.05$). However, there was no significant difference among the three groups in time from the last stitch to extubation (fig. 1). Recovery room admission temperature and total recovery room time were similar for the three groups (table 2).

No significant differences among the three anesthetic groups were observed in RR and 24-hour postoperative narcotic requirement. In the recovery room, the fentanyl group required 21.8 ± 5.1 mg of meperidine, the enflurane group 26.5 ± 6.5 mg, and the halothane group 18.1 ± 3.7 mg. At 24 hours postoperatively, the fentanyl group had required 159.1 ± 26.3 mg, the enflurane group 154.5 ± 20.6 mg, and the halothane group 158.6 ± 17.6 mg. These 24-hour totals were in addition to the recovery room requirements.

Pa_{O_2}, Pa_{CO_2}, pH, and bicarbonate concentration ($[HCO_3^-]$) did not differ significantly with type of anesthetic (table 3). For each group, Pa_{O_2} did not change significantly over the first 24 hours postoperatively; however, over this same time period, Pa_{CO_2} decreased, while pH and $[HCO_3^-]$ increased. These changes were statisticlly significant at $P < 0.05$.

TABLE 3. Postoperative Arterial Blood Gases (Mean ± SEM) Among Anesthetic Agents

	Fentanyl (n = 20)	Enflurane (n = 24)	Halothane (n = 23)
Recovery room			
Pa_{O_2} (torr)	101 ± 5	97 ± 6	87 ± 4
Pa_{CO_2} (torr)	40 ± 1	42 ± 1	40 ± 1
pH	7.37 ± 0.01	7.31 ± 0.01	7.37 ± 0.01
$[HCO_3]$(mEq/l)	22.4 ± 0.3	22.9 ± 0.5	22.6 ± 0.5
24 Hrs postoperative			
Pa_{O_2} (torr)	103 ± 6	96 ± 5	98 ± 5
Pa_{CO_2} (torr)*	38 ± 1	38 ± 1	38 ± 1
pH*	7.42 ± 0.01	7.43 ± 0.01	7.42 ± 0.01
$[HCO_3]$(mEq/l)*	24.6 ± 0.3	24.5 ± 0.5	24.0 ± 0.4

* All groups significantly different from recovery room measurements, $P < 0.05$.

Discussion

The contention that morbidly obese patients require more time to awaken after given a lipid soluble volatile anesthetic[1,2] is not supported by this study. Despite the early eye-opening noted in the fentanyl group, no difference in time to extubation was observed. The patient's ability to open eyes on command can not be used alone as a measure of recovery from anesthetic agents. The lack of significant difference in total recovery room time also argues against the concern of prolonged soporific effects of volatile agents in the morbidly obese population.

No differences in arterial blood gas tension measurements as a function of type of anesthetic agent employed were noted in the RR or 24 hours postoperatively. Although severe postoperative hypoxemia has been identified in this population,[7] the use of proper positioning (semi-recumbent) and oxygen supplementation ($FI_{O_2} = 0.4$), maintained oxygenation at acceptable levels regardless of anesthetic agent used. Changes in acid-base balance seem not to represent a function of the anesthetic employed, but rather the operation itself.

This clinical study also demonstrates that postoperative narcotic requirements were similar in those patients who received intraoperative analgesics (fentanyl group) as compared to those who received only volatile anesthetics (enflurane or halothane group). Thus, giving narcotics intraoperatively did not reduce postoperative analgesic requirements compared to giving only volatile agents intraoperatively. Similarly, storage of halothane or enflurane in adipose tissue reservoirs did not result in reduced postoperative narcotic requirements.

The longer anesthesia time experienced by the fentanyl group can not be ascribed to the anesthetic technique. This group of patients presented more intraoperative surgical problems (presumably by chance) than did either of the volatile anesthetic groups. The greater MAC-hour dosage observed for halothane compared with enflurane despite the same duration of anesthesia for these two groups deserves comment. Halothane causes less cardiovascular depression compared with enflurane.[8] Thus, the clinical tendency might be to administer a relative overdose with halothane because of its cardiovascular stability. The increased dose of sodium thiopental employed in the fentanyl group can be attributed to the use of that fixed agent to supplement the fentanyl anesthetic. Such fixed-agent supplementation was not utilized for either volatile anesthetic. Differences in effects on the peripheral vasculature exist between narcotic agents and the volatile agents.[9,10] However, differences in intraoperative heat loss could not be demonstrated by assessing recovery-room admission temperature.

Use of the digit-span test to measure attention and concentration was introduced by Wechsler,[11] and employed by Botwinick and Storandt to assess changes in attention and concentration with aging.[3] Its simplicity and ease of administration encourage its clinical application. However, results in the RR and 24 hours postoperatively did not differ from preoperative control values. Thus, an association between the digit-span score and latent effects of anesthetic agents appear tenuous at best.

Conclusions

Increased lipid solubility of volatile anesthetics (halothane or enflurane) produces neither delayed awaking nor prolonged recovery time in morbidly obese patients. Those obese patients who receive intraoperative fentanyl, require no less postoperative narcotics than comparable subjects who do not receive intraoperative narcotics. Although patients given nitrous/fentanyl (balanced) anesthesia open their eyes on command sooner, time to extubation does not differ significantly from those patients given either nitrous/enflurane or nitrous/halothane. Considering early (24 hours) postoperative outcomes, there is little to commend one general anesthetic technique over another in morbidly obese patients. The clinical usefulness of either enflurane or halothane anesthesia does not seem to differ from that of balanced anesthesia with fentanyl.

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