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Nitrous Oxide and Laparoscopic Bariatric Surgery

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Background: Nitrous oxide (N_2O) is frequently used to supplement more potent anesthetic agents. One side-effect of N_2O is its ability to expand an air-containing space. We investigated if N_2O adversely affected operating conditions by distending normal bowel during laparoscopic bariatric procedures.

Methods: 50 morbidly obese patients were divided into 2 study groups. Group 1 patients were ventilated with a halogenated anesthetic/oxygen/air mixture, while Group 2 received a halogenated anesthetic/oxygen/N_2O mixture. At 30, 60, and 90 min intervals during the operation, the surgeon was asked if N_2O was being used.

Results: The surgeons responded correctly only 42% (30 min), 50% (60 min), and 48% (90 min) of the time. In Group 2 (N_2O) patients, they incorrectly answered that N_2O *was not* being used 88% (30 min), 68% (60 min), and 68% (90 min); and in Group 1 (air) patients, they incorrectly answered that N_2O *was* being used 28% (30 min), 32% (60 min), and 36% (90 min) of the time.

Conclusion: We found that using N_2O did not cause noticeable bowel distention during laparoscopic bariatric procedures of relatively short duration.

Key words: Laparoscopy, gastric bypass, complications, bowel distention, nausea, anesthesia, nitrous oxide

Introduction

Nitrous oxide (N_2O) is a weak anesthetic gas used to supplement more potent anesthetic agents. One well known side-effect of N_2O is its ability to expand an air-containing space.[1] Although this phenomenon may have clinical significance for closed spaces such as obstructed bowel, it is controversial as to whether N_2O will significantly distend normal bowel. We investigated whether N_2O adversely affected operating conditions in patients undergoing laparoscopic bariatric operations.

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Methods

Following approval by the Human Subjects Committee at Stanford University Medical Center, informed written consent was obtained from 50 consecutive patients undergoing either laparoscopic Roux-en-Y gastric bypass (48 patients) or gastric banding (2 patients) operations. Demographic data including patient gender, age, height, weight, BMI, medical co-morbidities and current medications were recorded.

General anesthesia was induced with propofol, and succinylcholine was used to facilitate tracheal intubation. All patients received a halogenated anesthetic agent (isoflurane, desflurane, sevoflurane) combined with a continuous intravenous infusion of the short-acting opioid remifentanil. Muscle relaxation was with a non-depolarizing muscle relaxant. A randomization table was used to assign each patient to one of two groups. In patients in Group 1, the lungs were ventilated with the volatile anesthetic, oxygen and air, while Group 2 patients received N_2O (50%) instead of air. An inspired O_2 concentration of 50% was maintained in both groups. At 30, 60, and 90 mins after initiation of a CO_2 pneumoperitoneum, the surgeon who was "blinded" as to whether the patient was receiving air or N_2O, was asked whether N_2O was being used.

The length of operation was recorded. All patients received at least one anti-emetic medication during surgery, and many received a combination of two or more anti-emetic drugs. In the post-anesthesia care unit (PACU), the incidence of nausea was noted, and if present what additional anti-emetics were administered.

Data are reported as mean (± SD) or the incidence of observations. A two sample t-test, Fisher-exact test or chi-square test were used for intergroup comparisons. $P < 0.05$ was regarded as statistically significant.

Results

There was no difference in demographic parameters or duration of surgery between groups (Table 1). Twenty-five patients received air in oxygen (Group 1), and 25 patients received N_2O in oxygen (Group 2). When asked at 30, 60 and 90 min after the start of surgery whether the patient was receiving N_2O or not, the surgeons responded correctly 42% (30 min), 50% (60 min) and 48% (90 min), which is equal to or less than would be expected by chance. There was no difference in the correct responses between the two surgeons (50% vs 45%). Interestingly, in Group 2 patients, the number of incorrect responses was significantly higher than in Group 1 when air was used. Surgeons incorrectly answered that N_2O *was not* being used 88% of the time at 30 min, and 68% at 60 and 90 min in Group 2 (N_2O) patients (Table 2). They also believed that N_2O was being used in Group 1 patients (air) 28% (30 min), 32% (60 min) and 36% (90 min) of the time.

In only one of the 50 patients studied was the degree of bowel distention so great that it impaired the operation. The surgeon requested that N_2O be discontinued, and was surprised when told that the patient was in Group 1 and had not received N_2O at any time.

Despite the use of prophylactic anti-emetics, the incidence of postoperative nausea or vomiting (PONV) was 48%. The difference in the incidence of PONV between Group 1 (44%) and Group 2 (52%) was not significant.

Table 1. Demographic data of 50 patients undergoing laparoscopic bariatric procedures

	Group 1	Group 2
Gender (m/f)	3/22	4/21
Age (yr)	46 (7)	47 (8)
BMI (kg/m^2)	45 (5)	45 (6)
Surgery Time (hr)	2.5 (0.5)	2.5 (0.5)

Values are incidence or mean (± SD).
m = male, f = female.
Group 1: Air and Oxygen.
Group 2: Nitrous Oxide and Oxygen.

Table 2. At 30, 60 and 90 minutes after the start of surgery, the surgeon was asked whether nitrous oxide (N_2O) was being used. The number and percent of correct and incorrect responses are shown

	Correct Response	Incorrect Response
30 Min*		
Group 1	18 (72%) (no)	7 (28%) (yes)
Group 2	3 (12%) (yes)	22 (88%) (no)
60 Min*		
Group 1	17 (68%) (no)	8 (32%) (yes)
Group 2	8 (32%) (yes)	17 (68%) (no)
90 Min*		
Group 1	16 (64%) (no)	9 (36%) (yes)
Group 2	8 (32%) (yes)	17 (68%) (no)

Difference between groups* $P < 0.05$, Fisher's exact test.
Group 1: Air and Oxygen.
Group 2: Nitrous Oxide and Oxygen.

Discussion

Nitrous oxide (N_2O) is a relatively inexpensive anesthetic with low blood and tissue solubility that allows rapid induction and emergence from anesthesia. The addition of N_2O reduces the amount of more potent volatile halogenated agents needed to achieve surgical anesthesia. These properties make N_2O particularly attractive for the morbidly obese surgical patient.

N_2O is 30 times more soluble than nitrogen (N_2), the major component of air. When a patient's lungs are ventilated with N_2O, it is absorbed into the blood and then leaves the blood and accumulates more rapidly in an air-containing space than the speed with which N_2 can be eliminated from that space into the blood. In a closed space, such as an obstructed bowel or pneumothorax, either the vol-

ume (if distensible) or the pressure (if non-distensible) of the space increases during exposure to N_2O.[1] The degree of the increase depends on the concentration of N_2O used, blood-flow to the organ, and the duration of N_2O exposure.

Several studies have claimed that N_2O distended bowel during laparotomy.[2,3] These reports have discouraged use of N_2O for abdominal surgery.[4] Other studies failed to demonstrate any deleterious effects.[5-7] In a study of normal weight patients undergoing laparoscopic cholecystectomy, surgeons correctly determined when N_2O was being used less than half of the time.[8] The authors of that study concluded that N_2O had no clinically significant side-effects during laparoscopy.[8] Our study confirmed these findings. We also found that there were no differences between air (N_2) and N_2O during laparoscopy.

In experiments on dogs, intestinal distention did not occur unless there was air in the bowel prior to N_2O exposure.[1] If air is present, intestinal gas volume can increase 100-200% after 4 hrs of N_2O exposure. The formula $D = 1/(1 - F_iN_2O)$ describes the maximum dilation (D) that can occur with any fraction of inspired (F_iN_2O) N_2O. With exposure to 50% N_2O, only a doubling of intestinal gas volume ($D = 1/(1 - 0.5) = 2$) is possible. In humans, the average intestinal gas content is approximately 100 ml, so doubling that volume should not be noticeable.[9] However, it is possible that if a large volume of air is initially present because of air-swallowing, then N_2O could have a distending effect on normal bowel.

Since N_2O diffusion into the bowel lumen is time-dependent, the duration of exposure in our study may not have been sufficiently long for significant distention to occur. During laparotomy, colon distention was only evident after 180 min and there were no notable effects during shorter procedures.[4] We recorded bowel conditions for the first 90 min, and average duration of surgery was 150 min. It is possible that longer operations with longer N_2O exposure could result in increased bowel volume.

N_2O has also been implicated as a cause of postoperative nausea and vomiting (PONV).[10] PONV and recovery of bowel function following open colon surgery was not be influenced by anesthetic technique, since there were no differences between intravenous anesthesia with propofol and general anesthesia with or without N_2O during laparotomy.[11] We found no difference in the incidence of nausea between our two study groups, but there were too few patients studied for us to make any conclusions as to whether N_2O exposure affected PONV.

In conclusion, concern about its potential to expand normal bowel during surgery has caused many anesthesiologists to avoid using N_2O. We found that N_2O is not associated with deleterious side-effects during laparoscopic bariatric operations of relatively short duration. The decision whether or not to administer N_2O should be up to the anesthesiologist.

References

1. Eger EI II, Saidman LJ. Hazards of nitrous oxide anesthesia in bowel obstruction and pneumothorax. Anesthesiology 1965; 26: 61-6.
2. Lewis GBH. Intestinal distension during nitrous oxide anaesthesia. Can Anaesth Soc J 1975; 22: 200-1.
3. Scheinin B, Lindgren SB, Scheinin TM. Preoperative nitrous oxide delays bowel function after colonic surgery. Br J Anaesth 1990; 64: 154-8.
4. Akca O, Lenhardt R, Fleischmann E et al. Nitrous oxide increases the incidence of bowel distention in patients undergoing elective colon resection. Acta Anaesthesiol Scand 2004; 48: 894-8.
5. Boulanger A, Hardy J-F. Intestinal distention during elective abdominal surgery: should nitrous oxide be banished? Can J Anaesth 1987; 34: 346-50.
6. Karlsten R, Kristensen JD. Nitrous oxide does not influence the surgeon's rating of operating conditions in lower abdominal surgery. Eur J Anaesthesiol 1993; 10: 215-7.
7. Krogh B, Jorn Jensen P, Henneberg SW et al. Nitrous oxide does not influence operating conditions or postoperative course in colonic surgery. Br J Anaesth 1994; 72: 55-7.
8. Taylor E, Feinstein R, White PF et al. Anesthesia for laparoscopic cholecystectomy. Is nitrous oxide contraindicated? Anesthesiology 1992; 76: 541-3.
9. Levitt MD. Volume and composition of human intestinal gas determined by means of an intestinal washout technique. N Engl J Med 1971; 284: 1324-8.
10. Divatia JV, Vaidya JS, Badwe RA et al. Omission of nitrous oxide during anesthesia reduces the incidence of postoperative nausea and vomiting. A meta-analysis. Anesthesiology 1996; 85: 1055-62.
11. Jensen AG, Kalman SH, Nystrom PO et al. Anaesthetic technique does not influence postoperative bowel function: a comparison of propofol, nitrous oxide and isoflurane. Can J Anesth 1992; 39: 938-43.

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