The frequency of respiratory failure in patients with morbid obesity undergoing gastric bypass

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Morbid obesity is associated with multiple metabolic and mechanical abnormalities that increase morbidity and mortality after major abdominal surgery. It is unclear whether patients undergoing bariatric surgery have increased pulmonary complications postoperatively. We performed a retrospective chart review of 207 patients who underwent elective gastric bypass surgery during a recent 2-year period. Body mass index (BMI = kg/m^2) of more than 35 was used to define morbid obesity. The purpose of this study was to determine the frequency of respiratory failure, defined as intubation for 24 hours or more and/or reintubation, in these patients. We also evaluated differences in the frequency of respiratory failure between patients with a BMI of 43 or less and those with a BMI of more than 43. Patients with morbid obesity undergoing elective weight loss surgery had few respiratory or other perioperative complications with our experienced team. The rates of respiratory failure and total postoperative complications were 8% in the group with a BMI of 43 or less and 14% in the group with a BMI of more than 43. Skillful anesthetic care allows patients with significant comorbid conditions to benefit from bariatric surgery with reasonable risk in terms of postoperative complications.

Key words: Gastric bypass, obesity, respiratory failure.

The etiology of obesity is multifactorial, including genetic, metabolic, psychologic, and socioeconomic factors.[1,2] Several studies suggest that an astonishing 25% to 45% of the adult population in the United States is obese.[3-6] Body mass index (BMI), defined as weight in kilograms divided by height in meters squared (kg/m^2), is a body measure that identifies patients known to be at increased risk of direct weight-related morbidity and premature death.[4,6,7] Morbid obesity is defined as a BMI of more than 35.[2,6]

Patients with morbid obesity undergoing bariatric surgery (operations designed to induce weight loss) present many unique challenges to the anesthesia team. Oberg and Poulsen[4] classified patients with BMI between 30 and 35 to be at moderate risk, 35 to 45 at high risk, and more than 45 at very high risk of anesthetic-related morbidity; a BMI of more than 35 had a risk of postoperative atelectasis as high as 45% and a subsequent higher risk of pneumonia and other postoperative pulmonary complications. The poor physiologic condition of these markedly obese patients and associated comorbid conditions led to a propensity for adverse postoperative outcomes.[8] Respiratory complications occurring after major abdominal surgery are believed to be increased by extreme obesity and are of concern to patients, surgeons, and anesthesia providers.[9] The serious medical conditions related to severe obesity and the technical demands of bariatric procedures lead one to expect that the risk of complications would be increased.

The purpose of this study was to determine the frequency of respiratory complications and, more specifically, respiratory failure in patients undergoing Roux-en-Y gastric bypass for morbid obesity in a tertiary referral center with a dedicated multidisciplinary anesthetic team with experience in elective bariatric surgery. Our hypothesis was that current advances in anesthetic care, our better understanding of pulmonary pathophysiology, and a dedicated, experienced, multidisciplinary surgical and anesthesia team have led to a lower incidence of postoperative respiratory complications in this high-risk patient population than have been reported in the literature. Because of these predicted improvements, bariatric surgery should remain a viable option for morbidly obese patients.

Materials and methods

The institutional review board (Mayo Clinic, Rochester, Minn) approved this investigation. The surgical database at the Mayo Clinic contains information for all patients undergoing gastric bypass. The sample consisted of all consecutive adult patients who underwent gastric bypass surgery at the Mayo Clinic between January 1, 1997, and December 31, 1999. Chart reviews were performed only on those who had provided consent for use of their medical records

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Table 1. Patient demographics*

	Group 1 BMI ≤ 43 (n = 42)	Group 2 BMI > 43 (n = 155)
Median age (range), y	49 (38-59)	45 (37-53)
Sex		
Male	7 (17%)	57 (36.8%)
Female	35 (83%)	98 (63.2%)
Median (range) BMI (kg/m^2)	39 (35-42)	52 (48-60)

* Data are given as number (percentage) unless otherwise indicated. BMI (kg/m^2) indicates body mass index.

under current institutional review board guidelines. Patients having this procedure performed as a reoperation were excluded from the study.

The preoperative medical, surgical, nursing, and anesthesia records for each surgical episode were reviewed. In addition to postoperative pulmonary complications, preoperative and demographic data were abstracted. Intraoperative data including ASA physical status (I-V), type and duration of anesthesia, and the need for various types of postoperative respiratory therapy also were recorded. The medical records were evaluated from date of admission until discharge. Respiratory outcomes of most interest were defined as follows: pulmonary emboli confirmed by positive radionuclide ventilation-perfusion scintigraphy or pulmonary angiography; atelectasis and/or aspiration confirmed by chest radiograph; need for reintubation; and need for prolonged intubation of more than 24 hours.[10] Events requiring stay in the intensive care unit, readmission to the intensive care unit, myocardial infarction, sepsis, and death also were obtained.

The sample consisted of 197 patients who were divided into 2 groups: 1, BMI of 43 or less; and 2, BMI of more than 43. We chose a BMI cutoff of 43 for the subgroups, because others have previously reported that patients with a BMI greater than 43 are at greatest risk for morbidity.[4]

Descriptive statistics were used to analyze the frequency of perioperative respiratory events. The mean and SD or median and range were calculated for each BMI subgroup as appropriate for the distribution of the data. To compare parameters within the 2 BMI categories, the Fisher exact test and the nonparametric Wilcoxon test were used whenever appropriate.

Results

Table 1 summarizes patient demographics and shows the median ages to be 49 and 45 years for groups 1 and 2, respectively. The percentage of women in this database was much greater than that of men in both subgroups ($P < .05$). The median BMI for the groups 1 and 2 was 39 and 52, respectively.

Obstructive sleep apnea was documented preoperatively in 11 (26%) of 42 group 1 patients, whereas 67.8% of those in group 2 (n = 155) had sleep apnea ($P < .05$). The frequency of use of continuous positive airway pressure (CPAP) also was higher ($P < .05$) in group 2. The percentage of comorbid conditions such as diabetes mellitus (increased fasting blood glucose level) and chronic obstructive pulmonary disease were similar in the 2 groups, but the percentage of previous myocardial infarction or other cardiac disease was greater ($P < .05$) in group 2 (Table 2).

The anesthetic data are described in Table 3. The majority of patients met the criteria for ASA physical status III; only 3% of the patients were classified as ASA physical status IV. The majority of patients received a combined anesthetic technique (general anesthesia plus epidural) for their anesthetic, including 37 (88%) in group 1 and 85.8% in group 2. A technically easy intubation was experienced most frequently (38/39 [97%] and 127/132 [96.2%], respectively) with rapid-sequence induction performed 69% (29/42) and 50.3% of the time in groups 1 and 2, respectively. The use of fiberoptic intubation was less in group 1 (3/42 [7%]) than in group 2 (13.5%). There was no difference in groups 1 and 2 in the maintenance of endotracheal intubation at the end of the operation (1/42 [2%] vs 3.2%, respectively). Similarly, there was no difference in the groups in the time spent in the recovery room.

Postoperative data are reviewed in Table 4. Although only 1 patient (2%) in group 1 remained intubated for more than 24 hours postoperatively, 8 patients (5.2%) in group 2 required prolonged intubation. The median durations of intubation of group 1 and 2 patients who were not extubated in the operating room immediately postoperatively or who required reintubation were 23 hours and 41 hours,

respectively; these differences did not reach statistical difference (P = .81). The respiratory intervention in which the groups showed a significant difference was in the use of CPAP postoperatively. Patients in group 1 were treated with additional respiratory support with CPAP only 10% of the time (4/42), whereas patients in group 2 were treated with CPAP 39.4% of the time (P = .0002). Of the 61 patients in group 2 who used CPAP postoperatively, 49 had used CPAP preoperatively as well.

Adverse pulmonary outcomes are reviewed in Table 5. While the total complication rate seemed greater in group 2 (10% [4/42] vs 12.3% [19/155]), the differences for the individual respiratory complications, including postoperative pulmonary emboli, aspiration, atelectasis, prolonged intubation, and reintubation, were minimal, and no statistical differences were found in either individual or overall pulmonary complications. None of the patients in either group experienced a perioperative myocardial infarction or sepsis.

Table 2. Preoperative comorbidity*

	Group 1 BMI ≤ 43 (n = 42)	Group 2 BMI > 43 (n = 155)
Diabetes mellitus	15 (36)	73 (47.1)
Chronic obstructive pulmonary disease	0 (0)	4 (2.6)
Sleep apnea	11 (26)	105 (67.7)
CPAP use	5 (12)	77 (49.7)
Tobacco use		
Past	9 (21)	39 (25.2)
Current	6 (14)	18 (11.6)
Hypertension	19 (45)	90 (58.1)
Coronary artery disease	7 (17)	9 (5.8)
Previous myocardial infarction	2 (5)	8 (5.2)
Other cardiac disease	4 (10)	11 (7.1)

* Data are given as number (percentage) unless otherwise indicated. BMI (kg/m^2) indicates body mass index; CPAP, continuous positive airway pressure.

Table 3. Anesthetic data*

	Group 1 BMI ≤ 43 (n = 42)	Group 2 BMI > 43 (n = 155)
ASA physical status		
II	11 (26)	14 (9.0)
III	31 (74)	137 (88.4)
IV	0 (0)	4 (2.6)
Type of anesthesia		
General	5 (12)	22 (14.2)
Combined (general and regional)	37 (88)	133 (85.8)
Intubation rating		
Easy	38 (97)	127 (96.2)
Difficult	1 (3)	5 (3.8)
Rapid-sequence induction (yes)	29 (69)	78 (50.3)
Fiberoptic intubation (yes)	3 (7)	21 (13.5)
Left intubated at end of operation (no)	1 (2)	5 (3.2)
Median (range) length of stay in recovery room (min)	67 (60-90)	68 (51-90)
Use of CPAP in recovery room (yes)	1 (2)	18 (11.6)

* Data are given as number (percentage) unless otherwise indicated. BMI (kg/m^2) indicates body mass index; CPAP, continuous positive airway pressure.

Table 4. Postoperative respiratory considerations*

	Group 1 BMI ≤ 43 (n = 42)	Group 2 BMI > 43 (n = 155)	*P* value
Prolonged postoperative intubation (>24 hours)	1 (2)	8 (5.2)	NS
Median (range) duration of postoperative intubation† (hours)	23 (16-151)	41 (34-48)	NS
Admission to ICU	5 (12)	23 (14.8)	NS
Median (range) ICU duration (hours)	36 (21-80)	40 (18-57)	NS
Respiratory cause for intubation or prolonged intubation	2 (5)	12 (7.7)	NS
Postoperative CPAP	4 (10)	61 (39.4)	.0002
CPAP used preoperatively and postoperatively	2 (5)	49 (31.6)	.0002

* Data are given as number (percentage) unless otherwise indicated. ICU indicates intensive care unit; CPAP, continuous positive airway pressure; BMI (kg/m^2), body mass index; NS, not significant. *P* > .6.
† If not extubated immediately postoperatively or if there was a need for reintubation.

Table 5. Adverse pulmonary outcomes*

	Group 1 BMI ≤ 43 (n = 42)	Group 2 BMI > 43 (n = 155)	*P* value
Postoperative pulmonary embolus	0 (0)	2 (1.3)	NS
Aspiration	0 (0)	1 (0.6)	NS
Atelectasis	1 (2)	2 (1.3)	NS
Reintubation	2 (5)	3 (1.9)	NS
Other complications	1 (2)	11 (7.1)	NS
Total complications	4 (10)	19 (12.3)	NS

* Data are given as number (percentage) unless otherwise indicated. BMI (kg/m^2) indicates body mass index; NS, not significant. For all values, *P* > .29.

Discussion

Bariatric surgery is a specialized area of general surgery dedicated to the treatment of severe obesity via anatomic modifications in the gastrointestinal tract designed to produce gastric restriction, malabsorption of nutrients, or both.[1] The Roux-en-Y gastric bypass procedure has proven effective in obtaining a durable weight loss for up to 10 years. Weight loss produces an overall improvement in quality of life and longevity. Another Mayo Clinic study showed that almost three fourths of bariatric patients maintained a prolonged weight loss of at least 50% of their excess body weight, and most had disappearance of insulin-requiring diabetes and a decrease in medication-dependent hypertension.[11] With these beneficial long-term outcomes, Roux-en-Y gastric bypass is an increasingly viable option for patients struggling with morbid obesity. Indeed a National Institutes of Health consensus conference in 1991 recognized and condoned bariatric surgery as an effective, acceptable treatment for patients with morbid obesity.[12]

The results of the 1992 National Bariatric Surgery Registry study for obesity identified respiratory complications as the most frequent postoperative complication occurring in about 5% of patients.[9] Many studies have shown an increase in postoperative pulmonary complications in obese patients. Garibaldi et al[13] reviewed 520 patients undergoing intra-abdominal operations and found that patients who weighed more than 250 pounds were at an almost 40% greater risk for developing pneumonia. In another study, Hood and Dewan[14] followed up 117 obese women during childbirth and found longer hospital stays and increased medical costs due to respiratory complications. Brooks-Brunn[15] also reported that patients with a BMI of 27 or more were at increased risk for pulmonary complications, with significant pulmonary complications occurring in 29% of 181 obese patients.

Based on the data obtained in our study, the risk of respiratory problems after bariatric surgery in this patient population is not as high as might be anticipated from review of the literature. We concluded that patients with morbid obesity planning to undergo elective Roux-en-Y gastric bypass surgery can be reassured that their risk of significant perioperative respiratory complications is relatively low (12.3%).

The respiratory system is of major concern to anesthesia personnel. Respiratory disorders, both mechanical and disease-related, can make patient management difficult. Obesity creates a substantial increase in the work of breathing attributable to the increase in elastic work and the decrease in efficiency of the respiratory muscles.[3,4,6] Because of the increased work, metabolic demands are greater, producing more carbon dioxide (increasing ventilation requirements), and requiring greater amounts of oxygen to meet the body needs.[1,4,6,7,16] In addition, functional residual capacity is decreased compared with that in nonobese counterparts. When the patient with morbid obesity is placed in the supine position, the decrease in functional residual capacity becomes profound.[1,4,17-19] Once anesthetized, functional residual capacity decreases even further, to more than 50% below normal in obese patients.[4,6,7,17] This decrease leads to small airway closure and subsequent abnormalities in ventilation and perfusion. In addition, fat accumulation around the ribs, under the diaphragm, and intraabdominally adds to this respiratory inefficiency by reducing chest wall compliance.[4,7,20] All of these perioperative respiratory factors should be taken into consideration when planning the best anesthetic for individual patients.

Postoperative respiratory care is complicated further by the observation that up to 30% of patients with morbid obesity will have obesity hypoventilation syndrome manifesting as episodic somnolence, sleep apnea, and loss of hypoxic drive.[7] Extreme manifestations of obesity hypoventilation syndrome include polycythemia, alveolar hypoventilation with hypoxemia, hypoventilation, pulmonary hypertension, and biventricular heart failure.[6,7,16,19,20] These patients seem to be at an even higher risk for postoperative respiratory complications.

Preoperative assessment of patients with morbid obesity permits modification of the anesthetic plan to meet individual patient needs regarding significant comorbidity and the risk for potential anesthetic difficulties. Benefits of additional research might include insight as to the frequency of respiratory failure in patients with greater BMIs and determination of a risk factor profile. Results of such studies also might be helpful in allowing more comprehensive preoperative discussion with patients concerning the risks of complications.

Many approaches to anesthesia have been applied to this patient population. The majority of the patients in this review received a combined technique of regional and general anesthesia with excellent outcomes. The use of preemptive and postoperative epidural analgesia maximizes respiratory function by better controlling postoperative pain. This level of pain control allows rapid patient mobilization and ambulation. Because of the previously identified comorbid conditions, patients undergoing bariatric surgery require meticulous assessment and specific anesthetic preparation to achieve optimal conditions for a successful anesthetic.

The knowledge, skill, and foresight of the anesthesia providers are key in predicting and preventing potentially serious complications. Specific equipment may be necessary for transporting the patient with morbid obesity and an operating room bed equipped to handle excessive weight is needed.[21] An air mattress transfer device (HoverMatt Transfer Solution, Allentown, Pa) may help keep the patient and operating room staff safe from injury when physically transferring a markedly obese immobile patient from bed to table or table to stretcher; these devices use an air pump to inflate a deflated air mattress placed under the patient preoperatively; then staff can easily slide the patient from the operating room table to the stretcher.

Preparations for a difficult airway, including the ability for fiberoptic intubation, laryngeal mask airway, and intubating stylet should be routine in the setup. Additional experienced assistance is important during induction of and emergence from anesthesia. If decreased neck mobility and difficult airway visualization are evident, an awake, fiberoptic-assisted intubation is the safest technique. Taking the time to properly position the patient for maximal visualization of the larynx increases success of intubation. Likewise, placing the patient in the sitting position and taping redundant tissue away from the midline may help identify intervertebral spaces for epidural placement. Longer epidural needles to reach the epidural space should be available.

Standard pneumatic blood pressure cuffs are not always accurate in patients with large arms, and an arterial line for monitoring often is necessary. Special attention must be given to padding and positioning of upper extremities to prevent nerve damage, and often, arms need to be left untucked to maintain proper support. Sampling and trending arterial blood gases will provide guidance about ventilatory needs.

At the end of the operation, transferring the patient to the cart and placing the patient in the semirecumbent position before extubation may facilitate larger tidal volumes. Extubation should not be performed until the patient is awake and responsive and can demonstrate intact laryngeal reflexes. Arranging for the use of CPAP in the recovery area may maximize respiratory function early on, and it may facilitate good pain control and early mobilization.

Multidisciplinary teams, ranging from the surgical and anesthesia teams to nursing, nutrition, and biomechanics, are necessary for the care of the patient with morbid obesity. Communication and cooperation among all patient care teams are essential to maintain patient safety and ensure a successful surgical experience.

Although our study shows a very low rate of serious respiratory complications in this high-risk population (12.3%), we acknowledge the limitations of our study are its retrospective design and the lack of a similar control group (a nonobese group or a group with morbid obesity undergoing nonbariatric surgery). Without such control groups, we are unable to draw absolute conclusions regarding this patient population; however, the excellent outcomes documented are reassuring.

We found that patients with morbid obesity have fewer complications than would be expected after undergoing Roux-en-Y gastric bypass surgery based on previous rates reported in the literature about surgery in the obese patient. We conclude that current anesthesia care of these patients by a team that understands potential complications will provide for a safe perioperative course.

REFERENCES

1. Oria HE, Brolin RE. Performance standards in bariatric surgery. *Eur J Gastroenterol Hepatol.* 1999;11:77-84.
2. Cowen GS, Hiler ML, Buffington C. Criteria for selection of patients for bariatric surgery. *Eur J Gastroenterol Hepatol.* 1999;11: 69-74.
3. Reisen E, Frolich ED. Obesity: cardiovascular and respiratory pathophysiology alterations. *Arch Intern Med.* 1981;141:431-434.
4. Oberg B, Poulsen TD. Obesity: an anesthetic challenge. *Acta Anaesthesiol Scand.* 1996;40:191-200.
5. Bistrian BR. The medical treatment of obesity. *Arch Intern Med.* 1981;141:429-430.
6. Buckley FP. Anesthesia for the morbidly obese patient. *Can J Anaesth.* 1994;41:R94-R100.
7. Hunter JD, Reid C, Noble D. Anesthetic management of the morbidly obese patient. *Hosp Med.* 1998;59:481-483.
8. Pasulka PS, Bistrian BR, Benotti PN, Blackburn GL. The risks of surgery in obese patients. *Ann Intern Med.* 1986;104:540-546.
9. Mason EE, Renquist KE, Jiang D. Perioperative risks and safety of surgery for severe obesity. *Am J Clin Nutr.* 1992;55(2 suppl):573S-576S.
10. Warner DO, Warner MA, Offord KP, Schroeder DR, Maxson P, Scanlon PD. Airway obstruction and perioperative complications in smokers undergoing abdominal surgery. *Anesthesiology.* 1999;90:372-378.
11. Balsiger BM, Kennedy FP, Abu-Lebdeh HS, et al. Prospective evaluation of Roux-en-Y gastric bypass primary operation for medically complicated obesity. *Mayo Clin Proc.* 2000;75:673-680.
12. Consensus Development Conference Panel. NIH conference. Gastrointestinal surgery for severe obesity. *Ann Intern Med.* 1991;115: 956-961.
13. Garibaldi RA, Britt MR, Coleman ML, et al. Risk factors for postoperative pneumonia. *Am J Med.* 1981;70:677-680.
14. Hood DD, Dewan DM. Anesthetic and obstetric outcomes in morbidly obese parturients. *Anesthesiology.* 1993;79:1210-1218.
15. Brooks-Brunn J. Predictors of postoperative pulmonary complications following abdominal surgery. *Chest.*1997;111:564-571.
16. Pi-Sunyer XF. Medical hazards of obesity. *Ann Intern Med.* 1993; 119:655-660.
17. Damia G, Mascheroni D, Corci M. Perioperative changes in functional residual capacity in morbidly obese patients. *Br J Anaesth.* 1998;60:574-578.
18. Paul DR, Hoyt JL, Boutros AR. Cardiovascular and respiratory changes in response to change of posture in the very obese. *Anesthesiology*. 1976;45:73-77.
19. Nakatsuka M. Pulmonary vascular resistance and right ventricular function in morbid obesity in relation to gastric bypass surgery. *J Clin Anesth.* 1996;8:205-209.
20. Stoll DA, Stein LE. Anesthetic management of the morbidly obese patient. *AANA J.* 1984;52:436-444.
21. Sarr MG, Felty CL, Hilmer DM, et al. Technical and practical considerations involved in operations on patients weighing more than 270 kg. *Arch Surg.* 1995;130:102-105.

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