Safety and Efficacy of Postoperative Continuous Positive Airway Pressure to Prevent Pulmonary Complications After Roux-en-Y Gastric Bypass

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Continuous positive airway pressure (CPAP) is used to prevent apneic arrest and/or hypoxia in patients suffering from obstructive sleep apnea. This modality has not been universally accepted for patients following upper gastrointestinal surgery because of concerns that pressurized air will inflate the stomach and proximal intestine, resulting in anastomotic disruption. This study was performed to assess the safety and efficacy of postoperative CPAP for patients undergoing a gastrojejunostomy as part of a Roux-en-Y gastric bypass (RYGB) procedure. A total of 1067 patients (837 women [78%] and 230 men [22%]) were prospectively evaluated for the risk of developing anastomotic leaks and pulmonary complications after the RYGB procedure. Of the 1067 patients undergoing gastric bypass, 420 had obstructive sleep apnea and 159 were dependent on CPAP. There were 15 major anastomotic leaks, two of which occurred in CPAP-treated patients. Contingency table analysis demonstrated that there was no correlation between CPAP utilization and the incidence of major anastomotic leakage ($P = 0.6$). Notably, no episodes of pneumonia were diagnosed in either group. Despite the theoretical risk of anastomotic injury from pressurized air delivered by CPAP, no anastomotic leaks occurred that were attributable to CPAP. There were no pulmonary complications in a patient population that is at risk for developing them postoperatively. CPAP is a useful modality for treating hypoventilation after RYGB without increasing the risk of developing postoperative anastomotic leaks. (J GASTROINTEST SURG 2002;6:354–358.)

KEY WORDS: Obstructive sleep apnea, anastomosis, pneumonia, anastomotic dehiscence

The incidence of obesity is increasing in epidemic proportions in the United States. Overweight patients are at increased risk for the development of comorbid conditions such as diabetes, hypertension osteoarthritis, hypercholesterolemia, and obstructive sleep apnea (OSA). Four out of five obese persons have at least one debilitating illness associated with this disease,[1] resulting in an increased risk of death, twofold greater in women and 12-fold greater in men.[2] Because of their medical comorbid conditions, obese patients pose a higher operative risk than nonobese individuals. OSA, defined as transient respiratory cessations during sleep, occurs frequently in obese patients. Obese patients have a 12- to 30-fold increased risk for the development of OSA relative to the general population.[3] Typically associated with upper body obesity,[4] OSA is found in 50% of obese men and 40% of obese women.[5] Frequent apneic events associated with hypoxemia severely compromise the cardiorespiratory system.[6,7]

The presence of OSA poses an increased risk for respiratory complications in obese patients undergoing laparotomy. Abdominal surgery, especially upper abdominal surgery, adversely affects pulmonary function.[8] The combination of preexisting OSA and laparotomy significantly increases morbidity and mortality from respiratory complications in obese patients.[9]

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Continuous positive airway pressure (CPAP) effectively treats sleep apnea.[10] Continuous positive pressure is applied to the upper airway with a nasal mask, nasal prongs, or a mask that covers both the nose and the mouth.[11] CPAP improves respiratory function in morbidly obese patients[12] and accelerates reestablishment of preoperative pulmonary function[13] after upper abdominal surgery. However, the use of CPAP has not been accepted after upper intestinal surgery involving bowel anastomosis. Concerns that pressurized air will inflate the stomach and intestine resulting in anastomotic disruption have precluded the application of CPAP for treatment of postoperative apnea.

Roux-en-Y gastric bypass (RYGB) is commonly performed for the treatment of clinically severe obesity.[14–16] RYGB consists of two anastomoses: a proximal gastrojejunostomy and a distal jejunojejunostomy (Fig. 1). Both anastomoses are at risk for disruption from intraluminal distention that might result from CPAP utilization. However, CPAP decreases pulmonary complications by preventing alveolar collapse in the postoperative period after RYGB. This study was undertaken to assess the safety and efficacy of postoperative CPAP for patients having a gastrojejunostomy performed as part of a gastric bypass procedure. We specifically examined the incidence of anastomotic disruption and respiratory complications in a population of obese patients undergoing RYGB.

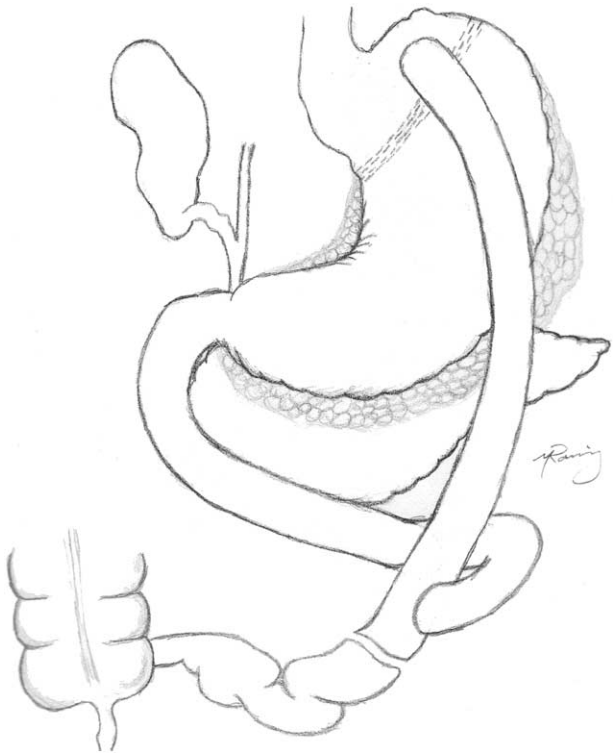

Fig. 1. The Roux-en-Y gastric bypass consists of two anastomoses. A proximal gastrojejunostomy connects the gastric pouch to the jejunal limb. The Y is created by a jejunojejunostomy approximately 50 cm distal to the gastrojejunostomy.

METHODS

Patients

All patients undergoing gastric bypass surgery at the UCLA Medical Center between December 1993 and June 2000 were included in the study. Clinical information regarding sleep apnea and the need for CPAP was entered into a database. A total of 1067 patients (837 women [78%] and 230 men [22%]) were prospectively evaluated for the risk of developing anastomotic leakage with and without CPAP. The hospital quality assurance coordinator monitored outcomes for all patients.

Surgery

All RYGB operations were performed by one of four bariatric surgeons using a standardized technique. Briefly, the proximal 30 ml gastric pouch was created by firing an Ethicon TLH-60 heavy wire stapler (Ethicon, Somerville, New Jersey) horizontally across the stomach. The jejunum was divided 30 cm distal to the ligament of Treitz and the first arcade of mesenteric vessels divided with a vascular GIA stapler (Ethicon). The distal cut end of the jejunum was then tunneled through the transverse mesocolon to lie anterior to the stomach. All anastomoses were hand sewn. The gastrojejunostomy was created by sewing the limb to the pouch side to side with a single layer of 3-0 Maxon sutures (Ethicon) over a 32 F bougie catheter, creating a 1 cm anastomosis. The small bowel anastomosis was performed side to side in two layers using an inner layer of running 3-0 Maxon sutures and an outer layer of interrupted 3-0 silk sutures. This jejunojenuostomy was created 40 to 50 cm distal to gastrojejunostomy. No attempt was made to test the anastomosis by injection of air or dye. The abdomen was closed with either interrupted No.1 Maxon sutures or a running 0 looped Maxon suture. The skin was closed with a running, continuous 4-0 Monocryl suture or skin staples (Ethicon). Postoperative nasogastric decompression was not routinely used.

Outcomes

All gastric bypass operations at the UCLA Medical Center were considered index procedures during the study period. A hospital-based quality assurance coordinator collected outcomes data independent of

the surgical team. Data concerning length of hospital stay and complications were entered into a database. All complications such as the development of pneumonia or leaks were reviewed. In addition to the independent review by the quality assurance coordinator, the attending physicians and/or house staff reported complications to the quality assurance manager to ensure that all complications were captured.

Statistical Analysis

Effects of CPAP and anastomotic leakage were analyzed by contingency table analysis. Statistical significance relating risk factors with continuous variables to the outcomes was determined by *t* test or analysis of variance where appropriate. Risk factors with dichotomous variables were tested by chi-square analysis. All data are presented as means ± standard error of the mean. All values were considered statistically significant at $P \leq 0.05$.

RESULTS

Patient Demographics

During the study period, 1067 patients underwent RYGB operations. Table 1 summarizes the patient demographic information. Seventy-eight percent of the patients were women. The male patients were taller and larger than the female patients. Comorbid conditions were more frequent in the men ($P \leq 0.05$). Of the 1067 patients undergoing gastric bypass, 420 had obstructive sleep apnea. Use of CPAP was significantly more frequent in men compared to women ($P \leq 0.05$). Of the 429 patients with sleep apnea, 159 had sleep studies documenting the need for and efficacy of CPAP for the avoidance of nocturnal apneic events. Before surgery, this patient cohort was receiving home CPAP. All of these patients received postoperative CPAP using their preoperative CPAP settings (range 10 to 12 cm H_2O at a rate of 12 to 16 cycles/min).

Table 1. Patient demographics

	Total population	Female	Male
Number	1067	837	230
Age (yr)	42.3 ± 0.3	42.2 ± 0.3	42.4 ± 0.7
Weight (pounds)	334 ± 2	313 ± 2	408 ± 6*
Height (inches)	66.1 ± 0.1	64.9 ± 0.1	70.6 ± 0.2*
Body mass index (Kg/m^2)	53.6 ± 0.3	52.4 ± 0.3	57.9 ± 0.8†
Smoking history	171 (16%)	130 (16%)	41 (18%)
Sleep apnea	420 (39%)	287 (34%)	133 (58%)†
CPAP dependency	159 (15%)	102 (12%)	57 (25%)†

Data are presented as mean ± standard error of the mean. Percentages in parentheses are relative to the number of patients referred to in a column. In our population there were 22% males and 78% females.

*$P < 0.05$ females vs. males, *t* test.

†$P < 0.05$ females vs. males, chi-square analysis.

Anastomotic Leakage

There were a total of 15 major anastomotic leaks (Table 2). The body mass index of patients with leaks is comparable to that in patients without anastomotic disruption: (52 ± 1.7 vs. 53.6 ± 0.3; $P = 0.24$, respectively). On average, the patients who developed leaks were slightly older than the general bariatric population (46 ± 2.1 years vs. 42.3 ± 0.3 years; $P \leq 0.001$, respectively).

All anastomotic leaks were confirmed radiographically by Gastrografin upper gastrointestinal series or by CT studies (Table 3). Only two of the leaks occurred in patients while they were receiving CPAP. The management strategy for treating anastomotic disruption is presented in Table 3. Contingency table analysis revealed that CPAP was not causally related to the development of postoperative anastomotic disruption after RYGB ($P = 0.65$; Table 4).

Respiratory Complications

There were no respiratory complications such as pneumonia or episodes of apnea in any patients after RYGB in our series.

DISCUSSION

The incidence of obesity is increasing in the United States, resulting in the performance of a greater number of bariatric operations. RYGB has become the "gold standard" operation for the treatment of clinically severe obesity.[15,16] Obese patients are at risk for postoperative complications after RYGB because of their greater preoperative disease burden. Despite the high surgical risk, the overall complication rate remains low. However, complications do occur and analysis of predictive risk factors is important to minimize the rate of complications.

Because of the high incidence of OSA in obese patients, these patients have a uniquely high risk for developing postoperative apnea, hypoxia, and pneumonia. This condition is effectively treated by CPAP. However, because of the concern that positive airway pressure places gastrointestinal anastomoses at risk for disruption, CPAP has not been routinely used in postoperative patients. The current study, which pro-

Table 2. Characteristics of patients who had leaks postoperatively vs. the total population

	Patients with leaks (N = 15)	Total population (N = 1067)
Age (yr)	46 ± 2.1	42.3 ± 0.3
Body mass index	52 ± 1.7	53.0 ± 0.3
Females	8 (53%)	837 (78%)
Males	7 (47%)	230 (22%)

spectively evaluated a consecutive series of 1067 gastric bypass operations, has demonstrated the safety and efficacy of CPAP utilization after RYGB.

The incidence of OSA among morbidly obese patients is very high.[4] In our series, 39% of patients presented with OSA, of whom 38% were CPAP dependent and were using this modality at home for the management of their OSA. Obstructive sleep apnea is a common risk factor for the development of respiratory complications following RYGB.[15–17] Aside from OSA, obese patients have compromised respiratory function characterized by decreased functional residual capacity, expiratory reserve volume, PaO_2, and an increase in the alveolar-arterial oxygen difference.[18] Taken together, these factors result in an increased risk for postoperative pulmonary complications such as sputum retention, atelectasis, and bronchopulmonary infections,[8] which cause significant postoperative morbidity and mortality after elective surgery. Gastric bypass series similar to the one presented here report rates of atelectasis and pneumonia ranging from 0.5% to 4%.[15–17]

Continuous airway pressure is currently the most effective medical treatment for OSA.[4] CPAP restores functional residual capacity to preoperative values[19,20] and improves oxygenation[21] after surgery. The prophylactic use of airway pressure systems during the first 24 hours postoperatively significantly reduces the pulmonary restrictive syndrome that occurs after gastroplasty in morbidly obese patients.[13] It also reduces the risk of acute respiratory distress syndrome after upper abdominal surgery.[22] The mechanical effect of CPAP is achieved by raising the intraluminal upper airway pressure. Thus the postoperative use of CPAP carries the theoretical risk of increasing the incidence of anastomotic leaks resulting from the increase in pressurized air into the stomach and proximal anastomosis. Fear of anastomotic disruption resulting from injection of air into the bowel has limited the use of CPAP in postoperative patients.

Although the percentage of anastomotic leaks in our series (1.4%) is slightly higher than that in other reports (0.5% to 1%),[15–17] our analysis demonstrates that the increase is not attributable to the use of CPAP. We routinely use CPAP for patients with sleep apnea. We also use it for patients with postoperative respiratory insufficiency. Despite concerns that positive pressure ventilation will result in anastomotic disruption, we did not identify a relationship between the use of CPAP and anastomotic disruption. Our findings and conclusions are limited to the population we studied: obese patients undergoing RYGB. Malnourished patients or those who are undergoing surgery for a malignancy may not have the same outcome because of compromised wound healing, which is not characteristic of RYGB patients.

We conclude that CPAP is a useful modality for treating patients at risk for apnea after RYGB. There were no pulmonary complications in a high-risk patient population and no anatomic leaks were attributable to the use of CPAP. We recommend the routine use of postoperative CPAP for RYGB patients with CPAP-dependent OSA.

Table 3. Diagnostic studies performed and management of patients with anastomotic disruption*

Patient	Diagnostic study	Management
1	Gastrografin swallow	Nonsurgical
2	Gastrografin swallow	Surgical
3	Gastrografin swallow	Surgical
4	Gastrografin swallow	Nonsurgical
5	Gastrografin swallow	Surgical
6	Gastrografin swallow	Surgical
7	Gastrografin swallow	Surgical
8	CT-scan	Nonsurgical
9	CT-scan	Nonsurgical
10	CT-scan	Surgical
11	CT-scan	Surgical
12	CT-scan	Surgical
13	CT-scan	Surgical
14	CT-scan	Surgical
15	CT-scan	Surgical

In 47% of the patients, the diagnosis was made by Gastrografin upper gastrointestinal series. Sixty-seven percent of the patients required surgical intervention for the management of the leaks.

Table 4. Contingency table analysis for CPAP and leakage

	(−) CPAP	(+) CPAP	Total/Leak
(−) Leak	895	157	1052
(+) Leak	13	2	15
Total/CPAP	908	159	

N = 1067; $P = 0.648$.

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