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30-Day Readmission Rates at a High Volume Bariatric Surgery Center: Laparoscopic Adjustable Gastric Banding, Laparoscopic Gastric Bypass, and Vertical Banded Gastroplasty-Roux-en-Y Gastric Bypass

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Background: Recent studies suggest that weight loss operations may actually increase the costs to society due to increased hospital readmission rates. The purpose of this study was to determine the 30-day readmission rates following bariatric operations at a high volume bariatric surgery program.

Methods: Records for all patients undergoing bariatric operations during a 3-year period were harvested from the hospital electronic medical database. All hospital readmissions within 30 days of surgery were reviewed to determine the cause, demographics, and patient characteristics. Logistic regression analysis assessed the impact of various factors on the risk of readmission.

Results: 2,823 consecutive patients were identified using the corrected operative log. Of these patients, 165 (5.8%) patients required 184 (6.5%) readmissions within 30 days of their index bariatric operation. Laparoscopic adjustable gastric banding (LAGB) had the lowest patient readmission rate of 3.1%; vertical banded gastroplasty-Roux-en-Y gastric bypass (VBG-RYGBP) 6.8% and Laparoscopic Roux-en-Y gastric bypass (LRYGBP) 7.3%. Technical considerations were the most common cause for readmission (41% of readmissions). White race and undergoing LAGB decreased the odds for readmission, while total operating-room time >120 minutes, initial hospital stay of >3 days and deep venous thrombosis increased the odds for readmission.

Conclusion: This study found an overall 30-day readmission rate of 6.5% following bariatric operations at a high volume bariatric surgery program. This study supports the concept of bariatric surgery Centers of Excellence and accreditation of Bariatric Surgery Programs based on hospital volume of bariatric operations.

Key words: Morbid obesity, laparoscopic adjustable gastric banding, laparoscopic Roux-en-Y gastric bypass, vertical banded gastroplasty, gastric bypass, surgical outcomes, hospital readmissions

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Introduction

The number of bariatric operations in the United States is rapidly increasing.[1] Recent articles, for example, have raised questions about the mortality rates for these procedures based on large, population-based, administrative databases.[2-4] The magnitude of operative mortality significantly impacts calculations on changes in life expectancy following weight loss surgery.[2,5] One cost-benefit model indicates that bariatric surgery becomes profitable for payers only at 5 years after the operations.[6]

Readmission rates following bariatric operations have surfaced as an important new variable in cost-benefit models of bariatric surgery. Indeed,

Zingmond and colleagues[7] found that the rate of hospitalization doubled in the first year following gastric bypass compared to the year preceding surgery. Similarly, Esconsa and colleagues[8] calculated that the mean cost to insurance payers for all patients 6 months after bariatric surgery was $29,921, with readmission rates forming an important determinant of cost. Nonetheless, few studies have documented readmission rates following weight loss surgery.

Nguyen and colleagues[9] recently suggested that 30-day readmission rates varied with the hospital volume of bariatric surgery, with high volume centers achieving the lowest rates. Consequently, the purpose of this study was to determine the rate of 30-day readmissions following weight loss surgery at a high volume bariatric surgery center.

Methods

Study Design: This was a retrospective study of the bariatric surgery database from June 2, 2003 to June 30, 2006. The subset of patients who were readmitted to the hospital within 30 days of the date of their index bariatric operation was studied.

Setting: Data was taken from the Bariatric Database at Hackensack University Medical Center, a 781-bed teaching and research hospital affiliated with The University of Medicine and Dentistry of New Jersey – New Jersey Medical School. The Bariatric Program at Hackensack University Medical Center is accredited by the American College of Surgeons as a IA Bariatric Surgery Program.

Statistics: Data are presented as median and ranges. Groups were compared by Kruskal-Wallis one-way analysis of variance (ANOVA). Step-wise and univariate logistic regression analysis was performed only on patient records with complete datasets. All statistical operations were accomplished using Unistat 5.5 Statistical Package for Windows (Unistat Ltd., London, United Kingdom).

Operations: Three bariatric operations are offered by the surgeons at Hackensack University Medical Center: an open vertical banded gastroplasty – Roux-en-Y gastric bypass (VBG-RYGBP); laparoscopic short limb Roux-en-Y gastric bypass (LRYGBP); and laparoscopic adjustable gastric banding (LAGB). Technical details of these procedures have been previously published.[10-13] We included all patients undergoing bariatric operations. In addition, in three patients a bariatric procedure was not possible: one due to adhesions and two due to previously undiagnosed malignancy.

Patient Definition: After obtaining permission from the institutional review board, all patients undergoing bariatric operations between June 2, 2003 and June 30, 2006 were entered in a retrospective hospital database based on the corrected operative log. Readmissions were defined as any admission for any reason. Emergency room visits not resulting in hospital admission were not included.

Variables: Patient demographics as well as anthropometrics were included when available. Co-morbid conditions as well as American Society of Anesthesiologists (ASA) score was also included. Each readmission was chart reviewed to determine the cause of readmission.

Results

Analysis of All 2,823 Patients

Surgical Volume: The Bariatric Surgery Center at Hackensack University Medical Center performed 2,823 bariatric procedures from June 2, 2003 to June 30, 2006. In that time-period, 776 VBG-RYBGP (27.5%), 1,185 LRYGBP (42.0%), and 862 LAGB (30.5%) were performed. Length of stay (LOS) for all patients at the time of operation ranged from 1-46 with a median of 2 days. The median length of stay for the VBG-RYGBP was 3 (2-39 days), for LRYGBP was 3 days (2-46), and for LAGB 1 day (range 0-8 days). LOS for LAGB was significantly shorter than VBG-RYGBP or LRYGBP.

Patient Characteristics: The sex distribution of the 2,823 patients was 74.3% female and 25.7% male. The median age of the cohort was 42 (13-79). The median age for VBG-RYGBP was 40 years (13-71 years). This was significantly lower than the age of the LAGB

patients 42 years (16-69 years) or LRYGBP patients 42 (16-79 years). The ages of the LRYGBP and the LAGB were not statistically different. Height, weight and body mass index (BMI) were available for 2,535 patients. Median weight for all patients was 127 kg. Median BMI for all patients was 46 kg/m^2 (35-93 kg/m^2). The median BMI of the patients undergoing LAGB was 44 kg/m^2 (35-84 kg/m^2): this was significantly less than either of the two bypass operations. The median BMI for LRYGBP was 46 kg/m^2 (35-93 kg/m^2) and for VBG-RYGBP 47 kg/m^2 (35-83 kg/m^2). The BMIs of the two bypass procedures were not statistically different. Median height for all patients was 165 cm (142-201). Information on race was available for 2795 patients: 2160 (77.3%) white, 318 African-Americans (11.4%), 208 others (7.4%), 84 Asians (3.0%), and 25 Native-Americans (.9%). Hispanic vs not Hispanic was not recorded by this database. Insurance type was listed for 2,795 patients: 1,620 (58.0%) private; 937 (33.5%) health maintenance organizations (HMO); 114 (4.1%) self pay; 105 (3.9%) Medicare and Medicaid; and 19 (0.7%) charity care.

Risk Stratification: ASA severity was available for 2786 patients. ASA 1: 303 (10.9%), ASA 2: 1,035 (37.2%), ASA 3: 1,428 (51.3%), ASA 4: 20 (0.7%).

Co-morbidities: Information on co-morbidities was available on all 2,823 patients. Patients were afflicted with the following co-morbidities: 43.7% hypertension, 23.9% type 2 diabetes mellitus, 19.8% sleep apnea, 17.7% hypercholesterolemia; 16.8% asthma; 10.4% depression; 4.7% hypertriglyceridemia; 3.2% coronary artery disease; and 0.3% deep venous thrombosis. The number of patients with a single co-morbidity was 825 (29.5%). Two co-morbidities afflicted 775 patients (27.0%), three co-morbidities 619 patients (22.1%), and more than three 214 patients (7.6%)

Readmitted Patient Characteristics

Readmission Rates: 165 patients were readmitted 184 times within 30 days of operation, for an overall readmission rate of 6.5% (184/2,823). The rate of individual patients requiring one or more readmissions was 5.9% (165/2,823). The rates of patients requiring one or more readmissions following individual operations were: VBG-RYGBP 6.8% (53/776); LRYGBP 7.3% (86/1185); and LAGB 3.1% (27/862). The range of postoperative days on which patients were readmitted was from 0 to 30 days. The median number of days was 8. Distribution of the time interval between operation and readmission is shown in Figure 1. The median length of stay during readmission was 3 days (1-34 days) (Table 1).

Patient Characteristics: The sex distribution of those readmitted within 30 days was 130 female (78.3%) and 36 male (21.7%). Median age for the 165 patients was 40 years (17-78). Height, weight, and BMI were available for 150 readmitted patients. Their median height was 165 cm and their median weight was 131 kg. Median BMI was 47. None of these factors were statistically different from the larger cohort. Information of race on those readmitted was available for all 165 patients: White 114 (69.2%), African-American 28 (16.9%), other 10 (6.02%), Asian 10 (6.02%), and Native American 3 (1.8%). The race make-up of those readmitted was not statistically different from those who were not readmitted. Type of insurance was available for all 165 patients: 99 (60.0%) private insurance; 48 (28.9%) health maintenance organizations (HMO); 9 (5.4%) Medicare and Medicaid; 9 (5.4%) self pay; and 1 (0.6%) charity care.

Co-morbidities: The type and rate of co-morbidities afflicting the 165 re-admitted patients included: hypertension 46.4%; asthma 19.6%; type 2 diabetes

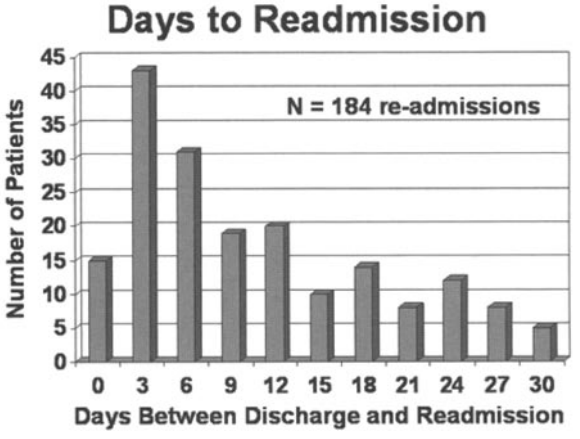

Figure 1. Time in days separating the index bariatric operation from the day of readmission for 165 patients who were re-admitted within 30 days of the index bariatric operation.

Table 1. Univariate logistic regression analysis for factors that increased the odds of readmission for 2,823 patients who underwent bariatric operations

Factor	Odds Ratio	Lower 95%	Upper 95%	Significance
LAGB	0.42	0.27	0.64	0.0000
Race White	0.64	0.46	0.91	0.0117
Time >120 min	1.90	1.37	2.63	0.0001
LOS >3 days	2.52	1.71	3.73	0.0000
DVT	9.64	2.28	40.67	0.0020

Laparoscopic adjustable gastric banding (LAGB); Total operating room time from entering to leaving room (Time); Hospital Length of Stay during index hospitalization (LOS); deep venous thrombosis (DVT).

mellitus 22.0%; hypercholesterolemia 16.7%; hypertriglyceridemia 6.0%; coronary artery disease 6.0%; depression 13.1%; chronic obstructive pulmonary disease 2.4%; sleep apnea 26.8%; and deep venous thrombosis 1.8%. There were no co-morbidities in 45 readmitted patients (27%), while 44 patients (26.5%) listed two co-morbidities, and 39 patients (23.5%) had only one co-morbidity.

Risk Stratification: The ASA score for those readmitted was available for 161 patients – ASA 1: 21 (12.7%), ASA 2: 56 (33.7%) ASA 3: 88 (53.0%), ASA 4: 1 (.06%)

Index Operation: Of the 165 patients requiring readmission, 53 (31.9%) had previously undergone a VBG-RYGBP, 86 LRYGBP (51.8%) and 27 LAGB (16.2%). Median total operating-room time (patient into-room to patient out-of-room) for the index bariatric operation for all readmitted patients was 137 minutes, compared to 120 minutes for these not readmitted. This was statistically significant. There was no difference in total operating-room time for those patients readmitted and those not readmitted for VBG-RYGBP or LRYGBP. There was, however, a statistically significant difference in total operating-room time for LAGB patients who were readmitted (112 minutes, 72-200) and those who were not readmitted (91 minutes, 52-274). Median initial LOS of those eventually readmitted was 3 days (1-46). This was a significantly longer LOS compared to those not readmitted (2 days, with range 1-46).

Increased Odds for Readmission: Step-wise and univariate logistic regression analysis disclosed five factors that significantly impacted the odds of readmission for the 2,823 patients who underwent index bariatric operations (Table 1). LAGB and being white decreased the risk of readmission while operations >120 minutes, initial LOS >3 days, and deep venous thrombosis increased the risk of readmission.

Causes of Readmission: The leading cause of readmission to the hospital was technical complications due to the surgery (Table 2). This accounted for 75 admissions (40.5%). The most frequent technical considerations were: stricture requiring dilatation 24; bowel obstructions 14; wound complications 11;

Table 2. Admission diagnoses for 165 patients who required 184 readmissions within 30 days of undergoing bariatric operations

Reason for Readmission	Number	%
Technical Complications due to Surgery	74	40.2%
Stricture Requiring Dilatation	24	13.0%
Bowel Obstruction	14	7.6%
Wound Complication	10	5.4%
Perforated Viscus	9	4.9%
Postoperative Bleeding	8	4.3%
Marginal Ulcer	6	3.3%
Abdominal Abscess	3	1.6%
Gastrointestinal Complaints	43	23.4%
Vomiting Without Radiological Abnormality	28	15.2%
Diarrhea, Constipation, Dehydration	13	7.1%
Acute Cholecystitis	2	1.1%
Abdominal Pain Without Vomiting	17	9.2%
Pulmonary Complications	17	9.2%
Pulmonary Embolism	5	2.7%
Deep Venous Thrombosis	3	1.6%
Kidney Stones & Urinary Tract Infections	7	3.8%
Elective Gynecological Procedures	4	2.2%
Miscellaneous	14	7.6%

perforated viscus 9; postoperative bleeding 8; marginal ulcer 6; and abscess 3. One of the admissions listed as a perforated viscus was a gastro-gastric fistula. One of the wound complications was a sternal wound infection following a coronary artery bypass graft. The second most common classification was GI condition without demonstrable relationship to the surgery. The majority of these admissions were for vomiting without radiographic abnormality (n=28). The third most common category was abdominal pain without vomiting and without radiographic abnormality accounting for 17 admissions (9.2%). Table 3 stratifies the technical complications of surgery by type of initial bariatric operations. Both VBG-RYGBP and LRYGBP required more readmissions for stricture than LAGB. LRYGBP patients developed more obstructions and GI hemorrhage than VBG-RYGBP and LAGB. VBG-RYGBP required more readmissions for wound complications than the laparoscopic operations.

Discussion

Several studies have reported readmission rates following bariatric surgery (Table 4).[8,9,14-18] Rates varied between 0.6% and 11.3%. The multi-institutional reports include data from both low volume and high volume institutions. Our overall readmission rate of 6.5% falls within the range of these published series.

Table 3. Stratification by type of operation for the technical complications of surgery that led to readmission within 30 days of the primary operation

Complication	VBG-RYGBP	LRYGBP	LAGB	Total
Stricture	10	13	1	24
Obstruction	2	9	3	14
Wound	6	4	0	10
Perforation	3	1	5	9
GI Hemorrhage	2	5	1	8
Marginal ulcer	1	5	0	6
Abscess	0	2	0	3
Total	24	39	10	74

Laparoscopic adjustable gastric banding (LAGB); Laparoscopic Roux-en-Y gastric bypass (LRYGBP); Vertical banded gastroplasty – Roux-en-Y gastric bypass (VBG-RYGBP)

Only two of the reports in Table 4 examined readmission rates at single institutions. Both institutions performed only LRYGBP. In 2005, McCarty and colleagues[14] reported a 30-day readmission rate of 1.7% for 2,000 consecutive LRYGBPs during a 3-year period. In 2006, Baker and colleagues[16] published readmission data from 250 consecutive LRYGBP patients. They observed a 4% readmission rate. Both these centers suggested that using a laparoscopic approach played a role in their low 30-day rates of readmission.

Five studies in Table 4 assessed readmission rates following weight loss operations using multi-institutional administrative databases. In 2005, Mehrotra and colleagues[15] used the Wisconsin inpatient hospital discharge data from 2000 through 2002 to calculate readmission rates for all bariatric operations. Among the 1,884 patients, 7.8% required readmission within 30 days.

Two studies in Table 4 related surgical volume to rates of 30-day readmission. In 2004, Nguyen and colleagues[9] identified 24,165 RYGBPs performed between 1999 and 2002 in the University Health System Consortium Clinical Data.[9] Patients experienced a 0.3% 30-day readmission rate in high (>110 cases/year) and moderate (50-100 cases/year) volume hospitals and a 0.6% rate in low (<59 cases/year) volume centers. In 2006, Bradley and Sharma[17] of Blue Cross and Blue Shield of North Carolina compared Bariatric Surgery Centers of Excellence to non-accredited centers. The Centers were approved using the criteria of the American Society of Bariatric Surgery. Bariatric patients undergoing surgery at Centers of Excellence required 30-day readmission at a rate of 3.4% to 7.6% during the 4 years of the study, compared to the non-accredited program's readmission rates of 8.3% to 16.5% per year.

In 2006, Escinosa and colleagues[8] audited insurance claims from 2001 through 2002 in the MarketScan database. They extracted records for 2,522 patients from 308 hospitals that had undergone bariatric operations. They calculated a 7.2% 30-day readmission rate. They listed reasons for return visits to the hospital within 180 days of surgery, which is remarkably similar to the causes of readmission for our patients. These included, in order of frequency: complications of surgical procedure; fluid/elec-

Table 4. Published 30-day readmission rates following bariatric operations[11-17]

1st Author	Year	Patients	30-Day Readmission Rate	Type of Study
N.T. Nguyen[9]	2004	24,166	0.6%	Multi Institutional/retrospective
T.M. McCarty[14]	2005	2,000	1.7%	Single institution/prospective
M. Mehrotra[15]	2005	1,884	7.8%	Multi Intuitional/retrospective
M.T. Baker[16]	2006	250	4.0%	Single Institution/prospective
D.W. Bradley[17]	2006	596	4.7%	Multi Intuitional/retrospective
W.E. Escinosa[8]	2006	2,552	11.3%	Multi Institutional/retrospective
W.E. Weller[18]	2007	7,868	7.6%	Multi Institutional/retrospective
J.K. Saunders	2007	2,813	6.5%	Single Institution/retrospective

trolyte disorders; disorders of the stomach and duodenum; intestinal obstruction; GI hemorrhage and biliary tract disease. Weller and colleagues[18] found that the majority of readmissions were prompted by digestive system complications of surgical procedures and other postoperative infections.

Zingmond et al[7] addressed 1-year and 3-year readmission rates for RYGBP. They harvested data from the California annual hospital Patient Discharge Database. During this time-period 1995 to 2003, 60,077 patients underwent RYGBP throughout California. During the first year after surgery, 7.9% required readmission. This rate climbed to 18.4% in the second year after surgery and to 14.9% during the third year.

Readmission rates following bariatric operations compare favorably with other complex gastrointestinal operations. Goodney and colleagues[20] calculated 30-day readmission rates for complex operations using the Medicare claims database. During the years 1994-1999, ~2.5 million Medicare patients underwent cardiovascular and cancer resections. Overall 30-day readmission rates for GI resections included: esophagectomy 18.4%; pancreatectomy 18.7%; gastrectomy 16.6%, and colectomy 11.1%. Rates for readmission for these GI operations substantially exceeded those in Table 4.

Readmission rates varied with the type of bariatric operation performed. In our institution, the overall rate of readmission for all bariatric operations was 6.5%. The highest rate of readmission was for LRYGBP at 7.3%. Next was the VBG-RYGBP at 6.7%. The lowest rate of readmission was for LAGB at 3.2%. Only one other publication has stratified 30-day readmission rates by type of operation. Among the 1,884 patients reported by Mehrotra,[15] the overall 30-day readmission rate was 7.8%, while rates for gastric bypass (RYGBP and LRYGBP; n=646) was 7.9%, gastric stapling (n=935) 11.3%, and other miscellaneous types (n=303) 3.3%.

Univariate logistic regression analysis assessed risk factors for readmission (Table 3). We found that total operating-room time (patient into-room – patient out-of-room) >120 minutes, hospital LOS at initial bariatric operation of >3 days, and deep venous thrombosis increased the odds of readmission. In contrast, white race and undergoing LAGB decreased the odds of readmission. Our study did not identify age, sex, BMI, various co-morbid diseases, number of co-morbid diseases, or type of insurance as factors that increased risk of readmission.

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Addendum

With the proofs already finalized, we discovered that two cases were not properly categorized. One patient categorized as having had the complication of bowel obstruction following VBG-RYGBP did not in fact have bariatric surgery. Another patient categorized as having had a wound complication following VBG-RYGBP was admitted to the hospital with a sternal wound infection following open-heart surgery. Changes to the text and tables were not made and we apologize to the readers.

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