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ORIGINAL RESEARCH

Low Educational Status, Smoking, and Multidisciplinary Team Experience Predict Hospital Length of Stay After Bariatric Surgery

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Abstract

Objective: The objective of the present study was to identify new risk factors associated with longer hospitalization following bariatric surgery.

Methods: Patient clinical, social, and biochemical data in addition to multidisciplinary team experience were analyzed in a cohort that included all patients undergoing bariatric surgery at our hospital. The primary outcome was length of hospital stay (LOS). Mortality was recorded to validate the obesity surgery mortality risk score (OS-MRS).

Results: This study included 299 sequential patients, 41 ± 10 years of age, and BMI of 50 ± 8 kg/m^2 who underwent bariatric surgery. Two thirds (196) of patients were hypertensive, a third (86) were diabetic and a third (91) were current or former smokers. Overall, LOS was 8 ± 5 days. The predictors of a longer LOS were smoking ($P < 0.05$) and less multidisciplinary team experience ($P < 0.05$). Looking at only the last three years of data, LOS was 6 ± 5 days, and the predictors of a longer LOS were low educational attainment ($P < 0.02$) and smoking ($P < 0.01$) but not team experience. The global mortality was 2.6%, with the OS-MRS identifying a high-risk group.

Conclusion: Excluding the initial learning phase, longer LOS independent predictors were patient low educational attainment and smoking. These predictors can help guide care to reduce complications.

Keywords: obesity, bariatric surgery, smoking, educational status

Introduction

Nowadays, for the morbidly obese patient,[1–3] the surgical approach is a treatment option that limits energy intake, reduces the intestinal absorption area (or both), and improves metabolic control[4,5] and general healthfulness.[6] In parallel, there have been attempts to identify pre-surgical patients with a higher rate of complications. In one study, BMI over 50 kg/m^2, hypertension, male gender, obstructive sleep apnea and pulmonary embolism (PE) were identifiable as risk factors.[7,8] The combination of at least four of these factors was associated with 7.6% perioperative mortality.[7,8] Paradoxically, however, current perioperative risk evaluation guidelines account only for BMI $>$ 50 kg/m^2 and do not account for obesity severity[9–11] per se. Therefore, we evaluated perioperative risk for bariatric surgery and outcomes considering patients' clinical and laboratory sequential six-month follow-up. Therefore, the objective of the present study was to identify new risk factors associated with longer hospitalization following bariatric surgery.

Methods

This was an observational retrospective study where the total collection period was 9 years, from March 2000 until November 2009. The national and local institutional review board approved this study (CAAE—0195.0.004.000-09).

Grade III obese patients previously resistant to other forms of weight loss therapy (as food restriction, pharmaceuticals, and psychological therapy) for at least six months were pre-selected for surgery. Within the data collection period, all patients that underwent bariatric surgery were included in this study. All patients underwent an open roux-en-Y with gastric bypass and silicone banding.[12] Patients received psychological therapy before and after surgery follow-up.

The following data were collected from patient charts: age, weight, height, gender, ethnicity, educational attainment, smoking status ([1] never smoked, [2] quit for at least one year, and [3] current smoker or quit for less than one year), diagnosis of hypertension (blood pressure greater than 140/90 mmHg), glucose intolerance, type 2 diabetes (fasting plasma glucose $\geq$ 126 mg/dL = 7 mmol/l), extremity venous ulcers, a functional capacity of at least 4 METs (Metabolic Equivalent of Task), biochemical data (cholesterol and fractions, uric acid), electrocardiogram, chest radiography, polysomnography, upper gastrointestinal endoscopy, spirometry, history of pulmonary embolism (including lower cava filters), hypothyroidism, familial coronary artery disease, use of statins, use of allopurinol, and result of liver biopsy performed during surgery. Laboratory results, chest radiography and electrocardiogram were only considered when performed within 4 months before all surgery. Polysomnography, endoscopy, and spirometry were considered when performed within one year before surgery.

All patients had their cardiovascular Obesity Surgery Mortality Risk Score (OS-MRS) calculated.[7] The OS-MRS is calculated with the following five risk factors, one point for each factor: male gender, age $\geq$ 45 years, hypertension, body mass index (BMI) $\geq$50 kg/m^2, and pulmonary embolism risk factor. Pulmonary embolism risk is defined as the presence of any of the following: previous venous thromboembolism, inferior vena cava filter, history of right heart failure, pulmonary hypertension, or physical findings of venous stasis. Patients with one or fewer points were classified as low risk, those with two or three points were moderate risk, and those with four or higher points were high risk.

Although not part of a perioperative evaluation, liver biopsies were routinely performed in all patients. Steatohepatitis was classified into mild, moderate, severe, and very severe. Fibrosis was classified into mild, moderate, and severe.[13]

Missing data for each variable are reported. Imputation with the mean was carried out for the covariates for logistic and Poisson regressions. Stepwise forward regression was used where variables with a likelihood ratio P value of less than 0.05 were included sequentially in the regression. For other analyses, the sample size floated to the total number of patients with the available data necessary for each analysis.

The multidisciplinary team was composed of clinical nutrition physicians, gastric surgeons, psychologists, and dietitians. Multidisciplinary team experience was defined as years of working as a bariatric multidisciplinary interaction team. Therefore, team experience of 1 corresponded to the result from the first year of the multidisciplinary team bariatric activity, and so on.

The primary endpoint analyzed was length of hospital stay (LOS). Secondary outcomes were all-cause mortality, myocardial infarction, pulmonary embolism, and stroke before 90 days post surgery. The odds ratio for mortality with the variables in OS-MRS and the c-statistic for event discrimination were calculated. Statistical analyses were performed with Stata® 9.0 (Statacorp, College Station, TX, USA). For validation, odds ratio and c-statistic mortality logistic regression was calculated. LOS predictors were calculated using Poisson regression. Linear regression was used to analyze predictors of lung disease. Data is expressed as mean ± standard deviation (for numeric variables) or percentage (for categorical variables).

Results

In all, 299 patients (who had a mean age of 41 ± 10 years) had bariatric surgery, and 95% of data from these patients were retrieved. A functional capacity over 4 METs was found in 85% of patients. Over 66% of the patients were hypertensive, 30% had type 2 diabetes, 32% were current or previous smokers, 50% had HDL-cholesterol below 40 mg/dL (1.03 mmol/L). Table 1 displays baseline data collected.

Spirometry was performed on 267 patients. Forced vital capacity was on average 92% ± 14%, forced expiratory volume in 1 second was 90% ± 15% and the Tiffeneau index was 82% ± 7% of the predicted for age and gender. Eighteen (6%) patients had a pattern

Table 1. Baseline characteristics of 284 patients who underwent bariatric surgery.

	Mean ± SD or frequency (%)	Missing data (%)
Demographics (N = 284)		
Age (years)	41 ± 10	0
Female	233 (82%)	0
Anthropometry		
Pre-surgery weight (kg)	135 ± 23	0
Height (cm)	164 ± 9	0
BMI (kg/m²)	50 ± 8	0
Biochemical data		
Total cholesterol (mmol/L)	4.89 ± 1.08	12
HDL-cholesterol (mmol/L)	1.03 ± 0.23	16
LDL-cholesterol (mmol/L)	3.05 ± 0.95	13
Triacyglycerides (mmol/L)	1.76 ± 1.05	12
Uric acid (μmol/L)	356 ± 118	9
HDL-cholesterol < 1.03 mmol/L	142 (50%)	16
Co-morbidities		
HTN	196 (69%)	0
DM2	86 (30%)	0
Glucose intolerance	85 (30%)	0
Venous stasis	43 (15%)	0
Hypothyroidism	23 (8%)	1
Obstructive sleep apnea	13 (5%)	0
Previous MI	3 (1%)	0
Previous pulmonary embolism	2 (1%)	0
Atrial fibrillation	1 (0.3%)	0
Current or previous smoker	91 (32%)	0
CAD family history	51 (18%)	0
Medications		
Allopurinol	15 (5%)	0
Statin	14 (5%)	0
Pre-surgery evaluation		
Functional capacity over 4 METs	231 (85%)	12
Pulmonary embolism risk (DeMaria)	58 (20%)	0
Increased cardiothoracic index	28 (10%)	9

Abbreviations: BMI, body mass index; MET, metabolic equivalent of task; CAD, Coronary Artery Disease; MI, myocardial infarct; HTN, hypertension.

of significant restrictive disease with a forced vital capacity below 70%, and 12 (4%) patients had a pattern of significant obstructive disease. Independent predictors of lung restrictive disease in this sample were type 2 diabetes ($P < 0.01$), serum uric acid ($P < 0.04$), and cardiomegaly ($P < 0.04$) with an r^2 of 13%.

A total of 275 patients had a liver biopsy performed. Only 10 (4%) patients had normal biopsy. Most patients, 254 (92%), had some degree of steatohepatitis, with 23 patients having severe and very severe findings on biopsies (8%). Seventy-six (27%) patients had some degree of liver fibrosis, 32 had moderate fibrosis (12%), and 2 had severe fibrosis (1%).

An upper gastrointestinal endoscopy was performed in 293 patients. Of these, an abnormal endoscopy was present in 241 (82%) patients. Gastritis (no ulcer erythema) was highly prevalent (184 patients, 62%). Esophagitis was present in 58 patients (19%), hiatal hernia in 79 patients (26%), duodenitis in 27 patients (9%), gastric ulcers in 9 patients (3%), duodenal ulcers in 8 patients (3%), gastric polyps in 7 patients (2%). Finally 52 patients (18%) had an endoscopy with no pathological findings.

Twenty-eight patients had no heart risk assessment. Of the 271 remaining, 235 (86%) were considered low risk for cardiovascular events.[9] In the 36 patients that warranted further evaluation, 16 patients had a radionuclide scanning performed that revealed mild ischemia or no ischemia. Echocardiogram was ordered for 8 patients, all of which were normal. Stress echocardiogram was ordered for 2 patients, one of which was negative for ischemia and the other was inconclusive. No additional exam could be ordered for this patient and for 8 other patients because their weight surpassed maximal table capacity in the cardiac catheterization and radionuclide imaging laboratories. Finally, two patients had a coronary angiogram performed that revealed no significant lesions. There were no recommendations to postpone or cancel any surgery. Surgical new intervention was necessary in 27 patients (9%); of these, 10 patients required an antibiotic prescription. Six of these patients went on to develop fatal septic shock. At 90 days, with all patients accounted for, eight deaths were recorded, six due to septic shock attributable to abdominal infection, and two associated with

massive PE. An additional adverse event within this time frame was a non-fatal stroke.

After 30 days post surgery, patients had a mean weight of 125 ± 21 kg, which corresponded to an excess weight loss (EWL) of 13% ± 6% and an excess of BMI weight loss (EBMIL) of 15% ± 7%. At six months, mean weight was 103 ± 19 kg with an average EWL of 44% ± 11% and an EBMIL of 49% ± 13%. Average total patient LOS was 7.5 ± 5.0 days. LOS ranged, in this service, from an average 14.5 days in the first year bariatric surgery was performed to an average 5.4 days in the last year analyzed in this study. The predictors of a longer LOS were years of team experience from beginning and smoking ($P < 0.001$).

Since years of team experience was an important predictor, but would not be relevant after the initial period, we chose to repeat the analysis with the final three years of the study. This included 183 patients (61% of the entire study) with an average LOS of 6.1 ± 5.0 days. Thereafter, the predictors of a longer LOS were patient smoking ($P < 0.01$) and patient educational attainment ($P < 0.02$). Current and previous smokers remained admitted 4 days and 1 day longer, respectively, when compared with those who had never smoked.

Patients with an educational attainment of elementary school or less and those with a high school education remained in the hospital 2 days and 1 day longer, respectively, when compared with those with at least a college education.

OS-MRS of each patient shows that almost half of the sample was classified as low risk, a second half as medium risk, and 6% as high risk. The global mortality rate was 2.6%, but it reached 12.5% in the high-risk group (Table 2). The odds ratio for mortality was comparable to the odds ratio of the original cohort. The c-statistic for the OS-MRS to predict mortality in this population was 0.69.

Discussion

In this study, the OS-MRS was validated through the odds ratio except for pulmonary embolism risk. This may be due to the fact that pulmonary embolism risk includes sleep apnea, which may have been underdiagnosed in our patients. Our patients had polysomnography only after clinical suspicion and pulmonary embolism risk factors may not have been actively sought out in the patients' complaints.

Table 2. Obesity Surgery Mortality Risk Score stratification and mortality rate at 90 days and validation of the risk score.[7.]

Class	Prevalence in original cohort	Mortality rate	This study	Mortality rate
A (0–1)	957 (46%)	0.3%	111 (37%)	1.8%
B (2–3)	999 (48%)	1.9%	156 (52%)	1.3%
C (4–5)	119 (6%)	7.6%	32 (11%)	12.5%
Risk factors	**Original cohort**			**This study**
	Odds ratio	**95% CI**		**Odds ratio**
BMI $\geq$ 50 kg/m^2	3.60	1.44–8.99		3.09
Male gender	2.80	1.32–5.92		2.60
Hypertension	2.78	1.11–7.01		2.83
PE risk	2.62	1.12–6.12		0.94
Age $\geq$ 45 years	1.64	0.78–3.48		1.23

Abbreviations: BMI, body mass index; PE, Pulmonary Embolism; CI, Confidence Interval.

Despite this, the discriminatory power of the OS-MRS was adequate since in this population it was able to identify a high-risk group of patients. Patients considered for bariatric surgery in this high-risk group could have their surgeries postponed in an attempt to reduce risk, and further preoperative attempts at weight loss could be made or these patients could be evaluated for a different procedure.

Adult patients in this study had considerable prevalence of comorbidities such as hypertension and type 2 diabetes. Half of the patients had dyslipidemia with low HDL-cholesterol. Chest radiography and clinical findings have low specificity for detecting respiratory abnormalities in obese patients. Thus, spirometry was performed on most patients, with pathological findings in few patients. There was an association of restrictive pulmonary disease[14,15] with type 2 diabetes, serum uric acid, and cardiomegaly, but not with LOS. The prevalence of abnormal endoscopies was similar to that described in the literature.[16–18] The frequency of abnormalities in liver biopsies found in this study was more than double that described for the morbidly obese in the literature,[19,20] but there was no correlation with LOS in our study.

Since we did not expect enough events to be able to identify predictors of mortality in this study, our main outcome was the LOS, which is indirectly linked to complications.[21] The predictors of a longer LOS identified in this study were the experience of the multidisciplinary team and smoking habit. The association with team experience could reflect a more conservative approach in the first cases, which included longer hospitalization time. Also, this could reflect the steep multidisciplinary team learning curve for bariatric surgery.[22] Considering that team experience would not be relevant after the initial years, we re-analyzed LOS only with patients who underwent surgery in the last three years of the study. In this group, smoking was maintained as a predictor,[23] but a new risk factor emerged. This new factor was patient educational attainment. We believe that the educational attainment may reflect patient compliance and adherence to care after surgery. This study, therefore, found that smoking and educational attainment are predictors of longer hospital stays and suggests that targeting interventions to smokers, such as stimulating them to quit ahead of surgery, and increasing orientation and support to patients with less educational attainment could help reduce complications and length of hospital stay after bariatric surgery.

Limitations

This was a 9-year retrospective study. In spite of the extensive clinical and laboratory data that was collected, misdiagnoses or misinterpretation of patient information could have taken place. In any case, careful statistical analyses removed all variables that were not linked to LOS. Educational attainment and smoking, therefore, should be carefully considered when selecting patients for bariatric surgery in addition to a comprehensive medical examination.[24]

Author Contributions

Conceived and designed the experiments: JFM, FS, AS, WS, JSM, JS. Analysed the data: JFM, FS, SC, JSM, CN, JS. Wrote the first draft of the manuscript:

JFM, FS, JSM. Contributed to the writing of the manuscript: JFM, AS, SC, WS, JSM, RC. Agree with manuscript results and conclusions: JFM, FS, AS, SC, WS, JSM, CN, RC, JES. Jointly developed the structure and arguments for the paper: JFM, AS, WS, JSM, CN, RC. Made critical revisions and approved final version: JFM, AS, SC, WS, JSM, JS. All authors reviewed and approved of the final manuscript.

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Competing Interests

Authors disclose no potential conflicts of interest.

Disclosures and Ethics

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References

1. Sabry MOD, Sampaio HAC, Silva MGC. Hipertensão e obesidade em um grupo populacional no Nordeste do Brasil. *Rev Nutr*. 2002;15:132–47.
2. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999–2010. *JAMA*. 2012;307:491–7.
3. Cunha SFC, Sanches M, Faria A, Santos JE, Borges CBN. Lean body mass changes within 12 months of bariatric surgery. *Rev Nutr*. 2010;23:535–42.
4. Martins C, Strommen M, Stavne OA, Nossum R, Màrvik R, Kulseng B. Bariatric surgery versus lifestyle intervention for morbid obesity-changes in body weight, risk factors and comorbidities at 1 year. *Obes Surg*. 2011; 21:841–9.
5. Bavaresco M, Paganini S, Lima TP, et al. Nutritional course of patients submitted to bariatric surgery. *Obes Surg*. 2010;20:716–21.
6. Sjöström L, Narbro K, Sjöström CD, et al. Effects of bariatric surgery on mortality in Swedish obese subjects. *N Engl J Med*. 2007;357:741–52.
7. DeMaria EJ, Portenier D, Wolfe L. Obesity surgery mortality risk score: proposal for a clinically useful score to predict mortality risk in patients undergoing gastric bypass. *Surg Obes Relat Dis*. 2007;3:134–40.
8. Flum DR, Belle SH, King WC, et al. Perioperative safety in the longitudinal assessment of bariatric surgery. *N Engl J Med*. 2009;361:445–54.
9. Fleisher LA, Beckman JA, Brown KA, et al. ACC/AHA 2007 guidelines on perioperative cardiovascular evaluation and care for noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 2002 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery) developed in collaboration with the American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Rhythm Society, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society for Vascular Medicine and Biology, and Society for Vascular Surgery. *J Am Coll Cardiol*. 2007;50:e159–241.
10. Feitosa AC, Ayub B, Caramelli B, et al. I Diretriz de avaliação perioperatória. *Arq Bras Cardiol*. 2007;88:e139–78.
11. Dindo D, Muller MK, Weber M, Clavien PA. Obesity in general elective surgery. *Lancet*. 2003;361:2032–5.
12. Fobi M, Lee H, Igwe D, et al. Gastric bypass in patients with BMI < 40 but >32 without life-threatening co-morbidities: preliminary report. *Obes Surg*. 2002;12:52–6.
13. Deitel M, Greenstein RJ. Recommendations for reporting weight loss. *Obes Surg*. 2003;13:159–60.
14. Yeh HC, Punjabi NM, Wang NY, et al. Cross-sectional and prospective study of lung function in adults with type 2 diabetes: the Atherosclerosis Risk in Communities (ARIC) study. *Diabetes Care*. 2008;31:741–6.
15. Tiengo A, Fadini GP, Avogaro A. The metabolic syndrome, diabetes and lung dysfunction. *Diabetes Metab*. 2008;34:447–54. Doi:10.1016/j.diabet.2008.08.001.
16. Muñoz R, Ibáñez L, Salinas J, et al. Importance of routine preoperative upper GI endoscopy: why all patients should be evaluated? *Obes Surg*. 2009;19:427–31.
17. Sharaf RN, Weinshel EH, Bini EJ, Rosenberg J, Sherman A, Ren CJ. Endoscopy plays an important preoperative role in bariatric surgery. *Obes Surg*. 2004;14:1367–72.
18. Orth WS, Madan AK, Ternovits CA, Tichansky DS. Effect of preoperative knowledge on weight loss after laparoscopic gastric bypass. *Obes Surg*. 2008;18:768–71.
19. Shalhub S, Parsee A, Gallagher SF, et al. The importance of routine liver biopsy in diagnosing nonalcoholic steatohepatitis in bariatric patients. *Obes Surg*. 2004;14:54–9.
20. Marchesini G, Marzocchi R. Metabolic syndrome and NASH. *Clin Liver Dis*. 2007;11:105–17.
21. Mason EE, Printen KJ, Barron P, Lewis JW, Kealey GP, Blommers TJ. Risk reduction in gastric operations for obesity. *Ann Surg*. 1979;190:158–65.
22. Schauer PR, Ikramuddin S. Laparoscopic surgery for morbid obesity. *Surg Clin North Am*. 2001;81:1145–79.
23. Sørensen LT, Hemmingsen U, Kallehave F, et al. Risk factors for tissue and wound complications in gastrointestinal surgery. *Ann Surg*. 2005;241:654–8.
24. Catheline JM, Bihan H, Le Quang T, et al. Preoperative cardiac and pulmonary assessment in bariatric surgery. *Obes Surg*. 2008;18:271–7.