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ORIGINAL CONTRIBUTIONS

Modifiable Factors to Prevent Prolonged Length of Stay after Sleeve Gastrectomy

Max Meneveau[1] · J. Hunter Mehaffey[1] · Peter D. Adams[1] · Florence E. Turrentine[1] · Bruce Schirmer[1] · Peter T. Hallowell[1]

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Abstract

Background Early discharge after laparoscopic sleeve gastrectomy (SG) is common and safe, but two-thirds of patients are still hospitalized longer than 1 day. The purpose of this study was to evaluate factors associated with early discharge at a single institution with intention to discharge on postoperative day 1.

Methods Retrospective review of preoperative, intraoperative, and postoperative factors was performed for all patients undergoing SG at an academic hospital between 2010 and 2016. The primary outcome measure was length of stay (LOS). Multivariate logistic regression was used to identify independent predictors of prolonged LOS.

Results A total of 367 patients undergoing SG were included. Two hundred eighty-seven (78%) were women and 294 (80%) were Caucasian. Mean age was 45.5 years and mean body mass index (BMI) was 48.7 kg/m2. One hundred twenty-three patients (33.5%) had a LOS ≤ 1 day. Compared to patients staying ≥ 2 days, early discharge patients had significantly lower BMI, creatinine, and American Society of Anesthesiologists class, were more likely to be White, married, have private insurance, and were more likely to have a morning start and no postoperative upper gastrointestinal (UGI) swallow study. Regression analysis demonstrated several independent predictors of prolonged LOS including institutional experience (OR 0.5, $p < 0.001$), case start time (OR 0.6, $p = 0.04$), and routine UGI swallow (OR 8.8, $p < 0.0001$) postoperatively.

Conclusions LOS after SG is affected by multiple factors, including patient health, socioeconomic status, case order, and postoperative management. Optimization of these may allow for improvement in preoperative education and streamlined postoperative pathways, resulting in reduced LOS.

Keywords Sleeve gastrectomy · Length of stay · Resource utilization · Bariatric pathway

Introduction

The obesity epidemic and its associated costs continue to grow at an alarming rate. It has been reported that obese patients account for 46% higher inpatient costs than non-obese individuals [1]. Surgery as a treatment for morbid obesity has been shown to be safe, effective, and superior to medical therapy in providing long-term durable weight loss and comorbidity resolution [2–4]. In the last 5 years, laparoscopic sleeve gastrectomy (SG) has become increasingly popular and is now the most commonly performed bariatric procedure in the USA [5].

For the last 10 years, the surgical community has pushed to develop surgical care pathways that both improve outcomes and reduce cost. One of the areas of focus has been on hospital length of stay (LOS). A number of studies have examined the safety and efficacy of early discharge after laparoscopic Roux-en-Y gastric bypass (LRYGB) [6–9]. Interestingly, there are a few studies on early discharge after SG. In one study of patients undergoing either LRYGB or SG, Khorgami et al. [9] found that discharge on postoperative day (POD) 1 was safe and not an independent risk factor for readmission. Additionally, non-modifiable predictors of late discharge (discharge after POD 2) included older age, increased body mass index (BMI), race other than Caucasian, chronic immunosuppressant use, presence of a bleeding disorder, being on dialysis, having chronic obstructive pulmonary disease, albumin < 3.5 mg/dL, and longer operative time [9]. However, there is limited data in the literature on modifiable factors that affect LOS after SG.

✉ Peter T. Hallowell
PTH2F@virginia.edu

[1] Department of Surgery, University of Virginia, Box 800709, Charlottesville, VA 22903, USA

The aim of this study was to evaluate the modifiable factors associated with successful early discharge after SG at a single institution with an intention to discharge on postoperative day 1. We hypothesized that LOS after SG is affected by a number of these modifiable patient factors. Identification of these factors may allow for optimization of postoperative care and reduction in medical costs, thereby providing increased value to the healthcare system.

Materials and Methods

Patients

After approval by the University of Virginia Institutional Review Board (IRB# 17132), a prospectively collected database through ACS NSQIP was queried for all patients undergoing sleeve gastrectomy for weight loss at our institution between 1 January 2010 and 1 August 2016. The database includes demographic data (age, sex, race), preoperative weight, and preoperative comorbidities (diabetes mellitus (DM), pulmonary disease, hypertension (HTN), gastroesophageal reflux disease (GERD), obstructive sleep apnea (OSA), degenerative joint disease (DJD), and psychiatric disease). Patient-specific data was collected, including driving distance, operative time, postoperative complications, and if they had an upper gastrointestinal (UGI) swallow study performed on postoperative day 1. POD1 UGI swallow was performed as a routine on all patients that underwent sleeve gastrectomy early in our experience. This was then phased out and only performed on those patients presenting concerning symptoms. Early case start was defined as before noon for case start. Travel times between each patient's home address and the medical center address were calculated using Google Maps (Alphabet Inc. Mountain View, CA). These calculations do not acknowledge traffic but provide a standard travel time given distance and posted speed limit for each patient.

Surgeons

The SG procedure was performed by two surgeons at our center starting in 2010. The surgeons were both specialists in minimally invasive and bariatric surgery and both had extensive experience with laparoscopic gastric bypass prior to adopting the SG in their practice. Surgeon experience was captured as the year the operation was performed after 2010.

Statistical Analysis

The primary outcome was length of hospital stay after sleeve gastrectomy. Categorical variables are reported as *n* (%) and continuous variables presented at median [interquartile range] except cost which is reported as mean ± standard deviation to capture variation. Statistical analysis was performed using χ^2 for categorical variable and Mann–Whitney *U* test for non-parametric continuous variables to calculate significance. Multivariate logistic regression was used to assess risk-adjusted predictors of prolonged LOS after SG. Variables were included at a rate of 1:10 for events of prolonged LOS and decided a priori based on clinical knowledge. A *p* value of 0.05 was the threshold for statistical significance.

Results

Baseline Factors and Demographics

A total of 367 patients were identified with a mean age of 45.5 years and BMI of 48.7 kg/m^2 at the time of surgery. There were 123 (33.5%) patients in the early discharge group (discharged on POD 1) and 244 (66.5%) patients with a LOS > 1 day. Table 1 demonstrates baseline preoperative characteristics and variables for each group. Between the early and late discharge groups there was no difference in most preoperative factors (Table 1). However, there were a few factors that

Table 1 Baseline and demographics

Variable	LOS (≤ 1 days) (*n* = 123)	LOS (> 1 days) (*n* = 244)	*P* value
Age (years)	44.7 ± 10.7	45.9 ± 10.2	0.37
BMI (kg/m^2)	46.9 ± 7.8	49.6 ± 10.6	*0.03*
Female	94 (76.4%)	193 (79.1%)	0.56
White	114 (92.6%)	180 (73.8%)	*< 0.0001*
Married	78 (63.4%)	125 (51.2%)	*0.03*
Private insurance status	37 (30.1%)	50 (20.5%)	*0.04*
HTN	66 (53.7%)	152 (62.3%)	0.11
Creatinine	0.8 [0.2]	0.8 [0.1]	*0.002*
Diabetes mellitus			0.31
Un-treated	95 (77.2%)	170 (69.7%)	
Oral medication	20 (16.3%)	53 (21.7%)	
Insulin	8 (6.5%)	21 (8.6%)	
Tobacco	20 (16.3%)	38 (15.6%)	0.87
Driving distance (miles)	46.6 [40.2]	48.9 [44.3]	0.71
ASA class			*0.01*
ASA class 2	49 (39.8%)	66 (27.1%)	
ASA class 3	73 (59.4%)	167 (68.4%)	
ASA class 4	1 (0.8%)	11 (4.5%)	

Baseline demographics and medical comorbidities of early and late discharge groups undergoing laparoscopic sleeve gastrectomy (SG). Creatinine and driving distance are expressed as median [interquartile range]. All other variables are expressed as *n* (%). The threshold for significance was set at $P < .05$. Significant variables are in italics. *LOS* length of stay, *BMI* body mass index, *HTN* hypertension, *ASA* American Society of Anesthesiologists

differed between the groups. Patients who were discharged early were more likely to have a lower BMI (46.9 vs 49.6 kg/m^2; $p = 0.03$), be of White race (92.7 vs 73.8%; $p = < 0.001$), be married (63.4 vs 51.2%; $p = 0.03$), have private insurance status (30.1 vs 20.5%; $p = 0.04$), and have a lower mean preoperative creatinine level (0.81 ± 0.15vs 0.92 ± 0.45, $p = 0.002$). Patients with a short length of stay were also more likely to have a low (< 3) American Society of Anesthesiologists (ASA) classification score than those who were discharged after POD1 (39.8 vs 27.1%, $p = 0.01$).

Outcomes and Complications

Table 2 demonstrates the outcomes and complications between the early and late discharge groups. Patients in the early discharge group were less likely to have undergone postoperative UGI swallow (10.6 vs 47.5%, $p < 0.001$), were more likely to have their case start before noon (72.4 vs 59.4%, $p = 0.02$), and incurred a significantly lower hospital cost ($9744.5 ± $3399.1 vs $13,587.4 ± $7951.1, $p < 0.001$). There was no difference in operative time (95.0 vs 101.5 min, $p = 0.24$) or the rate of postoperative leak (0 vs 0.8%, $p = 0.55$). Patients in the increased LOS group were more likely to have had a postoperative bleed (0 vs 6.2%; $p = 0.003$) and were more likely to be readmitted (4.1 vs 11.1%; $p = 0.03$).

There was no acute renal failure or mortality within the study population.

Independent Predictors of Length of Stay

Multivariate logistic regression analysis demonstrated a number of independent predictors of length of stay (Table 3). Predictors of increased LOS included BMI (OR 10 for each 10-point increase in BMI, $p = 0.01$), preoperative creatinine (OR 9.8, $p = 0.01$), and having undergone UGI swallow on POD1 (OR 3.6, $p = 0.001$). Factors that predicted early discharge included White race (OR 0.2, $p < 0.001$), institutional experience (OR 0.5 per year, $p < 0.001$), and early case start (OR 0.5, $p = 0.02$).

Discussion

The present study demonstrates that a number of modifiable, as well as non-modifiable, factors affecting hospital LOS after SG. Preoperative factors associated with early discharge included lower BMI, White race, being married, private insurance status, and having a lower creatinine. The early discharge group was also less likely to have undergone UGI swallow and likely had their operation start before noon. Importantly, the early discharge group incurred a significantly lower hospital cost, and the rate of postoperative complications and readmission were significantly higher in the late discharge group. Finally, logistic regression analysis demonstrated that higher BMI, higher preoperative creatinine, and having undergone UGI swallow on POD1 were all predictors of late discharge. In contrast, increasing institutional experience and early case start were predictors of early discharge.

Prolonged LOS after surgery is a major burden on the healthcare system both in terms of cost and resource utilization [7, 10, 11]. In one recent study of patients undergoing orthopedic surgery, it was estimated that one additional day of hospitalization incurred an additional cost of $2000 [12]. Recently, the creation of fast-track, or "enhanced recovery" pathways after surgery have sought to reduce LOS and cost

Table 2. Outcomes and complications

Variable	LOS (≤ 1 days) ($n = 123$)	LOS (> 1 days) ($n = 244$)	*P* value
Length of stay	1 [0]	2 [1]	
Upper GI swallow	13 (10.6%)	116 (47.5%)	*< 0.0001*
AM start (before noon)	89 (72.4%)	145 (59.4%)	*0.02*
Operative time (minutes)	95.0 [39.0]	101.5 [47.5]	0.24
Hospital cost (dollars)	$9744.5 ± $3399.1	$13,587.4 ± $7951.1	*< 0.0001*
Leak	0 (0%)	2 (0.8%)	0.55
DVT	0 (0%)	3 (1.2%)	0.55
Bleed	0 (0%)	15 (6.2%)	*0.003*
Acute renal failure	0 (0%)	0 (0%)	
Readmission	5 (4.1%)	27 (11.1%)	*0.03*
Mortality	0 (0%)	0 (0%)	

Postoperative outcomes and complications between the early and late discharge groups undergoing SG. Length of stay and operative time are expressed as median [interquartile range]. All other variables are expressed as *n* (%). The threshold for significance was set at $P < .05$. Significant variables are in italics. *LOS* length of stay, *DVT* deep vein thrombosis

Table 3 Multivariate logistic regression

Parameter	Odds ratio	95% confidence interval		*P* value
Age (years)	1.0	1.0	1.0	0.43
BMI (kg/m^2)	1.0	1.0	1.1	*0.01*
Female	2.0	1.0	4.0	0.07
White	0.2	0.1	0.5	*< 0.001*
Married	1.0	0.6	1.9	0.97
ASA 3 or 4	1.1	0.6	1.9	0.76
Tobacco	0.8	0.4	1.8	0.65
Institutional experience (per year)	0.5	0.4	0.7	*< 0.001*
AM start (before noon)	0.5	0.3	0.9	*0.02*
Private insurance status	0.9	0.5	1.7	0.72
Diabetes mellitus	1.0	0.6	2.0	0.90
Creatinine	9.8	1.6	59.0	*0.01*
Driving distance (10 miles)	1.0	0.9	1.0	0.17
Operative time (minutes)	1.0	1.0	1.0	0.95
Upper GI swallow	3.6	1.7	7.8	*0.001*

c-statistic = 0.8

Factors predictive of late discharge. Modifiable factors predictive of late discharge include operative start time and upper GI swallow. The threshold for significance was set at $P < .05$. Significant variables are in italics. *LOS* length of stay, *BMI* body mass index, *ASA* American Society of Anesthesiologists

while delivering high-quality surgical care [6–11]. The present study demonstrated prolonged LOS after SG incurs an average additional total hospital cost of $4000. Furthermore, we demonstrated a number of non-modifiable, as well as modifiable, patient factors which could be critical components in developing successful clinical care pathways after sleeve gastrectomy.

We demonstrated that a number of factors leading to prolonged LOS after SG are non-modifiable elements including medical comorbidities and patient characteristics. These included ASA classification, creatinine, and BMI. These findings were consistent with non-modifiable factors found to affect LOS in studies of patients undergoing other surgical procedures, including RYGB [9, 13]. Additionally, we showed that some non-modifiable social risk factors affect LOS. One of these factors was being married, which is an indirect measure of social support at home. It has previously been shown that patients with robust support systems available after discharge have a shorter hospital LOS after surgery [14]. In our study, White race and insurance status were also associated with early discharge, which is a consistent finding with previous studies [9, 13, 15]. These two variables represent socioeconomic status and highlight a continued disparity among surgical populations.

We demonstrated that early case start-time was a significant predictor of early discharge. This was likely due to longer in-hospital postoperative recovery time on POD0 compared to patients who underwent surgery late in the day. It is likely, therefore, that planning an early start time for patients expected to be discharged on POD1 could significantly increase the success of early discharge in this group. For example, if a surgeon were to schedule his/her sleeve gastrectomy's to start early in the day and follow with different cases such as RYGB or hernia repairs (where the expected discharge date is greater than POD1), it is more likely the sleeve gastrectomy patients would be ready for discharge on POD1.

Institutional experience was associated with early discharge. As we became more comfortable with SG, patients were more likely to have a shorter LOS. This finding is consistent with other studies that have shown that LOS after SG decreases as surgeon experience increases [16]. Forgoing upper gastrointestinal swallow study on POD1 was also predictive of early discharge. Studies have shown that routinely performing upper gastrointestinal swallow study after SG is unnecessary, does not improve safety, and leads to increased cost [17, 18]. Ultimately, modifiable risk factors such as case start-time and postoperative swallow study need to be optimized in pathway-driven care.

There are a number of limitations to the present study including its retrospective nature precluding the proof of causality. The event rate of postoperative leak was very low in our population and therefore was not an independent predictor of length of stay. However, it is likely that given a larger population, LOS would be significantly longer in those with postoperative leak. Additionally, we are limited to data captured through the ACS NSQIP database and hospital billing data from a single institution. It could therefore not be fully representative of the national population. Improved national databases that capture not only a broader population of patients undergoing SG but expanded financial and operating room

timing data, justification for UGI, and patient-reported outcomes would ideally provide more conclusive data regarding early discharge after SG.

Conclusion

Long LOS after surgery increases cost and resource utilization. There are many non-modifiable risk factors that affect LOS after sleeve gastrectomy. These include both patient health and socioeconomic status. Some factors are modifiable such as case order and postoperative care protocols. Optimization of these factors may allow for improvement in postoperative pathways, resulting in reduced LOS.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

Ethical Approval The study was retrospective. This article does not contain any studies with human participants or animals performed by any of the authors. For this type of study formal consent is not required.

Informed Consent Does not apply. Exempt from IRB review with waiver of consent. IRB#1880.

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