Obesity Surgery, ***15****, 1104-1110*

Laparoscopic Roux-en-Y Gastric Bypass: Differences in Outcome between Attendings and Assistants of Different Training Backgrounds

Gloria P. Hsu, BS; John M. Morton, MD, MPH, FACS; Li Jin, BS; Bassem Y. Safadi, MD, FACS; Thomas S. Satterwhite, BS; Myriam J. Curet, MD, FACS

Department of Surgery, Stanford University School of Medicine, Stanford, CA, USA

Background: Laparoscopic Roux-en-Y gastric bypass (LRYGBP) is associated with a significant learning curve. We hypothesize that differences in surgeon and assistant training backgrounds may significantly impact outcomes during the learning curve.

Methods: Retrospective analysis was performed on patients undergoing LRYGBP at an academic medical center between January 1998 and August 2003. Operations were performed by surgeons with different training backgrounds: without formal laparoscopic fellowship (S1, n=95); immediately following laparoscopic fellowship (S2, n=100); and with extensive laparoscopic experience post fellowship (S3, n=88). First assistants were attendings, fellows, or residents. The variables analyzed included demographics, operative times, estimated blood loss (EBL), rate of conversion, length of stay (LOS), ICU stay, re-operation/re-admission rate, and complications. Results were analyzed by ANOVA and Fisher's exact test.

Results: There were significant differences among surgeons of different training backgrounds in EBL, LOS, rate of ICU admission, and intraoperative and late complications rates. Among assistants of different training levels, there were significant differences in operative time, EBL, intraoperative complication rates and re-admission rates.

Conclusions: Differences in training background of the surgeons resulted in significant differences in outcome, including EBL, LOS, ICU admission and intraoperative and late complication rates. Lower assistant training levels significantly impacted efficiency through lengthened operative times and increased EBL, as well as increased intraoperative complication rates and re-admission rates. Our results suggested that participating in a laparoscopic fellowship and operating with a more experienced assistant may improve outcomes during the learning curve.

Key words: Morbid obesity, laparoscopic gastric bypass, outcomes, training

Reprint requests to: Myriam J. Curet, MD, FACS, Department of Surgery, H3680, Stanford University, 300 Pasteur Dr., Stanford, CA 94305, USA. Fax: 650-736-1663;
e-mail: mcuret@stanford.edu

Introduction

Laparoscopic Roux-en-Y gastric bypass (LRYGBP) is a technically demanding operation, with a prolonged learning curve similar to that of other complex laparoscopic operations.[1-3] Because of the morbidity and mortality possible during the learning period, any factors that can be modified to improve outcomes can potentially be of great benefit to the patient. Learning curves for LRYGBP have been defined variously as 75, 100, and 150 cases, with longer operative times and higher morbidity rates during the early part of the learning curve.[4-8] To date, several studies have examined the potential impact of fellowship training on the learning curve for LRYGBP,[8,9] finding that laparoscopic gastric bypass fellowship training improves perioperative outcomes and decreases operative times during a surgeon's early experience with LRYGBP. Another recent study has demonstrated that operative times are increased when residents are operative assistants.[10]

In light of what is not known about the outcomes of attendings operating with residents while themselves in the learning curve of a new operation, it seems useful to evaluate whether the training level of the assistant and the training background of the attending are important determinants of patient outcomes during the learning curve. In this study, a unique situation exists where three groups of surgeons with different laparoscopic training backgrounds began their LRYGBP experience at the same institution during discrete time periods, while operating with first assistants of different training levels. As a result, among the many factors likely involved in the determination of perioperative outcomes during the learning curve of LRYGBP, we

 © FD-Communications Inc.

chose to look specifically at the impact of different surgeon and assistant training backgrounds.

Methods

A retrospective analysis was performed on patients undergoing LRYGBP at an academic medical center between January 1998 and August 2003. Data were collected retrospectively from office charts and hospital records. Patient parameters recorded included age, gender, date of surgery, preoperative body mass index (BMI), number of prior abdominal surgeries, American Society of Anesthesiologists (ASA) class, and number of co-morbidities (Co-morbidities recorded included anemia, hypercholesterolemia/hypertriglyceridemia, hypothyroidism, renal insufficiency, depression, hypertension, obstructive sleep apnea, gastroesophageal reflux disease, stress incontinence, degenerative joint disease/arthritis, asthma, peripheral edema, other co-morbidities as appropriate, and the presence of lung or heart disease by pulmonary function tests or echocardiography).

Operative parameters recorded included surgeon, first assistant, concomitant operations, operative time, estimated blood loss, conversion to open operation, retrocolic versus antecolic Roux limb, and major intra-operative complications. Other parameters recorded included length of hospital stay, length of ICU stay, intraoperative complications, early major complications occurring during hospital stay, late major complications occurring after discharge within 30 days postoperatively, and whether patients required a postoperative esophagogastroduodenoscopy (EGD) or dilatation. Patients with a history of prior bariatric procedures were excluded. The remaining patients all met the National Institutes of Health guidelines of BMI >40 kg/m^2 or BMI 35-40 kg/m^2 with a major morbidity.[11] In addition, all patients met our bariatric surgery program's strict screening criteria and underwent our extensive preoperative educational program.

Operations were performed by surgeons with different training backgrounds: Surgeon 1 (S1, January 1998 to June 2001, n=95) did not undergo a formal laparoscopic fellowship; after laparoscopic mentorships, S1 had extensive experience in advanced foregut laparoscopic surgery, including laparoscopic cholecystectomies, Nissen fundoplications, paraesophageal hernia repairs and splenectomies. S1 then performed 11 open RYGBP operations before performing his first LRYGBPs. Surgeon 2 (S2, February 2001 to June 2002, n=100) started her bariatric fellowship with S1 after S1 had been doing LRYGBPs for 2.5 years. Initially, S2 assisted S1. Then, S2 performed the small bowel portion of the operation under supervision. Next, S2 performed the gastric portion of the operation under supervision and eventually performed six entire LRYGBPs under supervision before completing the fellowship. S2 then began operating autonomously immediately following the 1-year fellowship. Surgeons 3a and 3b (S3, July 2002 to August 2003, n=88) each underwent a general laparoscopic fellowship and had extensive broad-based advanced laparoscopic experience following the fellowship, including laparoscopic cholecystectomies, appendectomies, fundoplications, paraesophageal hernia repairs, inguinal and ventral hernia repairs, splenectomies and colectomies, before undertaking LRYGBPs. Because we are comparing training backgrounds, and S3a and S3b both had similar training, the data for surgeons 3a and 3b were combined for analysis (S3).

There was little variation in surgical technique between the surgeons, with the exception of preferences for retro-colic versus ante-colic Roux (S1 and S2 predominantly performed retro-colic bypasses, whereas S3a and S3b both started with predominantly retro-colic bypasses before switching to predominantly ante-colic bypasses). All surgeons used Higa's technique of a 2-layered hand-sewn gastrojejunostomy, stapled jejunojejunostomy with hand-sewn enterotomy, and manually closed the mesenteric defects.[6]

First assistants were attendings (n=84), fellows (n=39), or residents (n=158). Of note, S1 mainly operated with residents until S2 started her fellowship. S2 operated mainly with residents and did not have a fellow. S3a and S3b assisted S2 on 23 cases before starting to do cases on their own; they initially assisted each other, before starting to operate with residents and fellows.

Results were analyzed separately by surgeon and assistant levels with Fisher's exact test for categorical variables and ANOVA for continuous variables using SAS (version 8, Cary, NC). *P*-values were considered significant at $P<0.05$. Independent variables were defined as age, BMI, number of co-mor-

bidities, number of previous abdominal surgeries, gender, ASA class, antecolic vs retrocolic, and concomitant operations. Dependent or outcome variables were defined as the operative time, EBL, LOS, conversion, intra-operative complications, early complications, late complications, ICU stay, re-operation, re-admission, and postoperative EGD/dilatation rates. All analysis results were corrected for possible confounding independent variables by regression analysis.

Results

Patient Demographics

Overall, patients were predominantly female (86%). On average the patients were 42 years old (range 20-63), had a BMI of 47 kg/m^2 (range 33.4-80.4), 6 co-morbidities (range 1-16), 1 prior abdominal surgery (range 0 to 16), and 52.6% of the patients had an ASA class of 3 or above.

Most patient parameters were non-significant across surgeons, with the exception of S1's patients having a higher average BMI (50.6 vs 45.6 and 45.2, $P<0.0001$), and S2's patients having a higher number of recorded morbidities (6.8 vs 5.4 and 5.2, $P=0.0002$; Table 1). There were no significant differences in gender, average age, ASA class, or number of prior abdominal surgeries among surgeons. Demographics were non-significant among assistants of different training levels.

Significant Differences across Surgeons

There were significant differences among surgeons of different training backgrounds in EBL, LOS, ICU admission and intraoperative and late complications rates (Table 2). Further analysis among surgeons showed that S1 had higher ICU admission, intraoper-

Table 1. Average patient demographics across surgeons

	Surgeon 1	Surgeon 2	Surgeon 3	*P*-value
Age (years)	43	41	42	NS
Gender (% female)	81	87	90	NS
Preoperative BMI (kg/m^2)*	50.6	45.6	45.2	<0.0001
ASA Class	2.6	2.5	2.5	NS
Co-morbidities*	5.4	6.8	5.9	0.0002
Prior Abdominal Surgeries	1.3	1.1	1.2	NS

*Asterisk indicates statistically significant difference across surgeons ($P<0.05$)

Table 2. Outcomes across surgeons (ANOVA analysis)

	S1 (n=95)	S2 (n=100)	S3 (n=88)	*P*-value
Conversion Rate (%)	5.3	2	0	NS
Operative Time (minutes)	185	188	177	NS
Estimated Blood Loss (cc's)*	71.9	38.2	54	<0.0001
Length of Stay (days)*	3.1	2.4	2.8	0.0004
ICU admission Rate (%)*	10.5	0	1.14	1.053E-04
Intra-op Complications (%)	14.7	5.0	3.4	0.003
Early Complications (%)	7.4	3.0	3.4	NS
Late Complications (%)*	12.6	2.0	3.4	0.003
Re-operative Rate (%)	16.9	10	6.8	NS
Re-admission Rate (%)	23.2	16	14.8	NS

*Asterisk indicates statistically significant difference across surgeons ($P<0.05$)

ative and late complications rates than either S2 or S3, and that S2 had a lower EBL and LOS than either S1 or S3. No significant difference was found in conversion, operative time, re-operation, or early complication rates among any of the surgeons (Table 3). No deaths were noted in any of the surgeon groups.

Significant Differences among Assistants

Among assistants of different training levels, there were significant differences in operative time, EBL, re-admission rates and intraoperative complication rates (Tables 3 and 4). Operating with a resident as first assistant during the learning curve appears to add 14 minutes to the operative time compared to operating with an attending, or 22 minutes compared to operating with a fellow. The re-admission rates and intraoperative complication rates are highest when operating with a resident.

Discussion

The learning curve for the LRYGBP has been defined by Schauer et al[4] as 100 cases, and by Oliak et al[5] as 75 cases during which there are significantly higher major complication rates and significantly longer operative times. We chose to study the first 88-100 cases performed by three groups of surgeons with different training backgrounds, in order to determine: 1) whether the difference in backgrounds led to a difference in outcomes during the learning curve, and 2) whether the training level of the first assistant is of any significance in patient outcomes during the learning curve.

There were few differences in patient demographics among the patients of the three surgeon groups, and none among those of the assistant groups. While S1 did have a higher average preoperative BMI group, the difference in the number of co-morbidi-

Table 3. Complications

	S1	S2	S3
Intraoperative	Leak (2) Transected orogastric tube (3) Splenic injury (2) (F-1) Pancreatic injury (F) Incomplete staple-line Redo gastrojejunostomy Redo jejunojejunostomy Incomplete gastric transaction (2) Gastric injury TOTAL: 14	Leak Redo jejunojejunostomy (2) Redo gastrojejunostomy (1) (A) Splenic injury TOTAL: 5	 Redo gastrojejunostomy (A) Redo jejunojejunostomy (A) Leak (A) TOTAL: 3
Early	SBO Leak (3) Kinked jejunojejunostomy (2) Mesenteric hernia (F) TOTAL: 7	Leak (2) (A-1) Incomplete staple-line TOTAL: 2	Incarcerated incisional hernia (A) Bleeding SBO (A) TOTAL: 3
Late	Fistula Umbilical hernia Mesenteric hernia (5) (F-1) Abscess SBO Bleeding Stricture Leak TOTAL: 12	Gastro-gastric fistula Perforation TOTAL: 2	Kinked jejunojejunostomy (A) SBO (A) Stricture (A) TOTAL: 3

F=Fellow; A=Attending; If not marked, then resident involved

Table 4. Outcomes among assistants (ANOVA analysis)

	Attending (n=84)	Fellow (n=39)	Resident (n=158)	*P*-value
Conversion Rate (%)	0	0	4.43	NS
Operative Time (minutes)*	177	169	191	0.014
Estimated Blood Loss (cc's)*	43.7	56.7	60	0.0051
Length of Stay (days)	2.58	2.36	2.92	NS
ICU admission Rate (%)	1.19	5.13	5.06	NS
Intra-op Complications (%)	4.8	5.1	10.1	0.048
Early Complications (%)	2.4	2.6	5.7	NS
Late Complications (%)	3.6	2.6	8.2	NS
Re-operative Rate (%)	6.2	10.3	14	NS
Re-admission Rate (%)*	11.9	2.56	18.35	0.0238

*Asterisk indicates statistically significant difference among assistants ($P<0.05$)

ties for S2's patients was likely at least partially attributable to differences in the stringency of record-keeping. Thus, we feel that the patient populations of the three groups of surgeons and assistants were sufficiently similar for a fair comparison, especially because all analyses were done while controlling for potential confounding variables. We chose to look at perioperative patient outcomes rather than patient outcomes in terms of weight loss, co-morbidity, or patient satisfaction, because we feel that operative outcomes are more directly reflective of surgeon skill and training, while the other factors are more dependent on confounding factors from the patient and follow-up perspective.

The most significant findings between surgeons were the difference in ICU admission and both intraoperative and late complication rates. In contrast to Ballantyne's findings,[9] we found that fellowship training did not result in shorter operative times. In accordance with Oliak et al's findings,[8] our results demonstrate that the surgeon who did not undergo a formal fellowship had higher complication rates. While there are data suggesting that patients with BMI's ≥60 kg/m^2 (super-super-obese patients) are at risk for more postoperative complications,[12] an analysis of S1's morbidly obese and super-obese patients compared to his super-super-obese patients during the learning curve showed no significant difference in outcomes between the two groups (Table 5). Thus, it would appear that S1's higher average preoperative BMI was not a major factor in determining the difference in his elevated ICU admission and late complication rates. This study does not take into account the advances in laparoscopic skill and knowledge in the overall surgical community between the periods from January 1998, when S1 first started practising laparoscopic surgery, to July 2002, when S3 started performing LRYGBPs. Hence, while the result of our analysis suggests that there may be a tangible improvement in outcomes with fellowship training, we cannot rule out the possibility that the improvements that we see are actually reflective of an overall improvement by the entire bariatric surgery community. Likewise, differences in ICU admission rates may reflect changes in postoperative management instituted as it became

Table 5. Outcomes of morbidly and super-obese vs super-super-obese patients

	Morbidly and Super-Obese (n=80) (BMI <60)	Super-Super-Obese (n=15) (BMI ≥60)	*P*-Value
Intraoperative complications	10	4	NS
Early complications	6	1	NS
Late Complications	10	2	NS
Re-operation rate (%)	17.5	13.3	NS
Re-admission rate (%)	25.0	13.3	NS

apparent that the majority of patients did not require ICU admission postoperatively.

Finally, S1 had the responsibility of instituting and developing the multidisciplinary program, which was fully functional and very experienced by the time S2 and S3 became part of the program. The program was in its infancy when S1 was doing his first cases. Differences in the thresholds for accepting patients, discharging patients home, transferring patients to ICU or for readmissions may simply reflect caution and inexperience of these protocol-driven issues. Some of the differences in outcomes may have been due to the learning curve of the program rather than the training of the surgeon.

Otherwise, there was little difference in outcomes among surgeons. Differences in surgeon training backgrounds appeared to give significant differences in EBL and LOS. However, considering the sizeable variation in recording EBL, and the habit of individual surgeons to record different volumes as their minimal blood loss, it is debatable whether the difference in EBL, while statistically significant, is actually a clinically significant result. The difference in LOS is likewise secondary to surgeon preference as well as changing institutional guidelines pursuant to insurance policies over the course of the years, and thus is likewise not clinically significant. Consequently, the main conclusion of our analysis for surgeons of different training backgrounds is an ambiguous one: fellowship training may improve patient outcomes after LRYGBP. In contrast, Oliak et al[8] felt strongly that laparoscopic gastric bypass fellowship training improved perioperative outcomes, specifically operative times and complication rates, during a surgeon's early experience with LRYGBP.

We found that differences in assistant training levels led to significant differences in EBL, operative time, intraoperative complication rates and readmission rates. The same question of clinical significance applies to the difference in EBL. The lengthened operative time potentially carries more clinical significance, in association with the incremental risk involved in prolonged anesthesia, and the impact on efficiency and turnover rate in the operating-room. Our results were consistent with a recent study detailing the "cost" in operative times for attendings operating with residents.[10] Expanding upon the findings of that paper, we were able to find that operating with residents during the learning curve of the attending not only added time to the operation, but also increased intraoperative complication and re-admission rates as well. However, our study did not address the exact mechanism of this difference in re-admission rates. Neither do we address whether there are any differences in outcome in operating with assistants of differing training levels after the learning curve period.

Conclusions

Our results suggest that laparoscopic fellowship training may improve outcomes during the learning curve of LRYGBP. In addition, our results suggest that operating with a more experienced assistant may significantly improve efficiency and outcomes during the learning curve of LRYGBP. Working specifically with a bariatric fellow may further improve efficiency and decrease re-admission rates. Although LRYGBP has been shown to have acceptable levels of morbidity and mortality overall, our data suggest that additional training and operating with a more experienced assistant can help maximize outcomes during the learning curve.

References

1. Cusick RA, Waldhausen JH, The learning curve associated with pediatric laparoscopic splenectomy. Lakartidningen 2001; 181: 393-7.
2. Voitk AJ. The learning curve in laparoscopic inguinal hernia repair for the community general surgeon. Chirurgia (Bucur) 1998; 41: 446-50.
3. Watson DI, Baigrie RJ, Jamieson GG. A learning curve for laparoscopic fundoplication. Definable, avoidable, or a waste of time? J Laparoendosc Surg 1996; 224: 198-203.
4. Schauer P, Ikramuddin S, Hamad G et al. The learning curve for laparoscopic Roux-en-Y gastric bypass is 100 cases. Surg Endosc 2003; 17: 212-5.
5. Oliak D, Ballantyne GH, Weber P et al. Laparoscopic Roux-en-Y gastric bypass: defining the learning curve. Surg Endosc 2003; 17: 405-8.
6. Higa KD, Boone KB, Ho T et al. Laparoscopic Roux-en-Y gastric bypass for morbid obesity: technique and

preliminary results of our first 400 patients. Arch Surg 2000; 135: 1029-34.
7. Suter M, Guisti V, Heraief E et al. Laparoscopic Roux-en-Y gastric bypass: initial 2-year experience. Surg Endosc 2003; 17: 603-9.
8. Oliak D, Owens M, Schmidt HJ. Impact of fellowship training on the learning curve for laparoscopic gastric bypass. Obes Surg 2004; 14: 197-200.
9. Ballantyne GH, Ewing D, Capella RF et al. The learning curve measured by operating times for laparoscopic and open gastric bypass: roles of surgeon's experience, institutional experience, body mass index and fellowship training. Obes Surg 2005; 15: 172-82.
10. Babineau TJ, Becker J, Gibbons G et al., The "cost" of operative training for surgical residents. Arch Surg 2004; 139: 366-70.
11. Gastrointestinal surgery for severe obesity. National Institutes of Health Consensus Development Conference Draft Statement. Obes Surg 1991; 1: 257-66.
12. Oliak D, Ballantyne GH, Davies RJ et al. Short-term results of laparoscopic gastric bypass in patients with BMI ≥60. Obes Surg 2002; 12: 643-7.

(Received May 18, 2005; accepted June 8, 2005)