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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

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Background: Surgeons must overcome a substantial learning curve before mastering laparoscopic Roux-en-Y gastric bypass (LRYGBP). This learning curve can be defined in terms of mortality, morbidity or length of surgery. The aim of this study was to compare the learning curves in terms of surgical time for the first 3 surgeons performing LRYGBP in our hospital with the length of surgery for open gastric bypass (CONTROLS).

Methods: We compared 494 primary LRYGBPs performed by 3 surgeons (393 by 1st SURGEON, 57 by 2nd SURGEON and 44 by 3rd SURGEON) to 159 open vertical banded gastroplasty-Roux-en-Y gastric bypasses (CONTROLS). Data for LRYGBP patients were prospectively recorded while those for CONTROLS were retrospectively obtained. Factors that significantly affected the length of surgery were identified by univariate and multivariate linear regression analysis.

Results: LRYGBP and CONTROL patients were similar in age, height, weight and BMI, although more CONTROLS were male. Median time for the 1st SURGEON performing LRYGBP dropped for each subsequent 100 operations: 1st 100 – 190 min, 2nd 100 – 135 min, 3rd 100 – 110 min and 4th 100 – 100 min. Median time for the 2nd SURGEON performing LRYGBP was 120 min, 3rd SURGEON 173 min and CONTROLS 64 min. Length of surgery significantly correlated with surgical experience in terms of number of operations and BMI of patient. Times for 2nd SURGEON, a fellowship trained laparoscopic surgeon, started significantly faster than 1st SURGEON's, but did not significantly improve with experience. 3rd SURGEON's initial times were similar to 1st SURGEON's, but his times improved more rapidly with experience. Times for CONTROLS were significantly faster than all laparoscopic groups and did not correlate with operation number or patient BMI.

Conclusions: The length of surgery for LRYGBPs continued to shorten beyond 400 operations for the first surgeon performing LRYGBP in our hospital. Previous fellowship training in LRYGBP shortened surgical times during initial clinical experience as an attending for the second surgeon. The learning curve for a subsequent experienced laparoscopic surgeon was truncated because of the already established LRYGBP program.

Key words: Morbid obesity, bariatric surgery, laparoscopic gastric bypass, Roux-en-Y, learning curve

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Introduction

Gastric bypass has been the most commonly performed weight reduction operation in the United States since at least 1990. Wittgrove, Clark and Tremblay performed the first laparoscopic Roux-en-Y gastric bypass (LRYGBP) on October 27, 1993 in San Diego.[2] Since then, there has been considerable debate on the number of cases required for a surgeon to master this difficult laparoscopic technique. This number seems to vary, based on the criteria used to define the learning curve. Schauer and colleagues,[3] for example, proposed that the learning curve for LRYGBP was 100 cases, based on a drop of technical complications by 50% after 100 operations. In an earlier publication, we observed that mortality and complications rates plateaued after 75 operations but that surgical times for LRYGBP continued to decline well after this number of procedures.[4] Cottam and colleagues[5] suggested that the time required to perform a laparoscopic gastric bypass decreased with greater surgeon's experience but lengthened with greater patient body mass index. Wittgrove and Clark,[6] for example, stated that their operative times approached 90 minutes only after 400 LRYGBPs. These results suggest that the length of the learning curve for LRYGBP varies when one considers different end-points such as rates of complications or length of surgery.

In this paper, we attempted to identify factors that affected the length of surgery for three surgeons during their initial experience with LRYGBP at Hackensack University Medical Center. Two of these surgeons were experienced laparoscopic surgeons before attempting LRYGBP, and the third recently graduated from a laparoscopic surgery fellowship in which he was trained in performing LRYGBP. We hypothesized that subsequent surgeons performing LRYGBP in the same hospital would experience a shorter learning curve than the first surgeon and that laparoscopic fellowship training in performing LRYGBP would also shorten the learning curve. Our specific aims were: 1) to define the learning curve for the first surgeon to perform LRYGBP in terms of length of surgery from incision to placement of the dressing during the introduction of LRYGBP into clinical practice; and 2) to identify any changes in the learning curve for subsequent surgeons who initiated their clinical practice of this operation in our hospital. In this study, we used consecutive primary open gastric bypasses performed by an extremely experienced team of bariatric surgeons as a control group for statistical comparisons. This study indicated that surgeon's experience and patient's body mass index significantly affected length of surgery out to at least 400 LRYGBPs and that subsequent surgeons achieved a shorter learning curve than the first surgeon. Also, previous laparoscopic fellowship training favorably impacted this learning curve.

Methods

Four groups of patients were studied. These were: 1) the first 393 laparoscopic Roux-en-Y gastric bypasses (LRYGBP) performed by the attending surgeon (HJS) who developed this operation at our hospital (1st SURGEON); 2) the first 57 LRYGBPs done by the second attending surgeon (DD) who performed this operation at our hospital (2nd SURGEON); 3) the first 44 LRYGBPs done by the third attending surgeon (GHB) performing this operation (3rd SURGEON) at our hospital; and 4) 195 open vertical banded gastroplasty – Roux-en-Y gastric bypasses (CONTROLS) performed during a 6-month period, January through June 2002, by an extremely experienced team of bariatric surgeons (RFC & JFC). The surgical technique of CONTROLS has been published elsewhere in detail.[7,8] The surgical technique of 1st and 2nd SURGEON has been previously detailed.[4] Revisions of previous bariatric operations were excluded from analysis. Laparoscopic operations were defined on an intent-to-treat basis, i.e. laparoscopic operations converted to open operations were included as laparoscopic operations. Patient characteristics, obesity-related medical conditions, hospital length of stay, and length of surgery were entered into a database. Data for the laparoscopic patients were prospectively gathered while the patient characteristics for the open patients were gathered retrospectively from hospital charts. Length of surgery was prospectively recorded for all operations in a hospital database. The 393 operations for the first surgeon performing LRYGBP were divided into four groups of 100 patients for purposes of analysis: 1st 100, 2nd 100, 3rd 100 and 4th 100.

Statistical Analysis

The Z-statistic and pooled variance were used to establish significant differences ($P<0.05$) between unpaired proportions of gender or obesity-related conditions. Kruskal-Wallis one-way ANOVA established the presences of significant differences among multiple groups. Pairwise tests using Dunn multiple comparisons identified significant differences between individual groups when appropriate comparisons were made against the open VBG-

RYGBP groups as the controls. Univariate and multivariate linear analysis tested relationships between continuous variables. Correlation coefficients and t-statistics identified significant univariate linear relationships. Correlation coefficient for the multiple regression and ANOVA of regression using f-statistics identified significant multivariate regressions. Heterogeneity of regression tests identified the presence of significant differences between slopes, intercepts and regressions. The 95% Tukey-HSD interval identified significant differences between individual pairs of intercepts, and multiple comparisons using the 95% Dunett interval identified significant differences between pairs of slopes.

Results

Patient Characteristics

A total of 653 gastric bypass operations were available for analysis: 494 LRYGBPs and 159 open VBG-RYGBPs. Of the LRYGBPs, 1st SURGEON performed 393, 2nd SURGEON 57 and 3rd SURGEON 44. Overall, 20% (132) of the gastric bypass patients were male and 80% (521) female. All three of the LRYGBP groups had a greater proportion of women than the open CONTROL (VBG-RYGBP) group ($P<0.05$). Race information was available for 355 patients: overall 80% (284) were white, 14% (50) black and 6% (21) other. The proportion of blacks was greater for 3rd SURGEON (30%) than the other three groups ($P<0.05$). Ethnicity data was not available. Age and body mass index (BMI) stratified by surgeon are listed in Table 1. The patients of 3rd SURGEON were significantly younger, lighter and had significantly smaller BMIs than the patients for CONTROLS ($P<0.05$). 1st SURGEON's patients were older and had greater BMIs than 3rd SURGEON's patients ($P<0.05$). Other comparisons of age, height, weight and BMI were not significantly different.

The rates of obesity-related medical conditions for all 653 patients were: type 2 diabetes mellitus 17%; sleep apnea 20%; asthma 17%; chronic obstructive pulmonary disease 2%; hypertension 39%; hypercholesterolemia 13%; coronary artery disease 2%; deep venous thrombosis 2%; and depression 24%. The number of depressed patients was significantly greater for 3rd SURGEON (67%) as compared with the patients of the other surgeons ($P<0.05$). The number of patients afflicted by sleep apnea was significantly fewer for 2nd SURGEON (11%) and greater for 3rd SURGEON (27%) as compared with CONTROLS (24%; $P<0.05$).

Length of Surgery

The median lengths of surgery for the three laparoscopic surgeons and CONTROLS are listed in Table 2. The lengths of surgery for all laparoscopic groups were significantly slower than CONTROLS ($P<0.05$). The length of surgery for each succeeding 100 LRYGBPs by 1st SURGEON was significantly faster than the preceding 100 operations ($P<0.05$). The length of surgery for 1st SURGEON's 1st 100 LRYGBPs was significantly slower than for 2nd SURGEON ($P<0.05$) but not 3rd SURGEON ($P>0.05$). The length of surgery for 1st SURGEON's 4th 100 LRYGBPs was significantly ($p<0.05$) faster than those of 2nd SURGEON and 3rd SURGEON. The times of 2nd SURGEON and

Table 1. Age (years) and BMI (kg/m^2) for 653 patients who underwent LRYGBP stratified by surgeon. Three surgeons (1st SURGEON, 2nd SURGEON and 3rd SURGEON) performed 494 LRYGBPs while one pair of surgeons performed 159 open VBG-RYGBPs (CONTROLS)

	1st SURGEON		2nd SURGEON		3rd SURGEON		CONTROLS	
	AGE (yrs)	BMI	AGE (yrs)	BMI	AGE (yrs)	BMI	AGE (yrs)	BMI
N	393	393	57	57	44	44	159	159
MEDIAN	40	49	38	47	34*	46*	41	50
MINIMUM	18	36	23	37	20	37	18	35
MAXIMUM	69	86	62	72	60	55	66	82

*significantly different from CONTROLS ($P<0.05$).

Table 2. Length of surgery (TIME) in minutes for 653 gastric bypass operations. 393 LRYGBPs were performed by one surgeon and stratified in sequential groups of 100 patients: 1st 100, 2nd 100, 3rd 100 and 4th 100. 57 LRYGBPs (1st 57) were the initial LRYGBP done by a 2nd SURGEON and 44 LRYGBPs were the initial LRYGBPs performed by 3rd SURGEON. 159 open VBG-RYGBPs were constructed by a team of two experienced open bariatric surgeons (CONTROLS)

	1st 100 TIME	2nd 100 TIME	3rd 100 TIME	4th 100 TIME	2nd SURGEON TIME	3rd SURGEON TIME	CONTROLS TIME
N	100	100	100	93	57	44	159
MEDIAN	175	125	110	100	120	173	64
MINIMUM	20	83	60	35	82	105	40
MAXIMUM	384	356	295	165	370	433	143

* significantly different from CONTROLS ($P<0.05$).

3rd SURGEON were not significantly different ($P>0.05$). Thus, 1st SURGEON continued to shorten the length of surgery with each successive 100 operations.

Length of Surgery – Controls

The length of surgery in minutes did not significantly ($P=0.07$) change with successive operations for the CONTROLS (open VBG-RYGBP) operations. The length of surgery remained essentially parallel (slope 0.07) to the x-axis (Figure 1A). The length of surgery in minutes also did not significantly ($P=0.17$) correlate with the body mass index of the patients (Figure 1B).

Length of Laparoscopic Operations – Operation Number

The univariate regressions for each 100 cases of 1st SURGEON, 2nd SURGEON, 3rd SURGEON and CONTROLS are shown in Figure 2. The length of surgery significantly decreased with increasing number of operation for 1st SURGEON and 3rd SURGEON but not for 2nd SURGEON ($P=0.70$). The y intercepts for all laparoscopic groups were significantly greater ($P<0.05$) than the CONTROLS. The slopes for the 1st 100 LRYGBPs, 2nd 100 LRYGBPs and 3rd SURGEON were significantly steeper than the slope of the CONTROLS ($P<0.05$). The length of surgery for all 393 opera-

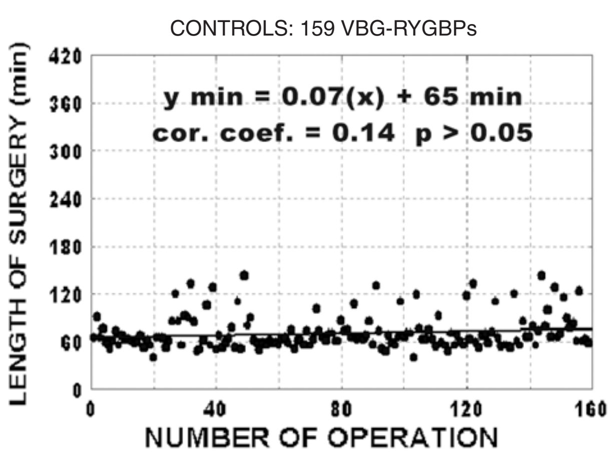

Figure 1A. Relationship between number of operation and length of operation in minutes for the CONTROLS: 159 VBG-RYGBPs performed by an experienced team of bariatric surgeons. The length of operation was consistent (parallel with the x-axis) and did not significantly correlate with the number of the operation.

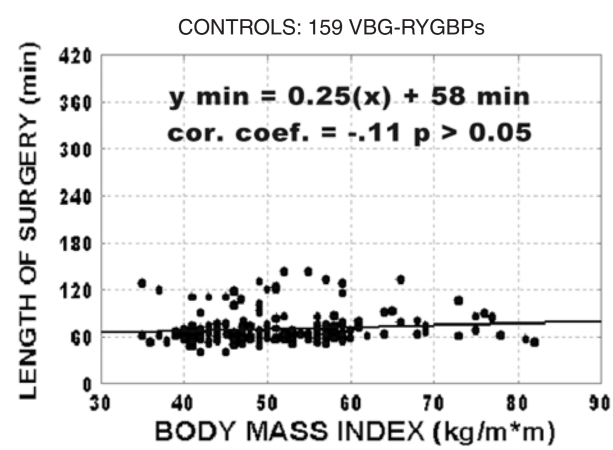

Figure 1B. Relationship between the BMI of the patient and the length of the operation in minutes for the CONTROLS: 159 VBG-RYGBPs performed by an experienced team of bariatric surgeons. Length of surgery remained consistent and did not correlate significantly with the BMI of the patients.

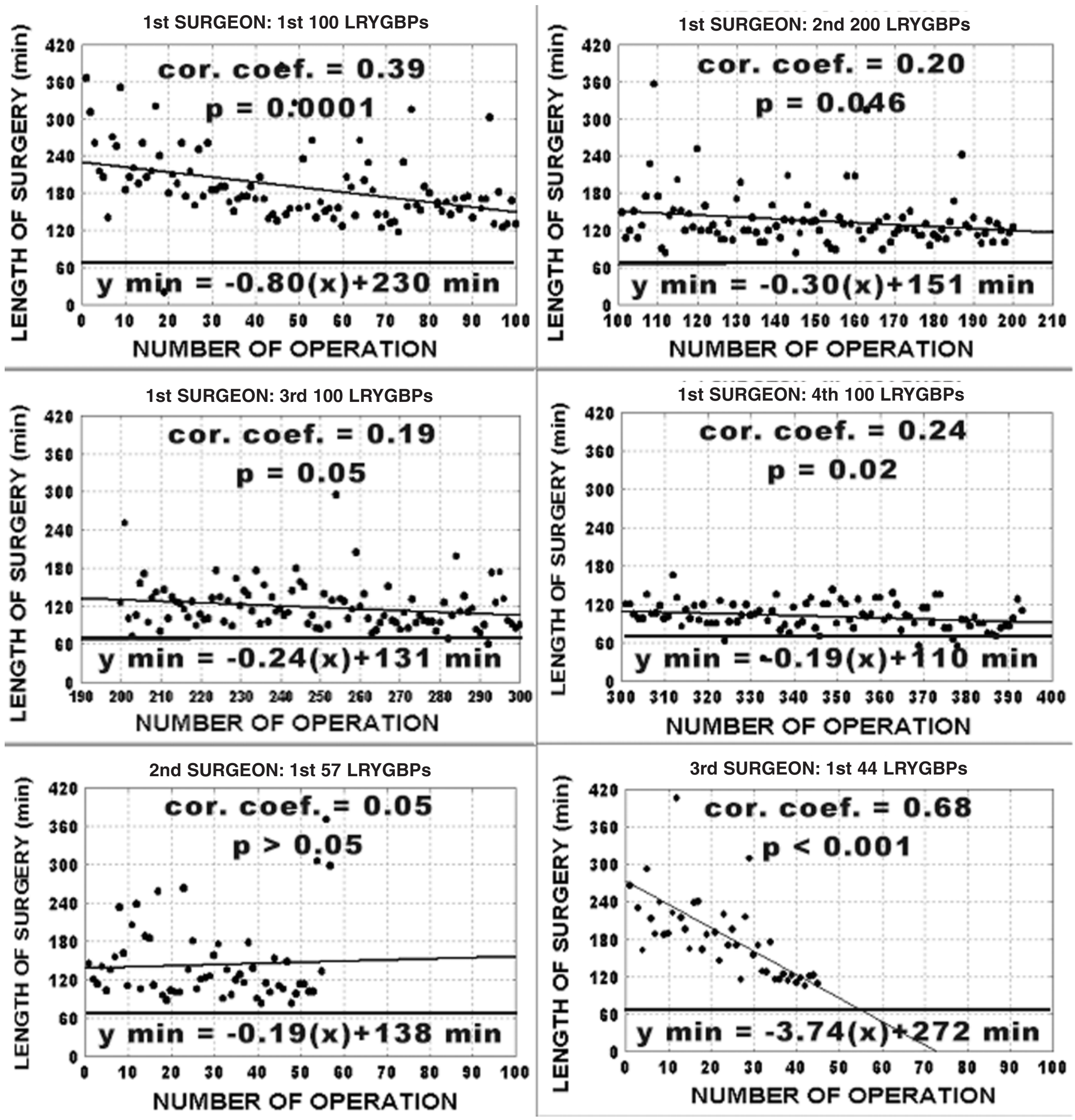

Figure 2. Linear relationships between number of operation and length of surgery for 493 patients who underwent LRYGBP stratified by three surgeons. The initial 393 LRYGBPs constructed by a single surgeon (1st SURGEON) are divided into four groups of 100 patients. Regression line for CONTROLS is indicated in each panel.

tions performed by 1st SURGEON significantly correlated with the number of the operation. The y intercept for each succeeding 100 cases for 1st SURGEON was significantly faster than the preceding 100 cases ($P<0.05$ by Tukey HSD interval). The slope of the 1st 100 cases was significantly steeper than the 3rd 100 and 4th 100 cases but not the 2nd 100 cases ($P<0.05$ by Tukey HSD interval). The slopes of 2nd SURGEON and 3rd SURGEON were significantly different from each other ($P<0.05$) but not from the other regressions ($P>0.05$).

Length of Laparoscopic Operatoins – Body Mass Index

Increasing BMI correlated with increasing length of surgery. BMI (kg/m^2) correlated with length of surgery in minutes for all 393 LRYGBPs performed by 1st SURGEON (Figure 3). The length of surgery for all laparoscopic groups except 3rd SURGEON significantly increased as the BMI of the patients increased (P<0.05). The y-intercepts for all laparoscopic groups were significantly different (P<0.05) from that of the CONTROLS. Only the slope of the

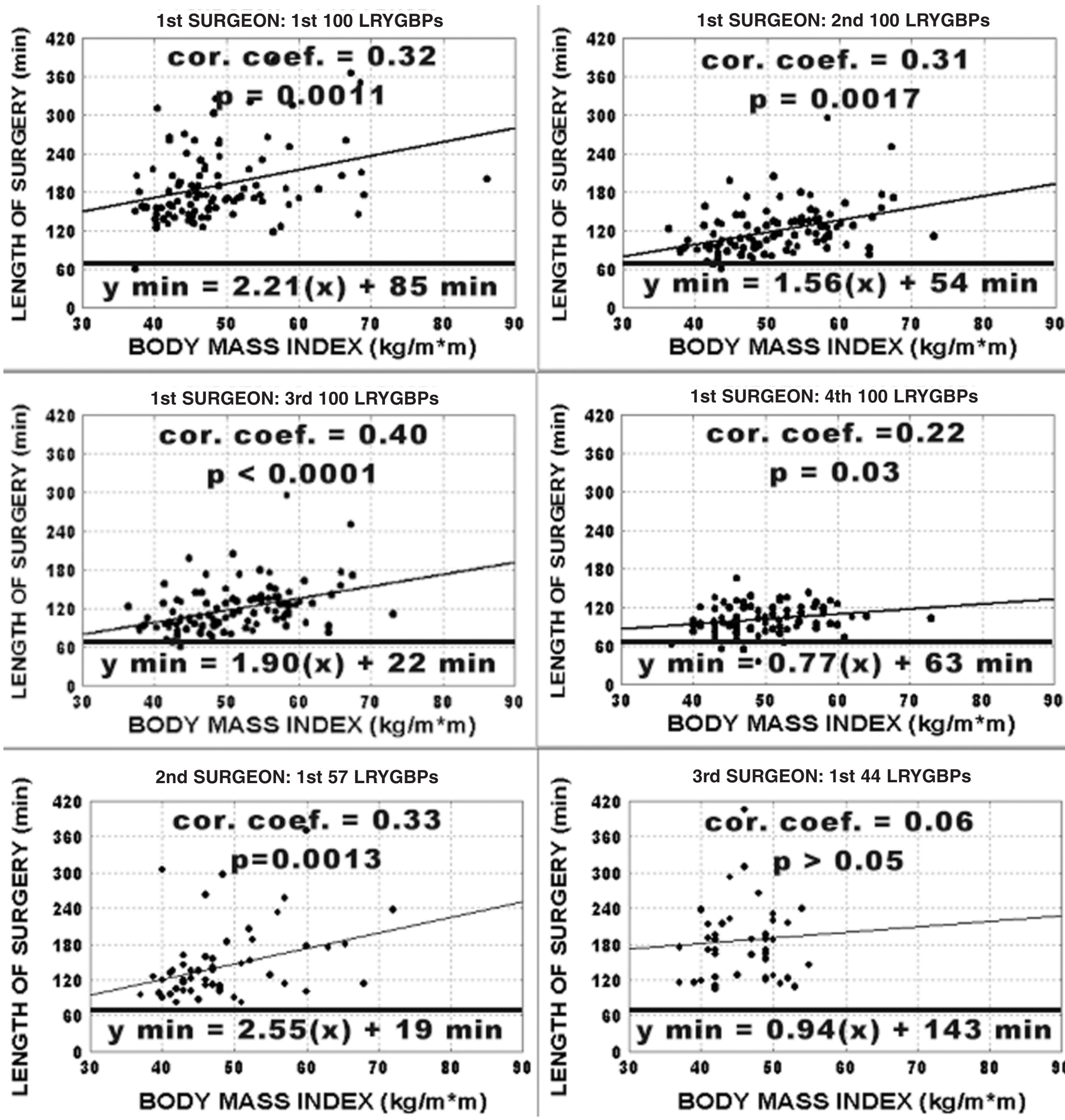

Figure 3. Linear relationship between BMI and length of surgery in minutes for the for 494 patients who underwent LRYGBP stratified by three surgeons. The initial 393 LRYGBPs constructed by a single surgeon (1st SURGEON) are divided into four groups of 100 patients.

1st 100 LRYGBPs for 1st SURGEON was significantly different ($P<0.05$) from the slope of the CONTROLS. Length of surgery consistently increased for all 393 LRYGBPs done by 1st SURGEON in relation to increasing BMI. The y-intercepts for each 100 operations for 1st SURGEON were significantly different but not in a consistent pattern. The slope for each successive 100 operations for 1st SURGEON became flatter but the differences were not significant ($P>0.05$). The slope of 2nd SURGEON and 3rd SURGEON were significantly different from each other ($P<0.05$) but not from the other regressions ($P>0.05$). These regressions demonstrated that BMI significantly increased the length of surgery for 1st SURGEON and 2nd SURGEON but not 3rd SURGEON.

Length of Surgery – Number of Operations

Multivariate regression analysis found significant correlations between number of operations and BMI with length of surgery. There was a significant correlation between the combination of operation number and BMI with length of all laparoscopic operations (F statistic 21.429; $P<0.0001$). Similarly, there were significant multivariate correlations between number of operations and BMI with length of surgery for each of the 100 operation groups for 1st SURGEON. The coefficient (slope) for number of operations increased from -0.78 to -0.18 and for BMI dropped from 2.12 to 0.71 from the 1st 100 operations to the 4th 100 operations. Neither number of operation nor BMI significantly correlated with length of surgery for SURGEON 2. Only number of operation significantly correlated in the multivariate equation for 3rd SURGEON. Overall experience of the surgeon and BMI of the patient correlated with length of laparoscopic operations, but the relationships varied with both experience and surgeon.

Discussion

In this study, we attempted to identify factors that impacted the operating time required to perform a laparoscopic Roux-en-Y gastric bypass (LRYGBP). We compared the length of surgery for 499 LRYGBPs done by 3 surgeons and 159 open gastric bypasses (VBG-RYGBP) accomplished by an experienced team of bariatric surgeons (CONTROLS). This proved an appropriate choice of a control group, because the lengths of the open operations were not affected by any continuous or categorical variable tested in this study. Patient characteristics and rates of obesity-related medical conditions were similar for open and laparoscopic patients. Linear regression analysis found that increasing experience of the surgeon, decreasing BMI of the patient and later month of the academic year (July-June) significantly correlated with shorter operative times for LRYGBPs. Our findings indicated that operating times continued to shorten for LRYGBP out to a surgeon's experience of at least 400 operations and that even after 400 operations laparoscopic operations remained longer than open gastric bypasses. Surgical times for the initial experience of a fellowship trained laparoscopic surgeon were significantly shorter than the initial LRYGBPs performed at our hospital. Initial operating times for a subsequent experienced laparoscopic surgeon were similar to the initial experience of the first surgeon but dropped more rapidly. Our results suggested that the learning curve for length of surgery was shorter for subsequent surgeons who initiated their clinical experience in a hospital with an established LRYGBP program.

We compared our laparoscopic gastric bypasses to a control group of 159 sequential, primary open gastric bypasses (VBG-RYGBP). An experienced team of two bariatric surgeons performed all the open gastric bypasses (RFC & JFC). The senior surgeon in this team (RFC) has limited his practice to bariatric surgery for three decades and has performed approximately 3,500 bariatric operations. This team has been performing open vertical banded gastroplasty - Roux-en-Y gastric bypass (VBG-RYGBP) together since 1997 and have done about 1,500 operations using exactly the same technique as described elsewhere. The laparoscopic and open gastric bypass patients were similar in age, height, BMI and obesity-related medical conditions. A greater percentage of open patients were male. The length of surgery for the control patients averaged 71 minutes, with a median of 64 minutes and range of 40 to 143 minutes. The length of surgery for the open VBG-RYGBPs did not significantly vary with increasing number of operations, age, sex, height, weight, BMI or presence of obesity-related medical conditions. This lack of variation reflected the large clinical experience of the two bariatric surgeons who performed these operations. They always operate together and have performed the same operation since 1993. No residents or laparoscopic surgery fellows participated in these operations. In addition, these operations were performed in the same operating rooms, during morning block-time and with the same operating room team.

The average length of surgery for our control group, 71 minutes, compared favorably to other published times for open gastric bypass. In randomized trials comparing open and laparoscopic gastric bypasses, Nguyen and colleagues[10] reported an average time of 200 minutes for 50 open gastric bypasses, and Westling and Gustavsson[11] reported an average of 100 minutes for 21 open gastric bypasses. In a series of 103 open gastric bypasses, Reddy and colleagues[12] averaged 117 minutes. Few publications on open gastric bypass, however, mention operative times. Surgical times were not generally a focus of interest in the pre-laparoscopy era even in randomized trials.[13-15]

LRYGBP is a difficult operation to master. The first 50 operations tend to take a prolonged period of time. At Hackensack, 1st SURGEON required an average of 209 minutes for the first 50 operations. When Wittgrove and Clark[16] pioneered LRYGBP starting in 1993, their first 27 operations required an average of 247 minutes. Schauer and colleagues[5] commenced their experience with LRYGBP at the University of Pittsburgh in 1997 and averaged 311 minutes for their first 50 cases. Teixeira and colleagues[17] required 275 minutes for their first 28 LRYGBPs, and, similarly, Papasavas and colleagues[18] achieved a mean of 272 minutes for their first 50 cases. De la Torre and Scott[19] averaged 199 minutes for 49 cases. Our experience and these published results indicate that a surgeon starting a new LRYGBP program at a hospital can expect to take an average of 3 to 4 hours during the first 50 operations.

Considerable attention has been devoted to the learning curve of this operation.[20,21] Length of surgery in minutes is one aspect of this learning curve. Table 3 lists the average surgical times for the first 200 LRYGBPs from 4 published series and also those of 1st SURGEON. The average times are listed for sequential groups of 50 operations. Average operative time for Schauer and colleagues[22] at the University of Pittsburgh dropped from 311 to 213 minutes. Average times at Ohio State University dropped from 185 minutes to 147 minutes; the first 50 cases in the series reported by Gould and colleagues[23] used a hand-assisted technique. At the Medical College of Ohio, Kligman and colleagues[24] dropped their times from 321 minutes in their first 40 cases to 168 minutes for cases 121-160. Times at Baylor University Medical Center decreased from 180 minutes for the first 50 cases to 108 minutes for the second 50.[25] Times in these series did not plateau. Times for 1st SURGEON continued to trend downward toward control levels even after 400 operations. In a series totaling 1,500 LRYGBPs, Higa, Ho and Boone reached a plateau very similar to our control group of about 60 minutes.[26,27] These series and the data presented here indicate that LRYGBP can be performed in times comparable to open gastric bypass but that a surgeon's length of surgery for LRYGBP continues to

Table 3. Learning curve of operating times for first 200 LRYGBPs from 4 published series compared with the first 200 operations by 1st SURGEON. Operations are stratified into groups of 50 operations

OPERATION NUMBER	1st SURGEON	SCHAUER[22]	GOULD[23]	KLIGMAN[24]	DRESEL[25]
1 - 50	209	311	185**	324***	180
51 - 100	171	227	143	225	108
101 - 150	141	237	152	190	
151 - 200	129	213*	147	168	

*operations 226-275.
**1-50 hand-assisted laparoscopic gastric bypasses; 51-200 laparoscopic gastric bypasses
***operations grouped: 1-40, 41-80, 81-120, 121-160.

shorten out past 400 operations.

Little information has been published regarding the learning curve of surgeons who initiate their clinical experience with LRYGBP in a hospital that already has an established LRYGBP program. 2nd SURGEON entered directly into clinical practice at Hackensack University Medical Center after completing a laparoscopic surgery fellowship in which he obtained extensive experience in performing LRYGBP. 2nd SURGEON used the same surgical technique as 1st SURGEON. At Hackensack, 2nd SURGEON averaged 120 minutes for his first 57 operations as an attending surgeon (Table 2). This was 46 minutes shorter than the average of 209 minutes for 1st SURGEON's first 50 operations. Indeed, the average times for 2nd SURGEON's first 57 cases (143 minutes; median 120 minutes) were similar to those of 1st SURGEON's 2nd 100 LRYGBPs (average 135 minutes; median 125 minutes). Interestingly, 2nd SURGEON's times were stable and did not significantly decrease with additional experience within the time frame of this study. Our results confirmed that fellowship training in LRYGBP substantially shortens the length of LRYGBP during a surgeon's initial clinical experience in a hospital with an established LRYGBP program.[28]

We also studied surgical times for LRYGBP of a subsequent experienced laparoscopic surgeon initiating his clinical experience at our hospital. 3rd SURGEON averaged 173 minutes for his first 44 operations, 23 minutes shorter than the average of 209 minutes for 1st SURGEON's first 50 operations (Table 2). 3rd SURGEON's technique differed somewhat from that of 1st SURGEON: 3rd SURGEON sewed the gastrojejunostomy rather than stapling it. Although 3rd SURGEON's average times were not significantly shorter than that of 1st SURGEON, his times dropped (slope -3.74) more rapidly than either 1st SURGEON (slope -1.01 for first 50; -0.80 for first 100) or 2nd SURGEON (slope 0.19 first 57); Figure 2 results suggest that the learning curve for a subsequent experienced laparoscopic surgeon is accelerated by institutional experience. We believe that the experience of the nursing and anesthesia teams as well as the development of institutional infra-structure all play a role in defining the learning curve for LRYGBP.

We previously reported that the average time of LRYGBPs was greater in patients with a BMI >60 kg/m^2.[29] Similarly, Suter and colleagues[30] in Lausanne, Switzerland, averaged 28 minutes longer for super-obese (196 minutes) than morbidly obese patients (168 minutes) during their first 104 LRYGBPs. A significant relationship between increasing BMI and increased length of surgery was still present even in 1st SURGEON's 4th 100 operations (Figure 3). This effect had dropped from an increase of 22 minutes in the first 100 operations to 7.7 minutes for each increase of 10 in the BMI. In contrast, the length of surgery lengthened by 25.5 minutes for 2nd SURGEON and only 9.4 minutes for 3rd SURGEON for each increase of 10 in the BMI. The smaller effect for 3rd SURGEON most likely reflected his criteria for patient selection that limited patients to BMI 35 to 55 kg/m^2. Surgeons should expect that operations in patients with a BMI >50 kg/m^2 will take significantly longer than patients with a BMI <50 kg/m^2.[31] Moreover, this effect appeared to persist beyond a surgeon's experience of 400 LRYGBPs.

We studied the combined influence of the surgeon's experience and BMI on surgical times. Both increasing experience and decreasing BMI of the patient significantly correlated with decreasing length of surgery for 1st SURGEON but not for the other two laparoscopic surgeons or for the control open gastric bypasses. Even during 1st SURGEON's 4th 100 operations, his surgical times significantly correlated with both number of the operation and BMI. The combination did not correlate at all for 2nd SURGEON. As pointed out above, fellowship training seemed to have stabilized 2nd SURGEON's surgical times in terms of experience. The number of operations may have been too few to identify a significant relationship between BMI and surgical times for 2nd SURGEON. In contrast, surgical experience proved a more important factor for 3rd SURGEON than BMI in determining surgical times. Again this may have reflected the limited range of BMIs on which 3rd SURGEON operated.

Our findings suggest that an experienced laparoscopic surgeon can minimize surgical times for LRYGBP during his/her first 50 operations by adopting several strategies. Using experienced nursing and anesthesia teams in a hospital with the established infra-structure for LRYGBP appears to accelerate the learning curve for surgical times. Also, limiting selection to patients with a BMI of 35 to 50 kg/m^2 will minimize the impact of weight or BMI on operative times. Surgeons should use the same experienced surgeon as the assistant surgeon whenever feasible. We also found that fellowship training in performing LRYGBP shortened surgical times. Finally, we would encourage surgeons to limit patient selection to smaller, low-risk patients during their early clinical experience, in hopes of minimizing rates of morbidity and mortality.

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