PAPER

Complications After Laparoscopic Gastric Bypass

A Review of 3464 Cases

Yale D. Podnos, MD, MPH; Juan C. Jimenez, MD; Samuel E. Wilson, MD; C. Melinda Stevens, BS; Ninh T. Nguyen, MD

Hypothesis: The type and frequency of complications after open Roux-en-Y gastric bypass (GBP) have changed with the development of laparoscopic technique.

Background: The number of laparoscopic GBP cases performed in the United States has increased dramatically during the past several years. We compared the type and frequency of complications after laparoscopic and open GBP.

Methods: We searched MEDLINE from January 1, 1994, through December 31, 2002, using the keywords *morbid obesity*, *laparoscopy*, *bariatric surgery*, and *gastric bypass*. We selected studies on laparoscopic or open GBP with more than 50 patients and published in the English language for analysis. We excluded studies with reoperative Roux-en-Y GBP cases or other bariatric procedures. The type and frequency of postoperative complications were recorded from each study. We used χ^2 and Fisher exact tests to determine statistical significance.

Results: Ten laparoscopic GBP studies with 3464 patients and 8 open GBP studies with 2771 patients were considered. The mean of the reported average age for patients undergoing laparoscopic GBP was 41 years compared with 43 years for open GBP. The mean percentages of female patients were 87% for laparoscopic GBP and 82% for open GBP; the mean reported average body mass index (calculated as weight in kilograms divided by the square of height in meters), 48.7 and 49.5, respectively. Compared with open GBP, laparoscopic GBP was associated with a decrease in the frequency of iatrogenic splenectomy, wound infection, incisional hernia, and mortality; however, there was an increase in the frequency of early and late bowel obstruction, gastrointestinal tract hemorrhage, and stomal stenosis. There were no significant differences in the frequency of anastomotic leak, pulmonary embolism, or pneumonia.

Conclusions: The type and frequency of postoperative complications after laparoscopic and open GBP are different. Certain complications increase with laparoscopic GBP, probably owing to the learning curve of this complex procedure, whereas other complications decrease because of the advantages of the smaller access incision.

Arch Surg. 2003;138:957-961

From the Department of Surgery, University of California–Irvine Medical Center.

OPEN ROUX-EN-Y gastric bypass (GBP) is the most commonly performed operation for the treatment of morbid obesity, and there is a recent trend to perform this procedure using the laparoscopic approach. Since the first published case series in 1994, multiple studies have demonstrated the feasibility and safety of laparoscopic GBP.[1-11] Advantages of the laparoscopic technique include less blood loss, shorter length of hospitalization, and a faster recovery.[4] Another well-known advantage of laparoscopic GBP is the reduction in wound-related complications because of the smaller access incision.[4-8] The advantages of laparoscopic GBP, however, come with a possible change in the type and frequency of postoperative complications. The technique of laparoscopic GBP has evolved since its inception, and this learning process can be associated with adverse events. Certain complications uncommonly reported in the open GBP literature have been reported since the development of laparoscopic GBP (eg, early small-bowel obstruction).[2,4,11] In addition, the frequency of certain complications after laparoscopic GBP (eg, anastomotic leak) appears to be higher than that reported after open GBP.[2,7,9] Therefore, it is important to audit the complications after laparoscopic GBP compared with open GBP and develop strategies to possibly minimize these complications.

Few studies have compared complications after laparoscopic and open GBP, and, to our knowledge, only 2 random-

©2003 American Medical Association. All rights reserved.
Downloaded From: http://archsurg.jamanetwork.com/ on 01/30/2015

ized trials have been reported.[4,12,13] These single-institution studies tend to have small sample sizes. In this review, we examined the results of laparoscopic and open GBP from selected series with an emphasis on comparing differences in perioperative complications between the 2 approaches.

METHODS

We searched PubMed MEDLINE (National Library of Medicine) for articles published from January 1, 1994, through December 31, 2002, using the keywords *morbid obesity*, *laparoscopy*, *bariatric surgery*, and *gastric bypass*. A full text copy of each English-language article was obtained for review. We chose for review studies with a clinical series on or trial of Roux-en-Y GBP containing more than 50 subjects. Studies reporting reoperative Roux-en-Y GBP, other outcomes of bariatric surgery (eg, weight loss), a selected patient group (eg, only patients with venous stasis disease), and other bariatric surgical procedures (eg, vertical banded gastroplasty, gastric banding, or biliopancreatic diversion) were excluded from the review. In case of multiple reports published from a single institution, the most recent publication with the largest number of patients that described postoperative complications was chosen. In addition, any series that did not clearly report postoperative complications and that used hybrid procedures (eg, hand-assisted laparoscopic GBP) were also excluded.

We searched each selected article for data pertaining to complications. The following data were reviewed in each article: age, sex, body mass index (BMI) (calculated as weight in kilograms divided by the square of height in meters), number of operations performed in each study, number of conversions in the laparoscopic series, and the type and frequency of complications. The type of complications recorded included gastrointestinal (GI) tract bleeding, wound infection, anastomotic leak, iatrogenic splenectomy, incisional hernia, bowel obstruction, anastomotic stricture, pulmonary emboli, and death. Leak complication included leaks at the gastrojejunostomy, the gastric remnant, or the gastric pouch. Bowel obstruction was categorized according to timing (early vs late). Early bowel obstruction was defined according to the author(s) of the individual study. Gastrointestinal tract bleeding was defined as any GI tract bleeding occurring in the early postoperative period (within 30 days).

The frequency of these complications was recorded in a database (Microsoft Excel 2000; Microsoft Corp, Redmond, Wash). Studies that failed to describe a given complication were precluded from inclusion in the data set (ie, failure to mention a certain complication was not counted as lack of occurrence). We then tabulated the frequency of each complication after laparoscopic and open GBP and compared the findings using χ^2 and Fisher exact tests (StatView; SAS Institute Inc, Carey, NC). A P value of less than .05 was considered significant.

RESULTS

A total of 10 studies encompassing 3464 patients who underwent laparoscopic GBP were included in this review. The study setting in these 10 articles included 4 academic and 6 nonacademic centers. We also included 8 articles encompassing 2771 patients who underwent open GBP. The study setting in these 8 articles consisted of 6 academic and 2 nonacademic centers. The distribution of study design was as follows: in the laparoscopic GBP database, 9 retrospective or prospective analyses and 1 randomized controlled trial; in the open GBP database, 6 retrospective or prospective analyses, 1 nonrandomized comparative study, and 1 randomized controlled trial.

PATIENT DEMOGRAPHICS

The mean of the reported average age of those undergoing laparoscopic GBP reported in 7 of the 10 studies was 41 years; of those undergoing open GBP in 4 of the 8 studies, 43 years. The mean percentage of female patients undergoing laparoscopic GBP reported in 7 of 10 studies was 87%; of those undergoing open GBP reported in 5 of the 8 studies, 82%. The mean of the average reported BMI of those undergoing laparoscopic GBP reported in 7 of the 10 studies was 48.7; of those undergoing open GBP reported in 3 of the 8 studies, 49.5.

CONVERSION

Conversion to open laparotomy in the laparoscopic GBP series was 2.2%, as reported in 9 of 10 studies. The reasons for conversion included hepatomegaly (48.7%), malfunction of equipment such as the stapler or ultrasonic dissector (12.8%), short instruments or trocars (7.7%), inadequate exposure (7.7%), twisted retrocolic limb (5.1%), injury to a vital structure such as the colon or the vena cava (5.1%), inability to safely insufflate the abdomen (5.1%), bleeding (2.6%), subcutaneous emphysema (2.6%), and gastrojejunal anastomotic leak (2.6%).

COMPLICATIONS

Frequency data of complications associated with laparoscopic GBP are given in **Table 1**.[2-11] The most frequent perioperative complication was wound infection (2.98%), and the most frequent late complication was anastomotic stomal stenosis (4.73%).

Frequency data of complications associated with open GBP are given in **Table 2**.[4,14-20] The most frequent perioperative complication was wound infection (6.63%), and the most frequent late complication was incisional hernia (8.58%).

Comparisons in frequency of complications after laparoscopic and open GBP are given in **Table 3**. The frequency of iatrogenic splenectomy was 0.41% as reported in 4 of 8 open GBP studies and was not reported in any of the laparoscopic GBP studies. There were no significant differences in the frequency of anastomotic leak, pulmonary embolus, and pneumonia between the 2 groups. Early bowel obstruction was not reported in any of the 8 open GBP studies but was reported in 3 of the 10 laparoscopic GBP studies. The frequency of GI tract hemorrhage was significantly higher but that of wound infection was significantly lower in the laparoscopic GBP series. The mortality rate was higher in the open GBP series compared with the laparoscopic GBP series (0.87% vs 0.23%, respectively). The causes of death after laparoscopic GBP included pulmonary embolism (50%), anastomotic leak (37.5%), and Roux limb necrosis (12.5%). The causes of death after open GBP included pulmonary embolism (50%), anastomotic leak (12.5%), respiratory failure (12.5%), sepsis (12.5%), upper GI tract hemorrhage (8.3%), and cardiac arrhythmia (4.1%). The

©2003 American Medical Association. All rights reserved.
Downloaded From: http://archsurg.jamanetwork.com/ on 01/30/2015

Table 1. Complications in Selected Series of Laparoscopic Gastric Bypass*

Reference (Year)	No. of Patients	PE	Leak	Bowel Obstruction	GI Bleed	Wound Infection	Stomal Stenosis	Ventral Hernia	Pneumonia	Death
Schauer et al[2] (2000)	275	2/275	12/275	3/275 (E)	3/275	24/275	13/275	2/275	1/275	1/275
Wittgrove and Clark[3] (2000)	500	NA	11/500	3/500 (L)	NA	28/500	8/500	0/500	NA	0/500
Nguyen et al[4] (2001)	79	0/79	1/79	3/79 (E)	3/79	1/79	9/79	0/79	NA	0/79
Higa et al[5] (2001)	1500	3/1500	14/1500	52/1500 (L)	NA	2/1500	73/1500	4/1500	1/1500	3/1500
Dresel et al[6] (2002)	100	0/100	3/100	5/100 (L)	3/100	2/100	3/100	1/100	NA	0/100
DeMaria et al[7] (2002)	281	3/281	14/281	5/281 (L)	NA	3/281	18/281	5/281	NA	0/281
Abdel-Galil and Sabry[8] (2002)	90	NA	5/90	9/90 (L)	NA	NA	18/90	NA	NA	0/90
Papasavas et al[9] (2002)	116	1/116	3/116	12/116 (L)	2/116	NA	4/116	NA	NA	1/116
Oliak et al[10] (2002)	300	2/300	4/300	5/300 (L)	NA	20/300	6/300	NA	1/300	3/300
Gould et al[11] (2002)	223	NA	4/223	4/223 (E)	NA	17/223	12/223	2/223	NA	0/223
Total No.	**3464**	**11/2651**	**71/3464**	**101/3464**	**11/570**	**97/3258**	**164/3464**	**14/2958**	**3/2075**	**8/3464**

Abbreviations: E, early; GI, gastrointestinal tract; L, late; NA, not available; PE, pulmonary embolism.
*Data are expressed as numbers of patients per study. Information regarding the number of patients who required iatrogenic splenectomy for splenic injury was not available for any study.

Table 2. Complications in Selected Series of Open Gastric Bypass*

Reference (Year)	No. of Patients	PE	Leak	Bowel Obstruction	GI Bleed	Wound Infection	Stomal Stenosis	Ventral Hernia	Splenic Injury†	Pneumonia	Death
Oh et al[14] (1997)	194	NA	0/194	1/194 (L)	NA	2/194	6/194	16/194	0/194	1/194	0/194
Fobi et al[15] (1998)	705	4/705	9/705	28/705 (L)	NA	NA	4/705	32/705	3/705	NA	3/705
Kirkpatrick and Zapas[16] (1998)	212	3/212	13/212	NA	NA	NA	NA	NA	NA	NA	4/212
MacLean et al[17] (2000)	274	1/274	NA	6/274 (L)	NA	NA	NA	40/274	NA	NA	1/274
Balsiger et al[18] (2000)	191	1/191	1/191	8/191 (L)	1/191	11/191	2/191	32/191	1/191	3/191	1/191
Nguyen et al[4] (2001)	76	1/76	2/76	0/76	0/76	8/76	2/76	6/76	0/76	NA	0/76
Livingston et al[19] (2002)	1067	9/1067	15/1067	10/1067 (L)	7/1067	NA	1/1067	NA	NA	0/1067	14/1067
See et al[20] (2002)	52	1/52	2/52	NA	NA	13/52	NA	2/52	1/52	1/52	1/52
Total No.	**2771**	**20/2577**	**42/2497**	**53/2507**	**8/1334**	**34/513**	**15/2233**	**128/1492**	**5/1218**	**5/1504**	**24/2771**

Abbreviations: GI, gastrointestinal tract; L, late; NA, not available; PE, pulmonary embolism.
*Data are expressed as numbers of patients per study.
†Indicates injury requiring iatrogenic splenectomy.

frequency of late bowel obstruction and stomal stenosis was higher after laparoscopic GBP than after open GBP; whereas the frequency of incisional hernia was lower after laparoscopic GBP.

COMMENT

Our results indicate a change in the type and frequency of complications associated with the introduction of laparoscopic GBP. There appears to be a decrease in wound-related complication (infection and hernia), the need for iatrogenic splenectomy, and mortality in the laparoscopic GBP series. In contrast, there appears to be a higher frequency of early and late bowel obstruction, GI tract hemorrhage, and stomal stenosis in the laparoscopic GBP series. Understanding the causes of these changes is important, as strategies may be developed to minimize complications associated with laparoscopic GBP.

Although infrequently reported, iatrogenic splenectomy has been reported after open GBP. In this review, 3 of 8 open GBP studies reported iatrogenic splenectomy.[15,18,20] The reason for splenic injury after open GBP included traction injury to the short gastric vessels or capsular tear from the use of retractors. In contrast, there were no reported cases of iatrogenic splenectomy in the laparoscopic GBP series.[2-11] The lower frequency of iatrogenic splenectomy after laparoscopic GBP is probably related to better visualization and exposure of the operative field with pneumoperitoneum without the need for mechanical retraction devices.

Table 3. Complications After Open and Laparoscopic GBP

Complication	No. (%) of Patients		*P* Value
	Open GBP	Laparoscopic GBP	
Intraoperative			
Iatrogenic splenectomy	5/1218 (0.41)	Not reported	
Perioperative			
Anastomotic leak	42/2497 (1.68)	71/3464 (2.05)	.31
Bowel obstruction	Not reported	10/577 (1.73)	
Gastrointestinal tract hemorrhage	8/1334 (0.60)	11/570 (1.93)	.008
Pulmonary embolus	20/2577 (0.78)	11/2651 (0.41)	.09
Wound infection	34/513 (6.63)	97/3258 (2.98)	<.001
Pneumonia	5/1504 (0.33)	3/2075 (0.14)	.24
Death	24/2771 (0.87)	8/3464 (0.23)	.001
Late			
Bowel obstruction	53/2507 (2.11)	91/2887 (3.15)	.02
Incisional hernia	128/1492 (8.58)	14/2958 (0.47)	<.001
Stomal stenosis	15/2233 (0.67)	164/3464 (4.73)	<.001

Abbreviations: GBP, gastric bypass; NS, not significant.

©2003 American Medical Association. All rights reserved.
Downloaded From: http://archsurg.jamanetwork.com/ on 01/30/2015

Wound infection is a common complication after open GBP.[14-18] Owing to the smaller access incision, the lower rate of wound infections after laparoscopic GBP is one of the easily recognized advantages of the laparoscopic approach. From our review, the rate of wound infection is lower after laparoscopic GBP than after open GBP (2.98% vs 6.63%, respectively). In addition to the lower frequency of wound infection after laparoscopic GBP, the degree of infection tends to be minor and can be easily managed with a short course of local wound care. Another advantage of laparoscopic GBP is the elimination of the risk for fascial dehiscence and wound evisceration. See et al[20] reported fascial dehiscence in 2 (3.8%) of 52 patients who underwent open GBP, and Livingston et al[19] reported wound evisceration in 3 (0.3%) of 1076 open GBP procedures. Fascial dehiscence and wound evisceration have not been reported after laparoscopic GBP.

Incisional hernia is a common complication after open GBP.[14-20] The results from this review demonstrated that the frequency of incisional hernia is lower after laparoscopic compared with open GBP (0.47% vs 8.58%, respectively). The extent of incisional hernia is related to the size of the initial incision. Incisional hernia after open GBP tends to be larger and requires a more extensive repair with mesh, whereas incisional hernia that develops after laparoscopic GBP tends to be small and can be repaired with primary closure or a laparoscopic mesh repair. One of the touted advantages of incisional hernia after open GBP is the insurance coverage for the repair in conjunction with an abdominoplasty; however, this idea is not truly an advantage as there is a risk for recurrence as high as 36% after the primary repair.[21]

Another easily recognized benefit of laparoscopic GBP is the reduced risk for retained instruments and laparotomy pads. Morbidly obese patients undergoing open GBP are at high risk for retained foreign objects. Gawande and colleagues[22] reported that the risk for retention of a foreign body after surgery increases in emergency operations, unplanned changes in procedure, and patients with a higher BMI. Obese patients have a large quantity of intra-abdominal fat that may conceal operative instruments and laparotomy pads. The risk for retained large instruments and laparotomy pads is essentially eliminated with the laparoscopic approach because it is nearly impossible to insert these items through a trocar. However, small foreign objects such as a Penrose drain can still be inadvertently left within the patient during laparoscopic GBP.[10]

Anastomotic leak is a dreaded complication after open GBP. There appears to be a higher leak rate after laparoscopic than after open GBP.[2,7,9] However, the results from this review did not show a significant difference between the frequency of leak after laparoscopic and open GBP. Leak rate after laparoscopic GBP is related to the learning curve. For example, Wittgrove and Clark[3] reported 9 anastomotic leaks (3.0%) in their first 300 laparoscopic gastric bypass procedures compared with only 2 leaks (1.0%) in their last 200 laparoscopic gastric bypass procedures. Surgeons who have passed their learning curve showed a decreasing frequency of anastomotic leak approaching that of open GBP.

With the introduction of laparoscopic GBP, one of the possible benefits of laparoscopic GBP was a reduction in bowel obstruction because of the theoretical reduction in adhesion formation. However, this review demonstrated that the frequency of early and late postoperative bowel obstruction is higher after laparoscopic GBP. The reason for the higher rate of early bowel obstruction after laparoscopic GBP appears to be related to the technical element for construction of the jejunojejunostomy. Nguyen and colleagues[23] reported 4 early bowel obstructions in their first 80 laparoscopic GBP cases. The use of a linear stapler to close the jejunojejunostomy enterotomy defect resulted in narrowing of the afferent limb in 3 of 4 obstructions. The fourth obstruction was caused by angulation of the afferent limb because of failure to place the antiobstruction suture. Early bowel obstruction is often technically preventable, as changes in techniques have eliminated this problem. The frequency of late bowel obstruction is also higher in the laparoscopic GBP series. In the early part of most laparoscopic series, most surgeons were not closing the jejunojejunostomy mesenteric defect, the transverse mesocolon defect, or the Petersen hernia defect.[2,4] Omission of these important technical steps resulted in a higher frequency of late bowel obstruction after laparoscopic GBP. We believe that the frequency of late bowel obstruction as a result of postoperative adhesions should be lowered after laparoscopic GBP as one of the benefits of minimally invasive surgery is the reduction of intra-abdominal adhesions.[24]

The frequency of postoperative GI tract hemorrhage is higher after laparoscopic than after open GBP (1.93% vs 0.60%, respectively). The cause of postoperative GI tract bleeding is presumed to be bleeding from the gastric remnant, the gastrojejunostomy, or the jejunojejunostomy staple-line. Some potential explanations for the lower frequency of GI tract hemorrhage after open GBP included the frequent use of a hand-sewn technique for creation of the gastrojejunostomy in open GBP. Second, oversewing of gastric staple-lines may be more frequently performed in open GBP. Lastly, some open GBP studies used the stapled but nontransected gastric pouch technique, which presumably reduces the risk for GI tract hemorrhage. To minimize postoperative GI tract hemorrhage, care must be taken to obtain meticulous hemostasis of all staple-line edges, to use a stapler with a shorter staple height (3.5 mm for the stomach and 2.5 mm for the small bowel), to oversew staple-line edges, or to use staple-line reinforcement materials to provide hemostasis.

Stomal stenosis of the gastrojejunostomy is a frequent complication after open and laparoscopic GBP.[4,7,14,15] The results of this review demonstrated a higher frequency of stomal stenosis after laparoscopic GBP. The reason for this finding is unknown but might be related to the higher number of anastomoses performed in the laparoscopic GBP series using the mechanical stapler compared with the hand-sewn technique used in the open GBP series. In addition, the frequency of stomal stenosis after open GBP in this review (0.67%) seems to be low as 1 institution reported only a single stomal stenosis occurring in 1067 patients.[19]

In this study, we did not find any significant differences in the frequency of postoperative pulmonary embolus or pneumonia between laparoscopic and open GBP.

©2003 American Medical Association. All rights reserved.
Downloaded From: http://archsurg.jamanetwork.com/ on 01/30/2015

Although the difference was not statistically significant, the frequency of pulmonary embolus was lower after laparoscopic GBP (0.41% vs 0.78%; $P=.09$). We found a lower death rate after laparoscopic than open GBP. The reason for the lower death rate after laparoscopic GBP is unknown but could be related to the lower frequency of pulmonary embolism after laparoscopic GBP, as pulmonary embolism accounts for 50% of deaths after laparoscopic and open GBP.

Certain limitations must be considered in interpreting the findings of our review. First, comparison of 2 techniques from different institutions with different patient populations must be examined with caution. Second, the true frequency of complications can be inaccurate because the report of complications depends on individual authors and their diligent effort in tabulating and reporting all potential complications. The method of study in most of these articles in this review is retrospective analysis. Lastly, the frequency of a certain complication could be overestimated because studies that did not describe a particular complication were excluded from the analysis for that complication.

CONCLUSIONS

Our findings demonstrated a change in the type and frequency of complications with the introduction of laparoscopic GBP. A reduction in certain complications after laparoscopic GBP is related to the small access incision (eg, lower wound infection, incisional hernia) and better visualization of the operative field (eg, lower iatrogenic splenectomy). Increases in the frequency of certain complications are related to technique or the learning curve of the laparoscopic approach (eg, GI tract bleeding, early and late bowel obstruction). For unknown reasons, there is a higher frequency of stomal stenosis and a lower frequency of death after laparoscopic GBP. Our findings suggest that surgeons must learn the proper techniques of laparoscopic GBP and have adequate training before performing this complex laparoscopic operation. In addition, professional societies should play a major role in providing training courses and proctoring programs for surgeons interested in performing laparoscopic GBP.

Accepted for publication May 4, 2003.

This study was presented at the 74th Annual Meeting of the Pacific Coast Surgical Association; February 17, 2003; Monterey, Calif; and is published after peer review and revision.

Corresponding author and reprints: Ninh T. Nguyen, MD, Department of Surgery, 101 The City Dr, Bldg 53, Room 209, Orange, CA 92868-3298 (e-mail: ninhn@uci.edu).

REFERENCES

1. Wittgrove AC, Clark GW, Tremblay LJ. Laparoscopic gastric bypass, Roux-en-Y: preliminary report of 5 cases. *Obes Surg.* 1994;4:353-357.
2. Schauer PR, Ikramuddin S, Gourash W, Ramanathan R, Luketich J. Outcomes after laparoscopic Roux-en-Y gastric bypass for morbid obesity. *Ann Surg.* 2000; 232:515-529.
3. Wittgrove AC, Clark WG. Laparoscopic gastric bypass, Roux-en-Y: 500 patients: technique and results, with 3-60 month follow-up. *Obes Surg.* 2000;10: 233-238.
4. Nguyen NT, Goldman C, Rosenquist J, et al. Laparoscopic versus open gastric bypass: a randomized study of outcomes, quality of life, and costs. *Ann Surg.* 2001;234:279-291.
5. Higa KD, Ho T, Boone KB. Laparoscopic Roux-en-Y gastric bypass: technique and 3-year follow-up. *J Laparoendosc Adv Surg Tech A.* 2001;11:377-382.
6. Dresel A, Kuhn JA, Westmoreland MV, et al. Establishing a laparoscopic gastric bypass program. *Am J Surg.* 2002;184:617-620.
7. DeMaria EJ, Sugerman HJ, Kellum JM, et al. Results of 281 consecutive total laparoscopic Roux-en-Y gastric bypasses to treat morbid obesity. *Ann Surg.* 2002; 235:640-647.
8. Abdel-Galil E, Sabry AA. Laparoscopic Roux-en-Y gastric bypass: evaluation of three different techniques. *Obes Surg.* 2002;12:639-642.
9. Papasavas PK, Hayetian FD, Caushaj PF, et al. Outcome analysis of laparoscopic Roux-en-Y gastric bypass for morbid obesity. *Surg Endosc.* 2002;16:1653-1657.
10. Oliak D, Ballantyne GH, Davies RJ, et al. Short-term results of laparoscopic gastric bypass in patients with BMI ≥60. *Obes Surg.* 2002;12:643-647.
11. Gould JC, Needleman BJ, Ellison EC, et al. Evolution of minimally invasive bariatric surgery. *Surgery.* 2002;132:565-572.
12. Nguyen NT, Ho HS, Palmer LS, Wolfe BM. A comparison study of laparoscopic versus open gastric bypass for morbid obesity. *J Am Coll Surg.* 2000;191:149-155.
13. Westling A, Gustavsson S. Laparoscopic vs open Roux-en-Y gastric bypass: a prospective, randomized trial. *Obes Surg.* 2001;11:284-292.
14. Oh CH, Kim HJ, Oh S. Weight loss following transected gastric bypass with proximal roux-en-Y. *Obes Surg.* 1997;7:142-147.
15. Fobi MAL, Lee H, Holness R, Cabinda D. Gastric bypass operation for obesity. *World J Surg.* 1998;22:925-935.
16. Kirkpatrick JR, Zapas JL. Divided gastric bypass: a fifteen-year experience. *Am Surg.* 1998;64:62-65.
17. MacLean LD, Rhode BM, Nohr CW. Late outcome of isolated gastric bypass. *Ann Surg.* 2000;231:524-528.
18. Balsiger BM, Kennedy FP, Abu-Lebdeh HS, et al. Prospective evaluation of Roux-en-Y gastric bypass as primary operation for medically complicated obesity. *Mayo Clin Proc.* 2000;75:673-680.
19. Livingston EH, Huerta S, Arthur D, et al. Male gender is a predictor of morbidity and age a predictor of mortality for patients undergoing gastric bypass surgery. *Ann Surg.* 2002;236:576-582.
20. See C, Carter PL, Elliott D, et al. An institutional experience with laparoscopic gastric bypass complications seen in the first year compared with open gastric bypass complications during the same period. *Am J Surg.* 2002;183:533-538.
21. Hesselink VJ, Luijendijk RW, de Wilt JHW, et al. An evaluation of risk factors in incisional hernia recurrence. *Surg Gynecol Obstet.* 1993;176:228-234.
22. Gawande AA, Studdert DM, Orav EJ, et al. Risk factors for retained instruments and sponges after surgery. *N Engl J Med.* 2003;348:229-235.
23. Nguyen NT, Neuhaus AM, Ho HS, et al. A prospective evaluation of intracorporeal laparoscopic small bowel anastomosis during gastric bypass. *Obes Surg.* 2001;11:196-199.
24. Garrard CL, Clements RH, Nanney L, et al. Adhesion formation is reduced after laparoscopic surgery. *Surg Endosc.* 1999;13:10-13.

©2003 American Medical Association. All rights reserved.

Downloaded From: http://archsurg.jamanetwork.com/ on 01/30/2015