Laparoscopic Roux-en-Y Gastric Bypass for Morbid Obesity

Technique and Preliminary Results of Our First 400 Patients

Kelvin D. Higa, MD; Keith B. Boone, MD; Tienchin Ho, MD; Orland G. Davies, MD

Hypothesis: A technique of the laparoscopic Roux-en-Y gastric bypass can be developed that is safe, effective, and practical in the community setting.

Design: A case series of 400 morbidly obese and super-obese individuals who underwent the laparoscopic Roux-en-Y gastric bypass over a 22-month period.

Setting: Community private practice in Fresno, Calif.

Patients: A consecutive sample of 400 patients (70 males and 330 females) who met National Institutes of Health criteria for recommendation of a bariatric procedure. Only patients who had a previous gastric or bariatric procedure were excluded from this sample.


Main Outcome Measures: Weight loss, complications, length of hospital stay, successful completion of the operation, and operative times were measured.

Results: Open conversion was required in 12 patients (6 males and 6 females) and a secondary operation for incomplete division of the stomach was required in 2 patients early in the case series. Alternative exposure and fixation techniques greatly reduced these occurrences. There were 6 staple-line failures owing to a change in the manufacture of the instrument. There were no leaks at the gastrojejunal anastomosis, but 21 patients required endoscopic balloon dilation for significant stenosis. The average hospital stay was 1.6 days for the patients who underwent laparoscopy and 2.7 days for patients requiring open conversion. Average excessive weight loss was 69% at 12 months. Operative times are between 60 and 90 minutes. Other complications are described.

Conclusion: The Roux-en-Y gastric bypass can be safely and effectively performed in the community setting using advanced laparoscopic techniques.

Arch Surg. 2000;135:1029-1034

The laparoscopic Roux-en-Y gastric bypass was first reported by Wittgrove et al1 in 1994. Although ingenious in the design of their operation, the use and the endoscopic placement of the 21-mm circular stapler (model ECS21 Endopath Stealth Endoscopic/Conventional Circular Stapler; Ethicon Endo-Surgery Inc, Cincinnati, Ohio) was a significant departure from our standard open technique. In addition, anastomotic gastrojejunostomy leak rates of 4% have been reported2 and parallel the experiences of Fazio et al3 with colorectal anastomosis using similar stapling devices. We chose to design a surgical procedure that more closely emulates our open procedure both in configuration and formation of the gastric pouch and the gastroenteric anastomosis.

Minimally invasive surgery has significant advantages over traditional surgery. However, these procedures “must be shown to be at least as effective and safe as the open procedures.”4 This study evaluates our experience with this procedure for efficacy and complications.

RESULTS

The procedure was completed laparoscopically in 388 patients over a 22-month period. Of the 12 patients who required open conversion, 6 were males (average BMI, 47) and 6 were females (average BMI, 57). Incomplete division of the gastric pouch occurred in 2 patients requiring reoperation for inadequate weight loss. This early experience forced us to adopt the present means of liver retraction with a 10-mm rod placed in the subxiphoid position. Traditional fan-type retractors were either too malleable or would lacerate the fatty liver parenchyma. Also greater use of the Harmonic scalpel (Ethicon Endo-Surgery Inc)
PATIENTS AND METHODS

PATIENTS

All patients (70 males and 330 females, aged between 13 and 70 years) were evaluated for surgery using National Institutes of Health guidelines. Each patient was counseled by the operative surgeon (K.D.H.) and advised of other bariatric surgical procedures and bariatric surgical programs. All patients were considered candidates for the laparoscopic procedure regardless of weight, body mass index (BMI), (weight, in kilograms, divided by height, in meters squared) or the presence of previous operations (except for gastric or bariatric procedures). It was our intention to determine exclusion criteria as early as possible.

The operative technique evolved to compensate for occurrences we had not experienced with the open surgery, such as internal hernias. Exposure and retraction methods developed that allowed a higher success rate and shorter operative times.

This case series represents patients operated on by a single surgeon (K.D.H.). Although one of us (K.B.B.) has performed over 200 such procedures, these are not included in this case series to simplify comparative data.

SURGICAL TECHNIQUE

The patient is placed supine in a gentle reverse-Trendelenburg position. Standard perioperative antibiotic agents and subcutaneous heparin sodium are administered and antiembolism devices are used. Bowel preparation consists of clear liquids for 24 hours prior to surgery.

The pneumoperitoneum and abdominal entry is established with an 11-mm trocar (ENDOPATH Optiview 11-mm Optical Trocar; Ethicon Endo-Surgery Inc). Three more blunt 12-mm ports were created using a 12-mm trocar (ENDOPATH Optiview 12-mm Optical Trocar; Ethicon Endo-Surgery Inc) and a single 5-mm or 10-mm port for liver retraction is placed Figure 1. Adhesions from previous surgical procedures are mobilized to allow displacement of the omentum to the upper abdomen. If the adhesions are too dense or the omentum bulky, the lesser sac is entered through the gastrocolic ligament. The ligation of Treitz is visualized by creating an opening through the transverse mesocolon. The proximal jejunum is divided 5 to 10 cm distal to the ligation of Treitz with a 45-mm linear cutter, 2.5-mm stapler (ENDOPATH Endoscopic Linear Cutter 45 mm; Ethicon Endo-Surgery Inc). The mesentery is divided with the same stapler and the Roux limb is measured. For patients whose BMI is less than 50, a 100-cm limb is measured; for those whose BMI is greater than 50, we use a 150-cm limb. A side-to-side jejunojejunostomy is performed using the 45-mm linear cutter, 2.5-mm stapler. The enterotomy is closed with interrupted 3-0 polyglactin (Vicryl) sutures. The mesenteric defect is closed with 3-0 silk sutures.

The gastric pouch is estimated at 20 mL and created by repeated application of the 35-mm linear cutter, 3.5-mm stapler (ENDOPATH Endoscopic Linear Cutter 35 mm; Ethicon Endo-Surgery Inc). The vagus nerves are preserved. The pouch is based on the lesser curve and oriented vertically with the exclusion of the gastric fundus. We believe, as does MacLean et al, this configuration improves emptying and prevents subsequent dilation of the pouch.

The Roux limb is brought up in a retrocolic position and lies anterior to the stomach remnant. The mesocolon is attached to the Roux limb with three 3-0 silk interrupted sutures to prevent migration of the limb. The gastrojejunostomy is a standard 2-layer, hand-sewn anastomosis performed with 3-0 polyglactin sutures, running and interrupted, and sized with an intraluminal 32F tube (Figure 2).

The skin is closed with staples. The trocar fascial openings are not closed.

PA...
One patient developed lower extremity weakness requiring readmission to the hospital. Magnetic resonance imaging and neurologic consultation diagnosed the problem as central pontine myelolysis. This rare disorder is usually seen in alcoholic and malnourished patients associated with hyponatremia. This patient lost 26.1 kg in 2 months and had normal electrolyte levels and nutritional values. The problem spontaneously resolved over the course of several months.

There were 2 major complications involving perforation. One occurred in an elderly patient with diabetes mellitus. On reexploration, a gastric perforation was found proximal to the gastrojejunostomy. We hypothesize a thermal injury from the Harmonic scalpel weakened this area. The other was a staple-line disruption owing to severe gastric distension secondary to meat the patient ingested the night prior to surgery. The meat bezoar became impacted at the jejunojejunostomy and caused the obstruction. This patient also suffered from a severe gastrogaffin aspiration pneumonitis at the time of induction of anesthesia. Both patients have done well following a hospital stay of 17 and 30 days, respectively (Table 1).

Four patients developed marginal ulcers. The use of nonsteroidal anti-inflammatory drugs likely played a role even though patients are routinely counseled against their use. Two patients presented with pain, 1 patient developed hemetemesis but did not require transfusion, and 1 patient presented with perforation requiring exploration and revision of the gastrojejunostomy.

Operative times varied greatly at first as we developed and improved on our retraction and dissection techniques. Currently, the operation can be performed reliably in 60 to 90 minutes, comparing favorably with our open procedure (Figure 3).

Average hospital stay without major complications for the patient who underwent laparoscopy was 1.6 days. The average hospital stay for those patients requiring open conversion was 2.7 days.

Nine patients developed symptomatic cholelithiasis. All patients underwent successful laparoscopic cholecystectomy.

Table 1. Complications of Laparoscopic Roux-en-Y Gastric Bypass

<table>
<thead>
<tr>
<th>Complication</th>
<th>Total No. of Patients</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staple-line disruption (bezoar)</td>
<td>1</td>
<td>Reoperation</td>
</tr>
<tr>
<td>Gastric perforation</td>
<td>1</td>
<td>Reoperation</td>
</tr>
<tr>
<td>Internal hernia</td>
<td>14</td>
<td>Laparoscopic reduction (12 patients) or open reduction (2 patients)</td>
</tr>
<tr>
<td>Gastrojejunostomy stenosis</td>
<td>21</td>
<td>Endoscopic balloon dilation</td>
</tr>
<tr>
<td>Intra-gastric hematoma</td>
<td>1</td>
<td>Readmission to the hospital</td>
</tr>
<tr>
<td>Incomplete transection of stomach</td>
<td>2</td>
<td>Reoperation (open)</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>1</td>
<td>4-U transfusion</td>
</tr>
<tr>
<td>Marginal ulcer</td>
<td>3</td>
<td>Medical management</td>
</tr>
<tr>
<td>Marginal ulcer with perforation</td>
<td>1</td>
<td>Exploration</td>
</tr>
<tr>
<td>Staple-line failures</td>
<td>6</td>
<td>Laparoscopic repair and drainage</td>
</tr>
<tr>
<td>Central pontine myelolysis</td>
<td>1</td>
<td>Readmission to the hospital</td>
</tr>
<tr>
<td>Symptomatic gallstones</td>
<td>9</td>
<td>Laparoscopic cholecystectomy</td>
</tr>
</tbody>
</table>
our experience and development of techniques has al-
did not select only ideal patients, as we wanted to deter-
in our series. Actually, it is advantageous to dissect low pelvic
patients. We used only standard length trocars and in-
our laparoscopic Roux-en-Y gastric bypass has been
internal hernias have only occurred in the laparo-
operative times varied considerably at first as different exposure and retraction techniques were
compared favorably with the 9% to 20% stenosis rate reported in a recent review.11
We have seen 2 life-threatening complications that
we have not as yet experienced with the open proce-
Symptomatic cholelithiasis occurred in only 2.25%
of patients. Our data does not support concomitant
of 60 to 90 minutes are usual and are actually shorter than
for our open gastric bypass.
We have seen 2 life-threatening complications that
we have not as yet experienced with the open proce-
despite the early problem with the Harmonic scalpel. The
manufacturer responded in a professional and expedi-
tious manner that helped us to identify and correct this
Table 2. Excessive Weight Loss at 12 Months *

<table>
<thead>
<tr>
<th>Initial BMI, kg/m²</th>
<th>EWL, %</th>
<th>Total No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;40</td>
<td>79</td>
<td>12</td>
</tr>
<tr>
<td>40-50</td>
<td>71</td>
<td>32</td>
</tr>
<tr>
<td>&gt;50-60</td>
<td>55</td>
<td>12</td>
</tr>
<tr>
<td>&gt;60-70</td>
<td>48</td>
<td>1</td>
</tr>
<tr>
<td>70+</td>
<td>37</td>
<td>1</td>
</tr>
</tbody>
</table>

*BMI indicates body mass index; EWL, excessive weight loss.

As with many advanced laparoscopic procedures, the learning curve can be a long and arduous journey. We
did not select only ideal patients, as we wanted to deter-
melding patients about their “last meal” and more careful
dissection with the Harmonic scalpel should eliminate
these complications.

Internal hernias have only occurred in the laparo-
scopic case series, apparently due to decreased intra-
abdominal adhesions. By using nonabsorbable sutures for
fixation of the Roux limb at the mesocolon and at the
small-bowel mesentery, this now occurs with a fre-
quency of less than 1%.

Stenosis of the gastrojejunostomy was a significant
problem requiring endoscopic balloon dilation in 5.25%
of our patients. Our experience compares favorably
with the 9% to 20% stenosis rate reported in a recent review.11
With any mechanical stapling device, one can expect
a certain failure rate. It was fortunate that a suffi-
cient volume of cases revealed an early problem with the
improved 45-mm linear cutter with 3.5-mm stapler. The
manufacturer responded in a professional and expedi-
tious manner that helped us to identify and correct this
problem.

The laparoscopic Roux-en-Y gastric bypass has been
shown to be safe and effective for the nonsuper obese pa-
tient (BMI <50) by Wittgrove et al.2 More recently, us-
ing similar techniques, Nguyen et al12 were able to per-
form this procedure on a patient with a BMI of 61. We
have not found absolute patient size, BMI, or the pres-
ence of previous operations to be prohibitive in our case
series. Actually, it is advantageous to dissect low pelvic
adhesions laparoscopically rather than extend the tradi-
tional upper midline incision. In 1 patient who had an
incarcerated ventral hernia that had failed 4 previous at-
tempts at repair, we were able to perform the laparo-
scopic Roux-en-Y gastric bypass without disruption of
the hernia. Subsequent repair will hopefully have a higher
degree of success after significant weight loss has oc-
curred.

Symptomatic cholelithiasis occurred in only 2.25%
of our patients. Our data does not support concomitant
routine cholecystectomy. However, all patients with symp-
toms suggestive of gallstones were evaluated preopera-
tively and laparoscopic cholecystectomy was performed
prior to or during the gastric bypass. Other patients were
prescribed ursodiol for 6 months following surgery.13
The pediatric age group (aged <18 years) deserves special consideration. We have performed this procedure on 2 pediatric patients (aged 13 and 17 years), but only after extensive counseling and cooperation with the local pediatric weight management program and their pediatricians. These patients were essentially “physiological adults.” We do not advocate surgical weight loss in the pediatric age group as a routine.

Initially, very few patients opted for the open procedure despite extensive counseling and disclosure of our limited experience with the laparoscopic technique. This underscores the responsibility we have as surgeons to look at new technology critically. Patients seem too willing to accept an unknown and possibly higher complication rate to avoid the pain and/or problems associated with larger incisions. The question is not: Can we perform this procedure laparoscopically; rather, should we perform this procedure laparoscopically? Each surgeon must evaluate his or her own technical abilities in this regard. More importantly, each surgeon must evaluate his or her commitment to the lifelong support required of the bariatric patient.

Presented at the 71st Annual Session of the Pacific Coast Surgical Association, San Francisco, Calif, February 20, 2000.

Corresponding author: Kelvin D. Higa, MD, Valley Surgical Specialists, 7202 N Millbrook Ave, Suite 105, Fresno, CA 93720.

REFERENCES


DISCUSSION

Mark A. Vierra, MD, Stanford, Calif: Dr Higa has presented today a remarkable single-surgeon experience of laparoscopic Roux-en-Y gastric bypass for morbid obesity including 400 patients operated on over only 22 months, and we were provided with data regarding a learning curve caring for these patients. During this series only 12 patients required conversion to laparotomy at the initial operation. Currently, the conversion rate is less than 1%. The operation is typically performed in 60 to 90 minutes using 4 disposable trocars and 5 abdominal puncture sites. Most patients are discharged within 1 to 2 days.

It is worth reviewing the complications although it is important to acknowledge that many of these are really complications of the development of the procedure, and I do not believe are likely to occur with the same frequency in the next series that we will hear about from Dr Higa. If I understand the presentation correctly, somewhere between 17 and 23 patients required reoperation. Most of these were performed by laparoscopy. There were 14 internal hernias, 1 stenosis of the roux limb at the mesocolon, 1 gastric perforation possibly related to thermal injury from the harmonic scalpel, 1 marginal ulcer with perforation, and 2 incomplete gastric divisions. There were 6 staple line failures on the stomach. All of these were recognized within 24 hours, and all occurred with one particular iteration of the stapling device. At least some of these were recognized intraoperatively. It is unclear to me from the presentation how many of these were actually cared for at the time of the initial procedure and how many were late complications which required later operation. Twenty-one patients underwent dilatation of the gastrojejunostomy for about 5%. There were no deaths in this series, no deep vein thromboses, no gastrojejunostomy leaks except at the staple lines and, at least to date, no hernias.

This represents a remarkable series, and Dr Higa deserves tremendous credit for the hard work that it took to refine his current technique. Now that he is on the flat part of his learning curve, his outcomes and complication rates I think are clearly better than what has been achieved in most open series of gastric bypasses. I am personally convinced that the technique described is a legitimate extension of laparoscopy to bariatric surgery. The surgery that he has chosen to perform, the Roux-en-Y bypass, is that endorsed by National Institutes of Health Consensus Panel report of 1991, and I believe that it reproduces all of the essential elements of the procedure that we have come to expect in the open gastric bypass. Those essential elements include the creation of a very small gastric pouch, a small calibrated gastrojejunostomy stoma, complete division of the stomach, a Roux limb rather than a loop of the gastric jejunostomy, and though some might think this is not perhaps necessary, retrocolic passage of the limb.

Early weight loss results would appear to be comparable to the best series available for the Roux-en-Y gastric bypass, and I have no significant concerns about the anatomical result achieved by this procedure. For those of you who do not do bariatric surgery, the different weight loss, depending on the initial BMI of the patient, is something that has been demonstrated with virtually any type of bariatric procedure.

I do have a few observations and some questions. The first is the issue of the internal hernias. In our early experience with laparoscopic gastric bypass procedures at Stanford [University], we also had several internal hernias through the transverse mesocolon. This is a problem that was unique to us during the laparoscopic procedures, one that we had not seen with open surgery, and it clearly requires careful attention to fixation of the Roux limb. The second is that we also had several failures of the 45-mm 3.5-mm stapling device. We have moved to the 45-mm device with 4.5-mm staples and have had no further staple line disruptions. At least a couple of these were seen intraoperatively and, as with Dr Higa, all were picked up within the first 24 hours.

The third has to do with the length of stay of these patients. I note that the patients that were converted to open stayed an average of only 2.7 days in the hospital. Clearly Dr
Higa has a practice geared toward early discharge and it is important always to remember that many apparent improvements in outcome attributed to laparoscopic procedures can probably be achieved with open surgery as well if we just set our minds to it.

My fourth comment is that there is clearly a learning curve for these procedures. In Dr Higa’s case this was undoubtedly due to the development of a new technique and partly to the acquisition of technical facility. His learning curve looks to be about 150 cases, and, as I look back on my own, it looks to be nearly perfectly superimposable on his. To some extent this curve for future generations may be shorter as the technical details of the procedure become better understood, but I think it is always going to be a very long one. These are not easy procedures to develop proficiency in.

Finally, this year Americans are going to spend somewhere between $30 and $50 billion on diet programs trying to lose weight. Every bit of evidence that we have available to us at the present time suggests that 1 year from now we will weigh more than we do today. The only reasonable option at this time for patients who are dangerously overweight is surgery, and if Dr Higa’s results can be widely reproduced, I believe that we will see a substantial and justifiable increase in the performance of bariatric surgery.

I have the following questions. Actually, you anticipated my first and that is how you are selecting patients. My understanding is that you are excluding no one except for patients with previous gastric operations. Have you seen any problems with patients with advanced cardiomyopathy of obesity or significant carbon dioxide retention? Second, what are you doing for deep vein thrombosis prophylaxis? Four hundred bariatric procedures without a single deep venous thrombosis or pulmonary embolus is really quite remarkable.

The third is, how do you decide whether to dilate an anastomosis? In talking with other surgeons who perform bariatric surgery, it strikes me that the criteria for dilating anastomoses vary tremendously and I wonder at what point you decide that that is appropriate.

Finally, who should be doing these operations? My bias is that these procedures must be performed only by surgeons willing to make the commitment to learn bariatric surgery including the critical elements of patient selection, and preoperative and postoperative care. On the other hand it is certainly the case that these operations require very advanced technical skills in laparoscopy. I would like to hear your thoughts on this topic.

Bruce Wolfe, MD, Sacramento, Calif: The key question is not whether laparoscopic gastric bypass can be done or not, but whether it is better. To this end, have you looked at your previous experience with open gastric bypass and done a formal data analysis to see if, in fact, the overall complications and outcomes are comparable. My second question is that you showed follow-up weight data on just 58 patients at 1 year. Are there only 58 patients who are 1-year postoperative, or is the follow-up rather incomplete which might impact detection of late complications, particularly the problem of postoperative intestinal obstruction, which appears to be more common following laparoscopic gastric bypass compared with the open procedure?

Dr Higa: For patients who are ill, those with cardiomyopathy, sleep apnea, or severe medical problems, we approach each patient individually. We are very intent on optimizing their performance ahead of time, sometimes even admitting patients for diuresis and for evaluation with appropriate consultation with cardiac and pulmonary specialists.

For deep vein thrombosis prophylaxis, we use anticoagulation with cardiac and pulmonary specialists. We also believe in early ambulation. Gastrojejunostomy stenosis is a recurring problem. It is one of our most frequent complications, and I call it a complication because it requires a secondary procedure. Patients present with progressive problems tolerating advancement of their diet, even to the point of liquids. Fortunately, this anastomosis is durable and is amenable to endoscopic balloon dilation.

The next question is a very difficult one. Who should be doing these procedures? The National Institutes of Health standards really call for a lifetime follow-up of these patients, and there has to be a great commitment to these patients, more than just about any other procedure we do in general surgery. I hope that the individuals who choose to do these are the ones who have a real interest and a passion for bariatric surgery. Then the question is, can everyone be trained in advanced laparoscopic techniques? There is a very long learning curve as you can see with our data. So I do not have a real good answer for that. I think that as time goes on individuals will select themselves based on their interest, commitment, and degree of laparoscopic skill.

Dr Wolfe asked a good question about formal data acquisition looking back at our open experience and our present experience. In the ideal setting a prospective randomized study of open vs laparoscopy would be of value, but patients really won’t stand for that. The idea of minimally invasive technology is such a powerful tool that patients are willing to sacrifice a lot of things including an unknown safety factor. We are convinced that our present laparoscopic experience is superior to our personal open experience.

Follow-up is difficult in this group of patients. Third-party payers do not recognize the need for lifetime follow-up, so many patients are unwilling to pay for visits, especially if they perceive there to be no problems. Our patients sign agreements to be followed for at least 1 year in our office, but too many do not. Although our first case was 2 years ago, we were not as productive in the first year of this study. Therefore, most of our patients have not been out of surgery for 12 months. I agree with the need for long-term results.