Hypothesis: Although perceived as a more technically demanding and time-consuming technique, the hand-sewn gastrojejunostomy during laparoscopic Roux-en-Y gastric bypass (RYGB) is associated with fewer complications and lower costs than stapled techniques.

Design: A retrospective medical record review of prospectively collected data.

Setting: University hospital.


Intervention: Three techniques were compared: hand-sewn anastomosis (HSA), circular-stapled anastomosis (CSA), and linear-stapled anastomosis (LSA).

Main Outcome Measures: Operative costs, including the cost of stapling devices, the cost of sutures, and operative times, were compared. Rates of anastomotic strictures, leaks, marginal ulcers, bleeding, and wound infections were determined.

Results: Eighty-seven patients underwent HSA; 13, CSA; and 8, LSA. Supply costs per patient were higher for CSA ($955) and LSA ($435) than for HSA ($2) (P<.001). The mean ± SEM operative time for laparoscopic RYGB was longer when performing CSA than HSA or LSA (285 ± 22 vs 215 ± 8 and 204 ± 28 minutes, respectively; P < .001). Stricture rates were higher after CSA than HSA and LSA (4 [31%] of 13 patients vs 3 [3%] of 87 patients and 0 of 8 patients, respectively; P < .01). The wound infection rate was higher after CSA than HSA and LSA (3 [23%] of 13 patients vs 1 [1%] of 87 patients and 0 of 8 patients, respectively; P < .001). There was no difference in anastomotic bleeding, and no anastomotic leaks occurred.

Conclusions: In this experience, hand-sewn gastrojejunostomy during laparoscopic RYGB reduced operating room supply costs and was completed faster than stapled techniques. However, these differences may reflect the learning curve because these techniques were used early in our experience. Lower postoperative stricture and wound infection rates seem to be the primary benefits of the HSA technique.

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Since the introduction of the laparoscopic Roux-en-Y gastric bypass (RYGB) in 1994, several reports have validated its safety, feasibility, and cost-effectiveness, with decreased morbidity and comparable weight loss with respect to the open technique. Advantages of laparoscopic RYGB vs the open technique include reduced operative blood loss, less postoperative pain, lower pulmonary complication rates, a shorter hospital stay, a shorter return to normal activities, and a better quality of life.8-10 For these reasons, this technique has gained popularity among bariatric surgeons. However, it is considered one of the most technically demanding laparoscopic procedures. Performing the gastrojejunostomy (GJ) is one of the most challenging steps during laparoscopic RYGB. Consequently, different techniques for performing the GJ have been devised to facilitate this step. The circular-stapled anastomosis (CSA) technique originally described by Wittgrove et al is the most commonly used technique of GJ in laparoscopic RYGB. While more thoroughly studied, the 2 main complications reported using a circular stapler after esophageal or gastric resections are anastomotic strictures and leaks.9 A prospective randomized trial comparing hand-sewn anastomosis (HSA) with CSA after esophageal resections reported stricture rates of 9.1% and 40%, respectively. After performing a CSA between the

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esophagus and the jejunum, anastomotic leak rates of 5.6% to 13% have been reported.10,11 In addition, one of the techniques for performing a CSA laparoscopically describes passing the anvil orally and down the esophagus. This poses potential injuries to the cervical esophageal mucosa3 or hypopharynx5 when advancing the anvil through the esophagus. A transgastric technique of anvil placement has been described to avoid the transoral route, and was reported to decrease the operative time and wound infections.12,13 Other complications specifically reported for laparoscopic CSA are stapler malfunction2 and an increased wound infection rate at the extended abdominal trocar site where the contaminated stapler is withdrawn.3 Reports in the literature14 for open RYGB for morbid obesity indicate that the HSA technique has lower stricture and leak rates compared with the CSA technique. Higa et al15 reported a 0% leak rate after 1040 laparoscopic RYGB procedures using an HSA for the GJ.

This study assesses the benefits and outcome between hand-sewn, circular-stapled, and linear-stapled GJ techniques during laparoscopic RYGB.

### METHODS

Consecutive patients undergoing laparoscopic RYGB between January 1, 1999, and December 31, 2001, were evaluated. Patients who underwent open RYGB or in whom the procedure was converted to an open procedure were excluded from the study. The 3 different techniques of GJ performed in these patients were HSA, CSA, and linear-stapled anastomosis (LSA). Operating room (OR) costs, including the cost of stapling devices, the cost of sutures, and OR times, were analyzed. Rates of complications specifically related to the GJ technique, including anastomotic strictures, leaks, bleeding, marginal ulceration, and wound infections, were determined. Only anastomotic strictures that required dilatations, bleeding whose origin from the anastomosis was confirmed by direct endoscopic evaluation, marginal ulcerations diagnosed by endoscopic evaluation, and wound infections requiring specific treatment were included for analysis.

### OPERATIVE TECHNIQUE

All patients underwent divided gastroplasty and the creation of a 15- to 30-mL proximal gastric pouch. A Roux limb (100-150 cm) was brought through a retrocolic retrogastric channel for subsequent GJ. All patients received antibiotic prophylaxis with 2 g of cefazolin sodium (Ancef) and 500 mg of metronidazole hydrochloride (Flagyl).

#### HSA TECHNIQUE

A gastrostomy and an enterotomy are created and extended to a diameter of 1 cm each. A 2-layered GJ is completed with 3-0 polyglactin 910 (Vicryl) running sutures for the inner layer and a 2-0 silk running suture for the outer layer. A 36F gastric lavage tube is passed across the anastomosis and used for its calibration.

#### CSA TECHNIQUE

Endoscopy is performed, and a guide wire is passed through an endoscopically previously guided gastrostomy.16 The CSA is performed by attaching the guide wire to the anvil and pulling the anvil of a circular stapler through the mouth and esophagus and into the gastric pouch. The tip of the anvil is then exteriorized through the gastrostomy. The handpiece of a 21-mm circular stapler (United States Surgical Corp, Norwalk, Conn) is introduced through an extended abdominal port site through an enterotomy on the Roux limb and engaged with the anvil. The stapler is fired and the handpiece withdrawn from the bowel and abdominal cavity. A second layer of closure is formed with a 2-0 silk running suture. The enterotomy through which the stapler is introduced in the Roux limb is closed using a blue linear stapler (United States Surgical Corp).

#### LSA TECHNIQUE

A gastrostomy and an enterotomy are created, and the legs of a 30-mm blue linear stapler are introduced and the stapler is fired. The common enterotomy is closed using 3-0 polyglactin 910 running sutures. A 2-0 silk running suture completes the outer layer of the anastomosis.

### STATISTICAL ANALYSES

All values are expressed as mean ± SEM. Operative results and costs were compared using either a Kruskal-Wallis test (nonparametric analysis of variance) or a 1-way analysis of variance. Complications were compared using the χ² test. P < .05 was considered statistically significant.

### RESULTS

Between January 1, 1999, and December 31, 2001, 108 consecutive patients in whom the RYGB was completed laparoscopically were the subject of this study. Of the 108 patients, 87 underwent HSA; 13, CSA; and 8, LSA. The follow-up time for HSA was significantly shorter than for

### Table 1. Operative Results of the 3 Different Gastrojejunostomy Techniques

<table>
<thead>
<tr>
<th>Variable</th>
<th>HSA</th>
<th>CSA</th>
<th>LSA</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative time, min</td>
<td>215 ± 8</td>
<td>285 ± 22</td>
<td>204 ± 28</td>
<td>&lt;.001‡</td>
</tr>
<tr>
<td>Blood loss, mL</td>
<td>104 ± 22</td>
<td>88 ± 21</td>
<td>81 ± 19</td>
<td>.20‡</td>
</tr>
<tr>
<td>Length of stay, d</td>
<td>3.9 ± 0.9</td>
<td>4.0 ± 0.6</td>
<td>2.4 ± 0.3</td>
<td>.06‡</td>
</tr>
</tbody>
</table>

Abbreviations: CSA, circular-stapled anastomosis; HSA, hand-sewn anastomosis.

*Data are given as mean ± SEM.

†One-way analysis of variance.

‡Kruskal-Wallis test (nonparametric 1-way analysis of variance).

### Table 2. Complications Following 2 Types of Gastrojejunostomy Techniques

<table>
<thead>
<tr>
<th>Complication</th>
<th>HSA (n = 87)</th>
<th>CSA (n = 13)</th>
<th>P Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strictures</td>
<td>3 (3)</td>
<td>4 (31)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Marginal ulcers</td>
<td>0</td>
<td>1 (8)</td>
<td>.13</td>
</tr>
<tr>
<td>Bleeding</td>
<td>2 (2)</td>
<td>1 (8)</td>
<td>.34</td>
</tr>
<tr>
<td>Wound infections</td>
<td>1 (1)</td>
<td>3 (23)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Abbreviations: CSA, circular-stapled anastomosis; HAS, hand-sewn anastomosis.

*Data are given as number (percentage) in each group. None of the complications listed occurred in the group that underwent linear-stapled anastomosis.

†χ² Test.

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CSA and LSA (8.0±0.4 vs 15.0±2.8 and 12.0±2.0 months, respectively; P=.03). Complications related to the GJ were monitored for 3 months in all patients.

The OR time for laparoscopic RYGB was significantly longer when performing a CSA than an HSA or an LSA. The OR supply costs per patient were significantly higher when the GJ was performed with CSA ($520 for the circular stapler and $435 for the linear stapler used to close the Roux limb enterotomy; total, $955) and LSA ($435) when compared with HSA ($2) (P<.001). There was no difference in estimated blood loss or length of stay between the 3 techniques. Results are summarized in Table 1.

The GJ stricture rate was higher with CSA than HSA and LSA. All patients reported vomiting as their presenting symptom within 48±7 days after the surgery and were cared for successfully with endoscopic dilations. The wound infection rate was higher with CSA than with HSA or LSA. There was no difference in anastomotic bleeding or ulceration between the 3 types of anastomoses. There were no anastomotic leaks. The complication rates related to each of the GJ techniques are listed in Table 2.

### Table 3. Results of Gastrojejunostomies Reported in Selected Series

<table>
<thead>
<tr>
<th>Source</th>
<th>Techniques</th>
<th>OR Time, min</th>
<th>EBL, mL</th>
<th>LOS, d</th>
<th>Strictures, %</th>
<th>Marginal Ulcers, %</th>
<th>Bleeding, %</th>
<th>Leaks, %</th>
<th>Wound Infections, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schauer et al,2 2000</td>
<td>CSA and LSA</td>
<td>260</td>
<td>115</td>
<td>3.6</td>
<td>4.7</td>
<td>0.7</td>
<td>1.1</td>
<td>3.3</td>
<td>8.7</td>
</tr>
<tr>
<td>Nguyen et al,3 2001</td>
<td>CSA</td>
<td>225</td>
<td>137</td>
<td>3.0</td>
<td>11.4</td>
<td>...</td>
<td>3.8</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Matthews et al,4 2000</td>
<td>CSA</td>
<td>231</td>
<td>...</td>
<td>4.0</td>
<td>27.1</td>
<td>...</td>
<td>...</td>
<td>2.1</td>
<td>...</td>
</tr>
<tr>
<td>Higa,5 2000</td>
<td>HSA</td>
<td>60-90</td>
<td>...</td>
<td>1.8</td>
<td>5.3</td>
<td>1.0</td>
<td>0.25</td>
<td>0</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Abbreviations: CSA, circular-stapled anastomosis; EBL, estimated blood loss; HSA, hand-sewn anastomosis; LOS, length of stay; LSA, linear-stapled anastomosis; OR, operating room.

In this study, the stricture rate was significantly higher with the CSA technique, which is consistent with previous reports in the literature (Table 3). As previously reported,38 most strictures were present within 90 days after surgery. There were no anastomotic leaks, regardless of the GJ technique. It is our practice to perform predominantly hand-sewn GJ in our patients.

Marginal ulcers should always be anticipated in patients after RYGB for morbid obesity, because the use of anti-inflammatory medications for the treatment of arthritis and degenerative joint disease is high in this group of patients. Other factors associated with the development of marginal ulcers include pouch size, pouch orientation, staple line integrity, and mucosal ischemia.19 We had an 8% incidence after CSA, higher than the 0.7% to 1.0% reported in the literature for different GJ techniques during laparoscopic RYGB (Table 3). Our only patient with a marginal ulcer presented with upper gastrointestinal bleeding 4 months after laparoscopic RYGB with CSA. The patient discontinued his nonsteroidal anti-inflammatory medication, and the ulcer healed.

Obesity is a predisposing factor for wound infection after surgery. The HSA technique helped reduce this complication in patients undergoing laparoscopic RYGB. The mechanism for wound infection during laparoscopic RYGB is the extraction of the contaminated hand-piece of the stapler through the extended abdominal wall incision after performing the anastomosis. Previous series reported infection rates of 1.3% to 8.7% when using a CSA technique (Table 3). The incidence of wound infections in our series was also higher for CSA than for HSA and LSA.

The OR charges for stapling devices were higher for both stapling techniques compared with the HSA technique, as expected. The most expensive of the 3 techniques was CSA, for which 2 staplers are required (one circular stapler for the anastomosis and a second linear stapler for the closure of the enterotomy in the Roux limb where the circular stapler was introduced).

In conclusion, GJ is a challenging step during laparoscopic RYGB and has been performed with various techniques. Reductions in wound infection and stricture rates seem to be the primary benefits of HSA vs CSA. Clearly, the HSA technique has the cost advantage over both stapling methods. As long as it can be completed safely and in a reasonable time, this study, along with what others have reported, dispels the notion that HSA is prohibitive during laparoscopic RYGB.

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REFERENCES


Correction

Error in Table. In the Original Article by Goodson and Moore titled “Overall Clinical Breast Examination as a Factor in Delayed Diagnosis of Breast Cancer,” published in the October issue of the ARCHIVES (2002;137:1152-1156), an error occurred in Table 2 on page 1153. In that table, the parenthetical dichotomized data should have appeared in a third, unheaded column in each quadrant. The corrected table is reprinted herein. The journal regrets the error.

Table 2. Distribution of Nodularity and Durity Scores*

<table>
<thead>
<tr>
<th>Increasing Nodularity</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>13</td>
<td>18</td>
<td>26</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>B</td>
<td>26</td>
<td>35</td>
<td>63</td>
<td>1</td>
<td>125</td>
</tr>
<tr>
<td>C</td>
<td>63</td>
<td>66</td>
<td>67</td>
<td>0</td>
<td>196</td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>105</td>
<td>120</td>
<td>157</td>
<td>4</td>
<td>386</td>
</tr>
</tbody>
</table>

*Obtained with 4-point scales and as dichotomized (in parentheses) for the analysis in this report. \( \chi^2 \) for 16 categories = 24.13, \( P = .004 \); \( \chi^2 \) for 4 categories = 10.71, \( P = .001 \).