Hypothesis: Gastric banding (GB) and Roux-en-Y gastric bypass (RYGBP) are used in the treatment of morbidly obese patients. We hypothesized that RYGBP provides superior results.

Design: Matched-pair study in patients with a body mass index (BMI) less than 50.

Setting: University hospital and regional community hospital with a common bariatric surgeon.

Patients: Four hundred forty-two patients were matched according to sex, age, and BMI.

Interventions: Laparoscopic GB or RYGBP.

Main Outcome Measures: Operative morbidity, weight loss, residual BMI, quality of life, food tolerance, lipid profile, and long-term morbidity.

Results: Follow-up was 92.3% at the end of the study period (6 years postoperatively). Early morbidity was higher after RYGBP than after GB (17.2% vs 5.4%; P < .001), but major morbidity was similar. Weight loss was quicker, maximal weight loss was greater, and weight loss remained significantly better after RYGBP until the sixth postoperative year. At 6 years, there were more failures (BMI > 35 or reversal of the procedure/conversion) after GB (48.3% vs 12.3%; P < .001). There were more long-term complications (41.6% vs 19%; P < .001) and more reoperations (26.7% vs 12.7%; P < .001) after GB. Comorbidities improved more after RYGBP.

Conclusions: Roux-en-Y gastric bypass is associated with better weight loss, resulting in a better correction of some comorbidities than GB, at the price of a higher early complication rate. This difference, however, is largely compensated by the much higher long-term complication and reoperation rates seen after GB.


The prevalence of morbid obesity has been growing exponentially over the past 20 years. A recent survey showed that bariatric procedures have more than doubled between 2003 and 2008. In the United States, the increase was much greater for gastric banding (GB) than for gastric bypass (RYGBP). Controversy about bariatric procedures has been ongoing. For patients with body mass index (BMI) less than 30 (calculated as weight in kilograms divided by height in meters squared), it lies mostly between purely restrictive operations (GB and vertical banded gastroplasty) and restrictive/malabsorptive procedures (RYGBP) also acting by hormone-mediated mechanisms influencing hunger and satiety. Several trials have demonstrated the superiority of RYGBP over vertical banded gastroplasty regarding weight loss and long-term complications, resulting in the progressive abandonment of the latter. Until now, 17 studies comparing GB with RYGBP have been published, including 2 randomized trials, 3 case-matched studies, and many with important methodological flaws (eg, small numbers and different patient groups) and/or very limited follow-up. Tice et al reviewed those available in 2008. General conclusions were that RYGBP pro-
vided better weight loss and comorbidity improvements. Because of the aforementioned drawbacks, however, conclusions from the existing studies should be interpreted with caution. In the present study, we compared GB and RYGBP in matched pairs of patients treated during the same time frame by the same team.

**METHODS**

Bariatric surgery was offered to patients with a BMI more than 40, or more than 35 with at least 1 severe comorbidity, after failed conservative therapy and complete evaluation by a multidisciplinary team. Until December 2000, information and preoperative education was provided individually, whereas patients attended a 3-session preoperative course as of 2001.30 All patients were informed about the importance of major/permanent changes in eating behavior, increase in physical activities, and intense follow-up.

Only patients with a BMI less than 50 who underwent a laparoscopic primary bariatric procedure before June 2005 were included in this study so that follow-up would be at least 6 years for everyone. Patients operated on early on with either technique were excluded to limit the effects of the learning curve, leaving 253 and 310 eligible patients in the GB and RYGBP groups, respectively. All data were retrieved retrospectively from our prospectively established database.

Patients who underwent GB were matched to RYGBP patients according to sex, age, and BMI. The GB patients with no match were excluded. All patients were operated on between March 1998 and May 2005.

Gastric banding was performed using either the LAP-BAND (BioEnterics) or the Swedish Adjustable Gastric Band (SAGB) (Obtech Medical for Ethicon Endo-Surgery). The original technique for implantation of either band was used (perigastric for the LAP-BAND and pars flaccida for the SAGB).30,31 Both techniques were still widely used during the study period. In a randomized trial comparing these 2 devices, we showed the midterm complication rates to be similar.32 A recent update of this study (unpublished data) confirmed that the long-term major complication rates remained similar after 10 years.

Roux-en-Y gastric bypass was performed in a retrocolic/retrogastric fashion with a small 10- to 15-mL gastric pouch, a short biliopancreatic limb, and a 100-cm Roux limb.32

Follow-up for GB patients was performed at monthly intervals for 6 months, every 2 months for the next 6 months, quarterly during the second year, and at least biannually thereafter. The first band adjustment was performed after 1 month after a barium study proving the band to be in the correct position. Further adjustments were based on food tolerance, satiety, and weight loss. The RYGBP patients were followed up after 1 month, quarterly during the first year, and biannually thereafter. After GB, barium swallows were performed every 18 to 24 months to ensure the absence of complication. A complete laboratory workup was performed at least annually. Follow-up data included early complications, percentage of excess weight loss (EWL), BMI, quality of life improvement (Moorehead-Ardelt questionnaire), late complications, and reoperations. Food tolerance was assessed with a questionnaire, in which a general score (range, 0-27, with 27 being the best) compounds overall patient satisfaction with food tolerance, frequency of vomiting/regurgitating, and ease/difficulty of eating different types of food.34 Ideal weight was defined by the median value in the World Health Organization table by Jelliffe35 and ideal BMI was defined as 25, the upper limit of the normal range.36 Early complications arose within the first month or during the same hospital stay if it was prolonged. Major early complications were life threatening and/or required reoperation. Weight loss was considered excellent with a residual BMI less than 30 and acceptable with a residual BMI less than 35. Weight loss failure was either EWL less than 25% or residual BMI more than 35. Complications after GB, except for band erosion, were always treated first conservatively with band deflation. With a few exceptions, this policy led to weight regain in most cases, despite dietary and sometimes psychological counseling. Eventually, a decision had to be made between keeping the band with severe adverse effects and/or poor weight loss and removing the band with or without conversion to another procedure, according to the patient’s wishes, to achieve acceptable weight loss and quality of life. Complications severely impairing quality of life were not seen after RYGBP. Poor weight loss or weight regain alone was never an indication for conversion. The need for reversal of the procedure/conversion was considered a failure. Patients who underwent reversal/conversion were excluded from further analysis as of reoperation.

Statistical analysis was performed using Systat 8.0 (IBM SPSS Inc). The t test for paired groups was used for numerical variables, and the McNemar test was used for categorical variables, as appropriate. The Fisher exact test was used for comparisons within groups. A P value <.05 was considered significant.

Of 253 eligible GB patients, 221 (87.3%) found a suitable match in the RYGBP group so that a total of 442 patients were included. As a result of matching, sex ratio, age, and initial BMI were similar between groups. The follow-up rates at 6 years were 92.8% and 91.9%, respectively, after GB and RYGBP.

**RESULTS**

There were significantly more early complications after RYGBP than after GB (17.2% vs 5.4%; P < .001). Most complications were not life threatening and were treated conservatively. Major morbidity included only technical complications and was higher in the RYGBP group, but the difference was not statistically significant (3.6% vs 2.2%; P = .54).

**WEIGHT LOSS**

Maximal weight loss was achieved after a mean of 36 months after GB vs 18 months after RYGBP (P < .01). Maximal EWL after RYGBP was significantly higher (78.5% vs 64.8%; P < .001), and the mean nadir BMI was lower (26.7 vs 29.4; P < .001) (Figure 1 and Figure 2). Although patients who required reversal/conversion were progressively excluded from analysis, weight loss was better with RYGBP, resulting in significantly more patients with an excellent or acceptable result at all intervals.

At 3 years, 42 (22.3%) of the available patients after GB had a BMI more than 35 (mean BMI, 40.1) compared with 15 (6.9%; mean BMI, 36.1) after RYGBP (P < .001). The 6-year figures were 51 (33.5%) and 25 (12.3%) (P < .001), respectively. Similarly, after 3 years, 10 (5.3%) of the GB patients had a BMI more than 40 compared with 3 (1.3%) after RYGBP (P = .02). After 6 years, the corresponding figures were 21 (13.8%) and 5 (2.4%) (P = .003). The distribution of EWL differed between the 2 groups, with a larger standard deviation after GB (27.1% vs 18.5% for EWL after 5 years).
The 6-year long-term complication rate was significantly higher after GB (41.6% vs 19%; \(P < .001\)) (Table 1), resulting in more reoperations (Table 2) (26.7% vs 12.7%; \(P < .001\)). After GB, functional problems like esophageal dilatation (10.4%), impairing reflux requiring (or resistant to) daily high-dose proton-pump inhibitor therapy (6.8%), or severe food intolerance (6.3%) accounted for the majority of long-term complications, together with band erosions (7.7%). Overall, band removal was necessary in 47 patients (21.3%), of whom 29 (13.1%) were converted to another procedure. The majority of long-term complications after RYGBP were related to internal hernia, and no reversal was necessary. No patient died during follow-up.

**SUCCESS OR FAILURE**

At 3 years, there were 39 failures (EWL < 25%) or the need for reversal/conversion after GB compared with zero after RYGBP (18.2% vs 0%; \(P < .001\)). For BMI more than 35 or the need for reversal/conversion, we had 68 and 15 failures, respectively (31.7% vs 6.9%; \(P < .001\)). After 6 years, for band removal/conversion or EWL less than 25%, there were 79 failures after GB and 5 after RYGBP (39.9% vs 2.5%; \(P < .001\)). If BMI more than 35 was considered, the figures were 99 after GB and 25 after RYGBP (48.3% vs 12.3%; \(P < .001\)). Figure 3 shows the progression of the failure rates.

**QUALITY OF LIFE AND FOOD TOLERANCE**

Quality of life improved in both groups. Improvement was quicker after RYGBP and a significant difference remained between both groups up to 4 years (Figure 4). Food tolerance was much better and remained unchanged after RYGBP, whereas there was a tendency for worsening over time after GB (Figure 5).

**COMORBIDITIES**

The initial lipid profile was similar between groups. Improvement after 5 years was significantly better after RYGBP (Figure 6). Total cholesterol level remained unchanged after GB but significantly decreased after RYGBP. The high-density lipoprotein level improved in both groups, resulting in a significantly better total to high-density lipoprotein cholesterol ratio after RYGBP. The low-density lipoprotein level remained unchanged after GB but decreased significantly after RYGBP. Triglyceride levels improved similarly. The mean fasting glucose level had a tendency to be lower after RYGBP after 3 (89.55 vs 92.79 mg/dL; \(P = .07\)) and 5 (91.17 vs 95.32 mg/dL; \(P = .11\)) years.

**COMMENT**

Gastric banding and RYGBP are the most popular procedures worldwide, and the debate about which is the best has been ongoing for years. Among factors influencing this controversy, the way procedures are evaluated plays a role, with some focusing on results and others on risks. Well-designed, large prospective randomized trials would be ideal to compare procedures. Such studies, however, are difficult to set up, with only about one-fifth of the patients accepting randomization.

In their review of 14 of the 17 currently published studies comparing GB and RYGBP, Tice et al concluded that RYGBP was superior regarding weight loss and comorbidities. They underlined, however, the poor overall quality of the included studies. In the largest randomized trial published to date, significant differences in preoperative data (age and BMI) indicate a likely bias in patient selection/acceptance.

Matched-pair studies are the second best way to make comparisons. The present study includes a homogeneous population and is the largest of this type. All the patients have reached the 6-year point, with follow-up exceeding 90%, allowing for 3 major conclusions: (1) Early morbidity is significantly lower with GB. (2) Roux-en-Y gastric bypass provides more weight loss. (3) Long-term complications and reoperations are more common after GB.
We show superior weight loss after RYGBP throughout the study period. The difference would be larger had patients who lost their band owing to complications not been excluded, because these patients are prone to weight regain unless they are converted to another bariatric procedure. This confirms the results of the 2 available randomized trials including 51 and 197 patients, respectively.\(^\text{11,12}\) Cottam et al,\(^\text{13}\) in their matched-pair study, found a similar difference. In all 4 studies with 4- or 5-year results,\(^\text{11,12,26}\) including the present one, a significant difference remains favoring RYGBP. Some argue that intense follow-up including several yearly visits and band adjustments is necessary to achieve optimal results. Our biannual plan after the second postoperative year may be insufficient, but it represents a minimum. We regularly intensify follow-up, multiply band adjustments, and repeat dietary counseling for patients with insufficient weight loss.

In the present study, early morbidity was higher after RYGBP, without a significant difference for major complications, confirming results reported by others.\(^\text{11,12,26,28}\) Being a more complex operation than GB, with a longer operative time and hospital stay, it is not surprising that the morbidity for RYGBP is higher.\(^\text{28}\) Gastric banding, however, had a significantly lower late morbidity compared to RYGBP, as shown in Table 1. Late Complications.

### Table 1. Late Complications

<table>
<thead>
<tr>
<th>GB</th>
<th>No. (%)</th>
<th>RYGBP</th>
<th>No. (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port/catheter leak</td>
<td>15 (6.8)</td>
<td>Anastomotic stricture</td>
<td>14 (6.3)</td>
<td></td>
</tr>
<tr>
<td>Psychological intolerance</td>
<td>2 (0.9)</td>
<td>Marginal ulcer</td>
<td>2 (0.9)</td>
<td></td>
</tr>
<tr>
<td>Port infection</td>
<td>2 (0.9)</td>
<td>Small-bowel obstruction (adhesions)</td>
<td>2 (0.9)</td>
<td></td>
</tr>
<tr>
<td>Band infection</td>
<td>1 (0.4)</td>
<td>Small-bowel obstruction (internal hernia)</td>
<td>2 (0.9)</td>
<td></td>
</tr>
<tr>
<td>Pouch dilatation±slippage</td>
<td>10 (4.5)</td>
<td>Symptomatic internal hernia</td>
<td>22 (9.9)</td>
<td></td>
</tr>
<tr>
<td>Esophageal dilatation</td>
<td>23 (10.4)</td>
<td>Incisional hernia</td>
<td>2 (0.9)</td>
<td></td>
</tr>
<tr>
<td>Band erosion</td>
<td>17 (7.7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Band leak</td>
<td>2 (0.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late food intolerance</td>
<td>14 (6.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastroesophageal reflux</td>
<td>15 (6.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total patients with complication(s)</td>
<td>92 (41.6)</td>
<td>42 (19)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Total patients with major complication(s)</td>
<td>47 (21.3)</td>
<td>0</td>
<td>&lt;.001</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: GB, gastric banding; RYGBP, Roux-en-Y gastric bypass.

### Table 2. Long-term Reoperations

<table>
<thead>
<tr>
<th>GB Reoperation</th>
<th>No. (%)</th>
<th>RYGBP Reoperation</th>
<th>No. (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention on port/catheter</td>
<td>19 (4.5)</td>
<td>Endoscopic dilatation</td>
<td>14 (6.3)</td>
<td></td>
</tr>
<tr>
<td>Band change</td>
<td>1 (0.4)</td>
<td>Laparoscopy for internal hernia/adehesions</td>
<td>21 (9.5)</td>
<td></td>
</tr>
<tr>
<td>Band repositioning</td>
<td>2 (0.9)</td>
<td>Laparotomy for internal hernia/adehesions</td>
<td>4 (1.8)</td>
<td></td>
</tr>
<tr>
<td>Band removal alone</td>
<td>15 (6.8)</td>
<td>Small-bowel resection</td>
<td>1 (0.4)</td>
<td></td>
</tr>
<tr>
<td>Band removal and conversion to RYGBP</td>
<td>28 (12.7)</td>
<td>Incisional hernia repair</td>
<td>2 (0.9)</td>
<td></td>
</tr>
<tr>
<td>Band removal and conversion to biliopancreatic diversion</td>
<td>1 (0.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total patients with reoperation(s)</td>
<td>59 (26.7)</td>
<td>Total (excluding anastomotic dilatation)</td>
<td>28 (12.7)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Total patients with reversal</td>
<td>47 (21.3)</td>
<td>0</td>
<td>&lt;.001</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: GB, gastric banding; RYGBP, Roux-en-Y gastric bypass.

Figure 3. Evolution of the failure rate according to time. Failure is defined by an excess weight loss (EWL) less than 25% or reversal of the procedure (band removal with or without conversion to another bariatric operation). GB indicates gastric banding and RY, Roux-en-Y gastric bypass. P < .001 at all intervals.

Figure 4. Evolution of quality of life according to the Moorehead-Ardelt quality of life (M-A QOL) score. *P < .01. GB indicates gastric banding and RYGBP, Roux-en-Y gastric bypass.
term complications after RYGBP are essentially limited to
complications of GB appear late in the course of follow-

milligrams per deciliter, divide by 1.8.

cholesterol, high-density lipoprotein cholesterol, and low-density lipoprotein

a 1% incidence of “major events” compared with 4.8% after RYGBP.41 In our own experience with RYGBP, we have
noticed a marked decrease in early morbidity (4.7% over-

ter GB is common in series with long-term results,42,43 and
reoperation rates after GB. A high long-term morbidity af-

ever, is not devoid of problems. In recent studies, its early morbidity ranged from 1% to 3%,38-40 and the Longitudi-

oral Assessment of Bariatric Surgery consortium reported
80 GB patients were op-
erve major long-term complications were significantly higher
after RYGBP than after GB.44 In the matched-case study by Weber et al,14 the results strongly favored RYGBP reg-

Quality of life improved similarly after both proce-
dures, as reported by Nguyen et al,11 despite poorer food
tolerance after GB. The importance of weight loss after
bariatric surgery may not play as important a role in quality
of life as has been suggested. Also, limited food tol-

A large meta-analysis concluded that the remission rates of several major comorbidities were significantly higher
after RYGBP than after GB.44 In the matched-case study by Weber et al,14 the results strongly favored RYGBP re-
garding diabetes mellitus and dyslipidemia. Bowne et al,20
Campos et al,26 and Boza et al27 reported similar findings,
while others found no difference in the short-term.21,22 Co-

This study has limitations. Eighty GB patients were op-
erve major long-term complications after GB. Results in the literature are variable, de-

There were significantly more long-term complications
after GB. Results in the literature are variable, de-

anastomotic strictures and bowel obstructions and symp-
tomatic internal hernia. We are convinced that the surgi-
tcal technique is important in these complications. We re-
port a quite acceptable 2.3% stricture rate, but we recently

Figure 6. Evolution of food tolerance after gastric banding (GB) and Roux-en-Y gastric bypass (RYGBP) over the first 5 years (the maximum score is 27). *P < .001.

Figure 6. Lipid profile results 5 years after surgery. C indicates total cholesterol level; C/H, total to high-density lipoprotein cholesterol ratio; GB, gastric banding; H, high-density lipoprotein cholesterol level; L, low-density lipoprotein cholesterol level; RY, Roux-en-Y gastric bypass; and T, triglyceride level. *P < .01 between GB and RY at 5 years. SI conversion factors: to convert total cholesterol, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol to milligrams per deciliter, divide by 0.0259; triglycerides to milligrams per deciliter, divide by 1.8.

Strengths of our study are the large sample size and
the homogeneity of the study population, the long follow-

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the homogeneity of the study population, the long follow-

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tients lost from follow-up tend to have worse results than patients attending regular visits, and this has recently been shown by te Riele et al10 after GB.

CONCLUSIONS

On the basis of our results and analysis of the literature, we conclude that RYGBP provides better, more rapid, and more sustained weight loss, resulting in better correction of comorbidities than GB. The cost is higher early morbidity. With increasing experience, however, and the development of centers of excellence, early morbidity after laparoscopic gastric bypass is declining. Even if early morbidity after RYGBP remains somewhat higher than after GB, this difference is largely compensated for by the much higher long-term major morbidity seen after GB, leading to a large number of major reoperations and their risks.

These results should ideally be confirmed by a large randomized study with long follow-up. Ethical considerations might prevent potential investigators, however, from setting up a study where one treatment arm seems to be clearly inferior to the other and where the lack of equipoise poses patient information and accrual difficult if not impossible. At the present time, RYGBP seems clearly superior to GB when treating morbidly obese patients, who should be informed accordingly.

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Author Contributions: Study concept and design: Romy and Suter. Acquisition of data: Romy, Donadini, Giusti, and Suter. Analysis and interpretation of data: Suter. Drafting of the manuscript: Suter. Critical revision of the manuscript for important intellectual content: Romy, Donadini, Giusti, and Suter. Statistical analysis: Suter. Administrative, technical, and material support: Romy and Giusti. Study supervision: Giusti and Suter.

Financial Disclosure: None reported.

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**ONLINE FIRST**

Can We Safely State That Laparoscopic Roux-en-Y Gastric Bypass Is a Better Weight Loss Procedure Than Adjustable Band Gastroplasty?

According to Romy et al, RYGBP is a “better” bariatric procedure than GB. I personally agree with them. However, before we make from this conclusion a paradigm, a few caveats remain.

First, case-control studies can suffer from bias when one treatment is sensed as better than the other ab initio. Since prospective randomized studies comparing the 2 procedures are hardly realizable, better evidence could be obtained by prospectively comparing matched patients submitted to either procedure in 2 different centers with recognized expertise in GB or RYGBP.

Second, the GB appears to be operator dependent with remarkably better results in some centers (and countries!). Some surgeons have become “band champions,” and it is likely that they would obtain quite different results than reported herein. In any case, a well-performed GB is better than a poorly executed RYGBP.

Third, the limited (if any) influence of the GB on incretins and other gastrointestinal hormones might turn out to be an advantage in the long-term. A growing number of patients have problems linked with glucose metabolism like neuroglycopenia and diabetes recurrence late after RYGBP. The exact origin of this evolution appearing several years after RYGBP remains unclear, but it is a source of increasing concern.

Last, for most surgeons, the GB is more easily reversible than the RYGBP and the threshold for conversion, lower. Whereas with the presently available treatment modes patients do poorly with a second procedure after reversal of the GB, a stomach that is anatomically intact after band removal would, without doubt, present better conditions for future (active) medications or for another bariatric procedure (perhaps endoscopically).

Notwithstanding these words of caution, Suter et al must be commended for their scientific rigor and zealous follow-up. Both constitute an enlightening example for all of us bariatric surgeons.

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