

Results of Roux-en-Y Gastric Bypass in Morbidly Obese vs Superobese Patients

Similar Body Weight Loss, Correction of Comorbidities, and Improvement of Quality of Life

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Hypothesis: Gastric bypass corrects comorbidities and quality of life similarly in superobese (SO) and morbidly obese (MO) patients despite higher residual weight in SO patients.

Design: Prospective cohort study comparing results of primary laparoscopic gastric bypass in MO and SO patients.

Setting: University hospital and community hospital with common bariatric programs.

Patients: A total of 492 MO and 133 SO patients treated consecutively between January 1, 1999, and June 30, 2006.

Intervention: Primary laparoscopic Roux-en-Y gastric bypass.

Main Outcome Measures: Operative morbidity, weight loss, residual body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared), evo-

lution of comorbidities, quality of life, and Bariatric Analysis and Reporting Outcome System score.

Results: Surgery was longer in SO patients, but operative morbidity was similar. The MO patients lost a maximum of 15 BMI units and maintained an average loss of 13 BMI units after 6 years, compared with 21 and 17 in SO patients, which corresponds to a 30.1% and 30.7% total body weight loss, respectively. After 6 years, the BMI was less than 35 in more than 90% of MO patients but in less than 50% of SO patients. Despite these differences, improvements in quality of life and comorbidities were impressive and similar in both groups.

Conclusion: Although many SO patients remain in the severely obese or MO category, equivalent improvements in quality of life and obesity-related comorbidities indicate that weight loss is not all that matters after bariatric surgery.

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THE PREVALENCE OF OVER-weight and obesity has increased markedly worldwide in past years. Obesity-related comorbidities are responsible for a shortened life expectancy and a reduced quality of life.^{1,2} In overweight or moderately obese individuals, modest weight loss after medical

ally insufficient to have a major effect on all of them, and it does not improve quality of life sufficiently. In most of the latter patients, only bariatric surgery can provide substantial and maintained weight loss, which in turn results in improvement of obesity-related comorbidities and quality of life.^{4,5} Moreover, several recent studies have shown that bariatric surgery not only provides weight loss and relief from comorbidities but also decreases mortality, especially from cardiovascular and cancer causes.⁵⁻⁹

Superobese (SO) patients (body mass index [BMI] [calculated as weight in kilograms divided by height in meters squared], ≥ 50) are usually considered more difficult to treat than less obese individuals, and the results of bariatric surgery in terms of weight loss are less satisfactory, with many patients remaining in the severely obese (BMI, 35-39) or even MO (BMI, 40-49) categories despite sub-

See Invited Critique at end of article

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therapy including diet, behavioral therapy, increased physical activity, or a combination of these has been shown to markedly improve obesity-related comorbidities, especially diabetes, dyslipidemia, and hypertension.³ Modest weight loss (10% body weight loss) may significantly improve some comorbidities even in morbidly obese (MO) individuals but is usu-

stantial weight loss.¹⁰ Ten years after Roux-en-Y gastric bypass (RYGBP), Christou et al¹¹ noted that the residual BMI after 5 years was greater than 35 in 43% of the SO patients, and even in 58% after 10 years, as opposed to 9% and 20%, respectively, in the MO population. Despite these differences, massive and prolonged weight loss occurs after RYGBP in SO individuals. It is largely unknown, however, whether it is associated with as good a correction of obesity-related comorbidities as in MO individuals. The aim of this prospective study was to compare the results of RYGBP in a large group of SO and MO patients during a 5-year period, regarding not only weight loss but also correction of comorbidities and improvement of quality of life.

METHODS

Patients with a BMI of 40 or more, or of 35 or more with at least 1 severe comorbidity, and in whom conservative therapy had failed were studied by a multidisciplinary team. Routine preoperative tests included, among others, a complete laboratory workup, upper gastrointestinal tract endoscopy, and nocturnal oxymetry. The patients also attended a 3-session course during which they received detailed information about the various bariatric procedures,¹² and they were instructed about the need for long-term follow-up, the risks to develop nutritional deficiencies, and potential requirement for lifelong dietary supplementation. As of June 2000, gastric bypass was presented as the procedure of choice for patients without contraindication who met the criteria for bariatric surgery according to the consensus development conference panel of the National Institutes of Health and the Consensus on Obesity Treatment in Switzerland.^{13,14} Biliopancreatic diversion was mentioned but not proposed routinely as a primary operation because it is associated with a higher risk of short-term morbidity and mortality, as well as long-term nutritional and metabolic complications, and there was no clear available evidence that it produces better results than gastric bypass in terms of weight loss.¹⁵

The operative technique has been described in detail elsewhere.¹⁶ Briefly, it was as follows. With careful preservation of the vagus nerve, the stomach was divided just below the cardia with the use of a linear stapler to form a proximal gastric pouch of approximately 10 to 15 mL. The jejunum was then divided between 30 and 50 cm from the angle of Treitz. The Roux limb was brought close to the gastric pouch in a retrocolic and retrogastric fashion. The anastomosis between the gastric pouch and the Roux limb was performed with a 21-mm circular stapler. The jejunojejunostomy was done side-to-side with a linear stapler, and the proximal end of the Roux limb was staple-closed with the same instrument. The length of the Roux-en-Y limb was determined according to the patient's BMI: 100 cm up to a BMI of 48 and 150 cm with a BMI greater than 48. Most investigators choose a BMI of 50 as the cutoff; our choice of 48 is based on our assumption that a slightly longer Roux limb, while not being harmful, might help some patients in the upper morbid obesity range to lose more weight, as do SO patients. The mesenteric windows were closed recently with running nonabsorbable sutures, but this was not the case during our early experience (absorbable sutures). Cholecystectomy was performed in patients with known gallstones and in most other patients to prevent the development of gallstones during rapid weight loss. Antibiotic prophylaxis was provided with a single dose of amoxicillin-clavulanate or ciprofloxacin intravenously at the induction of anesthesia until November 2004; after that date, we began extending treatment for 72 hours.

In our experience, a longer antibiotic course significantly reduces the prevalence of postoperative intra-abdominal infections after laparoscopic RYGBP (2.8% vs 0.3%; $P = .001$). Thromboembolic prophylaxis was provided by means of low-molecular-weight heparin at a weight-adjusted dose and continued for 2 weeks. The day after surgery, a water-soluble contrast study was performed. If the study proved negative for leaks, oral liquids were started, and the patients were advanced to a semi-liquid diet on the third postoperative day, which was maintained for 1 month.

Since 1995, a prospective computerized bariatric database has been in use, including the patients' preoperative demographic and anthropometric data, comorbidities, and operative and follow-up data. Early complications were defined as those arising within the first 30 postoperative days or during the same hospital stay. Major complications either were life threatening or required reoperation. Follow-up data included evolution of weight expressed as the percentage of excess weight loss (EWL), BMI, quality of life improvement according to the Moorhead-Ardelt quality of life questionnaire,¹⁷ evolution of comorbidities, late complications, reoperations, and the Bariatric Analysis and Reporting Outcome System (BAROS) score, which is a recognized system in the overall evaluation of results after bariatric surgery.¹⁷ A complete laboratory workup was performed at least once a year to evaluate fasting glucose level, lipid profile, uric acid level, and potential mineral or vitamin deficiencies. Every year, a form was completed to assess the development of obesity-related comorbidities. This evaluation was based on the yearly individual patient's interview and the laboratory tests. Resolution of a given comorbidity was defined as its complete disappearance with no residual treatment. For patients with obstructive sleep apnea, complete resolution was assumed if repeated oximetry values were normal and continuous positive airway pressure had been discontinued or, in the absence of treatment, if symptoms or snoring had disappeared as assessed by the patient and/or the sleeping partner. Improvement was defined as either better control of the condition with the same medication or equivalent or better control with reduced medication. Worsening was defined as worse control and/or increased medication or the new development of a comorbidity that had not existed before surgery.

Follow-up was performed by the surgical as well as the medical team. Normal diet was resumed and multivitamin supplementation was started 1 month after surgery. Further follow-up included a quarterly visit during the first postoperative year and 2 visits a year later.

Our setting includes the University Hospital in Lausanne and the regional hospital in Chablais, each with a dedicated team for the evaluation and treatment of morbid obesity, the surgeon being common to both. To achieve a follow-up period of at least 24 months for all the patients, only those operated on before July 2006 were considered in this series. Results were compared between MO patients (BMI, <50) and SO patients (BMI, ≥ 50). Statistical analysis was done by means of the unpaired t test or Mann-Whitney test for continuous variables, and the χ^2 test or Fisher exact test for categorical variables, as appropriate.

RESULTS

A total of 625 patients underwent primary RYGBP during the study period. There were 492 MO and 133 SO patients, whose preoperative characteristics are summarized in **Table 1**. The SO group included 24 super-SO patients (BMI, ≥ 60). There were more males in the SO group, but the mean age was the same. The prevalence

Table 1. Preoperative Characteristics of the Patients

	Morbidly Obese (n=492)	Superobese (n=133)	P Value
Sex, No. M/F	109/383	45/88	.005
Age, mean (range), y	39.8 (18-66)	40.4 (18-61)	.55
Weight, mean (range), kg	119.4 (86-177)	154.6 (107-227)	<.001
BMI, mean (range)	43.2 (34-49.9)	55.4 (50-73.4)	<.001
Excess weight, mean (range), %	95.7 (55-126)	150.9 (116-234)	<.001
Abnormal glucose metabolism, No. (%)	265/479 (55.3)	78/128 (60.9)	.25
Hypertension, No. (%)	270/487 (55.4)	83/129 (64.3)	.07
Sleep apnea syndrome, No. (%)	200/489 (40.9)	80/130 (61.5)	<.001
GERD, No. (%)	272/473 (57.5)	64/121 (52.9)	.36
Hypercholesterolemia, No. (%)	323/471 (68.6)	82/124 (66.1)	.60
Hypertriglyceridemia, No. (%)	182/469 (38.8)	40/123 (32.5)	.19
Hyperuricemia, No. (%)	190/486 (39.1)	73/129 (56.6)	<.001
Chronic back pain, No. (%)	357/488 (73.2)	79/128 (61.7)	.01
Chronic lower limb joint pain, No. (%)	334/487 (68.6)	79/128 (61.7)	.14

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); GERD, gastroesophageal reflux disease.

Table 2. Operative and Hospital Data

	Morbidly Obese (n=492)	Superobese (n=133)	P Value
Laparoscopy, No. (%)	484 (98.4)	130 (97.7)	.62
Duration of surgery, mean (range), min	140.7 (85-315)	164.3 (100-355)	<.001
Median postoperative stay, mean (range), d	4 (2-66)	5 (3-61)	.009
Total morbidity, No. (%)	81 (16.5)	19 (14.3)	.54
Major morbidity, No. (%)	20 (4.1)	5 (3.8)	.87
Mortality, No. (%)	1 (0.2)	0	.60

of sleep apnea syndrome and hyperuricemia was significantly higher among SO patients, and there was also a trend for a higher prevalence of hypertension in this group. On the contrary, back pain was less common than in the MO patient group.

Table 2 provides the operative and hospital data, and **Table 3** gives the early complications. Duration of surgery was significantly longer and hospital stay was prolonged by 1 day in SO patients. Total morbidity, major morbidity, and mortality were not different between the 2 groups, and both morbidity and mortality decreased throughout the study period, reflecting the learning curve. Total morbidity among the first 25% of our patients was 21.1%, compared with 10.9% in the last 25% ($P = .01$). Major morbidity similarly dropped from 7.0% to 1.9% ($P = .001$).

During follow-up, we progressively lost track of a number of patients, either because they changed address or returned to their home country and could not be traced or simply because they refused to attend follow-up visits despite written and/or telephone reminders. After 5 years, our follow-up rate of 84.0% (263 of 313 eligible patients) was still acceptable for a bariatric population, and there was no difference between MO and SO patients.

The MO subjects lost a maximum of 15 BMI units (34.7% body weight loss) after 18 months and maintained an average loss of 13 BMI units (30.1% body weight loss) after 6 years. In SO patients, a maximum loss of 21 BMI units (37.3% body weight loss) was observed after

Table 3. Comparison of Early Morbidity Between Morbidly Obese and Superobese Patients

	No. (%)		P Value
	Morbidly Obese (n=492)	Superobese (n=133)	
Leak of gastrojejunostomy	8 (1.6)	3 (2.3)	.70
Leak of jejunojejunostomy	1 (0.2)	1 (0.8)	.38
Leak of gastric remnant	2 (0.4)	1 (0.8)	.51
Intestinal obstruction	7 (1.4)	3 (2.3)	.45
Intra-abdominal infection (no leak)	13 (2.6)	2 (1.5)	.20
Wound infection	18 (3.7)	5 (3.8)	>.99
Hemorrhage	20 (4.1)	5 (3.8)	>.99
Thromboembolism	7 (1.4)	1 (0.8)	>.99
Bronchopneumonia	5 (1.0)	3 (2.3)	.37
Pleural effusion	6 (1.2)	1 (0.8)	>.99
Other	10 (2.0)	2 (1.5)	>.99
Total No. of patients with complications	81 (16.5)	19 (14.3)	.64
Patient with major complications	20 (4.1)	5 (3.8)	.87

2½ years (19.4 in SO and 25.1 in super-SO) and an average of 17 BMI units (30.7% body weight loss) after 6 years (17.3 in SO and 22.2 in super-SO). These percentages are remarkably similar between MO and SO patients. Apart from an increased absolute weight loss, the outcome in super-SO patients was not profoundly different from that of the rest of the SO group, and no further separate analysis was attempted. **Figure 1** and **Figure 2** show the evolution of BMI and EWL in both patient groups. The EWL was less in SO than in MO patients at all time points, except after 4 years. **Figure 3** depicts the distribution of EWL among the patients, and **Figure 4** that of BMI. As a consequence of the higher initial BMI and reduced EWL, the mean BMI in the SO patient group remained significantly higher throughout the study period. Up to 6 years after surgery, more than 75% of MO patients achieved an EWL of 50% or more, compared with only 50% to 60% of their SO counterparts. As a result, 85% to more than 90% of the MO patients maintained a BMI less than 35, compared with less

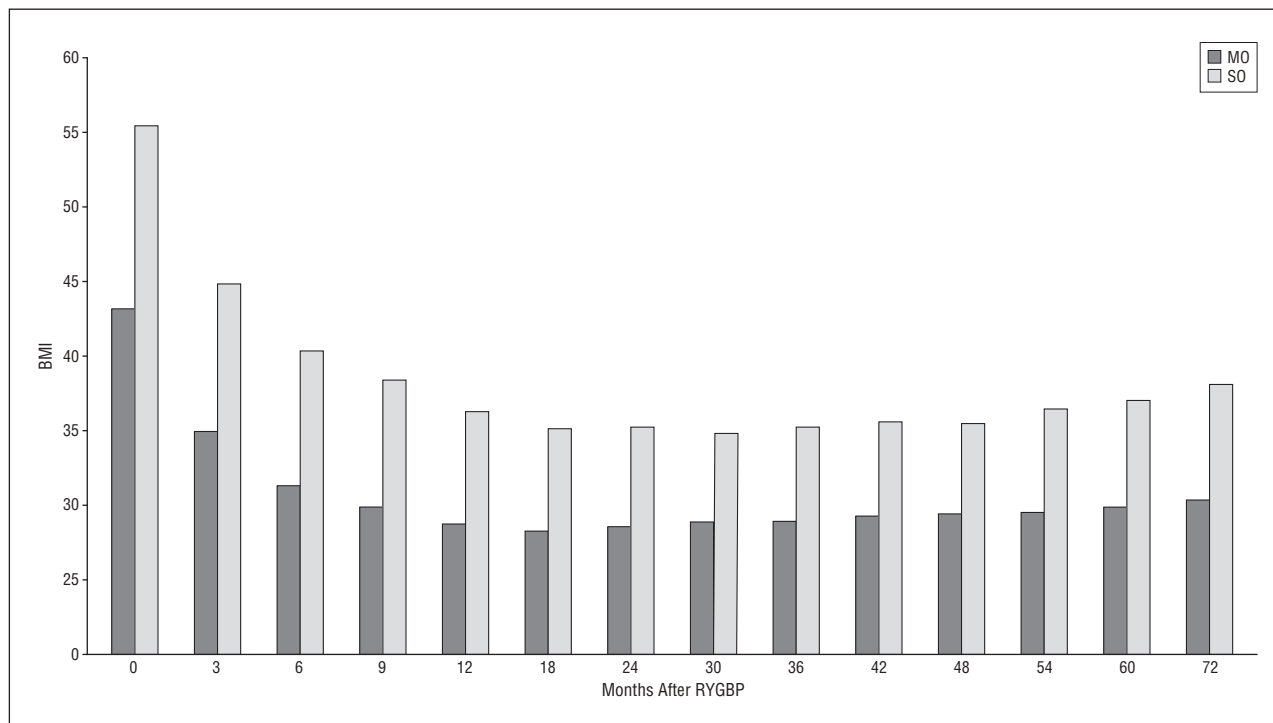


Figure 1. Evolution of the body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared) over time in morbidly obese (MO) and superobese (SO) patients after Roux-en-Y gastric bypass (RYGBP).

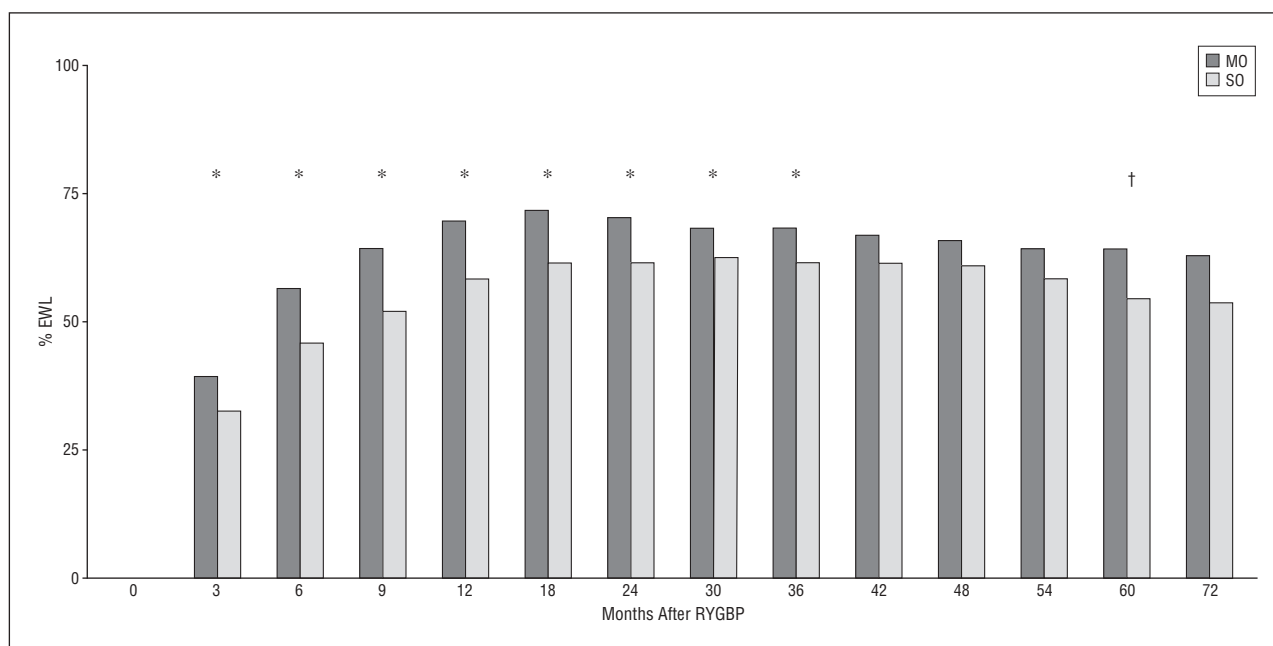


Figure 2. Evolution of excess weight loss (EWL) over time in morbidly obese (MO) and superobese (SO) patients after Roux-en-Y gastric bypass (RYGBP). * $P < .01$. † $P < .05$.

than 50% of the SO patients, of whom 25% remained in the MO range (≥ 40).

The evolution of the lipid profile is shown in **Figure 5**. Interestingly, the mean basal values did not differ between the 2 groups preoperatively. As of the first postoperative year, all mean values in both groups, except for high-density lipoprotein cholesterol, were significantly lower than before surgery. These differences re-

mained relatively constant over time, and there were very few differences between the 2 groups. The prevalence of an abnormal lipid profile significantly decreased in both groups. The mean fasting plasma glucose levels decreased in both groups, as did the prevalence of an elevated value. After a minimum of 3 years, 90% of the MO and 91% of the SO patients with abnormal preoperative glucose metabolism had complete correction. The mean

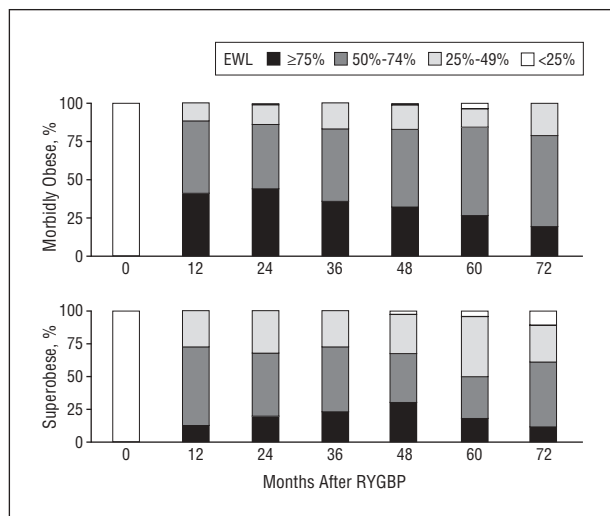


Figure 3. Distribution of excess weight loss (EWL) over time after Roux-en-Y gastric bypass (RYGBP) according to Reinhold criteria.¹⁸

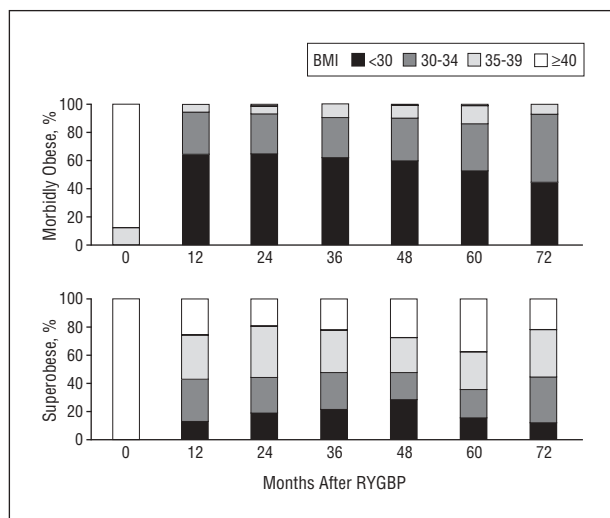


Figure 4. Distribution of BMI in morbidly obese and superobese patients over time after Roux-en-Y gastric bypass (RYGBP). BMI indicates body mass index (calculated as weight in kilograms divided by height in meters squared).

values for urates were significantly higher in SO patients before and up to 2 years postoperatively, but no difference was noted later. The evolution of other comorbidities, such as hypertension, sleep apnea syndrome, gastroesophageal reflux disease, low back pain, and joint pain, was evaluated in patients with a minimum of 3 years of follow-up and in patients with at least 5 years of follow-up (Figure 6). There was no significant difference between MO and SO patients, and results were very similar after 3 and 5 years.

Figure 7 shows the improvement in quality of life according to the Moorehead-Ardelt quality of life questionnaire, with no significant difference between the MO and SO patients at any time. According to the BAROS, most patients (>90%) in both groups maintained a good to excellent score as of the first postoperative year and for the whole study period. The mean BAROS score was significantly higher at all time points in MO compared with SO patients, but this was only because of the higher

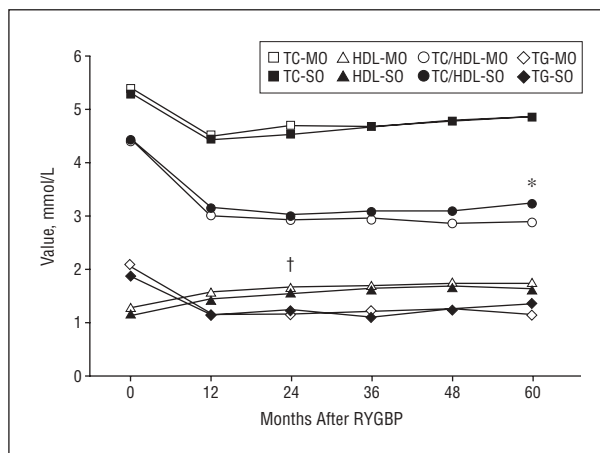


Figure 5. Evolution of the lipid profile. Mean total cholesterol (TC) (reference value, <5 mmol/L), high-density lipoprotein (HDL) cholesterol (reference value, >1.34 mmol/L), TC to HDL cholesterol ratio (reference value, <5), and triglyceride (TG) (reference value, <1.9 mmol/L) values in morbidly obese (MO) and superobese (SO) patients over time after Roux-en-Y gastric bypass (RYGBP). To convert TC and HDL cholesterol to milligrams per deciliter, divide by 0.0259; TG to milligrams per deciliter, divide by 0.0113. * $P < .05$. † $P < .01$.

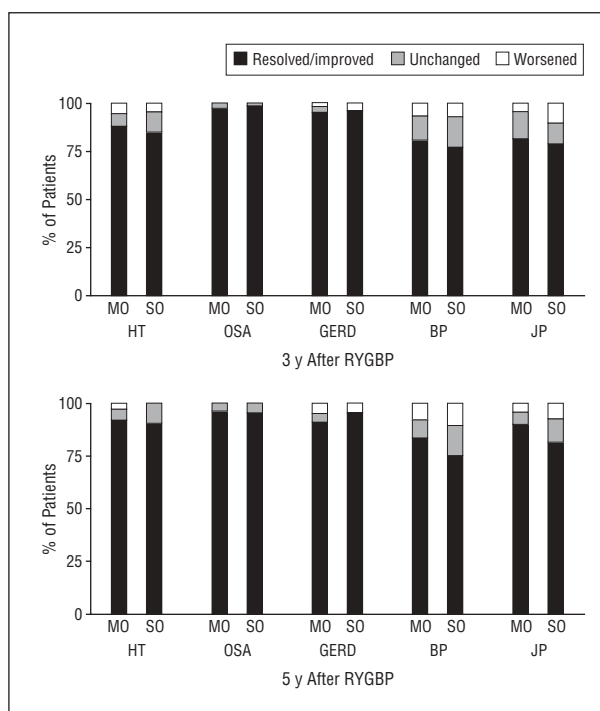


Figure 6. Evolution of other comorbidities. Improvement or resolution of hypertension (HT), obstructive sleep apnea syndrome (OSA), gastroesophageal reflux disease (GERD), back pain (BP), and joint pain (JP) in morbidly obese (MO) and superobese (SO) patients 3 and 5 years after Roux-en-Y gastric bypass (RYGBP).

EWL. Other subcomponents of the BAROS score (overall evolution of comorbidities, quality of life, and complications) did not differ between the 2 groups.

COMMENT

Bariatric surgery is intended to induce significant and sustained weight loss in MO patients, thereby correcting or improving obesity-related comorbidities, improving qual-

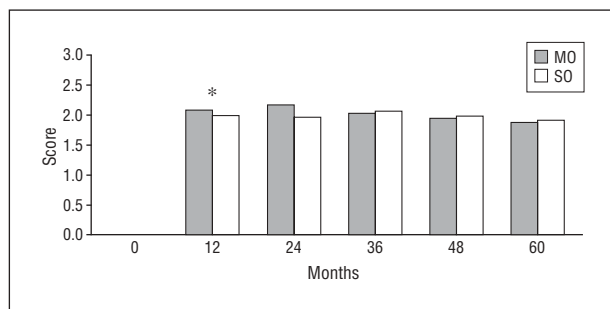


Figure 7. Improvement in quality of life in morbidly obese (MO) and superobese (SO) patients according to score on the Moorehead-Ardelt questionnaire. * $P = .03$.

ity of life and ultimately survival. Even modest (approximately 10%) or substantial (>10%) medically induced weight reduction has been shown repeatedly to improve glycemic control, hypertension, and lipid profile in obese individuals.³ After bariatric surgery, several studies have shown that massive weight reduction is associated with considerable improvement in heart disease and hypertension,¹⁹⁻²¹ serum lipid profile,^{22,23} diabetes mellitus,^{21,24-27} sleep apnea syndrome,²⁸ and metabolic syndrome,²⁹ among others. Recently, 2 studies from different parts of the world showed a decrease in cardiovascular and cancer-related deaths after bariatric surgery compared with non-operated-on MO patients.^{5,6} The same studies and others have also demonstrated a reduced overall mortality in surgically treated MO patients in comparison with those treated medically.⁵⁻⁹ To the best of our knowledge, the present study is the first to compare 5-year detailed results after RYGBP between MO and SO patients.

Our first interesting finding is the absence of an age difference between MO and SO patients. If weight gain were a continuum, one would expect the heavier patients to be older and have more obesity-related complications. A BMI of 50 as the limit between MO and SO is somewhat artificial, but it could be that overweight and obesity have different clinical manifestations, with MO and SO representing 2 similar but nonetheless different forms of the disease, or that subjects' susceptibility to obesity varies. It is generally accepted, however, that SO is more severe than MO, and this belief is reinforced by our increased prevalence of some comorbid conditions (hypertension, sleep apnea, and hyperuricemia) in the former group. Despite these differences, and contrary to what is generally reported in the literature, we did not find an increased operative morbidity in the SO group, in accordance with Gould et al,³⁰ who found no difference in postoperative morbidity between patients with BMIs less than 60 and 60 or more.

Although absolute weight reduction in kilograms was significantly greater in SO patients, those subjects remained heavier than MO subjects throughout the study period. This was not unexpected because others have reported similar results regarding weight loss.^{11,31} Despite these differences, the evolution of all evaluated comorbidities was remarkably similar in both groups, with improvement or correction in a high percentage of patients. Furthermore, correction of comorbidities, especially dyslipidemia and abnormal glucose metabolism, was not necessarily correlated with EWL. Quality of life improve-

ment was also the same in both groups. The BAROS composite score reflected these results and thus was higher in MO than in SO patients because EWL, which accounts for about one-third of the score, was less in the latter subjects. Gould et al³⁰ found very similar outcomes 1 or 2 years after surgery in their study comparing super-SO patients with less obese individuals.

A number of authors believe that, because results of RYGBP in terms of weight loss are less satisfactory in the SO subjects, these patients should be offered more aggressive and malabsorptive procedures such as biliopancreatic diversion.³¹⁻³⁷ Although there is some indication from the literature that biliopancreatic diversion might provide better weight loss, there are few, if any, data regarding the evolution of comorbidities after weight loss from biliopancreatic diversion in SO patients. The results of the present series show that RYGBP provides identical body weight loss and corrects comorbidities similarly in MO and SO patients despite a higher residual BMI in the latter. As even modest weight loss results in marked improvement of several obesity-related comorbidities, it is no surprise that similar percentages of body weight loss in MO and SO patients result in similar effects, at least for the first 5 postoperative years. Although a significant amount of weight loss is maintained long after bariatric surgery,^{4,24} slow long-term weight regain has been noted after every bariatric procedure, hence longer follow-up will be necessary to evaluate whether these improvements persist over time and whether and how much long-term weight regain, a recognized problem especially in the SO, affects them.

CONCLUSIONS

This study shows that the percentage of body weight loss is remarkably similar in MO and SO patients after laparoscopic RYGBP. This results in very similar improvements in all types of evaluated comorbidities as well as in quality of life in both groups, despite the fact that a significant proportion of our SO patients remain in the severe or even MO categories. Weight loss or residual BMI is not all that matters, and all aspects of the results of bariatric surgery must be evaluated to draw meaningful conclusions about the effectiveness of a given bariatric operation. Only large randomized studies comparing RYGBP with other bariatric procedures and studying all aspects of weight loss surgery, with long-term follow-up, will be able to establish whether one procedure is superior to the others, especially in the SO patient group.

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INVITED CRITIQUE

Suter and colleagues have touched on an important issue in their study. In 2007, the American Society of Bariatric Surgeons changed its name to more accurately reflect what is accomplished with a bariatric operation. *Metabolic* was added to the society name to emphasize the fact that these are more than weight-loss operations. The primary objective of bariatric surgery is improved health. A formerly diabetic patient who is still obese long after undergoing bariatric surgery has had a successful, life-altering outcome regardless of the amount of weight lost. Rather than reporting surgical results in terms of percentage of EWL, the bariatric surgical community should emphasize the changes in health and quality of life that follow these operations. Some may argue that bariatric surgeons are doing that now. I would argue that we are not doing it well enough. When we discuss surgical criteria, it is BMI that receives the head-

line; comorbidities get honorable mention. Weight loss is the first outcome discussed in our bariatric surgery lectures, in our clinical encounters with patients, and in our published reports. It is no wonder that, despite mountains of clinical evidence touting the health benefits of bariatric surgery, it is still acceptable for insurance companies to deny benefits for "weight-loss surgery." As these authors state in the conclusion of their article, "weight loss or residual BMI is not all that matters. . . ."

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