Weight Gain After Short- and Long-Limb Gastric Bypass in Patients Followed for Longer Than 10 Years

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Objective: To complete a long-term (>10 years) follow-up of patients undergoing isolated roux-en-Y gastric bypass for severe obesity.

Background: Long-term results of gastric bypass in patients followed for longer than 10 years is not reported in the literature.

Methods: Accurate weights were recorded on 228 of 272 (83.8%) of patients at a mean of 11.4 years (range, 4.7–14.9 years) after surgery. Results were documented on an individual basis for both long- and short-limb gastric bypass and compared with results at the nadir BMI and % excess weight loss (%EWL) at 5 years and >10 years post surgery.

Results: There was a significant ($P < 0.0001$) increase in BMI in both morbidly obese (BMI $<$ 50 kg/m^2) and super obese patients (BMI $>$ 50 kg/m^2) from the nadir to 5 years and from 5 to 10 years. The super obese lost more rapidly from time zero and gained more rapidly after reaching the lowest weight at approximately 2 years than the morbidly obese patients. There was no difference in results between the long- and short-limb operations. There was a significant increase in failures and decrease in excellent results at 10 years when compared with 5 years. The failure rate when all patients are followed for at least 10 years was 20.4% for morbidly obese patients and 34.9% for super obese patients.

Conclusions: The gastric bypass limb length does not impact long-term weight loss. Significant weight gain occurs continuously in patients after reaching the nadir weight following gastric bypass. Despite this weight gain, the long-term mortality remains low at 3.1%.

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In the past, we reported the results of gastric bypass in 274 patients consecutively operated upon, who were followed for a mean of 5.5 ± 1.5 years (range, 3–8.4 years).[1,2] We were concerned with weight loss and how this was influenced by preoperative weight, time to follow-up, and the presence of a long- or short-limb bypass. We emphasized clinical classification of all patients as excellent, good, or failure on the basis of final body mass indices.[3] We also compared our results of gastric bypass to those reported by Marceau et al[4] with biliopancreatic diversion with duodenal switch because they, uniquely, in the literature provided data on the above-mentioned variables with a similar follow-up time.

It is the purpose of the present study to report follow-up on the same patients after a mean of 11.4 years (range, 4.7–14.9 years) and again to compare the results to those achieved with biliopancreatic diversion and duodenal switch with follow-up of all patients greater than 10 years.[5]

METHODS

Patient Follow-up

This is a retrospective study in which patients were contacted by a questionnaire and invited to return to our outpatient department for examination, or provide the name of a local doctor to supply that information, or depended on a phone conversation with the patient. The study was conducted in accord with the ethical standards of the Committee on Human Experimentation of the McGill University Health Center. In the questionnaire, patients were asked to report on their preoperative and postoperative health status and if they suffered from any comorbidities of obesity or postoperative complications of gastric bypass. The provincial health insurance system provided the addresses on all patients, which is necessary to maintain a Medicare card (universal health care system). In the cases where questionnaires were not returned, addresses were cross referenced in a telephone directory available on the Internet (http://www.canada411.ca), after which patients were invited to our outpatient clinic or, if this was not possible, were asked to provide information over the phone. Weights obtained by questionnaire or telephone were compared with weights revealed at the time of clinic visits. Deaths, time of death, and cause were documented.

Operative Technique

All operations were performed by open laparotomy using a previously reported technique.[1,2] Briefly, a small 4-cm-long pouch on the lesser curvature of the stomach was created adjacent to a 28 or 30 Maloney bougie with a

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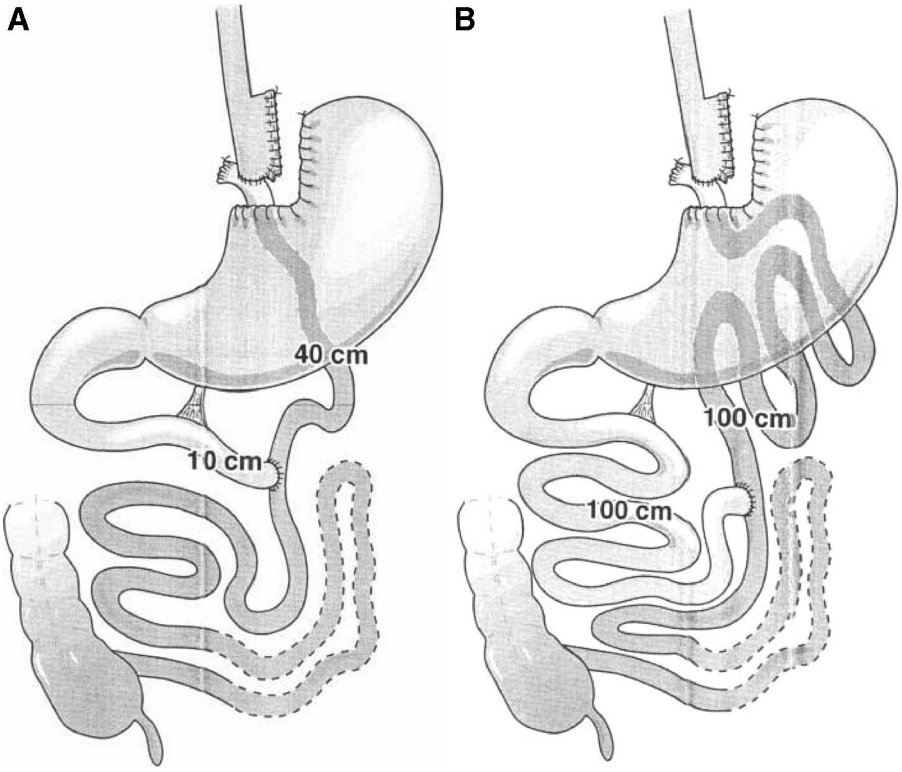

FIGURE 1. A, Standard short-limbed gastric bypass with 10-cm afferent limb and 40-cm Roux-en-Y limb and a 15- to 20-mL gastric pouch. B, Long-limb gastric bypass with 100-cm afferent limb and 100-cm Roux-en-Y limb and a 15- to 20-mL gastric pouch. (Reprinted with permission from MacLean LD, Rhode BM, Nohr CW. Long- or short-limb gastric bypass. *J Gatrointest Surg*. 2001;5:525–530.)

V. Mueller PI-90 stapler (MMM Company, St. Paul, MN) using 4.8-mm staples. This stapler is used to make 2 double rows of stables with an interval of free tissue in between that permits division by sharp dissection or cautery. The staple line of the pouch was oversewn with PDS sutures and the staple line of the excluded gastric body was inverted. Omentum was sutured between the staple lines. A proximal loop of jejunum was divided 10 cm from the ligament of Treitz and the distal end was advanced in a retrocolic, retrogastric position to create a 40 cm Roux-en-Y limb, which was anastomosed to the small gastric pouch. This was the operation designated as the short-limb procedure (Fig. 1A). The long-limb operation was created by dividing the jejunum 100 cm distal to the ligament of Treitz and making the Roux-en-Y limb also100 cm (Fig. 1B). The anastomosis had always enlarged to the diameter of the adjacent jejunum when measured at endoscopy after 6 months to 1 year. This enlargement occurred whether absorbable or nonabsorbable suture material was used.

Outcomes Reporting

We used a modification of the Reinhold classification[3] to evaluate our outcomes based on the body mass index (BMI) attained after 10 or more years of follow-up. (Table 1). An excellent or good result (BMI $\leq$ 35 kg/m^2) was considered a success. We have also used the method of Biron et al[5] to classify results after 10 years whereby success is achieved for morbidly obese patients if the BMI is $<$35 kg/m^2 and for super obese $<$40 kg/m^2. We compared the results of the patients classified before surgery as either morbidly obese or super obese over time and the influence during that time of a long- or short-limb bypass.

Statistics

All statistical analyses were performed using SPSS 12.0 for windows. All mean BMIs in both morbid and super obese groups were tested for significance using a one-way analysis of variance with posthoc testing of the various means using Scheffé's test. The individual results at 5 and 10 years were tested for significance using the Pearson χ^2 test. Change in BMI and estimated weight loss (%EWL) (preoperative minus postoperative BMI or %EWL) was used to assess the magnitude of weight loss between groups with different limb lengths using the independent sample t test.

RESULTS

Of the 272 consecutive patients in this series, 228 (83.8%) were followed up. Of these, 76% were seen in our outpatient department or by their local doctor and 24%

TABLE 1. Basis for Evaluation of Results (Reinhold Classification)

Result	Body Mass Index (kg/m^2)	Excess Body Weight (%)
Excellent	$<$30	0–25
Good	30–35	26–50
Failure	$>$35	$>$50

TABLE 2. Demographics and Weight Loss After Gastric Bypass

Demographic	Value
Patients followed	228/272 (83.4%)
Sex (% women)	82%
30-day operative mortality	1/272 (0.36%)
Long-term mortality (>10 yr)	7/228 (3.1%)
Duration of follow-up (yr)	11.4 + 0.2
Initial BMI	
All patients (n = 272)	48.1 ± 1.0
Morbid obese patients (n = 172)	44.3 ± 0.7
Super obese patients (n = 100)	56.2 ± 0.6
Lowest BMI of patients we were able to follow	
All patients (n = 228)	28.6 ± 0.3
Morbid obese patients (n = 144)	26.4 ± 0.4
Super obese patients (n = 84)	31.4 ± 0.7
Lowest % excess weight loss of patients we were able to follow	
All patients (n = 228)	88.6 ± 1.3
Morbid obese patients (n = 144)	91.8 ± 1.7
Super obese patients (n = 84)	78.2 ± 1.8
BMI at last available follow-up at a mean 11.4 yr	
All patients (n = 228)	33.6 ± 1.3
Morbid obese patients (n = 144)	31.0 ± 0.5
Super obese patients (n = 84)	38.3 ± 0.8
% Excess weight loss at last available follow-up at a mean 11.4 yr	
All patients (n = 228)	67.6 ± 2.3
Morbid obese patients (n = 144)	71.9 ± 2.1
Super obese patients (n = 84)	59.7 ± 2.1

Values are mean ± SEM.

provided information via questionnaire or a telephone conversation. We asked 41 patients to provide us with their weight by telephone prior to coming to the clinic in the next 2 to 3 days for complete follow-up including accurate weight measurements. We found that 36 patients underestimated their actual weight by 5.8 ± 1.1 kg and 5 overestimated their actual weight by 3.8 ± 1.2 kg. Because of this variability, we elected not to apply any correction factor to the weight data reported by phone or questionnaire alone. A total of 161 patients were followed longer then 10 years, 60 patients were followed for at least 5 years, 43 were lost to follow-up, 1 patient died within 30 days of surgery, and 7 patients died during the long term follow-up period. The distribution of BMIs was as follows: 35 to 39, 6.3%; 40 to 49, 57%; 50 to 59, 29.8%; and >60, 7%.

One patient died of pulmonary embolus on the second postoperative day for a 0.36% 30-day operative mortality. Seven patients died post surgery at: 4.8 years of suicide, 5.7 years of suicide, 6.6 years of liver failure, 8 years of unknown cause, 8.8 years of pulmonary embolus, 8.8 years of cardiac failure, and at 13 years of cerebrovascular accident, for a 3.2% long term post operative mortality.

Of the 272 patients in the study, 172 (63.2%) were morbidly obese (BMI < 50 kg/m^2) and 100 (36.8%) were super obese (BMI ≥ 50 kg/m^2). A total of 189 (69.5%) had a short-limb operation and 83 (30.5%) had the long-limb operation. We performed the short-limb operation up to the end of 1993 and begun using the long-limb operation after that time based on the popularity of adding more "malabsorption" to the short-limb Roux-en-Y gastric bypass. Because of the numbers of patients operated upon, the ratios of short- versus long-limb bypass remained relatively consistent between the subgroups. Of the 172 morbidly obese patients, 119 (69%) had the short-limb operation and 53 (31%) had the long-limb operation. Of the 100 super obese patients, 70 (70%) had the short-limb operation and 30 (30%) had the long-limb operation.

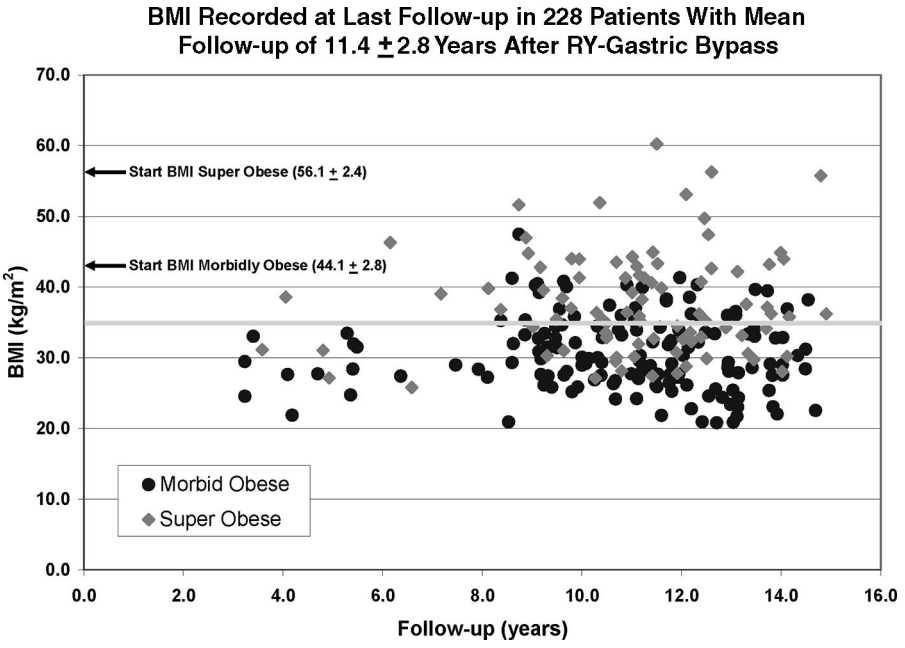

FIGURE 2. Plot of raw BMI values of 228 patients post RY gastric bypass at the last follow-up period (11.4 ± 2.8 years, mean ± SD) stratified by BMI into morbid obesity (BMI < 50) and superobesity (BMI ≥ 50).

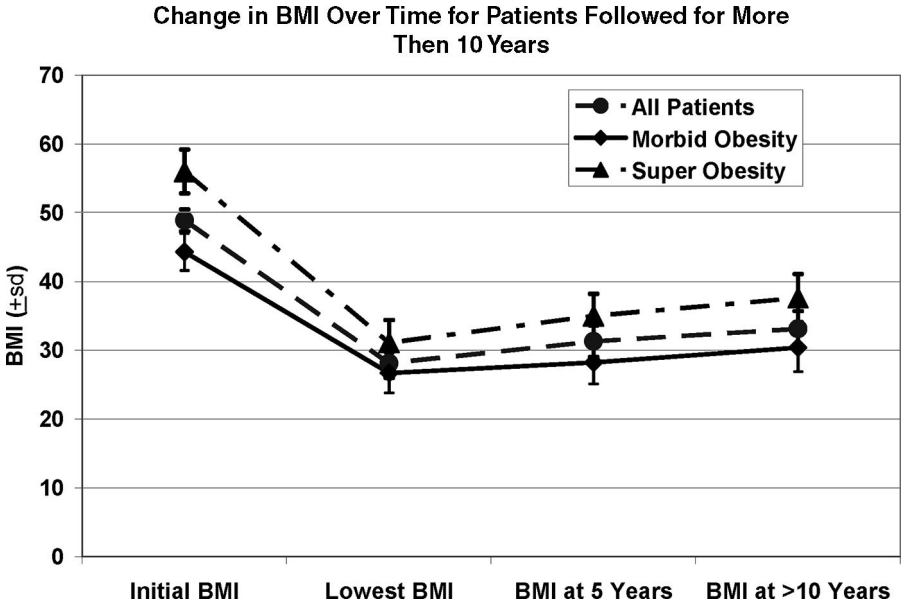

FIGURE 3. Plot of decrease of BMI against time for the 161 patients followed for more then 10 years (up to 15). The points represent the mean ± SD. Point 0 is the preoperative BMI. The nadir or lowest BMI occurred at 2.2 ± 1.9 years. The 5-year point represents a mean follow-up of 6.4 ± 3.2 years and the >10-year time point represents a follow-up of 12.3 ± 1.2 years. The superobese patients lost more quickly and gained more rapidly than the morbid obese ($P < 0.0001$). All increases in BMI from lowest to 5 and 10 year periods are significant ($P < 0.0001$).

The cumulative weight loss and characteristics of the patient population appear in Table 2. The lowest BMI of the morbidly obese patients we were able to follow was 26.4 and occurred at 1.9 years after surgery. This increased to 31.0 at final analysis 11.4 years after surgery. The lowest BMI for the super obese patients we were able to follow was 31.4 and occurred at 2.2 years following operation. This increased to 38.3 at final evaluation 11.6 years after surgery. A similar pattern was seen with the %EWL.

Figure 2 shows the raw BMI data of all 228 patients at their last follow-up time point. The mean follow-up period was 11.4 years. A number of patients have BMI values above 35 and the majority are super obese patients with starting BMI >50. The change in mean BMI over time for 161 patients followed for more than 10 years appears in Figure 3. There is significant weight gain ($P < 0.0001$) from the lowest BMI at approximately 2 years compared with 5 years after surgery and from 5 to 10 years after surgery in all patients or when the patients are separated into morbidly obese (BMI < 50) and super obese (BMI ≥ 50). Additionally, there is a significant difference ($P < 0.0001$) between morbid obese and super obese curves. The super obese lose more rapidly from the preoperative BMI to the lowest BMI and gain more rapidly than the morbid obese patients thereafter ($P < 0.0001$). Similar trends in weight regain when patients are followed more then 10 years are shown when the %EWL is examined (Fig. 4). The best %EWL was 89%, observed at about 2.5 years post surgery and decreased significantly to 68.1% at about 12.3 years post surgery ($P < 0.001$).

The individual results based on the Reinhold classification appear in Table 3. There is a significant decrease in excellent results and increase in failures from the results obtained within the first 5 years of follow-up compared with those obtained after more then 10 years of follow-up in all patients or when stratified by BMI into morbid obesity or super obesity.

While the long-limb bypass appears to improve the results slightly at 5 years in the super obese patients (Fig. 5), this difference was not significant. Furthermore, this apparent benefit was no longer seen at 10 years of follow-up. In patients who had a BMI over 60 kg/m^2, who might be benefited by the long-limb operation the most, the final BMI was 37.8 ± 4.4 in long-limb patients and 42.9 ± 9.6 (mean ± SD) in the short-limb group, but this difference is not significant ($P = 0.133$). Table 4 shows the detailed analysis of the effect of limb length on long-term weight in morbidly obese or superobese patients. Because of the sequential study design, the follow-up was significantly shorter in the long-limb group. However, neither change in BMI nor final BMI was different between the short- and long-limb groups, even when the patients are stratified by BMI to morbidly obese and super obese groups.

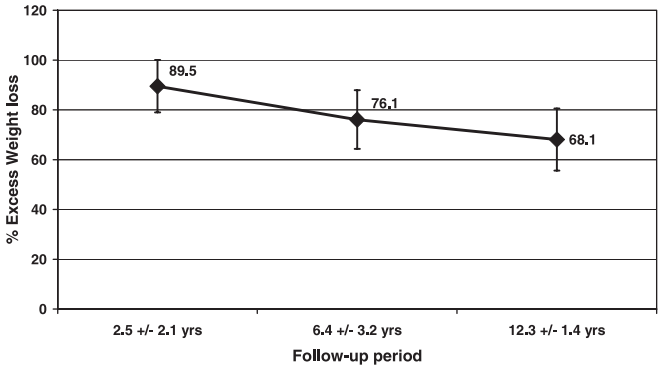

FIGURE 4. Plot of % excess weight loss against time for the 161 patients followed for more then 10 years (up to 15). A significant weight regain occurs following the best weight loss at about 2.5 ± 2.1 years compared with longer follow-up periods ($P < 0.0001$).

TABLE 3. Gastric Bypass Results for Severe Obesity According to the Reinhold Classification for Patients That Were Followed for 10 or More Years (Maximum 15 Years)

	Results Within First 5 Year of Follow-up			Results After >10 Year of Follow-up		
	All Patients	Morbidly Obese (BMI < 50)	Super Obese (BMI ≥ 50)	All Patients	Morbidly Obese (BMI < 50)	Super Obese (BMI ≥ 50)
Age (yr)	42.0 ± 3.4	40.2 ± 3.5	45.3 ± 4.2	—	—	—
M:F	128:33	80:18	48:15	—	—	—
Excellent (BMI < 30)	58/161 (52%)	63/98 (64%)	16/63 (25%)	58/161 (36%)	50/98 (51%)	8/63 (13%)
Good (BMI 30–35)	46/161 (30%)	26/98 (27%)	20/63 (32%)	46/161 (29%)	28/98 (29%)	18/63 (29%)
Failure (BMI > 35)	57/161 (18%)	9/98 (9%)	27/63 (43%)	57/161 (35%)*	20/98 (20%)†	37/63 (58%)‡

*$P < 0.0001$ versus 5-year failure rate.
†$P < 0.0001$ versus 5-year failure rate.
‡$P < 0.0001$ versus 5-year failure rate.

A comparison of failure rates in the biliopancreatic diversion with duodenal switch operation reported by Biron et al[5] and the gastric bypass as performed at our center appears in Table 5. All patients in both groups were followed over 10 years after surgery. We compared failure rates based on final BMI ≥35 kg/m^2 for morbidly obese and BMI ≥40 kg/m^2 for super obese patients. The 2 different operations produce comparable failure rates in patients who are followed for more then 10 years post surgery according to their criteria.

DISCUSSION

Significant weight gain after gastric bypass just like the results reported after biliopancreatic diversion with duodenal switch is a prominent feature of this retrospective study. The modest lengthening of the Roux and afferent limbs in the gastric bypass operation did not improve weight loss when comparisons are made after 10 years of follow-up. One could dispute the definition of success herein defined. We agree with Biron et al[5] that patient satisfaction is low when morbidly obese patients have a final BMI >35 kg/m^2 and when super obese patients have a final BMI >40 kg/m^2 many years after their operation.

Other long-term studies (>10-year follow-up) do not confirm the late failure rates herein reported. Hess et al[6] were able to follow 167 of 182 patients (92%) more than 10 years after biliopancreatic diversion with duodenal switch. They found 87 (52%) had lost at least 80% of excess weight. Only 6% lost less than 50% of excess weight.[6] We found that 55 of 161 (34%) of our patients had lost at least 80% of excess weight after more than 10 years follow-up. Hess et al report a mean initial excess weight loss of 75% (no SD reported) for patients followed for more then 10 years.[6] This compares with 68.6% ± 21.4% (mean ± SD) reported by Biron et al[5] and 67.6% ± 25.1% (mean ± SD) reported herein for the gastric bypass operation.

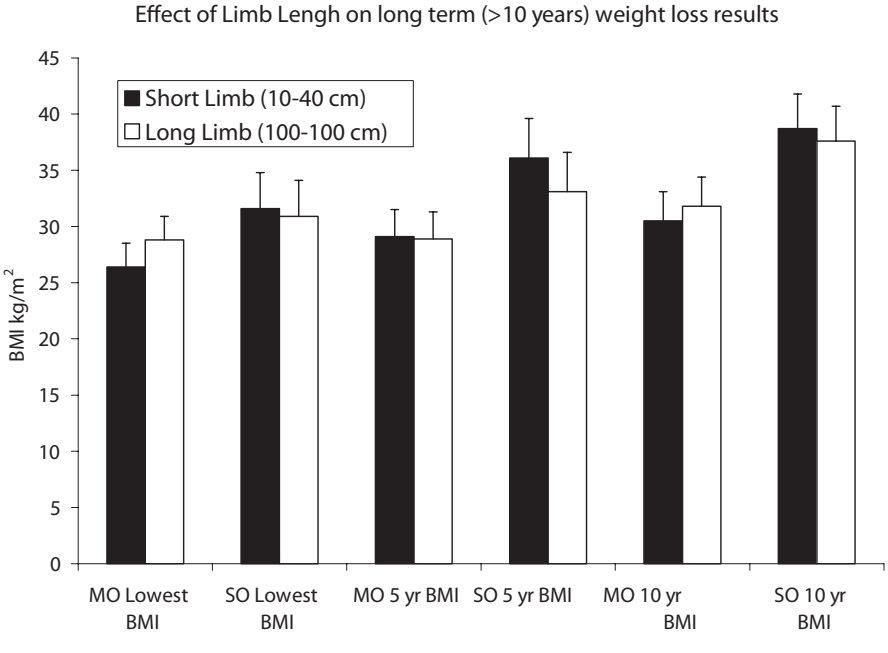

FIGURE 5. The effect of limb length on long-term weight loss in morbidly obese (MO) and super (MO) obese patients.

TABLE 4. Results of Long and Short Limb Bypass in Morbidly Obese and Super Obese Patients

	Short Limb	Long Limb	*P*
Morbidly obese patients (preoperative BMI < 50 kg/m^2)			
No. of patients	86	46	
Initial BMI	44.4 ± 3.1	44.0 ± 3.1	0.53
Final BMI	30.5 ± 5.3	31.8 ± 5.4	0.17
Change in BMI	13.9 ± 5.7	12.2 ± 5.9	0.11
Follow-up (yr)	12.3 ± 1.2	9.5 ± 1.5	<0.05
Super obese patients (preoperative BMI ≥ 50 kg/m^2)			
No. of patients	54	23	
Initial BMI	56.4 ± 6.0	55.8 ± 4.5	0.66
Final BMI	38.6 ± 7.7	37.7 ± 6.1	0.59
Change in BMI	17.8 ± 6.9	18.1 ± 6.3	0.83
Follow-up (yr)	12.3 ± 1.2	9.5 ± 1.5	<0.05

TABLE 5. Failure Rate Is Based on Final BMI ≥ 35 kg/m^2 for Morbidly Obese and BMI ≥ 40 kg/m^2 for Super Obese*

Follow-up ($\geq$10 yr failure rate)	Morbidly Obese (initial BMI $<$ 50 kg/m^2)	Super Obese (initial BMI $\geq$ 50 kg/m^2)
Duodenal switch	53/263 (20.2%)	38/93 (40.9%)
Gastric bypass	20/98 (20.4%)	22/63 (34.9%)

*Biron et al.[5]

Scopinaro et al[7] have reported excess weight loss of 74% ± 15% (mean ± SD) at 10 years, 75% ± 16% at 12 years, 75% ± 16% at 14 years, and 77% ± 18% at 18 years with no difference between morbid obese and super obese patients. At 10 years, 90% of the patients had a reduction of the initial excess weight >50%. In our case, 80% of our patients had a reduction of the initial excess weight >50%.

Fobi et al[8] using the transected banded gastric bypass followed 22 of 51 patients for 10 years and reported a mean of 72% excess weight loss, but no range (eg, mean ± SD) of results or stratification based on preoperative weight was supplied. Their data are similar to ours with 67.6% excess weight loss at >10 years follow-up.

Pories et al[9] showed a remarkable stability of postoperative weight after gastric bypass for up to 14 years. Their study of 608 patients with a 97% follow-up showed a 58% loss of excess weight after 5 years and a BMI of 33.7. After 10 years, the excess weight loss was 55% and the BMI was 34.7 (range, 22.5–64.7). At 14 years (10 patients), the EWL was 49% and the BMI 34.9 (range, 25.9–54.6). Since only 158 of the 608 patients in this series were followed for 10 years, late weight gain may be missed.

Others have noticed weight gain from the nadir weight after gastric bypass. Ponce and Dixon[10] found a decrease in excess weight loss at 5 to 7 years after gastric bypass so that there was an overlap of this value between lap band operations and gastric bypass.

The stratification of severely obese patients into morbidly obese if the BMI is less then 50 and super obese when the BMI is greater or equal to 50 has not shown any advantage in interpreting our outcome results after 10 years of follow-up and the effect of limb length on this outcome. Up to the end of 1994, which is the closing date for this study, 9.9% of patients had BMI >60 with a maximum BMI = 80 (range, 35–80). The mean BMI of patients that we see today has increased by at least 5 points and 15.4% of the patients have BMI >60 with a maximum BMI = 105.5 (range, 35–105.5). Setting a BMI cutoff of 50 to stratify patients as super obese ignores this trend and nullifies any recommendations. A better stratification might be to report BMI centiles (10 BMI units) and use this stratification to bring out the challenges of achieving weight loss in these massive patients. Other variables such as race (eg, blacks demonstrate less weight loss with bariatric surgery compared with whites) or perhaps genetic profiles may also have to be considered.

Despite significant weight gain, which does impact on quality of life as judged by the patients, the mortality rate has remained very low at 3.1% and comorbidities have remained extremely low as judged by assessing the medications the patients are currently taking. A larger study with longer follow-up will be necessary to establish the impact of late weight gain on recurrence of comorbidities.

Satiety is a prominent feature of weight loss after gastric bypass and persists in those patients with an excellent result. Patients who regain large amounts of weight say they are eating almost as much as before the operation. This increase in intake takes place over several years and does not occur suddenly as with staple line dehiscence.

In the past, we found that excellent weight loss occurred with a wide open gastrojejunal anastomosis. We also did not show increase in pouch size over a 5-year period using upper gastrointestinal x-ray examinations. How satiety is controlled is not apparent from this study, but it is quite clear that significant weight gain can occur in cooperative, well-motivated patients who have experienced substantial improvement in quality of life after surgery before late weight gain.

It is equally puzzling that a malabsorptive procedure, the biliopancreatic diversion with duodenal switch, should have a similar reported late failure rate as a restrictive operation, the Roux-en-Y gastric bypass. A prospective randomized trial comparing the 2 techniques with appropriate follow-up periods (>10 years) is needed to confirm the findings suggested by these retrospective studies.

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