The Greenville Gastric Bypass

Progress Report at 3 Years

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Two hundred and ten morbidly obese patients underwent a standardized gastric bypass procedure between February 1980 and November 1983. We conclude, based on 100% follow-up, that the operation is safe (operative mortality—1%, significant complications—10%) and effective (reoperation rate—4%). Only one patient failed to lose more than 25% of preoperative weight. The operation produced a mean weight loss in the group from 289 pounds (202–505) before surgery to 176 pounds (118–308) at 18 months after surgery. Stated as "per cent of ideal weight," patients lost from a preoperative mean of 214% (153–350) to 130% (88–189) at 18 months. Maximum weight loss was reached by 18 months after the procedure and was maintained during 36 months of observation in over 95% of patients. When patients were divided into four groups according to preoperative weight, weight loss occurred at a roughly similar rate, but heavier patients, although they lost more weight, plateaued at a higher weight than patients originally less obese. Striking and objective benefits were seen in patients with diabetes, hypertension, heart disease, and pulmonary insufficiency.

PREVIOUSLY WE REPORTED gastric bypass to be a more effective operation than gastric partition for the treatment of morbid obesity.[1] In a prospective, randomized study comparing the two operations, we found that gastric bypass patients lost 15% more of their original weight at 12 months and 21% more at 18 months. There were no failures in the gastric bypass group while 28 of the 45 operations failed in the gastric partition group. Because the gastric pouches and the anastomoses were constructed similarly in both operations, we proposed that the superiority of gastric bypass may have involved distal gastric and duodenal exclusion.

We have continued to perform the same standardized gastric bypass and are now able to report our results based on 100% follow-up in 210 morbidly obese patients for a period up to 36 months (mean of 18 months).

Presented at the Ninety-Fifth Annual Meeting of the Southern Surgical Association, December 5–7, 1983, Hot Springs, Virginia.

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Submitted for publication: January 17, 1984.

Materials and Methods

Two hundred and ten individuals, each a minimum of 100 pounds above their ideal weight as defined by the 1983 Height and Weight Standards of the Metropolitan Life Insurance Company (Table 1), represent a consecutive series of morbidly obese patients treated with gastric bypass from February 1980 to November 1983 at the East Carolina University School of Medicine. All patients had been morbidly obese for at least 5 years and had failed previous attempts at dieting.

The average age was 35 years with a range of 13 to 63. There were 189 women with an average weight of 284 pounds (202–505) and 21 men with an average weight of 341 pounds (224–445). The whole group had a mean weight of 289 pounds, or 214% of the ideal body weight.

The patients were evaluated extensively in the obesity clinic by one of two surgeons and a nurse practitioner who coordinated preoperative testing and postoperative follow-up. The minimal preoperative clinical profile obtained consisted of a complete medical and dietary history, physical examination, complete blood count, urinalysis, SMA-12 chemistries, skin tests to common antigens, glucose tolerance test, T3, T4, cortisol, B6, B12, Vitamin C, Folate, electrocardiogram, chest x-ray, pulmonary function test with arterial blood gases, and an upper gastrointestinal series. Several required more sophisticated studies including fiberoptic endoscopy, echocardiography, stress testing, and angiography if indicated during their preliminary evaluations. A psychiatrist screened all patients for psychopathology. Additional members of the family, if available, were counseled regarding the surgery.

Ninety-five patients were hypertensive; with 70 receiving antihypertensives. There were 37 adult onset and

TABLE 1. *1983 Height and Weight Standards of the Metropolitan Life Insurance Company*

Height	Small	Medium	Large
		Men	
5'2"	128–134	131–141	138–150
5'3"	130–136	133–143	140–153
5'4"	132–138	135–145	142–156
5'5"	134–140	137–148	144–160
5'6"	136–142	139–151	146–164
5'7"	138–145	142–154	149–168
5'8"	140–148	145–157	152–172
5'9"	142–151	148–160	155–176
5'10"	144–154	151–163	158–180
5'11"	146–157	154–166	161–184
6'0"	149–160	157–170	164–188
6'1"	152–164	160–174	168–192
6'2"	155–168	164–178	172–197
6'3"	158–172	167–182	176–202
6'4"	162–176	171–187	181–207
		Women	
4'10"	102–111	109–121	118–131
4'11"	103–113	111–123	120–134
5'0"	104–115	113–126	122–137
5'1"	106–118	115–129	125–140
5'2"	108–121	118–132	128–143
5'3"	111–124	121–135	131–147
5'4"	114–127	124–138	134–151
5'5"	117–130	127–141	137–155
5'6"	120–133	130–144	140–159
5'7"	123–136	133–147	143–163
5'8"	126–139	136–150	146–167
5'9"	129–142	139–153	149–170
5'10"	132–145	142–156	152–173
5'11"	135–148	145–159	155–176
6'0"	138–151	148–162	158–179

two juvenile onset diabetics. Seven required insulin and five took oral hypoglycemic agents.

An unmanageable risk factor such as hypertension, diabetes, pulmonary insufficiency, or an arthritic disability was frequently the indication for referral for obesity surgery. Completion of the preoperative evaluation generally required 1 to 2 months, and this time interval provided the patient a time period to consider the scope and appropriateness of gastric bypass surgery.

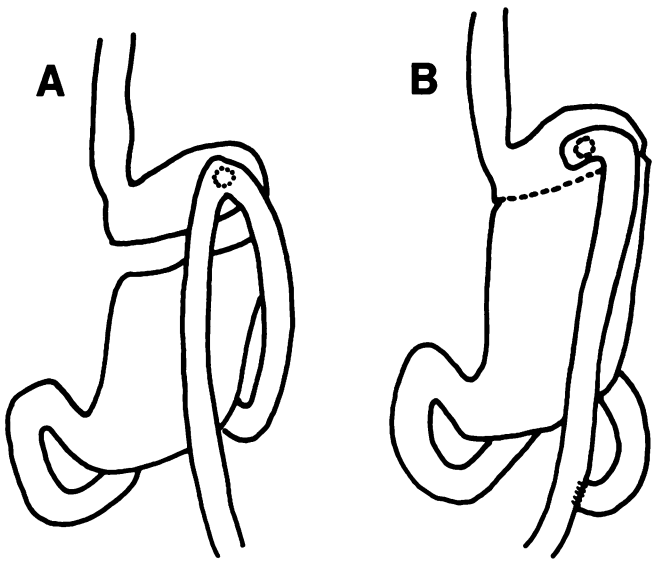

FIG. 1*A*. Mason and Ito's original gastric bypass. *B*. The Greenville modification of the gastric bypass.

TABLE 2. *Weight Loss Following Gastric Bypass for Morbid Obesity*

Time	N	Mean Weight (pounds)	Per Cent Original Weight	Per Cent Ideal Weight
Preoperative	210	289 (202–505)	100	214 (153–350)
1 month	191	260 (175–492)	90 (76–97)	193 (143–337)
6 months	167	206 (139–418)	70 (57–84)	153 (114–286)
12 months	148	181 (114–397)	62 (43–97)	134 (91–272)
18 months	86	167 (110–251)	59 (41–78)	125 (79–187)
24 months	68	168 (110–269)	60 (40–84)	125 (86–188)
36 months	26	176 (118–308)	61 (46–83)	130 (88–189)

Gastric Bypass and Perioperative Management

Patients were admitted the night before surgery and instructed to shower with pHisoHex.® Prophylactic cephalosporin was given intravenously the morning of surgery and for 2 days thereafter. In addition, patients with laboratory or clinical evidence of infection were treated initially with chloramphenicol and later with combinations of other antibiotics as specific cultures indicated.

All operations were performed by two surgeons (EGF and WJP) to maintain uniformity. While the operation, shown in Figure 1, has been previously described in detail,[2] several key points merit emphasis. A 30 to 50-ml proximal pouch was fashioned by a double, transverse application of staples with two simultaneously applied TA-90 instruments across the gastric fundus. Mobilization of the short gastric vessels was unnecessary. The vagus nerves were preserved. A gastrojejunostomy with two layers of continuous, nonabsorbable, monofilament polypropylene was constructed snugly around a 0.8-cm Salem Sump tube to provide a small, "nonstretchable" anastomosis. The efferent limb passed through the lesser sac and base of the transverse mesocolon and varied between 25 to 40 cm in length. The Roux-en-Y configuration is completed by a side-to-side stapled jejunojejunostomy 10 to 15 cm from the ligament of Treitz. Hemostasis at this anastomosis is crucial. The midline fascia is approximated with continuous, double-stranded, monofilament nylon suture permitting rapid closure of the wound and completion of the procedure in 90 minutes or less. Brief surgery with minimal dissection should be the hallmark of any procedure for obesity.

Patients were observed in the intensive care unit overnight and ambulation and breathing exercises were initiated. The pulse was found to be the most accurate indicator of the patient's initial progress. When the pulse

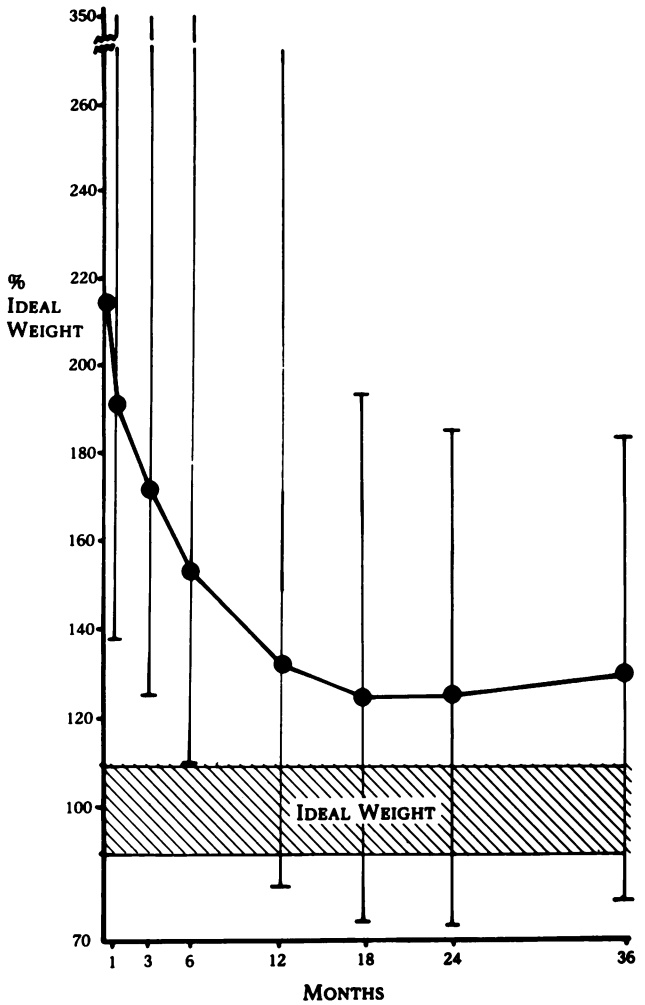

FIG. 2. Weight loss after gastric bypass for morbid obesity as expressed in per cent of ideal weight. The ranges of the weights at each time interval are indicated.

exceeded 120 for over 4 to 6 hours, the patient was intensively studied to define and treat the cause. If no source of tachycardia was found, the patient was explored even if he or she appeared otherwise well. In five apparently well patients we found leaks, early infections, or hematomas that benefited from surgery. In only one patient so treated did we fail to find a cause for the warning tachycardia.

The nasogastric tube remained in place for several days until the patient experienced return of bowel function and a gastrografin swallow documented the patency of the gastrojejunostomy. Sips of water were initiated soon after return of bowel function. The following day the diet was advanced to Ensure®, 2 ounces at mealtime with between-meal hourly 1-ounce water supplements. The patients were generally discharged from the hospital on this regimen 1 week after the procedure and remained on this diet an additional 7 to 10 days. The diet was then gradually advanced while stressing the importance of complete chewing of food, keeping within volume limitations, and concentrating on nutritious and varied foods. Oral vitamin supplementation was started 2 weeks after operation.

Follow-up visits to the obesity clinic were arranged at monthly intervals during the first 3 months and then every 3 months thereafter during the first year. When the patient's weight stabilized, return appointments were scheduled every 6 months during which the patient alternately saw the primary surgeon or the nurse practitioner. Data obtained at each clinic visit were immediately entered into a computer database. A 100% follow-up has been maintained throughout the series.

Results

Two hundred nine of 210 patients lost over 29% of their original weight. Table 2 demonstrates the weight loss in terms of average weight and range, per cent original weight and range, and per cent ideal weight and range based on the Metropolitan Life Insurance Tables.

The rates of weight loss, as reflected by per cent of original weight and per cent of ideal weight, are shown in graphic form in Figures 2, 3, and 4. These represen-

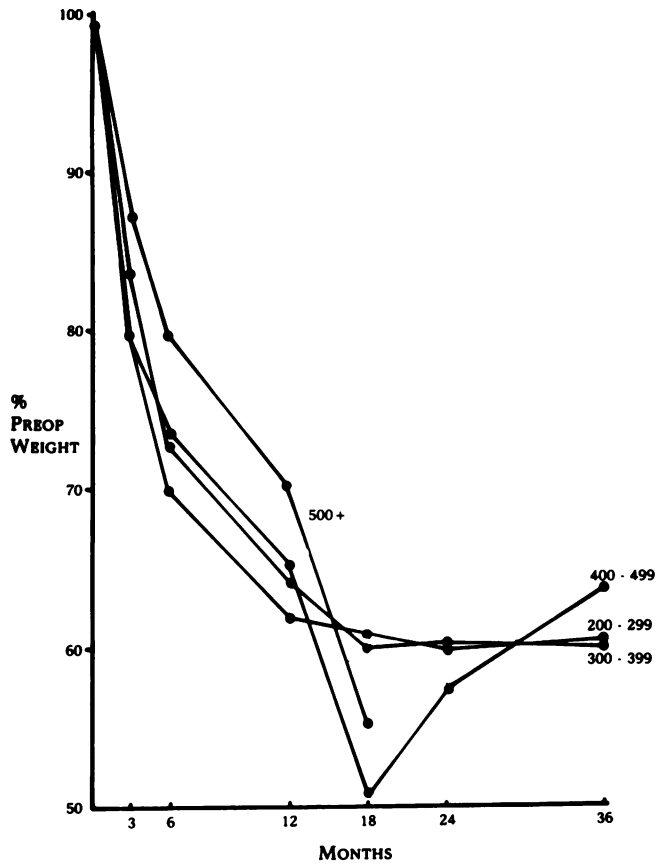

FIG. 3. Weight loss after gastric bypass for morbid obesity as expressed in per cent of preoperative weight. All weight groups lost at the same rate.

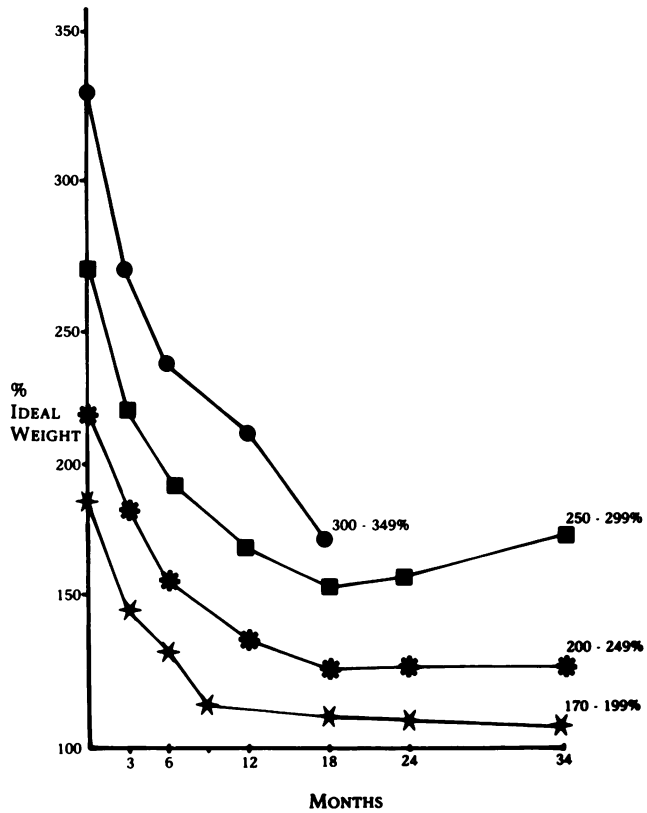

FIG. 4. Weight loss after gastric bypass for morbid obesity as expressed in per cent of ideal weight. Heavier patients plateau at higher levels.

tations demonstrate that all patients lose at approximately the same rate regardless of preoperative weight ranges ($p > 0.05$ by two-tailed Student's t-test for all groups) and generally reach maximal weight loss at 18 months after surgery. Furthermore, analysis of the per cent of Ideal Weight (Fig. 4) in four patient groups divided according to their degree of preoperative obesity demonstrated a statistically significant difference between all groups ($p < 0.001$–0.005) at all but one time period analyzed.

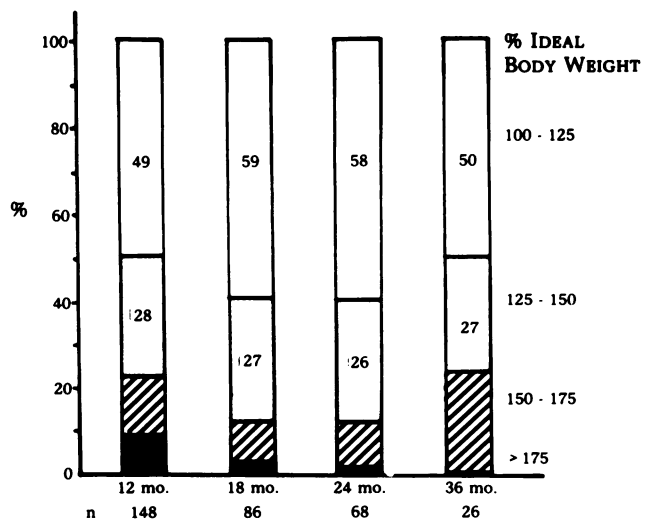

FIG. 5. The benefits of the gastric bypass were maintained throughout the 3 years of observation. At least three-quarters of the patients were brought within 50% of their ideal weight and about one-half achieved levels within 25% of their ideal weight.

Figure 5 demonstrates that the benefits of the procedure were maintained in this group of patients throughout the 3 years of observation. At 3 years, only one patient failed to lose more than 25% of her original weight. Over three-fourths of the patients demonstrate either excellent results (within 25% of their ideal weight) or good results (within 50% of their ideal weight) according to criteria established by Reinhold.[4]

Perioperative complications associated with the gastric bypass operation are shown in Table 3. There were two deaths, producing a mortality rate of just below 1%. There were 32 wound infections, ranging from superficial to severe (15%), and 21 other complications (10%). A number of these complications occurred in the same patients, giving an overall significant complications rate of 10%. Eight patients (4%) required reoperation.

Late complications associated with the gastric bypass operation are shown in Table 4. Further surgery was required in only those patients who developed symptomatic incisional hernias and cholecystitis. All others could be managed medically.

Table 5 demonstrates the excellent reduction in incidence of diabetes, hypertension, heart disease, and pulmonary disease following the gastric bypass. The precise mechanism for these extraordinary reversals of complex disease processes following gastric bypass is not clear.

During endoscopic evaluation of postgastric bypass pa-

TABLE 3. *Perioperative Complications Following Gastric Bypass for Morbid Obesity (N = 210, 100% Follow-up)*

		Number	Per Cent
Perioperative deaths		2	1
35-year old woman, perforated pouch, died 24 hours later			
35-year old woman, respiratory arrest, died 3 months after surgery			
Wound infections (all included, mild–severe)		32	15
Other (several in the same patients)		21	10
Bleeding	5		
Splenectomy	4		
Subphrenic abscess	4		
Arrhythmia	2		
Dehisshance	1		
Erysipelas	1		
Wound necrosis	1		
Hematoma	1		
Retained sponge	1		
Leak	1		
Significant complications		20	10
Reoperations for all complications		8	4

TABLE 4. *Late Complications Following Gastric Bypass for Morbid Obesity (N = 210, 100% Follow-up)*

			Number	Per Cent
Deaths			2	1
Carcinoma of the larynx				
Suicide				
Associated with surgery			27	13
Incisional hernias	11	5		
Small bowel obstruction	5	2		
Malnutrition	4	2		
Ulcer	3	2		
Stenosis	3	1		
Failure to lose over 25%	1	0.5		
Probably unrelated to surgery			23	11
Depression	19	9		
Cholecystitis	9	4		
Cardiac problems	5	2		

tients, we have identified superficial, linear gastritis in the distal, bypassed gastric segments in 95% of patients evaluated. The gastritis does not appear to change in severity or distribution over time. Gastritis and even intestinal metaplasia have been documented histologically. The cause of these unexpected endoscopic findings is unknown and represents an area that we plan to further evaluate.

Discussion

This study shows that the "Greenville Bypass" is an effective and safe operation for the treatment of morbid obesity. The procedure is a modification of the first gastric bypass procedure described by Mason and Ito in 1969.[5] Their concept of gastric reduction surgery was a monumental contribution that offered a safer and more physiologic alternative to intestinal bypasses performed at that time for morbid obesity.

Morbid obesity is a dangerous and costly disease. It is estimated to affect at least 5 million Americans and to cause a large number of early deaths as well as considerable morbidity including hypertension, stroke, myocardial disease, diabetes, biliary disease, arthritis, and cancer of the breast, uterus, and stomach. In addition, the morbidly obese encounter social inconvenience, economic discrimination, and public ridicule.[3]

Surgical approaches to this disease have proven to be superior to such medical measures as diet, appetite-suppressants, and teeth wiring. Although there are a large number and variety of operations performed for morbid obesity, few have received adequate evaluation. Since 1954, the following operations have been eloquently promoted:

Jejunocolic bypass
Jejunoileal bypass
Gastrojejunal bypass
Gastric partition
  Stoma at center of staple line
  Stoma at greater curvature
  Stoma at lesser curvature
  Stoma strengthened with mesh, etc.
Gastrogastrostomy
Vertical banded gastroplasty

The long list of alternative procedures suggests that no single operation has been the perfect solution to morbid obesity. Most of these have been abandoned because of experience with failures in favor of newer procedures. Clinical evaluation has lagged far behind clinical enthusiasm and application in bariatric surgery. Unfortunately, 29 years passed between the time Sandblom and Kremen described the ileojejunal bypass[6] and the time Griffen advocated that "jejuno-ileal bypass . . . should be abandoned."[7]

A failure to learn from history will commit us to repeating it. A new operative procedure requires objective evaluation before widespread adoption in general practice. This is particularly important in assessing surgery for morbid obesity because treatment failures are usually lost during follow-up. The criteria for accurate evaluation of a procedure need to be standardized. In reports for obesity surgery, results expressed only as pounds lost, excess weight lost, or per cent of weight lost can be misleading. The method of expressing results in terms of per cent of the ideal weight attained will eliminate bias and unnecessary confusion.

Since most surgeons accept the ideal weight tables as the basis for recommending surgery, we suggest that they consider accepting the ideal weight tables as their basis for reporting results. Patients lost to follow-up must be considered treatment failures. These proposals would facilitate objective comparison of series and operations.

This report can only attest to the success of our procedure for 3 years. We plan to continue the follow-up and are currently pursuing studies related to gastric and intestinal physiology, cellular mucosal changes in the by-

TABLE 5. *The Effect of the Gastric Bypass on Diabetes, Hypertension, Heart Disease, and Pulmonary Insufficiancy in the Morbidly Obese*

Preoperative	Number	Postoperative	Number
Diabetes			
Adult onset	37		
Insulin	7	Insulin	0
Oral agents	5	Oral agent	1
Juvenile onset	2	Insulin	1
Hypertension			
On medications	70	On thiazides alone	3
No medications	25		
Heart disease	6	All sharply improved	
Pulmonary disease			
Sleep apnea	2	All improved	
Asthma	21		

passed segments, and effectiveness of physical and social rehabilitation.

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Discussion

DR. WARD O. GRIFFEN, JR. (Lexington, Kentucky): First I'd like to congratulate the authors on achieving a 100% follow-up. This is a very difficult problem, and one which has plagued and continues to plague most of the reporting of experience in bariatric surgery.

We too have found the gastric bypass to be a superior operation in the management of the morbidly obese patient, having performed more than 1,000 such procedures. It is safe. It is effective.

Our major criterion for success is having the patient ultimately achieve a permanent weight of not more than 30% above their ideal body weight. We use this figure because insurance statistics indicate that it is at this level of excess weight that life-threatening diseases associated with obesity begin to appear. Using this guideline, we have about an 80% success rate.

In following our patients, we have noted a 10% incidence of postoperative anemia. Most of these are secondary to iron deficiency. This is not surprising, since the Roux-en-Y reconstruction bypasses the duodenum and the upper jejunum, where most of the iron is absorbed normally. In general, this is easy to treat by increasing the iron intake. However, a few of our patients have developed a vitamin B12 deficiency and anemia with it, and hence the finding by the authors of intestinal metaplasia in some of the bypassed stomach is intriguing. Has this change decreased or eliminated the parietal cell mass, so that insufficient intrinsic factor is available? To this end, I wonder if the authors have seen vitamin B12 deficiency, and if it is correlated with those patients who have shown intestinal metaplasia of the bypassed stomach.

But the other thing that you see here, which is what we have been commenting on, is that people with this procedure tend to level out a little bit earlier than those with gastric bypass. Here we are at 12 months, and they have dropped down to 160% or so of their ideal body weight. So they lose less weight, and they tend to trough out earlier, and then they begin to gain.

Now, this is out to 2 years. But now, out to 3 years, we have 50 patients, and they have gained another 5% increment in their weight.

What is not shown here is that this is a population of young people. They have the onset of their obesity usually before the age of 12 years. Seventy per cent of these people were childhood onset. In addition, they have one or both parents who were morbidly obese.

We studied the Mormon genealogy, looking at pedigrees, and it became very clear that this is a strongly genetic disease in these young people who have childhood-onset morbid obesity. Now, if that is the case, should not we be adopting the safest procedures, that are easily reversible and allow us to look at the lower end of the stomach? I am concerned that we will end up, like we did with our extensive gastric resections in the past, 20 years from now with a large population of people with very severe metabolic disturbances.

The horizontal stapling, if done correctly, gives reasonable results, and it sorts out those who are going to get a good result *versus* those that want to eat, and they have to eat a lot to break through this particular procedure. And, in addition, one can reverse it very easily through the endoscope.

So I would ask Dr. Pories if he might not want to consider his operation in the light of future morbidity.

DR. FRANK G. MOODY (Houston, Texas): It is a privilege to discuss such a fine study, characterized not only by the amount of weight loss, but also weight containment—and, as has been mentioned, the 100% follow-up, which I think is essential in this type of a study.

I rise to discuss the other operation. Three years ago, while I was still in Salt Lake City, we embarked upon trying to find the satiety receptors in the stomach. We thought probably they were in the cardia. Therefore, we elected to use a double-staple-line, horizontal gastric partition, with a very carefully monitored 50-ml pouch, brought up to about 30 cm of water pressure. We put a 1-cm opening on the greater curve, very precisely measured with a No. 10 Hagar dilator and, if it was not tight, then we would use vertical sutures to make it snug. There was no circumferential band.

I performed 316 such operations without one death. There were very few complications in this group, especially after we got the hang of how to do it safely.

(Slide) These are 311 patients that we have been able to follow. We have lost about 5% of the patients per year, and you notice that the follow-up extends to 2 years.

I would like to ask Dr. Pories if it is not better to represent the data in terms of ideal weight. I notice he does represent it graphically this way, but it might be nice to bring it out on the slide, as is done here. This is the per cent of ideal weight. Our people are about the same weight as his. But it gives you a chance to break out the men, which we have done here and, as you can see, they really are not heavier than the women. In fact, they just barely reach twice their ideal weight by their height.

DR. H. WILLIAM SCOTT, JR. (Nashville, Tennessee): I too would like to congratulate Dr. Pories and his associates on this very nice study. It is a logical continuation of his randomized prospective comparison of gastric partition and gastric bypass that clearly showed, in his hands, that gastric partition failed to bring excess weight down in these morbidly obese patients, when handled otherwise identically as those with gastric bypass, which did the job very satisfactorily.

The results of this larger series that Dr. Pories reports with gastric bypass continue to be impressively good: a fall in mean weight in the group from 289 pounds to 176 pounds at 18 months, with the low mortality rate of 1%, and a complications rate of 11%. These are very good results. Concomitant relief from diabetes, pulmonary insufficiency, and reduction in hypertension were also good objective benefits.

Why did these excellent results come from gastric bypass, and not from gastric partition?

Our own similar results with these two modalities in a much smaller series of morbidly obese patients give some answers, and I would like to express my ideas about these and ask Dr. Pories to comment.

First of all, gastric bypass not only restricts the intake of solids and liquids in obese subjects, but the exit from the pouch via the jejunum reduces the intake by the patient of high carbohydrate liquids, in particular, and highly salted liquids. This happens because the patient suffers from the postgastrectomy dumping syndrome. No one with gastric partition, even if he drinks a gallon of sweet liquid, will have the dumping syndrome. With gastric bypass he does what is called in our part of the country "gets torn up," and has a lot of diarrhea and a lot of other dumping problems.