

The malabsorptive very, very long limb Roux-en-Y gastric bypass for super obesity: Results in 257 patients

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Background. For the past 11 years, we have used a malabsorptive form of Roux-en-Y gastric bypass (RYGB), the “very, very long limb” RYGB, for selected patients with BMIs $>50 \text{ kg/m}^2$ and in highly selected patients with BMI $<50 \text{ kg/m}^2$. This modified distal gastric bypass establishes a 100-cm common channel (for digestion and absorption) and a “very, very” long Roux limb of 400 to 500 cm. **Methods.** To determine long-term efficacy and complications, we followed prospectively 257 consecutive patients; 188 (73%) participated in a postoperative survey.

Results. Of the patients, 60% were female; overall age ($\bar{x} \pm \text{SD}$) was 45 ± 11 years, and BMI was $61 \pm 11 \text{ kg/m}^2$. Operative mortality was 1% with substantive postoperative morbidity occurring in 13%. Eighty-two percent of patients returning the survey an average of 48 months postoperatively (range, 12 to 148 months) lost $>50\%$ of excess body weight; BMI at follow-up was $37 \pm 9 \text{ kg/m}^2$. Resolution of comorbidities included diabetes mellitus (94%), hypertension (65%), sleep apnea (48%), and asthma (30%). Side effects included mild food intolerance (82%), occasional loose or watery stools (71%), nephrolithiasis (16%), and symptomatic steatorrhea (5%). Nine patients (4%) who developed or were developing impending protein/calorie malnutrition required proximal relocation of the enteroenterostomy with symptom resolution.

Conclusions. Overall, 90% were satisfied with the operation, and 93% would recommend it to a friend. The very, very long limb RYGB is relatively safe and effective and has acceptable side effects in the treatment of selected patients with super obesity (BMI >50). Because of the possibility of malabsorptive sequelae, patients should be selected based on degree of medical sophistication, insight, and compliance. (Surgery 2006;140:517-23.)

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INTRODUCTION

The standard Roux-en-Y gastric bypass (RYGB) is an effective and durable weight loss procedure for morbid obesity.^{1,2} Super obesity, however, defined as having a body mass index (BMI) of $>50 \text{ kg/m}^2$, may require a more aggressive operation that involves a selective malabsorption to effect a sufficient amount

of weight to ameliorate weight-related comorbidities. Current more aggressive bariatric operations that involve an element of malabsorption include distal gastric bypass,³ biliopancreatic diversion (BPD),⁴ and duodenal switch with biliopancreatic diversion,^{5,6} all of which have their advantages and disadvantages.⁷ Previously, we reported our preliminary experience in 19 patients with a modification of RYGB termed the “very, very” long limb RYGB (VVLL-RYGB).⁸ This procedure (Fig) is a modification of the distal gastric bypass³ and consists of the typical proximal anatomy of a vertical, disconnected RYGB.⁹ However, the VVLL-RYGB has a short 50- to 60-cm biliopancreatic limb, a 100-cm common channel of distal ileum, and a much longer (300 to 500 cm) Roux limb — thus, the term very, very long limb RYGB to differentiate it from the very long limb (150 cm) RYGB of Brolin et al.¹⁰

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The VVLL-RYGB procedure was designed to minimize the length of bypassed small bowel (biliopancreatic limb), while establishing a short common channel of distal ileum to minimize digestion and absorption. With any form of malabsorptive anatomy, potential long-term nutritional and metabolic sequelae exist. Our aims were to evaluate the perioperative morbidity and mortality and, more importantly, the long-term efficacy on weight loss, comorbidities, and development of metabolic complications.

METHODS

After approval by the Mayo Institutional Review Board, we conducted a retrospective review using our prospective database of all consecutive patients ($n = 1435$) undergoing bariatric surgery from 1985 to 2004, which allowed at least a 1-year follow-up. This review included all 257 consecutive patients undergoing VVLL-RYGB. In addition to our usual set of questionnaires sent at 3, 6, 12, 18, 24, 36 and 48 months postoperatively, we also sent out a more detailed follow-up questionnaire to acquire up-to-date demographic data, dietary and bowel habits, medications, changes in preoperative weight-related comorbidities, weight, long-term postoperative morbidity, and overall satisfaction. In addition, attempts were made to contact by phone those patients who did not respond after multiple mailings. A total of 188 questionnaires (73%) were returned; those who did not respond were either dead ($n = 2$) or refused to participate and/or sign the release of information form ($n = 67$), which is a necessary prerequisite in Minnesota to use patient information. Mean postoperative follow-up at the time patients filled out the questionnaires was 43 months (range, 6 to 143 months).

Inclusion criteria for VVLL-RYGB were a BMI $>50 \text{ kg/m}^2$ in a patient deemed to be reliable and compliant; highly selected patients with a BMI of 40 to 50 kg/m^2 with a very high, objective risk of cardiovascular disease; or selected patients with an intact gastropasty who failed to maintain any weight loss. Patients were followed, whenever possible, in our nutrition clinic with a detailed metabolic protocol. Patients were counseled to take a multivitamin with iron and a chewable calcium supplement twice daily and to self-administer vitamin B₁₂ (cyanocobalmin) $1000 \mu\text{g}$ IM each month. Whenever follow-up was necessary to be performed at home because of distance or insurance provider, a protocol for metabolic follow-up was transmitted to the patient's home physician.

Analysis of data. Demographic and follow-up data are reported as means \pm standard deviation

Table I. Operative mortality and morbidity in 257 patients undergoing VVLL-RYGB

Complication	# patients	%
Death	2	1
Anastomotic/staple line leak	4	2
Intraabdominal abscess	2	1
Wound dehiscence	5	2
Wound infection	22	9
Small-bowel obstruction	3	1
Pulmonary embolus	2	1
Other†	5	1

VVLL-RYGB, very, very long limb Roux-en-Y gastric bypass.

†One each: pneumonia, non-Q wave myocardial infarction, GI bleeding, pancreatic leak, necrotizing fasciitis occurring distant to abdominal incision complicated by enterocutaneous fistula.

for continuous data that were normally distributed or as median (range) when appropriate.

RESULTS

Patients. During this 19-year period, the 257 patients who underwent VVLL-RYGB were 45 ± 11 years of age (range, 15 to 74 years) with a BMI of $61 \pm 11 \text{ kg/m}^2$ (range, 41 to 108). There were 102 men and 155 women; the percentage of males in this group is much greater than in our overall bariatric experience during the same time period (40% vs 25%, respectively). Prevalence of comorbidities at the time of VVLL-RYGB included severe arthritis/arthropathy (79%), hypertension (60%), diabetes mellitus requiring insulin or oral hypoglycemia agents (46%), obstructive sleep apnea (33%), and asthma (24%).

Operative mortality/morbidity. Of the 257 operations, 18 (7%) were revisions of previous, unsuccessful bariatric procedures. All of the 257 operations were performed as open procedures. Overall, 2 patients died postoperatively for an operative mortality of 0.8%. Major morbidity occurred in 13% of patients (Table I) and included some form of anastomotic or staple line leak in 4 patients (2%), intraabdominal abscesses in 2 (1%), wound dehiscence in 5 (2%), and wound infection in 22 (9%). Median hospital stay was 7 days (range, 3 to 147 days).

Resolution of morbidity. The survey questionnaire was returned by 73% of patients ($n = 188$) at a mean of 48 months postoperatively (range, 12 to 148 months). Of these patients, 82% had lost and maintained a weight loss of $>50\%$ of excess body weight; the lowest BMI achieved was $35 \pm 8 \text{ kg/m}^2$, but BMI at the time of follow-up was $37 \pm 9 \text{ kg/m}^2$. Comorbidities resolved completely as follows: diabetes mellitus requiring insulin or oral hypoglyce-

mic agents (94%), hypertension (65%), obstructive sleep apnea (48%), and asthma (30%). Symptoms of arthritis/arthropathy improved in most patients.

Long-term complications/side effects of VVLL-RYGB. Serious side effects included impending protein/calorie malnutrition secondary to severe steatorrhea/diarrhea in 9 patients (4%), all of whom required reoperation and relocation of the jejunoileostomy 100 to 200 cm proximally; postoperatively, the steatorrhea/diarrhea/malnutrition resolved in all 9 patients. Occasional loose or watery stools of 3 or 4 per day occurred in 71% but gross steatorrhea (not requiring operative intervention) was present in 5%. Nephrolithiasis (usually calcium oxalate) occurred in 31 patients (16%), 21 of whom (about two thirds) had no prior history of nephrolithiasis.¹¹ Some element of food intolerance was present in 82%, usually to ice cream, solid red meat, or exceptionally fatty foods.

Overall satisfaction. When asked about their overall satisfaction with the procedure, 90% of patients responded positively, and 93% said they would recommend this operation to a friend or relative.

DISCUSSION

Our experience with the VVLL-RYGB confirms its efficacy and relative safety in this select population of patients at the extreme of morbid obesity. Operative mortality in this high-risk group was low (<1%), and operative morbidity was as expected, with an 11% incidence of wound complications (infection, dehiscence) characteristic of the super obese after an open celiotomy. Most encouraging, however, were the reversal of comorbidities, the relative paucity of severe malnutrition, and the success in weight loss achieved and maintained. One finding of cautious note was the development of renal lithiasis in 16% of patients, two thirds of whom had no prior history of kidney stones.

On first glance, the VVLL-RYGB may be confused with the original “distal” gastric bypass (Fig 1).³ We designed the VVLL-RYGB specifically with a short “bypassed” biliopancreatic limb (~60 cm) and a maximally long Roux-en-Y limb to maximize absorptive area for ingested water, electrolytes, minerals, vitamins, and simple nutrients not requiring enzymatic breakdown by the biliopancreatic secretions. This Roux limb averages about 400 cm in length, and the term “very, very, long limb” (VVLL) was chosen to differentiate its length from the 150-cm very long limb Roux et al¹⁰ as well as the 150-cm Roux limbs of the distal gastric bypass, the biliopancreatic diversion (BPD) of Scopinaro and colleagues⁴ and the duodenal switch-biliopancreatic

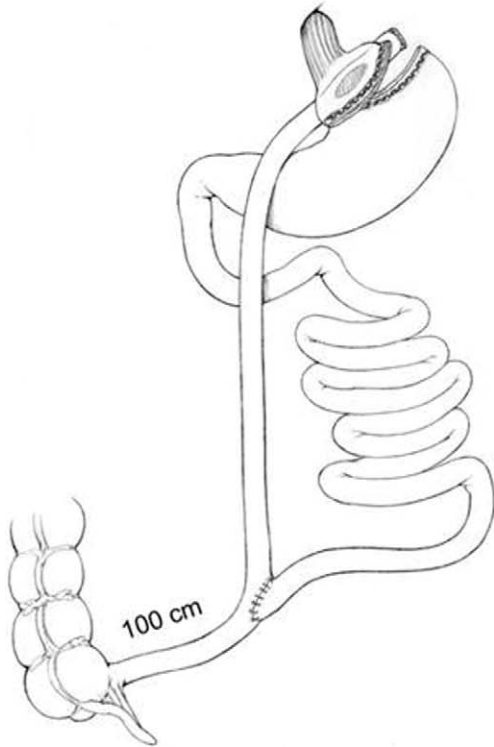
diversion (DS/BD) of Hess, Marceaux, and others.^{5,6} All three of these other selective malabsorptive procedures use a 50- to 100-cm common channel of distal ileum for enzymatic digestion and absorption of orally ingested, complex foodstuff as well as the reabsorption of bile salts. The primary differences with the VVLL-RYGB lie in the length of “bypassed” jejunum and the lack of need for the 80% gastrectomy of the BPD, and the greater curvature sleeve gastrectomy after DS/BD. Moreover, by maximizing the length of the Roux limb, recovering additional length of “common channel” is facilitated should the patient develop severely symptomatic steatorrhea or protein/calorie malnutrition. With the distal gastric bypass and the BPD, if additional length of common channel is required, there is “only” 150 cm of Roux limb from which to “recover” the additional length for the common channel, yet still maintain a long enough Roux limb (~70 cm) to prevent bile reflux, thus allowing recovery of only about 80 additional centimeters of common channel. For the DS/BD, because the pylorus is preserved in theory, one may be able to recover more common channel from the Roux limb.

The VVLL-RYGB does have some disadvantages over the DS/BD. With the latter operation, the Roux limb only needs to reach as far rostrally as the proximal duodenum, rather than to the cardia as with the VVLL-RYGB or the distal gastric bypass; this disadvantage may be most pertinent in the taller male patient. Although proponents claim less difficulties with eating after the DS/BD because of preservation of the pylorus, preventing “dumping” and allowing ingestion of a more regular diet,^{5,6} our results with the VVLL-RYGB revealed few, major, persistent problems with food intolerances and a 90% overall satisfaction rate.

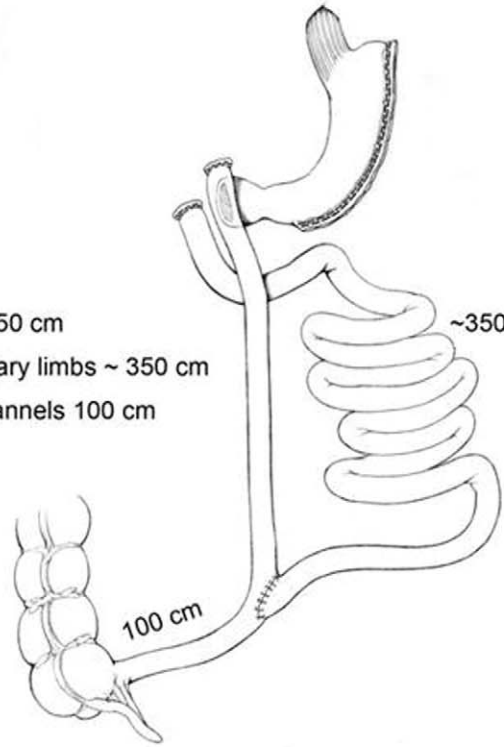
In terms of weight loss and resolution of weight-related comorbidities, the VVLL-RYGB stacks up well to the other selective, malabsorptive procedures⁷ and to other forms of bariatric surgery.¹² Fully 80% of our patients lost and maintained a weight loss of >50% excess body weight at a mean follow-up of 48 months (range, 12 to 148 months), and the mean weight loss was about 66% of excess body weight. This weight loss compares favorably to very similar results presented after BPD⁴ and DS/BD.^{5,6} In addition, the resolution of weight-related comorbidities also is consistent with reports of these and other bariatric procedures.

As with any malabsorptive procedure, serious nutritional and metabolic complications need to be understood, acknowledged, and screened for regularly. Severe, clinically intolerable steatorrhea

Digital Gastric Bypass



Digital Gastric Bypass



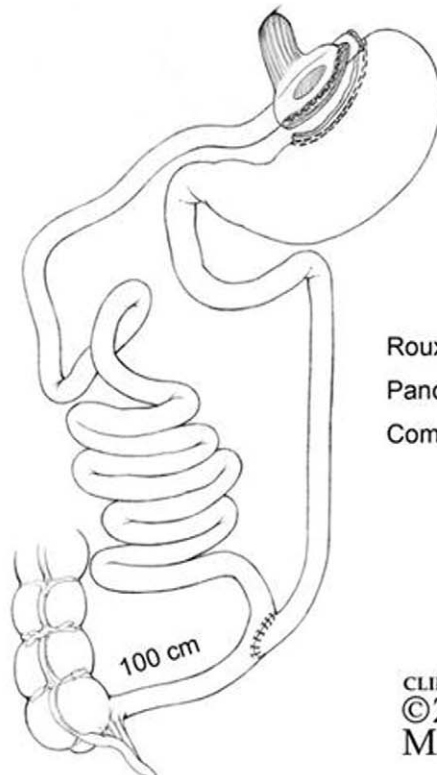
Roux limbs 150 cm
Pancreatobiliary limbs ~ 350 cm
Common Channels 100 cm

~350 cm

100 cm

100 cm

Very Very Long Limb RYGB



Roux limb ~ 400 cm
Pancreatobiliary limb ~ 60 cm
Common Channel 100 cm

100 cm

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Fig 1. Types of selective malabsorptive procedures.

complicated by impending protein/calorie malnutrition developed in “only” 4%, requiring proximal relocation of the entry of biliopancreatic digestive juices 100 to 200 cm proximally. Others have reported a much greater incidence of steatorrhea after distal gastric bypass.³

Whereas the length of the common channel should determine the presence or absence of steatorrhea, the longer Roux limb of the VVLL-RYGB may help to minimize overall protein/calorie malnutrition. Although ideally, we as surgeons would tailor the length of the Roux limb specifically for each patient, reliable insight or criteria into the exact length of common channel of ileum tailored to each patient are not available, and so most surgeons have made the length of the common channel about 100 cm.

Another concern of the VVLL-RYGB, which we have described previously,¹¹ is a 16% incidence of kidney stones, most of which are believed to be calcium oxalate stones. Such stones were very common after jejunoileal bypass, which is no longer performed and had a common channel of distal ileum of only about 10 cm. Our previous report of oxalate stones and even oxalate nephropathy after conventional RYGB (with a common channel length of 250 to 600 cm) and VVLL-RYGB was the first to report this complication of RYGB.¹¹ Whether renal lithiasis complicates distal gastric bypass, BPD, and DS/BD is unknown and, as of yet, curiously unreported. We wonder if it has been looked for in patients after these procedures given that any anatomy associated with fat malabsorption can result in enhanced oxalate absorption due to saponification of minerals (such as calcium) that normally bind oxalate and inhibit its absorption. In addition, the undigested fatty acids and bile acids increase the permeability of the colonic epithelium to oxalate.¹³ Currently, questions about a history of oxalate stones are part of our preoperative evaluation, and, if present, a formal urinary analysis is carried out to look for enteric hyperoxaluria. If the condition exists, we avoid the VVLL-RYGB, not only because of kidney stone formation but also because of the possibility of developing oxalate nephropathy, a nonreversible type of renal failure.¹⁴ Postoperatively, all patients after VVLL-RYGB are instructed to ingest calcium supplements with meals to decrease free oxalate in the colon in addition to optimizing calcium absorption to prevent development of metabolic bone disease.

We need to acknowledge several limitations of our study. First, we have no reliable data to prove that the weight loss after VVLL-RYGB is superior to that after conventional RYGB in the super obese.

We know of no study that has addressed this question adequately with a well-designed, prospective study. Second, although we surveyed our patients for medical problems, eating habits, satisfaction, and other factors, we do not have reliable or complete data concerning vitamin, mineral, or micronutrient concentrations in these patients because many of our patients came to our facility from long distances. However, we are careful to outline an appropriate, detailed medical surveillance for those patients unable to return after the first 6 months. In addition, because of concerns about potential side effects of this malabsorptive procedure, we try to select patients very carefully for medical insight, family and local medical support, and overall compliance. We strongly maintain that this more aggressive form of RYGB should not be performed in patients in whom medical follow-up or compliance is questionable.

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DISCUSSION

Dr Jay B. Prystowsky (Chicago, Ill): As you know, the field of bariatric surgery is about 50 years old. For the first 20 to 30 years, it was dominated by malabsorptive procedures. Then gastric restrictive procedures predominated, but during the last 10 to 15 years, we have seen the pendulum swing back to combine some element of malabsorption as surgeons try to enhance the amount and durability of weight loss.

Dr. Sarr and his group at Mayo have been champions of the very, very, very long limb gastric bypass, fundamentally a simple modification to the conventional gastric bypass that is an attractive option to consider. Your results in terms of morbidity and mortality are excellent, and I think any bariatric surgeon would be very pleased to achieve these results. I do have some questions primarily related to the malabsorptive aspect of this operation.

First, can you amplify a bit more about your inclusion and exclusion criteria for patients who underwent this operation? Specifically, you mention in your last slide your concerns about patients who may not be reliable or compliant. Can you give us some tangible tips on how you make that decision?

Secondly, is this the procedure that the Mayo Clinic prefers for revisional surgery? Specifically, if you have a patient who had a failed gastric bypass, do you simply convert to a very, very long limb by shortening the common channel?

You mentioned that reoperation is necessary in about 4% of patients, and that in those cases you lengthened the common channel to somewhere between 200 and 300 centimeters, which raises the question: Why not just give everybody the 200- to 300-centimeter common channel to minimize or eliminate the reoperation rate? Is the extra 100 to 150 centimeters of common channel worth it for the price of a 4% reoperation rate?

About 18% of patients were unable to achieve or maintain greater than 50% excess weight loss despite a gastric bypass, a short common channel, and presumably selecting these patients very carefully. And they were in experienced hands.

This is a very interesting group of patients: Why aren't they losing weight?

Finally, I want to play devil's advocate. Eighteen percent of patients did not achieve satisfactory weight loss, 4% had to be reoperated because of malnutrition, another 5% had severe diarrhea, and roughly 16% had oxalate stone that would presumably put them at a risk for nephropathy in the future. Taken altogether, that is roughly 40% of patients who have some long-term problem that is either unacceptable or potentially harmful. So I come to the simple question: Is this a good operation?

Dr Henry Buchwald (Minneapolis, Minn): I would suggest that you change the name of your operation to "very, very long Roux limb gastric bypass." Put "Roux" before "limb," so that your audience knows which limb is involved.

When we do this operation, we use equal limb-lengths for the biliopancreatic and the Roux limb and a common channel of 75 centimeters. With our procedure, we have just about the same rate of problems with malnutrition, protein deficiency, and so on, as you, but a lower incidence of nephrolithiasis. I wonder if your very long Roux limb is setting these patients up for nephrolithiasis because they have a greater length of intestine to absorb oral oxalate.

A short time ago, almost every bariatric surgeon was doing the gastric bypass procedure, which represented a convergence to the middle from the simpler operation of vertical banded gastroplasty and the more difficult biliopancreatic diversion/duodenal switch. Today, I think there is a divergence from the center with respect to procedures. Bariatric surgeons are doing fewer gastric bypasses, and they are going to the very simple laparoscopic adjustable gastric banding, on the one hand, and, on the other, to the more complicated malabsorptive procedures, which would include your very, very long Roux limb gastric bypass.

Dr J. Stephen Marshall (Peoria, Ill): Did you notice any deficiencies that were increased compared to your regular gastric bypass population such as iodine, calcium, or the D vitamins?

In the group of patients that had to have their common channel lengthened, did you notice any significant gain of weight?

Dr W. K. Nelson: Concerning our inclusion and exclusion criteria, we use a multidisciplinary approach. All candidates see dietitians, psychologists, endocrinologists with an interest in nutrition, and surgeons. Should our multidisciplinary team believe the patient to be unreliable or medically naive, they are excluded from this operation.

Why do 22% of them not lose greater than 50% of their body weight? I don't want anyone to get the opinion that they are not losing weight. These people have, in some cases, hundreds of pounds to lose. In a typical Roux-en-Y gastric bypass, a patient may only need to lose 120 pounds. These patients in some cases need to lose 300, 400, or 500 pounds to be at an ideal body weight. So while they may not have lost 300 pounds, maybe they lost 250, and they didn't qualify as losing half of their body weight, but still lost an amazing amount of weight, and have much better lives because of it.

Is the very, very long limb Roux-en-Y gastric bypass our procedure of choice for revisional surgery? Yes. Basically you can relocate the jejunojejunostomy to a jejunoileostomy, but for some reason the results are not as good in those patients as in the primary gastric bypasses.

Why not make the common channel 200 and 250 centimeters on all patients? Everyone seems to

respond to this procedure differently. We think that a 200- to 250-centimeter common channel would be too long in the majority of patients to accomplish substantial weight loss, and so, in looking back, we accept a 4% reoperation rate as trying to address the target population and then having to move the jejunoileostomy proximally.

Dr Buchwald, we will continue to use our name for this operation similar to the previous name of very long limb Roux-en-Y gastric bypass as coined by Brolin. With regard to oxalate problems in your patient population, we didn't think we had problems in our patient population until we specifically looked for them.

Dr Marshall, with response to elemental deficiencies that we have noticed in these patients, we asked all these patients to take multivitamins daily with iron, B12 injections, and supplemental calcium. They obviously need close, long-term follow-up.