

# Follow-up of Nutritional and Metabolic Problems After Bariatric Surgery

KEN FUJIOKA, MD

Over the next several years, the number of patients who will have had bariatric surgery for morbid obesity will reach close to a million. Several well-described nutritional problems such as B12 and iron deficiency will be noted in these patients. Many of these patients will be lost to the original surgeon and will now be in the care of the "other physicians." These and other mineral and vitamin problems will need to be screened and treated. If these problems are left undiagnosed, severe and irreparable problems can result. Early problems, such as vomiting and dumping syndrome, will be easily recognized and treated, but other long-term problems, such as changes in bone metabolism, will need to be monitored. Again, if some of these long-term problems are not addressed in a timely fashion, then eventual treatment becomes much more difficult. This commentary will cover the common as well newer problems that are now developing in the patient who has had bariatric surgery. Patients who have undergone bariatric surgery require medical follow-up for reasons that are often determined by the type of surgical procedure performed. The majority of this review will deal with patients who have had the standard Roux-en-Y gastric bypass, which is a primarily restrictive procedure with a mild component of noncaloric malabsorption. At the end of this report, a short section will be devoted to the problems associated with the malabsorptive procedures.

*Diabetes Care* 28:481–484, 2005

**F**ollow-up of the morbidly obese patient who has had gastric bypass can conveniently be divided into two areas: the issues of surgical complications and weight loss during the first year, and the nutritional and metabolic issues that arise after the first year.

**ISSUES DURING POSTOPERATIVE YEAR 1** —The vast majority of weight loss after gastric bypass is accomplished at or around 1 year after surgery (1,2). Twelve to 18 months after surgery, some patients continue to lose a small amount of weight while others begin to maintain their lower weight. At eighteen to 24 months after surgery, almost all patients have stopped losing weight and most patients are maintaining or regaining weight.

## Vomiting and dumping syndrome

Vomiting almost always occurs during the first few months after surgery and is often described as "spitting up food that is

stuck." It typically happens one to three times a week and is usually due to overeating or not chewing food adequately. Patients need to adjust to the much smaller gastric pouch that now receives food from the esophagus; bariatric surgery has diminished the stomach's ability to grind food into small particles. Vomiting is well tolerated by most patients. If vomiting becomes more frequent, low potassium and/or low magnesium levels often occur, requiring oral replacement. Liquid forms of potassium are available but are not well tolerated by patients due to palatability; fortunately, by postoperative month 1, pills are usually able to pass through the anastomotic or restricted portion of the stomach. To ensure that the potassium can traverse the 1-cm anastomoses, smaller pills or capsules are often prescribed.

Vomiting can signal other problems and is associated with strictures and stomal stenosis. Intolerance for solid foods is a key symptom; if this develops,

then endoscopic evaluation should be strongly considered. If intolerance to solid food develops 6 months after surgery, then the diagnosis of stenosis is very high. In one study, abnormal findings at endoscopy showed stomal stenosis in 39% of patients with nausea, vomiting, or dysphagia referred for endoscopy (3). Such stenosis can usually be treated by balloon dilation at the time of diagnosis. Many of these patients will require repeat dilations, determined by their ability to tolerate most solid foods.

Dumping syndrome is an extremely common, and somewhat intentional, problem after gastric bypass. High-osmolarity foods (e.g., foods high in sugar content), after bypassing much of the stomach undigested, cause an osmotic overload upon entering the small intestine. This osmotic overload brings fluid into the lumen of the small intestine, resulting in a vagal reaction. Patients will often complain about lightheadedness and sweating after eating a high-glucose meal or drinking fluid with a meal. This is a very uncomfortable feeling and is accompanied by impressive fatigue. Diarrhea may or may not occur, as there is usually sufficient distal bowel to absorb such food, and nutritional problems are rare. Foods that are identified in our clinic as causing dumping syndrome include ice cream and pastries.

Dehydration occurs frequently and is due to multiple factors. The very small surgically created gastric pouch makes it extremely difficult for patients to hold much fluid. Because dumping syndrome occurs if fluids are mixed with food, patients also must drink fluids separately from meals. (Fluid with a meal can solubilize food and increase osmolarity.) As a result, patients must constantly sip fluid throughout the day to meet their fluid requirements. Brief hospitalizations or urgent care visits for dehydration are very common during the first 6 months after surgery.

Water consumption is the best method to prevent dehydration. If rehydration is needed, salty broths or liquids containing salt work well. Many patients can tolerate sports fluid replacement drinks,

From the Department of Endocrinology, Scripps Clinic, San Diego, California.

Address correspondence and reprint requests to Ken Fujioka, MD, Director of Nutrition and Metabolic Research, Scripps Clinic, Suite 317, 12395 El Camino Real, San Diego, CA 92130. E-mail: fujioka.ken@scrippshealth.org.

Received for publication 12 October 2004 and accepted in revised form 19 October 2004.

© 2005 by the American Diabetes Association.

either diluted 50% or occasionally full strength. Many gastric pouches after gastric bypass are  $\leq 50$  ml in size, and patients must learn to constantly sip fluid and not drink large gulps.

While protein malnutrition was very common with the truly malabsorptive surgical procedures of the past, it is rare after gastric bypass or any of the current restrictive surgeries. If protein malnutrition develops after gastric bypass, one needs to look at the total food intake of the patient and determine whether the patient is meeting his/her caloric and protein needs (4). Protein supplements are very helpful, and with the current trend of Americans eating high-protein diets, numerous high-protein low-carbohydrate supplements are readily available.

Hair loss, or telogen effluvium, is seen frequently 3–6 months after surgery. Patients note diffuse shedding of normal hair. Lasting as long as 6–12 months, it can be terribly distressing to the patient. The stress of weight loss disrupts the normal growth cycle of individual hairs, resulting in large numbers of growing hair simultaneously entering the dying (telogen) phase. Although there is no known treatment, it usually reverses without intervention (5).

Gallstone formation is very common during weight loss (6), and surgery-induced weight loss is no exception. In one study of bariatric surgery patients, 71% developed gallstones, despite the fact that two-thirds of the patients received preventative treatment (7). Of those patients who formed gallstones, 41% were symptomatic. Bariatric surgery patients presenting with right upper quadrant abdominal pain should thus be appropriately evaluated. At our own institution, all symptomatic patients undergo an ultrasound of the gallbladder before surgery. If patients have gallstones, these are removed either before or at the time of surgery. After surgery, all patients with an intact gallbladder will be placed on a gallstone-solubilizing agent for at least 6 months after surgery.

## ISSUES AFTER POSTOPERATIVE YEAR 1

### B<sub>12</sub> deficiency

As weight loss begins to slow down, the risk of other nutritional problems increases. B<sub>12</sub> and iron deficiency are two of the most common problems and often do

not respond to typical multivitamin supplementation (8–10). Such nutrient issues are primarily seen with gastric bypass and any of the malabsorption procedures.

Because food now bypasses the lower stomach, B<sub>12</sub> deficiency is frequently observed. If B<sub>12</sub> is not supplemented above and beyond a multivitamin, 30% of patients will be unable to maintain normal levels of plasma B<sub>12</sub> at 1 year (9). After 1 year, the prevalence of B<sub>12</sub> deficiency appears to increase yearly and has been reported to be between 36 and 70% in the long term (11,12).

Over the counter oral and sublingual forms of vitamin B<sub>12</sub> are available for use (13,14). Optimal dose and efficacy have not been well studied, but doses of 25,000 units sublingual B<sub>12</sub> twice a week are usually sufficient to maintain normal plasma levels of B<sub>12</sub>. Some (up to 10%) patients will not respond to high-dose sublingual or oral B<sub>12</sub> and will require monthly intramuscular B<sub>12</sub> injections.

### Iron deficiency

Iron deficiency after gastric bypass is usually only seen in menstruating women. Ferritin or iron levels and erythrocyte counts need to be monitored, as iron deficiency can develop early after surgery or years later; one study found that iron stores continuously declined up to 7 years after bypass surgery (15). Due to bypass of the lower stomach, it is very difficult for iron-deficient patients to absorb sufficient oral iron. Intramuscular iron can be impractical over the long run. At our institution, intravenous iron dextran or iron sucrose is used regularly; many patients require intravenous iron several times a year. This is done as an outpatient procedure and is well tolerated by patients.

### Ulcers, NSAIDs, and abdominal pain

Patients with persistent iron loss should be evaluated for blood loss through the gastrointestinal tract. Ulcers at the margin of the anastomoses between the stomach pouch and the small intestine are a common cause of blood loss. All NSAIDs (nonsteroidal anti-inflammatory drugs), including aspirin, and COX-2 (cyclooxygenase-2) inhibitors, have the potential to cause ulcers; use of these drugs is to be avoided at all costs in gastric bypass patients. A study of gastric bypass patients referred for endoscopy found that marginal ulcers were present in 27% of pa-

tients (3). In our clinic, gastric bypass patients with abdominal pain are considered to have an ulcer until proven otherwise. Not all marginal ulcers will bleed significantly but most will have pain.

## LONG-TERM METABOLIC ISSUES AFTER GASTRIC BYPASS

Several articles are starting to surface regarding problems with bone mineralization in gastric bypass patients (16–18). With increasing numbers of patients undergoing bariatric surgery (an estimated 100,000 procedures annually), long-term follow-up of this growing and aging population will need to monitor bone health and metabolism. While it is recommended that bone density be measured after bariatric surgery, there are no specific guidelines for treatment and follow-up (Table 1). In our clinic, we are currently following vitamin D, calcium, and parathyroid hormone levels, as well as bone densitometry.

### Secondary hyperparathyroidism

One form of bone demineralization, secondary hyperparathyroidism, has been reported by several groups to occur in patients who have had gastric bypass (19–21). While the prevalence is unclear, it appears to be more common than previously thought. At our institution, we studied 65 consecutive patients seen for follow-up after gastric bypass. Time since surgery varied from 1 to 9 years; parathyroid hormone, calcium, and vitamin D levels were measured. Twenty-nine percent of patients were found to have elevated parathyroid hormone levels. Although the study group was small, patients at >4 years' postsurgery had a much higher rate of secondary hyperparathyroidism. Average 25(OH)D level in patients with secondary hyperparathyroidism was 21 ng/ml, whereas patients with normal parathyroid hormone levels had an average 25(OH)D level of 30 ng/ml (normal 20–57 ng/ml). The majority of the patients with secondary hyperparathyroidism has responded to pharmacologic replacement of vitamin D, with normalization of parathyroid hormone levels. It should be noted that vitamin D and calcium supplementation at the usual recommended daily requirements did not normalize parathyroid hormone levels in at least one study (20).

Table 1—Recommended follow-up of the bariatric surgery patient by the nonsurgeon\*

	1 month	3 months	6 months	12 months	18 months	24 months	Annually
Chemistry panel	X	X	X	X	X	X	X
Magnesium	X	X	X	X	X	X	X
Complete blood count	X	X	X	X	X	X	X
Iron studies	X	X	X	X	X	X	X
Vitamin D				X	X	X	X
Parathyroid hormone				X	X	X	X
Bone density				X		X†	X†

\*This table is made up of recommendations based on clinical practice and is not meant to be a complete set of guidelines. Depending on the bariatric procedure done, the individual practitioner will need to determine what studies are needed for each patient. In patients who underwent a purely restrictive procedure (e.g., banding), many of these studies may not need to be done. †If the patient is found to have an abnormally low bone density, or decreasing bone density, then measure bone density annually.

### Malabsorptive bariatric surgery

Currently, Roux-en-Y gastric bypass, which is a restrictive procedure with minimal to no malabsorption, comprises the vast majority of bariatric surgeries. Several decades ago, a bariatric procedure known as the biliopancreatic diversion or Scopinaro procedure was popular. It is still occasionally performed in morbidly obese patients and is intended to cause fat malabsorption to produce massive amounts of weight loss. The procedure involves a gastric restriction and diverts bile and pancreatic juice into the distal ileum (22). This leaves a very short segment of small bowel to absorb all the nutrients that require biliary and pancreatic juices. Variations of this procedure (biliopancreatic diversion with duodenal switch) causing malabsorption are still performed. In addition to the above-mentioned nutritional issues, patients who have this procedure often have other more severe problems related to protein and fat malabsorption.

Protein deficiency is easy to recognize by following albumin. Fat malabsorption manifests its presence by loss of fat-soluble vitamins. Patients can present with a number of problems after this procedure. In our clinic, the most common presenting complaint is fractured bones or a bone density study showing “severe bone loss.” Due to fat malabsorption, severe vitamin D deficiency will develop along with an already reduced ability to absorb calcium (23).

In general, fat-soluble vitamins A, D, and K will be deficient in two-thirds of these patients within 4 years after surgery. Up to 50% will have hypocalcemia, and all of these patients with low vitamin D levels will have secondary hyperparathyroidism (24,25).

Manifestations of all the different fat-soluble vitamins can be seen, ranging from unusual rashes, to osteomalacia, to easy bruising. Fortunately, there is a rather simple solution: pancreatic enzyme replacement. When pancreatic enzymes are replaced, there is some weight regain, and physicians often observe patient noncompliance as a result. The hyperparathyroidism may be difficult to treat and may require separate treatment or even surgery.

Other problems associated with this type of procedure include severe hair loss, liver disease (usually transient), kidney disease, and unusual body odors (26). The lifestyle after this procedure can be difficult due to the frequent bowel movements (over 10 times a day) and the foul-smelling stool that the fat malabsorption causes.

**SUMMARY**— Despite billions of dollars spent on weight loss treatment, the number of morbidly obese patients continues to increase. The only treatment option shown to have any type of success in this population is bariatric surgery. Over 100,000 bariatric surgeries are performed annually, with gastric bypass being the most common surgery. Compliance with long-term follow-up is vital, as nutritional and metabolic problems can be easily treated or avoided. With increasing numbers of patients undergoing bariatric surgery, physicians other than the initial surgeon will need to become involved in the follow-up of such patients (27).

### References

1. Fujioka K, Toussi RH, Brunson ME, Mendes RA: Health care utilization before and after bariatric surgery, the managed

care experience. *Obes Res* 9 (Suppl. 3):93S, 2001

2. Kral JG: Surgical treatment of obesity. *Med Clin North Am* 73:251–264, 1989
3. Huang CS, Forse RA, Jacobson BC, Farfay FA: Endoscopic findings and their clinical correlations in patients with symptoms after gastric bypass surgery. *Gastrointest Endosc* 58:859–866, 2003
4. Moize V, Geliebter A, Gluck ME, Yahav E, Lorence M, Colarusso T, Drake V, Flancbaum L: Obese patients have inadequate protein intake related to protein intolerance up to 1 year following Roux-en-Y gastric bypass. *Obes Surg* 13:23–28, 2003
5. Bologna JL, Braverman IM: Skin manifestations of internal disease. In *Harrison's Principles of Internal Medicine*. 15th ed. Braunwald E, Ed. New York, McGraw-Hill, 2001, p. 315–330
6. Liddle RA, Goldstein RB, Saxton J: Gallstone formation during weight-reduction dieting. *Arch Intern Med* 149:1750–1753, 1989
7. Wudel LJ Jr, Wright JK, Debelak JP, Allos TM, Shyr Y, Chapman WC: Prevention of gallstone formation in morbidly obese patients undergoing rapid weight loss: results of a randomized controlled pilot study. *J Surg Res* 102:50–56, 2002
8. Yale CE, Gohdes PN, Schilling RF: Cobalamin absorption and hematologic status after two types of gastric surgery for obesity. *Am J Hematology* 42:63–66, 1993
9. Provenzale D, Reinhold RB, Golner B, Irwin V, Dallal GE, Papathanasopoulos N, Sahyoun N, Samloff IM, Russell RM: Evidence for diminished B<sub>12</sub> absorption after gastric bypass: oral supplementation does not prevent low plasma B<sub>12</sub> levels. *J Am Coll Nutr* 11:29–35, 1992
10. Brolin RE, Gorman RC, Milgrim LM, Kessler HA: Multivitamin prophylaxis in prevention of post-gastric bypass vitamin and mineral deficiencies. *Int J Obes* 15: 661–667, 1991
11. Amaral JF, Thompson WR, Caldwell MD, Martin HF, Randall HT: Prospective he-

- matologic evaluation of gastric exclusion surgery for morbid obesity. *Ann Surg* 201: 186–193, 1985
12. Halverson JD: Micronutrient deficiencies after gastric bypass for morbid obesity. *Ann Surg* 52:594–598, 1986
  13. Sharabi A, Cohen E, Sulkes J, Garty M: Replacement therapy for vitamin B<sub>12</sub> deficiency: comparison between the sublingual and oral route. *Br J Clin Pharmacol* 56:635–638, 2003
  14. Neville J: Sublingual vitamin B<sub>12</sub> (Letter). *J Fam Pract* 42:342, 1996
  15. Avinoah E, Ovnat A, Charuzi I: Nutritional status seven years after Roux-en-Y gastric bypass surgery. *Surgery* 111:137–142, 1992
  16. Coates PS, Fernstrom JD, Fernstrom MH, Schauer PR, Greenspan SL: Gastric bypass surgery for morbid obesity leads to an increase in bone turnover and a decrease in bone mass. *J Clin Endocrinol Metab* 89: 1061–1065, 2004
  17. Collazo-Clavell ML, Jimenez A, Hodgson SF, Sarr MG: Osteomalacia after Roux-en-Y gastric bypass. *Endo Pract* 1:195–198, 2004
  18. von Mach MA, Stoeckli R, Bilz S, Kraenzlin M, Langer I, Keller U: Changes in bone mineral content after surgical treatment of morbid obesity. *Metabolism* 53:918–921, 2004
  19. Shaker JL, Norton AJ, Woods MF, Fallon MD, Findling JW: Secondary hyperparathyroidism and osteopenia in women following gastric exclusion surgery for obesity. *Osteoporos Int* 1:177–181, 1991
  20. Goode LR, Brolin RE, Hasina A: Bone and gastric bypass surgery: effects of dietary calcium and vitamin D. *Obes Res* 12:40–46, 2004
  21. Fujioka K, Lee M, Dailey GE: Secondary hyperparathyroidism after bariatric surgery for morbid obesity (Abstract). *Obes Res* 12:A37, 2004
  22. Consensus Development Conference Panel: NIH conference: gastrointestinal surgery for severe obesity. *Ann Intern Med* 115:956–961, 1991
  23. Chapin BL, Lemar HJ Jr, Knodel DH, Carter PL: Secondary hyperparathyroidism following biliopancreatic diversion. *Arch Surg* 131:1048–1052, 1996
  24. Slater GH, Ren CJ, Siegel N, Williams T, Barr D, Wolfe B, Dolan K, Fielding GA: Serum fat-soluble vitamin deficiency and abnormal calcium metabolism after mal-absorptive bariatric surgery. *J Gastrointest Surg* 8:48–55, 2004
  25. Newbury L, Dolan K, Hatzifotis M, Low N, Fielding G: Calcium and vitamin D depletion and elevated parathyroid hormone following biliopancreatic diversion. *Obes Surg* 13:893–895, 2003
  26. Papadia F, Marinari GM, Camerini G, Adami GF, Murelli F, Carlini F, Stabilini C, Scopinaro N: Short-term liver function after biliopancreatic diversion. *Obes Surg* 13:752–755, 2003
  27. Stocker DJ: Management of the bariatric surgery patient (Review). *Endocrinol Metab Clin North Am* 32:437–457, 2003