Nutritional deficiencies are unrecognized in approximately 50% of patients who undergo gastric bypass surgery. The authors present some of the more common nutritional deficiencies and related complications that can occur in this patient population. Greater awareness of the potential effects of nutritional deficiency after gastric bypass surgery may help physicians better recognize and manage these challenging conditions.

In 2008, more than 220,000 people in the United States had bariatric surgery. Interventions of this type generally fall into two categories: (1) gastric bypass, and (2) restrictive techniques (eg, gastric banding).

Gastric bypass surgery is the most common form of bariatric surgery, while Roux-en-Y gastric bypass surgery is the most common gastric bypass procedure. During the procedure, a portion of the stomach is made into a small pouch and then attached to a distal segment of the small intestine, largely avoiding the duodenum and part of the jejunum.

In restrictive technique surgeries, a restriction is created near the fundus of the stomach to reduce the amount of food a patient can consume.

Although perioperative complications associated with gastric bypass surgery are generally low (<1%), the postoperative complications can be quite high. For example, because bariatric surgery often involves gut manipulation that alters the natural absorption of nutrients, nutritional deficiencies can develop. The most common deficiencies are vitamin B12, folate, zinc, iron, copper, calcium, and vitamin D and can lead to secondary problems, such as osteoporosis, Wernicke encephalopathy, anemia, and peripheral neuropathy.

To avoid such complications, dietary supplementation often begins shortly after surgery, while the patient is still in the hospital. However, adverse effects can develop months after the procedure. For example, patients may not be compliant with taking prescribed supplements, or physicians may become less diligent about monitoring patients for nutritional deficiencies. One study found that 3 years after gastric bypass surgery, even with multivitamin supplementation, as many as 50% of patients had iron deficiency, while nearly 30% had cobalamin deficiency.

Physicians must be aware of potential deficiencies and typical patient presentations as well as prevention and treatment options. In the present review, we highlight some of the nutritional deficiencies that can arise after gastric bypass surgery if precautions and proper supplementation do not occur.

**Nutritional Deficiencies**

Although gastric bypass surgery is successful in many ways, the resulting avoidance of the small intestine often leads to various nutritional deficiencies that may be found later in these patients (Figure). Therefore, careful postsurgical monitoring and surveillance can help patients avoid problems caused by such deficiencies.

**Vitamin B12**

Found in meat and dairy products, vitamin B12 plays an important role in the growth and replication of cells as well as nervous system functioning. The recommended daily allowance of this nutrient is 2.4 µg. A deficiency in vitamin B12 is the most common nutritional deficiency in patients who have had gastric bypass surgery. Potential complications from a natural vitamin B12 deficiency include anemia (leading to fatigue and generalized weakness), neuropathy, and cognitive difficulties.

Bariatric patients are at an increased risk of developing vitamin B12 deficiency because their digestive tracts have been altered in such a way as to interfere with the natural absorption of this vitamin. In healthy adults, vitamin B12 is broken down in the acidic environment of the stomach. Intrinsic factor—released by the parietal cells in the stomach—binds with vitamin B12 in the duodenum. The bound vitamin B12 is then absorbed in the ileum. In patients who have had gastric bypass surgery, most of the stomach and duodenum are bypassed, limiting the breakdown of vitamin B12 and its subsequent binding with intrinsic factor.
Vitamin B₁₂ is a cofactor in two reactions: (1) the transition of methylmalonic acid to succinyl coenzyme A, and (2) the transition of homocysteine to methionine. Therefore, a decrease in vitamin B₁₂ can result in higher levels of methylmalonic acid and homocysteine. When testing patients for vitamin B₁₂ deficiencies, measuring methylmalonic acid and homocysteine together can result in greater than 95% sensitivity. In one study, the mean corpuscular volume was normal in 17% of known vitamin B₁₂-deficient patients.

If physicians are persistent about checking vitamin B₁₂ levels and, if necessary, methylmalonic acid levels, then serious deficiencies can often be prevented in patients. If a vitamin B₁₂ deficiency is found, then replacement with oral or injection forms of vitamin B₁₂ may be necessary.

Folate and Zinc

As one of the organic building blocks necessary for all human cells, folate is needed by the body to make new cells such as neurons and red blood cells. Folate and its synthetic form, folic acid, are found in various foods, including fortified cereals, legumes, leafy vegetables, and other fruits and vegetables. Folate deficiencies can lead to various problems, including decreased erythropoiesis, which can lead to megaloblastic anemia as well as various neurologic and psychiatric problems. Although folate deficiency has been discussed in atherosclerotic disease and cancer, its role has not been fully established. Folate is particularly important for pregnant women to prevent birth defects such as neural tube defects. The recommended daily allowance of folate for pregnant women is 600 µg. The recommended daily allowance of folate for pregnant women is 600 µg. Source: Dietary supplement fact sheets. Office of Dietary Supplements Web site. http://ods.od.nih.gov/Health_Information/Information_About_Individual_Dietary_Supplements.aspx. Accessed October 20, 2009.

Medications such as antacids, methotrexate sodium, and phenytoin can also interfere with absorption or utilization of folate.

Iron

Another essential nutrient for the human body is iron, a metallic element found in red meat and vegetables. The recommended daily allowance of iron is about 8 mg to 18 mg daily, depending on age and sex.

Although the precise mechanism of iron absorption is unclear, the duodenum and jejunum of the small intestine appear to play a primary role. Anything that interferes with iron absorption (eg, intestinal surgery) or excessive iron excretion can lead to iron deficiency, which can cause anemia, brittle nails, fatigue, generalized weakness, irritability, and pica syndrome. Iron deficiency remains the most common known cause of anemia in addition to being the most common known nutritional deficiency among adults.

Copper

As a nutrient involved in various enzymatic reactions, copper is a strong antioxidant essential to the human body. It is found in meat, vegetables, legumes, and whole grains. Recommended daily allowance of copper for adults is about 700 µg.

Copper deficiencies may accompany iron deficiencies. Individuals with copper deficiency may develop progressive difficulty walking, increased muscle tone or spasticity, heart enlargement, skin changes, or neuropathy. A deficiency in copper can also lead to a variety of neurologic and psychiatric disorders.

Absorption of copper occurs primarily in the small intestine. Various processes can affect intestinal absorption, including gut manipulation (intestinal surgery), genetics (Menkes kinky hair syndrome), and poor dietary habits.
**Calcium and Vitamin D**

There have been multiple reports of calcium and vitamin D deficiency and hyperparathyroidism in patients who have had recent gastric bypass surgery. Aggressive supplementation of calcium and vitamin D has been recommended around the time of the operation to combat these adverse effects. Calcium absorption and metabolism are carefully regulated by levels of calcium, vitamin D, and parathyroid hormone. Because these levels may be altered after bariatric surgery, careful monitoring is needed to maintain homeostasis. The recommended daily allowance of calcium for adults is between 1000 mg and 1300 mg and that of vitamin D is between 5 μg and 15 μg; though the recommended dietary calcium intake should be higher for bariatric surgery patients. Good sources of calcium include dairy products such as cheese or milk. Additional supplementation may be needed for these patients.

**Conclusion**

At this time, consensus—including specific postoperative recommended daily allowance guidelines—is needed to ensure the proper postsurgical treatment for patients who have had bariatric surgery, especially gastric bypass surgery.

To prevent surgical and other postoperative complications, one study described the implementation of a multi-disciplinary team—consisting of a primary care physician, dietitian, gastroenterologist, and nursing staff—for patients undergoing bariatric surgery and the subsequent limited complications in patients. Combined, multidisciplinary teams and consensus guidelines could help physicians provide better nutritional care for this patient population.

**References**


