Nutrition in obesity

Module 23.5

Nutritional support after bariatric surgery

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Learning Objectives

- To understand physiological and nutritional consequences of different bariatric surgical interventions;
- To identify specific nutritional deficiencies after bariatric surgery;
- To understand nutritional implications after bariatric surgery in specific situations:
  - Pregnancy
  - Adolescence
- To know how to prevent nutritional deficiencies after bariatric surgery;
- To know how to monitor nutritional status after bariatric surgery.

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Key Messages

- Bariatric surgery is associated with long lasting effects on obesity as well as on obesity-associated disease;
- The number of bariatric surgical procedures performed annually is increasing;
Bariatric surgical procedures can be divided into purely restrictive, malabsorptive, or combined types;

In particular malabsorptive and combined procedures are associated with risk of micronutrient deficiencies eg minerals, trace elements, and vitamins;

Certain deficiencies can cause irreversible squeal;

In order to prevent deficiencies after bariatric surgery, it is necessary to have life-long supplementation with multivitamins and certain other micronutrients (iron, calcium/vitamin D, vitamin B12) with regular monitoring of blood levels;

Following bariatric surgery particular attention should be paid to pregnant women and adolescents, who should be under the supervision of specialized multidisciplinary teams.

1. Introduction

Obesity is a multifactorial disease with an increasing incidence, particularly in the western world. Its co-morbidities such as type 2 diabetes, hypertension, dyslipidemia, joint disorders and significant reduction in health related quality of life constitute a health problem with major medical, socio-psychological as well as economical consequences. Primary treatment for obesity should include lifestyle changes such as exercise and diet, behavioural modification and/or pharmacological treatment. Unfortunately, many patients experience unsatisfactory results with such conservative treatment modalities. An increasing amount of data suggest that bariatric surgery is the only treatment for obesity with documented long-lasting effects not only on the obesity itself, but also on associated disease. Moreover, in a large matched-control study comprising more than 4 000 subjects (1), bariatric surgery was demonstrated to be associated with a significant reduction (approximately 30%) in mortality compared to controls that were traditionally treated in primary health care. Obviously, the health-related gain with bariatric surgery should be weighed against the risks associated with the procedure.

Severe complications after bariatric surgery, such as anastomotic leakage are reported in the range of 1-4% and 30-day mortality between 0.2-0.5%. Today, bariatric surgery is indicated in subjects with body mass index (BMI) > 40 kg/m2 or > 35 kg/m2 in the presence of co-morbidity. Most reports after bariatric surgery record losses of 20-30% of preoperative total body weight, corresponding to 50-80% of excess body weight loss (EBWL) (1)

In parallel with improved results after bariatric surgery and lower surgery-related morbidity and mortality, the number of surgical procedures for obesity has increased during the last decades, and in 2004, 140 000 procedures were performed in the US (2). Also, with the increased prevalence of obesity in younger subjects, the proportion of adolescents undergoing bariatric surgical procedures has increased. However, due to postoperative reduction in nutritional intake, all bariatric surgical procedures are associated with a risk of nutritional deficiencies, which increases with time after the operation. To avoid such complications, an understanding of the physiological and metabolic changes after bariatric surgery is necessary. Moreover, pre- as well as postoperative monitoring of nutritional status by members of a multidisciplinary team should be ensured in order to facilitate early detection of nutritional deficiencies.

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2. Bariatric surgical procedures

Surgical bariatric procedures are traditionally classified as restrictive, malabsorptive, and combined. In restrictive procedures, weight loss is achieved solely by reduced capacity for nutritional intake, whereas in malabsorptive procedures, the effect is induced through bypass of absorptive and secretory areas of the stomach and small intestine. Vertical banded gastroplasty (VBG, Fig. 1), adjustable gastric banding (Fig. 2), and sleeve gastrectomy (Fig. 3), are purely restrictive procedures whereas bilopancreatic diversion (BPD, Fig. 4), and bilopancreatic diversion with duodenal switch (BPD-DS, Fig. 5), are malabsorptive. In roux-en-Y gastric bypass (RYGB, Fig. 6), a small gastric pouch is connected to the small intestine. The “biliopancreatic limb” (remaining stomach, duodenum and proximal small intestine) is connected via an enteroanastomosis to the alimentary limb 120-150 cm below the gastric pouch. By this means, RYGB combines restriction of food intake with reduction of gastrointestinal absorptive area. RYGP is the most commonly performed bariatric surgical procedure performed today (approximately 65% of all procedures) and is often referred to as the “gold standard technique” (3). Nutritional deficiencies are more prone to occur after malabsorptive compared to restrictive procedures. In turn, weight loss is most commonly reported to be less after gastric banding/VBG compared to RYGB or BPD/BPD-DS. Therefore, purely restrictive procedures are seldom recommended in subjects with BMI > 45kg/m².
3. Macronutrient deficiencies

Macronutrient deficiencies are most commonly seen after purely malabsorptive procedures due to reduced absorption of protein and/or fat. However, all bariatric procedures have been reported occasionally to result in protein malnutrition due to reduced intake.

3.1 Protein-calorie malnutrition

In the early days of bariatric surgery, after jejuno-ileal bypass, a procedure that has now been virtually abandoned, protein-calorie malnutrition was commonly seen due to severe malabsorption. Nowadays, this nutritional deficiency is rarely seen after restrictive procedures or after RYGP with roux limbs < 130 cm. However, BPD and BPD-DS has been reported to be associated with hypoalbuminaemia in 3-10% of cases (4). Therefore, it is only necessary to screen for protein-calorie malnutrition after malabsorptive procedures and after RYGB with long roux limbs.

3.2 Fat malabsorption

As with protein-calorie malnutrition, severe fat malabsorption is seen mainly after more aggressive surgical procedures, such as BPD and BPD-DS. Although a certain degree of fat malabsorption is part of the purpose of this type of procedure, excessive fat malabsorption can result in fat soluble vitamin and occasionally in essential fatty acid deficiency (5).
4. Micronutrient deficiencies

Micronutrient deficiencies are not uncommon after bariatric surgery. Most recognized are deficiencies in iron, vitamin B12, folic acid and calcium. Such deficiencies may manifest clinically as anaemia (iron, vitamin B12, folic acid), neurological sequel (vitamin B12, folic acid, thiamine) or osteoporosis (calcium, vitamin D).

4.1 Iron

A sufficient supply of iron is crucial in order to avoid anaemia, since it is a vital constituent of the haemoglobin molecule. In order for dietary iron to be absorbed, it needs to be reduced to the ferrous state by gastric secretions followed by absorption in the duodenum and proximal jejunum. Iron deficiency is probably the most common deficiency after bariatric surgery, and the incidence seems to be related to preoperative BMI (6). The mechanism for iron deficiency after bariatric surgery is a combination of reduced hydrochloric acid production by the stomach and, if a bypass is created, reduced availability of intestinal surface to absorb iron. Iron deficiency is more common after malabsorptive compared to purely restrictive procedures, the reported incidence ranging from 15-50%. Menstruating women are at particular risk. Although most multivitamin preparations contain iron, such supplementation is inadequate to prevent iron deficiency in patients at increased risk. Therefore, menstruating women, and all patients undergoing malabsorptive procedures should be prescribed extra iron supplementation (100 mg ferrous sulphate daily). Regular screening for serum concentrations of iron, ferritin and TIBC (Total Iron Binding Capacity) might not be necessary, but blood concentrations of haemoglobin should be checked annually in all patients after bariatric surgery.

4.2 Vitamin B12

Vitamin B12 (Cobalamin) is a water-soluble vitamin, which serves as a cofactor in many vital processes and is required for normal nerve cell activity, DNA replication and multiple other functions. Vitamin B12 is bound to protein in ingested nutrients, and in order to be released, gastric acid is needed. Moreover, binding to intrinsic factor, which is released from the stomach is necessary for intestinal absorption. Vitamin B12 deficiency is commonly seen after RYGB (up to one third of patients), but to a lesser extent after restrictive procedures (7). B12 deficiency may be sub-clinical without obvious symptoms, but since irreversible neurological sequelae can develop insidiously, serum concentrations should be monitored annually. Multivitamin supplementation alone does not prevent B12 deficiency after RYGB. However, due to preserved ileal absorption of crystalline (non-bound) B12, supplementation with oral vitamin B12 corrects deficiencies in most cases. An alternative is a regimen that bypasses the gastrointestinal tract i.e. sublingual, nasal or parenteral. After RYGB, patients should be supplemented with 350-600 microgr of vitamin B12 daily. After purely restrictive procedures, multivitamin supplementation is sufficient in most patients, but sampling for serum concentrations should be performed liberally, in particular when clinical or laboratory signs indicate the possibility of B12 deficiency.
4.3 Folic acid

Folate deficiency is not as common as iron or vitamin B12 deficiency after bariatric surgery, but can be an alternative cause of anemia. Although folic acid requires gastric acid exposure for absorption and is preferably taken up in the proximal small intestine, the whole jejunum has this capability, and adaptation with time is likely to take place. Folate deficiency has been reported to occur in 0-38% of cases following RYGB. Unlike iron deficiency, folate deficiency is totally prevented by multivitamin supplementation. Low serum concentrations of folate do, therefore, indicate low compliance with multivitamin intake. It is particularly important to identify low concentrations of folate before and during pregnancy, since it can induce neural tube defects in the foetus. Serum concentrations of folate should therefore be monitored annually in women of childbearing age, at least in those who do not use oral contraceptives. It should also be regularly checked in patients with anemia without iron deficiency. Since macrocytic anemia is a hallmark of both vitamin B12 and folic acid deficiency, levels of both B12 and folic acid should be checked whenever macrocytosis is observed.

4.4 Calcium and vitamin D

Calcium is crucial for bone homeostasis and mineralization. For normal uptake, which occurs maximally in the duodenum and proximal jejunum, vitamin D is needed. Vitamin D is also important for several metabolic processes, and deficiency of vitamin D has been linked to disease states such as cancer, rheumatoid arthritis, hypertension, diabetes, and peripheral vascular disease (8). Uptake of vitamin D occurs mainly in jejunum and ileum. A low serum calcium increases release of parathyroid hormone (PTH) and can lead to secondary hyperparathyroidism which, in turn, increases hydroxylation of 1,25 hydroxyvitamin D3 to the active form. The end result of this process is increased absorption of calcium from bone with risk of osteoporosis.

Low serum concentrations of calcium as well as vitamin D have been reported to be common in morbidly obese subjects. Possible explanations include low physical activity, reduced exposure to sunlight, and increased storage of calcium in body fat with reduced bioavailability. These abnormalities are often aggravated after bariatric surgery, in particular after malabsorptive procedures with exclusion of the duodenum and proximal jejunum. However, with reduced intake of dairy products and other calcium and vitamin D containing foods, deficiencies are not uncommonly seen after VBG and adjustable gastric banding as well. Some authors therefore, recommend regular monitoring of calcium, phosphorus, alkaline phosphatases, PTH, and 25-hydroxyvitamin D in all patients after bariatric surgery. A high intake of calcium (2g/d) should be recommended. In addition, supplementation with calcium citrate (1.5 g/d) and vitamin D (800 i.u./d) should be prescribed. Calcium carbonate is likely to be of less use, since it is not bioavailable in the absence of gastric acid.

4.5 Vitamin B1, Thiamine

Vitamin B1 is a water-soluble vitamin being important for carbohydrate metabolism, nerve conduction, and heart and muscle function. Like other B vitamins, vitamin B1 requires gastric acid for intestinal absorption. Deficiency is therefore more common after RYGB or BPD compared to restrictive procedures. However, deficiencies have
sometimes been reported after VBG and adjustable gastric banding, as a result of reduced intake and/or absorption, particularly when vomiting is frequent. Since body stores of vitamin B1 are limited, deficiency can occur as early as 6 weeks after bariatric surgery (9). Due to reduced absorption, oral supplementation may not be sufficient to correct the deficiency in such situations. Vitamin B1 deficiency may present clinically as beriberi (10) or, in worse cases, as cerebral thiamine deficiency (Wernickes encephalopathy) with ophtalmoplegia, nystagmus, ataxia, and encephalopathy (11). Prompt recognition is called for in such cases in order to avoid permanent neural impairment. A less severe clinical situation is so-called dry beriberi or isolated peripheral neuropathy (12). Symptoms may involve burning paresthesiae, peripheral lower extremity weakness, and sensory impairment. Multivitamin supplementation prevents vitamin B1 deficiency in most cases. If deficiency becomes clinically manifest, oral administration of 50-100 mg should correct the situation. However, in severe cases or in patients with hyperemesis, thiamine should be given parenterally.

4.6 Vitamins A and K

Besides vitamin D, deficiencies of other fat-soluble vitamins can occur after malabsorptive bariatric procedures, particularly after BPD, due to fat malabsorption. Such deficiencies are less well documented and the frequency of overt clinical manifestations is almost unknown. Symptoms of vitamin A deficiency include night blindness, conjunctival xerosis, diffuse keratitis, and corneal scarring. This complication has been reported occasionally in patients after BPD who did not comply with multivitamin supplementation. Prolonged prothrombin time that normalizes with vitamin K supplementation has been reported in 20% of patients after bili-intestinal bypass (a malabsorptive procedure) (13). Although multivitamin supplementation should prevent deficiencies of vitamin A and K after bariatric surgery, awareness of the possibility of these complications is important, in particular if poor compliance with supplementation is suspected. For these reasons, some authors recommend regular check for concentrations of fat-soluble vitamins after malabsorptive bariatric surgery.

4.7 Zinc and copper

Zinc, being dependent on fat absorption, has been reported to be deficient after malabsorptive bariatric procedures (14). Clinical manifestations are, however, not common after bariatric surgery although prolonged alopecia has been reported to be normalized by high doses of zinc in patients after vertical gastroplasty. Copper is an important cofactor for enzymes involved in erythrocyte and nerve function. As with zinc, low concentrations of copper have been reported, particularly in patients with prolonged vomiting. Anaemia as well as demyelinating neuropathy after bariatric surgery has been reported. Zinc and copper deficiencies are not routinely screened for, but should be considered in patients with anaemia, prolonged alopecia or neurological symptoms without other known causes.
5. Pregnancy after bariatric surgery

Uneventful pregnancy is indeed possible after bariatric surgical procedures. However, awareness of certain maternal and foetal risks is important in order to avoid metabolic and/or nutritional complications. For this reason, it is strongly recommended that pregnant women who have undergone bariatric surgery are followed up regularly at specialized centres. Moreover, pregnancy after bariatric surgery should be avoided before a weight-stable plateau is achieved; usually 1-2 years after the operation. Any metabolic or nutritional derangements should be identified and corrected, preferably prior to pregnancy.

After restrictive procedures, hyperemesis gravidarum may be aggravated by small gastric pouch volumes, whereas malabsorption is more likely to have greater impact after BPD and RYGB. For normal foetal growth and development, iron-deficiency anaemia as well as deficiencies of vitamin B12, folate, calcium, and vitamin D need to be avoided. Supplementation may need to be higher due to malabsorption. Awareness of the possibility of deficiencies in folate and B vitamins is most important, since these can increase homocysteine concentrations, with increased risk of thrombosis and placental insufficiencies and consequent birth defects. Concentrations of vitamin A require close monitoring, since low as well as high levels can be teratogenic.

After delivery, maternal metabolic and/or nutritional deficiencies can impair the quality of breast milk. Infantile megaloblastic anaemia (15) and visual impairment (16) has been reported due to maternal deficiency of vitamin B12 and A, respectively, during lactation. Maternal energy requirements may increase by up to 40% during lactation, a goal that might conflict with the mother’s wish to reduce weight after delivery. Awareness of this conflict is important and close counselling by specialized nurses, dieticians or even psychologists may sometimes be needed.

6. Adolescents and bariatric surgery

The mean age for patients undergoing bariatric surgery in Europe is approximately 30 years. With the increasing incidence of obesity among younger people and with improved results after bariatric surgery, the frequency of bariatric surgical procedures performed on younger patients is increasing continuously. Although most data suggest successful outcomes, the long-time experience is, however, limited.

Two important factors affecting the risk of developing nutritional deficiencies after bariatric surgery distinguish adolescents from older patients. The first is related to the fact that adolescents can expect a longer life span with altered gastrointestinal anatomy and physiology, and the second is the observation that adolescents, compared to older patients are prone to be less compliant with medication in general and, thus, also with supplementation. This is also supported by the fact that as few as 10-15% of adolescent patients have been reported to take their recommended supplements postoperatively after RYGB (17). In order, therefore, to avoid long-term problems with osteoporosis, anaemia, and neurological sequelae, close monitoring by multidisciplinary teams, with experience of working with adolescents, is strongly recommended (18, 19). Such programmes have been demonstrated to maintain postoperative concentrations of albumin, iron, ferritin, folate and vitamin B12 unchanged from those measured preoperatively. Although such short-term results
are encouraging, experience from continuous monitoring over time is needed in order to evaluate long-term effects.

7. Summary

The number of bariatric surgical procedures performed for morbid obesity is continuously increasing. In particular malabsorptive and combined malabsorptive/restrictive procedures, such as BPD and RYGB, are associated with risk of nutritional deficiencies. The risk increases with time after the operation and all those involved in the care of patients who have undergone bariatric surgery need to be familiar with the potential complexity of this problem. Preoperative information as well as postoperative monitoring and counselling by members of a multidisciplinary team are crucial in order to prevent, detect, and/or treat such deficiencies. Besides multivitamin supplementation, most patients should be prescribed iron, calcium/vitamin D, and vitamin B12 after bariatric surgery. Blood sampling for at least haemoglobin, iron, vitamin B12, and folate should be performed annually. If symptoms suggestive of nutritional deficiencies occur, extensive blood tests for other micronutrients should be performed. Special surveillance should be undertaken in pregnant women and adolescents, who should be followed by members of experienced specialized multidisciplinary teams.

8. References