

Review

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Vitamin deficiencies and prevention methods after bariatric surgery

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Abstract

Bariatric surgeries have proven to be an effective treatment for morbid obesity to reduce the excess body weight of the individuals. Besides weight loss and improvement in metabolic parameters, bariatric surgery procedures can also cause some complications. One of the most common complications observed after bariatric surgery is vitamin deficiencies. Vitamin deficiencies occur due to malabsorptive surgery in patients with absorption disorder and restrictive surgery in patients with inadequate intake. These deficiencies may be accompanied by systematic and neurological findings. Therefore, regular follow-up of patients after bariatric surgery is crucial. If any vitamin deficiency is detected in the patient clinically or biochemically, it is recommended to eliminate this deficiency through supplementation.

Keywords: Obesity, bariatric surgery, vitamin deficiency, supplementation

INTRODUCTION

Obesity is a public health problem characterized by excessive fat accumulation in adipose tissue resulting from the complex relationship among the genetic, socioeconomic, and cultural factors and the imbalance between energy intake and expenditure^[1,2]. Especially morbid obesity [body mass index (BMI) ≥ 40 kg/m²] adversely affects the quality of life of the individual and is associated with many chronic diseases^[3,4].

In recent years, there has been an increase in the frequency of application of bariatric surgical methods due to the increase in the prevalence of morbid obesity, raising public awareness regarding obesity, and



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improvements in surgical procedures^[5,6]. The goal of bariatric surgery, which is an effective treatment for morbid obesity, is to achieve weight loss in the patient and improve his/her quality of life^[5].

Bariatric surgery methods are classified as restrictive, malabsorptive, and combined methods according to the effect mechanism. In restrictive methods, a small gastric sac is created to limit the amount of food the patient can consume at one time. In malabsorptive methods, a part of the small intestine is bypassed and consequently the absorption of nutrients decreases. In combination methods, both mechanisms are used to achieve weight loss^[7].

Several studies have shown that bariatric surgical procedures ensure weight loss and improvement in metabolic parameters in morbidly obese individuals^[8-10]. However, these individuals need to be evaluated for long-term complications of the surgery^[11]. One of the most common complications after bariatric surgery is vitamin deficiencies. Vitamin deficiencies have been observed in patients who underwent malabsorptive surgery due to absorption disorder and in patients who underwent restrictive surgery due to inadequate intake^[12].

In a study conducted on subjects during the first year following a Roux-en-Y gastric bypass (RYGB), which is a malabsorptive method, vitamin A deficiency in 11% of patients, vitamin C deficiency in 34.6% of patients, vitamin D deficiency in 7% of patients, thiamine deficiency in 18.3% of patients, riboflavin deficiency in 13.6% of patients and vitamin B12 deficiency in 13.6% of patients were found^[13]. Similarly, in another study, in the first year following RYGB, vitamin D deficiency in 12% of patients, vitamin B12 deficiency in 60% of patients, and folic acid deficiency in 47% of patients were determined^[14].

Literature data show that patients who have undergone bariatric surgery are at risk for vitamin B12, thiamine, folic acid, and vitamin A, D, and K deficiency^[15-19]. These deficiencies in patients can be observed in a wide range together with systematic and neurological findings. Therefore, regular monitoring of vitamin levels as well as initiating supportive treatment in the case of deficiency is very important^[20].

This review aims to provide information about vitamin deficiencies seen after bariatric surgeries and prevention methods in the light of the literature.

WATER-SOLUBLE VITAMINS

Thiamine

It is reported that thiamine deficiency, which usually occurs within 4-6 weeks after surgery, is observed in approximately 30% of patients^[12]. For this reason, the European Federation of Neurological Societies recommends postoperative monitoring of the thiamine levels of patients for at least 6 months and, where necessary, performing parenteral thiamine supplementation^[21].

A 100-mg oral thiamine supplementation twice a day is the standard treatment for thiamine deficiency. Patients with symptoms of Wernicke's encephalopathy or acute psychosis need to be kept under medical surveillance in the hospital. These patients should receive at least 250 mg/day thiamine intramuscularly or intravenously for 3-5 days^[20,22,23]. If thiamine deficiency after bariatric surgery cannot be treated with oral thiamine supplementation, it is associated with excessive bacterial growth in the small intestine. Antibiotic treatment is needed to overcome this deficiency, which is called bariatric beriberi^[15].

Riboflavin

Biochemical rather than clinical riboflavin deficiency was reported after bariatric surgery^[13]. If there are findings associated with riboflavin deficiency such as dermatitis, stomatitis, and glossitis in patient, and riboflavin deficiency is also observed biochemically, riboflavin deficiency should be eliminated with 5-10 mg/day oral riboflavin supplementation^[20,23,24].

Folate

Folate acts as a cofactor in the synthesis of methionine, thymidine, and purine nucleotides. Folate deficiency, which occurs as a result of not eating a sufficient and balanced diet, is associated with anorexia, weight loss, and weakness in individuals^[20,24,25]. After bariatric surgery, an average of 38% of patients are reported to have folate deficiency and this deficiency progresses asymptotically^[12]. In the study conducted by Gudzone *et al.*^[14], vitamin D, iron, vitamin B12, and folate levels were evaluated in the first year after RYGB. The prevalence of folate deficiency was reported to be 13% in the first year following the operation in patients who underwent RYGB. In this study, it was emphasized that preoperative and postoperative micronutrient levels of patients were not evaluated and micronutrient deficiencies were common in the evaluated parameters.

Folate deficiency can be treated with 1-5 mg/day oral folic acid supplementation^[20,23,24].

An increase in serum folic acid levels after bariatric surgery is indicative of excessive bacterial growth in the small intestine. This is because some bacteria present in the intestinal flora are capable of synthesizing folic acid^[25]. Excess bacterial proliferation in the small intestine is a disorder observed frequently after the bariatric surgery that changes the intestine structure^[26]. Therefore, patients should also be evaluated for the intestinal malabsorptive disease after bariatric surgery^[24].

Vitamin B12

Vitamin B12 deficiency is quite common in older individuals, vegetarians, pregnant women, and people with kidney or intestinal disease^[27]. After bariatric surgery, vitamin B12 deficiency was observed in 4%-62% of patients and it was argued that the deficiency occurred mostly due to duodenal bypass^[12,24,28]. A selective literature review was performed by Weng *et al.*^[29], who reported that preoperative vitamin B12 prevalence was 2.3% and postoperative prevalence in the 12th month after the operation was 6.5%. In another study, 75 patients with a mean age of 49 were studied; weight loss and nutrient deficiencies were evaluated. According to the results of this study, prevalence of vitamin B12 deficiency increased to 61.8% five years after RYGB operation^[28].

Malabsorption and insufficient food intake were reported as the main reasons for vitamin B12 deficiency in patients who underwent bariatric surgery. Additionally, postoperative food intolerance and bacterial overgrowth in the small intestine were also suggested as causes of the deficiency. Reduction of B12 absorption in the distal ileum as a result of the loss of intrinsic factor-secreting cells, gastric acid suppression therapy with H₂-receptor blockers, and the use of proton-pump inhibitors are other pathophysiological mechanisms leading to the development of vitamin B12 deficiency in patients^[29].

Vitamin B12 depots of the liver and kidney may delay postoperative deficiency for up to three years. Therefore, vitamin B12 deficiency can also be observed several years after the operation^[28].

In a study conducted on patients who underwent sleeve gastrectomy (SG), it was reported that, contrary to the literature, serum B12 levels increased significantly in the third postoperative month compared to preoperative data. In this study, 85% of patients reported that they received B12 supplementation and the increase in serum B12 levels was associated with this condition^[30].

Effective treatment methods of vitamin B12 deficiency was reported as orally 500-2000 µg/day B12 support, 1000-3000 µg intramuscular B12 support every six months, 500 µg nasal B12 support once a week, or 500 µg sublingual B12 support once a day^[20,23,28].

Vitamin C

The deficiency of vitamin C was reported to be common in the first year following the RYGB, occurring in 34.6% of patients^[13]. The studies conducted on the subject reported that the deficiency increased in the first year and continued for 2 years following the surgery^[31,32].

It is recommended that vitamin C deficiency, which is observed frequently after bariatric surgery, should be treated with 200 mg/day oral vitamin C supplementation^[20,23,24].

Biotin

Biotin deficiency after bariatric surgery has not been reported in studies examining biotin deficiency after bariatric surgery^[33,34]. A case regarding the loss of sense of taste after SG is reported in the literature. The patient's loss of taste was eliminated by oral biotin supplementation of 20 mg/day for several weeks^[20,23,35].

FAT-SOLUBLE VITAMINS

Vitamin A

Data from the literature suggest that vitamin A deficiency is more common in patients who have undergone biliopancreatic diversion (BPD) and RYGB surgeries in which the duodenal channel was bypassed^[36,37]. The presence of bile and bile acids in this channel was suggested as the cause of this situation. The relative reduction in bile and bile acids is accompanied by the deconjugation of bile acids, which occurs as a result of bacterial overgrowth in the small intestine, and, thus, vitamin A deficiency is observed in patients^[24].

In the studies on the subject, it was also reported that 10%-11% of vitamin A deficiency occurs in the first year following RYGB and BPD^[36,38].

As an initial treatment for vitamin A deficiency, 10,000 international unit (IU)/day vitamin A oral supplementation is recommended. Since β -carotene-related vitamin A toxicity was not reported in the literature, the use of this compound in the treatment of vitamin A deficiency is recommended^[20,23,24].

Vitamin D

Vitamin D deficiency is a condition observed frequently after bariatric surgery that causes bone losses and fractures, thus morbidity in the long term^[39]. After bariatric surgery, decreased absorption areas in the small intestine, pancreatic secretion, and changes in bile distribution are the factors that lead to decreased absorption of vitamin D^[40].

Vitamin D deficiency is also quite common in morbidly obese patients waiting for bariatric surgery. The prevalence of vitamin D deficiency before surgery is reported to be between 54% and 80%. Inadequate vitamin D intake, insufficient exposure to sunlight, and low bioavailability of vitamin D are reported as the reasons for this condition^[40]. In the case of vitamin D deficiency, parathyroid hormone levels increase in order to maintain calcium balance in the body. This secondary hyperparathyroidism effect increases bone resorption and is associated with osteoporosis and osteomalacia in adults^[41]. It is reported in the literature that the prevalence of secondary hyperparathyroidism after bariatric surgery is up to 58%^[42]. Due to the increased incidence of secondary hyperparathyroid syndrome and vitamin D deficiency after surgery, the effect of different surgical procedures on vitamin D levels has been investigated in several studies^[13,43-47].

Studies have shown that vitamin D deficiency is observed only after SG, which is known as a restrictive method^[43,44]. In a study following patients for one year after SG, vitamin D deficiency was found in 39% of patients despite using daily multivitamin support^[43]. In another study, a significant loss in bone mass and bone structure was observed one year following SG^[44].

Vitamin D deficiency was reported to be 7% in the first year following RYGB, which is a malabsorptive method^[13]. This rate was reported to be 65% in the 10th postoperative year and suggested to be due to increased levels of parathyroid hormone^[41].

The prevalence of vitamin D deficiency was determined as 63% in the fourth year after BPD and 73% in the eighth year^[45,46]. In adjustable gastric band surgery, vitamin D deficiency has been reported to be the second most common micronutrient deficiency after iron (Fe) deficiency^[47].

Data from the literature indicate that vitamin D deficiency is observed following many bariatric procedures^[13,42-47]. In these patients, it is known that bone turnover is accelerated in relation to low bone mineral density and this poses a risk for bone fractures. Therefore, it is very important to regularly monitor the vitamin D levels of patients after surgery and, if necessary, provide vitamin D supplementation^[24,48,49].

In the treatment of vitamin D deficiency, 50,000 IU ergocalciferol support once a week for 12 weeks, and then, 1000-5000 IU/day cholecalciferol support is recommended^[20,23]. In patients with osteomalacia, 50,000 IU ergocalciferol should be given once a week and 600,000 IU ergocalciferol supplementation in total should be reached in 12 weeks. However, there is also evidence that high-dose oral vitamin D supplementation causes liver abnormalities and hypercalcemia. Therefore, patient follow-up should be performed regularly during and after supplementation^[24].

Vitamin E

In the study carried out by Cuesta *et al.*^[38], anthropometric measurements and vitamin levels of 178 patients who underwent 116 RYGB and 62 BPD operations were evaluated before and after surgery. In the first year following RYGB, vitamin E deficiency was not found in the patients and the prevalence of vitamin E deficiency was 4.8% in the first year following BPD.

In case of deficiency, 800-1200 IU/day oral vitamin E supplementation was recommended^[20,23,24].

Vitamin K

Vitamin K deficiency was reported to be rare in the short term after RYGB. Nevertheless, in a study in which BPD patients were followed up for 42 months, vitamin K deficiency was determined in 60% of patients^[50].

It is recommended that vitamin K deficiency be treated with either 2.5-25.0 mg/day of vitamin K taken orally or 5-15 mg parenteral vitamin K supplementation taken intramuscularly or subcutaneously^[20,23,24].

CONCLUSION AND RECOMMENDATIONS

One of the most common complications observed in patients after bariatric surgery is vitamin deficiencies. These deficiencies can negatively affect the quality of life, nutritional behavior, and the goals that are desired to be achieved after surgery by causing many biochemical and clinical disorders in patients. Therefore, regular follow-up of patients after surgery is very important. If any vitamin deficiency is detected in the patient biochemically or clinically, relevant vitamin deficiency should be eliminated immediately through supplementation.

It was reported that vitamin deficiencies are more common in malabsorptive surgery methods; therefore, the patient's bariatric surgery procedure should also be considered while applying vitamin supplementation.

In patients who underwent restrictive surgery, adequate and balanced nutrition should be provided after surgery via the nutrition programs prepared by expert dietitians to prevent vitamin deficiency.

In addition, vitamin deficiencies that exist before surgery in patients may get worse after surgery. Therefore, vitamin levels should be evaluated before surgery and if there is deficiency it must be treated before the operation.

DECLARATIONS

Authors' contributions

Did the literature review, summarized the studies on the subject: Küçükkatirci H
Made the studies that are summarized on the subject into an article: Çalapakkorur S
Reviewed and approved the final version of the article: Çalapakkorur S, Küçükkatirci H

Availability of data and materials

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Conflicts of interest

Both authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

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