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Nutritional consequences of bariatric surgery

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Abstract

Bariatric surgeries involvement in treating comorbid obesity is growing fast. Since it was first approved as a treatment for those who had previously failed to reduce weight through conventional ways, the usage of bariatric surgery has significantly increased. The body mass index is frequently used in clinical practise to identify obesity, which is generally understood to mean having a significant quantity of harmful body fat (BMI). Since the BMI's creation, numerous studies involving sizable populations have shown a J-shaped relationship between the BMI and risk of morbidity or mortality, with a BMI greater than 30 kg/m2 (the definition of obesity in many guidelines) being undeniably linked to an elevated risk of morbidity or mortality. A severe and rapidly expanding global health hazard is the prevalence of morbid obesity. While some people can lose additional weight by making lifestyle changes, participating in exercise programmes, and following diet plans, bariatric surgery is still the treatment of choice for many patients who don't react to other forms of therapy. In terms of weight loss and comorbidity alleviation, bariatric procedures have produced excellent results. However, some issues with bariatric surgery have been reported, including anastomotic leakage, stenosis, haemorrhage, weight regain, and nutritional inadequacies. Due to the Roux-en-Y gastric bypass's poor absorption capabilities (RYGB), ND is an expected complication. Sleeve gastrectomy (SG) and other restraint-inducing operations are also linked to ND. The purpose of this review of the research is to present and discuss the nutritional effects of bariatric procedures and the currently available treatment alternatives.

Keywords: Obesity. Weight loss. Nutritional deficiencies. Bariatric surgery. Vitamin supplements.
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Introduction

The Roux-en-Y gastric bypass (RYGB) has a malabsorptive tendency, hence ND is a common complication. ND is also associated with sleeve gastrectomy (SG) and other operations that cause restriction. Uncertainty exists regarding the aetiology, prevalence, and signs of ND following SG.[(1)] The most common bariatric surgery in 2017 was the sleeve gastroplasty (SG), followed by the laparoscopic adjustable gastric banding (LAGB), Roux-en-Y gastric bypass (17.8%), and biliopancreatic diversion with duodenal switch (0.7%). (BPD-DS). Prior to BPD-DS, SG was utilized as a first stage operation and was orig-

inally thought to be merely restrictive. According to a 2015 study, gastric banding and SG both cause nutritional deficiencies of the same severity. [2]

Obesity definition

Body mass index (BMI), which is calculated as the ratio of a person's height in square metres (kg/m2) to their weight in kilogrammes (kg/m2), is frequently used in clinical practise to identify obesity, which is commonly defined as having too much body fat and posing a health concern. Obesity is defined by a number of standards as having a BMI of 30 kg/m2 or greater, which is unmistakably linked to an increased risk of morbidity and mortality.[3]

Risk factors

Contrary to hypertension, dyslipidemias, diabetes mellitus, and smoking, obesity continues to be the modifiable CVD risk factor that has not been well addressed by pharmaceutical or lifestyle therapies. The majority of the CVD risk associated with a high BMI or raised waist circumference has also been shown to be caused by the altered intermediate risk variables (atherogenic dyslipidemia, hypertension, and diabetes mellitus).[4]

Management of Obesity Physical activity combined with dietary modification

More weight is lost when physical activity and dietary changes are combined than when dietary changes alone are used**.** [5]

Anti-obesity drugs

Those with a body mass index (BMI) of >30 kg/m2 or a BMI of >27 kg/m2 with weight-related comorbidities may be candidates for anti-obesity medication therapy if they don't react to lifestyle measures after six months. However, the primary objective of treatment shouldn't be weight loss.[6]

The effectiveness of currently available anti-obesity medications is frequently restricted to a reduction of 5–10% of body weight over a year. Drug-induced weight loss usually takes longer than 6 to 8 months to manifest. Since obesity is a chronic condition, long-term treatment is necessary.[7]

For a long time (more than 12 weeks), four drugs (liraglutide, orlistat, naltrexone extended-release [ER]/bupropion ER, phentermine/topiramate controlled-release, and orlistat) can be taken to aid in weight loss.[8] According to data from the most recent meta-analyses, the average weight loss (%) with anti-obesity medications used for at least 12 months ranged from 2.9% to 6.8%. Lorcaserin (3.1%), orlistat (2.9%), phentermine/topiramate (6.8%), liraglutide (5.4%), and naltrexone/bupropion (4.0%) are some of the medications in this group. However, they are pricey and, according on the individual, may have adverse consequences.[9] A recently created once-weekly agonist of the glucagon-like peptide-1 receptor called semaglutide (Ozempic®) causes more weight reduction and blood sugar lowering than other GLPs. -1 AR.[10]

Bariatric Surgery

By limiting gastric capacity and/or lowering exposure to the small intestinal absorptive region, bariatric surgery seeks to decrease food intake.It has been established that the most efficient and long-lasting treatment for morbid obesity is bariatric surgery. The quality of life is significantly improved after bariatric surgery compared to medication therapy, and diabetes and other comorbidities are remitted. Additionally, it increases survival and cardiovascular results.[11]

Types of bariatric procedures

1. Restrictive: Sleeve gastrectomy (SG), Laparoscopic adjustable gastric banding (LAGB), and Intragastric balloon
2. Malabsorptive: Jejunoileal bypass
3. Roux-en-Y gastric bypass (RYGB), Mini gastric bypass, and biliopancreatic diversion all combine restrictive and malabsorptive effects (BPD)

Indications for bariatric surgery

Patients between the ages of 18 and 65: a BMI of less than 35 kg/m2 (even when there are no medical problems)

2. Having a BMI of less than 30 kg/m2 and at least one obesity-related comorbidity, such as Type 2 diabetes, hypertension, hyperlipidemia, obstructive sleep apnea/obesity hypoventilation syndrome, nonalcoholic fatty liver disease, nonalcoholic steatohepatitis, asthma, venous stasis, incapacitating arthritis, or a reduced quality of life. Patients must have failed to reduce weight or to maintain long-term weight loss despite receiving the necessary surgical and/or non-surgical comprehensive medical care in order to be considered for surgery. Patients ought to have demonstrated that they kept their planned medical appointments**.**[12]

Contraindications for bariatric surgery

• The lack of a discernible time of medical supervision.
• A patient who is unable to take part in ongoing medical monitoring.
• Personality and eating disorders, unless expressly advised by a psychiatrist with experience treating obesity. • Non-stabilized psychotic disorders, severe depression, and eating disorders.
• Abuse of alcohol or drug addiction.
• Illnesses that provide a short-term life threat, such as pulmonary hypertension.
• Patients who lack long-term family or social support that would necessitate such care and are unable to take care of themselves.[13]

Complications of bariatric surgery

Intraoperative complications can include things like anesthesia-related mishaps, bowel, spleen, or liver injuries, or damage to a vital blood vessel like the inferior vena cava (IVC) or portal vein. Myocardial infarction, deep vein thrombosis (DVT), pulmonary embolism, and haemorrhage do happen, even if they are rare. [14]

Anastomotic leaks are the most frequent and terrifying surgical consequence. Surgical site infection (SSI), pulmonary embolism Internal hernias and marginal ulcers.[15-17]

Etiology of Nutritional Deficiency After Sleeve Gastrectomy

Anemia from iron shortage, fluid deficits, vitamin and mineral deficiencies, metabolic bone disease, and iron deficiency anaemia are only a few of the nutritional effects of SG that have been seen. According to a systematic review, the overall incidence of ND after SG is predicted to be 2.6%. [18] The mechanism for ND after SG is multifaceted, and it has been hypothesised that many patients had pre-existing ND before surgery. Patients with morbid obesity typically lack vital vitamins and minerals due to their bad eating habits. If pre-existing ND is not treated before surgery, it will likely persist afterward and the micronutrient levels could get worse.[19] Similar to what happens after a partial gastrectomy for peptic ulcer disease, resection of the gastric fundus in

SG can decrease the absorption of several micronutrients as iron, folic acid, and vitamin B12. In addition, deficiencies in hypocupraemia, folic acid, and vitamins B1 and B6 may be associated with the SG calorie restriction pattern. Because hydrochloric acid is required for iron absorption and because some chelators, such as ascorbic acid, sugars, and amino acids, require acid pH to combine with soluble ferric iron to maintain it in soluble form at neutral or slightly alkaline pH, the decreased gastric acid secretion associated with SG prevents iron absorption and causes iron deficiency anaemia. Additionally, the hypoacidity of the remaining gastric sleeve prevents copper from being absorbed, which negatively impacts the haematological and neurological systems.Vitamin B12 deficits may be caused by a reduction in the consumption of foods high in vitamin B12, particularly red meat, as well as a reduction in the creation of the intrinsic factor required for the bioavailability and absorption of vitamin B12 .[20]

Other gastrointestinal disorders such celiac disease, Helicobacter pylori infection, and atrophic gastritis may potentially have an impact on ND after SG. In particular, H. pylori can impair iron and vitamin B12 absorption, which might result in severe nutritional deficits after SG. This means that early H. pylori diagnosis and eradication before SG can reduce the postoperative iron and vitamin B12 shortage.[21]

Iron Metabolism

Hakeem,[22] in a report from 2009, discussed how SG affects iron metabolism. He identified 61 patients who underwent SG by laparoscopy. Blood haemoglobin and iron markers, such as serum iron, transferrin saturation, ferritin, and soluble transferrin receptor (sTf-R), were measured before surgery as well as six and twelve months later. Three (4.9%) patients developed anaemia and iron deficiency at the 12-month assessment. We identified three unique patterns of iron deficiency: the first was characterised by abnormally high sTf-R levels, the second by low serum iron and transferrin saturation with high sTf-R, and the third by low ferritin and iron levels with reduced transferrin saturation. Additionally, there was a noticeable rise in the incidence of vitamin B12 deficiency (8.1% climbed to 26.2%) and inadequate folic acid (0% increased to 9.8% postoperatively). Some of the iron deficiency seen after SG may be explained by a considerable decrease in iron absorption. Ruz et al. found that 12 months following bariatric surgery, including SG, there was a considerable decrease in the absorption of both haem-iron (23.9% fell to 6.2%) and non-haem-iron (11.1% decreased to 4.7%). This study suggests that iron supplementation is essential to prevent a drop in iron status following SG.

Zinc Metabolism

Sallé et al.[23] came to the conclusion that zinc insufficiency is a common but underappreciated issue following bariatric surgery. Following SG, zinc shortage was discovered to be less common than after RYGB and biliopancreatic diversion. One year after surgery, 18.8% of the 33 patients who had SG had zinc insufficiency, as opposed to 6.5% before surgery. Over time, there was a little decrease in the mean serum level of zinc. At one year following SG, patients were 25.0% more likely to be iron deficient than they were before surgery, and the authors attributed this rise in insufficiency to either insufficient protein intake, an issue with the compensatory

systems of the gut and liver, or insufficient dietary zinc intake. Patients who have had SG are significantly more likely to develop ND because they are not getting adequate vitamins and other minerals, according to Aarts et al**.** [(24)] Iron deficiency was seen in 43% of patients, vitamin D deficiency in 39%, anaemia in 26%, folic acid shortage in 15%, hypoalbuminemia in 15%, and vitamin B12 deficiency in 9%.

Calcium and Vitamin D Metabolism

In a study involving 30 females, Ruiz-Tovar et al. [(25)] investigated how SG impacts the metabolism of calcium and vitamin D. The prevalence of vitamin D deficiency decreased from 96.7% preoperatively to 3.3% at the 1-year postoperative follow-up. One patient had hypoalbuminemia prior to starting SG, and the other had insufficient folic acid. Following surgery, the serum folic acid and albumin levels of both patients were normal. Serum levels of vitamin B12, vitamin D, folic acid, and iron considerably increased 24 months after surgery, although albumin, zinc, and calcium levels barely changed. The first study of its kind to show higher vitamin D levels after bariatric surgery was this one, in particular SG. This phenomenon can be explained by the study's location in Spain, which receives greater sunlight exposure than the previous studies' locations in North America and northern Europe, which receive less.Doctors allegedly recommended their patients to work out outside to enhance their physical condition and get more sun exposure. Similar to their earlier work, Ruiz-Tovar et al. [(26)] examined changes in bone mineral density (BMD) 1 and 2 years after SG. The BMD values of the spine increased statistically significantly at both time points (5.7% at 1 year and 7.9% at 2 years). Additionally, it has been demonstrated that rising vitamin D levels are closely related to rising BMD. Moore and Sherman state that vitamin D deficiency is believed to be caused by a reduction in food intake after SG and other types of bariatric surgery.[(27)] The authors used a daily supplementation regimen of 1,500 mg of calcium citrate and 2,000 IU of vitamin D3 to successfully lower the incidence of vitamin D insufficiency. Patients undergoing bariatric surgery should take high-dose vitamin D supplements, no matter the surgical approach, suggest Lanzarini et al. [(28)] If the patients' 25(OH)D blood levels were below 30 ng/mL, they received an additional 16,000 IU of vitamin D3 supplementation every two weeks in addition to 400 IU of 25(OH)D each day for their SG or RYGB. Compared to 48.3% of patients who received the required dose of vitamin D, 69% of patients who received high-dose vitamin D supplementation had normal vitamin D levels. The results of a randomised experiment, which shown that vitamin D deficiency following SG may be successfully treated and avoided by taking 80 g/day of fatty vitamin D3 supplements, supported this assertion. [(29)]

Long-Term Effects of Sleeve Gastrectomy

Saif et al. [(30)] examined the long-term impacts of SG on nutritional status in 82 people with morbid obesity. In the patients who completed a 5-year follow-up, vitamin deficiencies of 42.0% of vitamin D, 30.8% of vitamin B1, 28.6% of hypoalbuminemia, 5.5% of zinc, and 14.3% of low blood haemoglobin levels were found. At the 5-year checkup, there were no cases of iron, calcium, or magnesium deficits. About 43.0% of patients reported doing this three years

after SG, and by year five, 63.3% of patients reported doing this. Pellitero et al. [20] evaluated the long-term status of vitamins and micronutrients after SG; 176 patients were prospectively tracked for up to 5 years after surgery. Vitamin D deficiency dropped from 73 to 35 percent, anaemia incidence from 23 to 40 percent, vitamin B12 and folic acid inadequacies from 6 to 0 percent, and more.and vitamin B1 and B6 deficiencies decreased from 12.0% to 0.2%. Prior to or after SG, none of the patients showed selenium insufficiency, while hypocupraemia rose from 0.5% to 9.8% five years later.

Neurologic Complications

After SG, micronutrient inadequacies might cause neurologic side effects, for example, Wernicke's encephalopathy, which is brought about by an absence of vitamin B1 (thiamine) (WE). Thirteen examinations enumerating the event of WE after SG, with most of patients being female, were remembered for a methodical writing survey. Oedema of the stomach wall and unfortunate dietary consistence were faulted for thiamine inadequacy. Notwithstanding extreme plyneuropathy now and again, the symptomatic group of three for WE additionally incorporates visual brokenness including nystagmus, cerebellar brokenness, and bewilderment. Thiamine-concentrated treatment for WE normally brings about complete side effect help inside a couple of months.[31] Beriberi, an issue connected to serious fringe polyneuropathy described by tactile and engine shortfalls, can likewise be welcomed on by vitamin B1 inadequacy. For a situation depicted by Durán et al. [32], a youthful female patient lost the capacity to walk a month and a half after SG because of creating paraesthesia, horrendous torment, and shortcoming in her lower appendages. The patient answered parenteral thiamine treatment gradually however consistently. The patient was delivered three months after the fact subsequent to getting physiotherapy and nutrient enhancements. Sawicka-Pierko et al. [33] revealed the instance of a moderately aged female who procured optic neuropathy 10 months after SG as one more serious neurologic consequence of nutrient deficiency. The patient had a respective loss of visual field notwithstanding a reciprocal drop in visual sharpness. The serum levels of vitamin B12 were thought to be fundamentally lower. Intramuscular vitamin B12 infusion helped to reduce the ocular side effects and raise the serum vitamin B12 level over the course of at least seven days of treatment. The authors urge all patients to receive long-term ophthalmological follow-up after SG. In 0.7% of patients, a shortage of vitamin B led to neurologic symptoms such WE, paraesthesia, muscle weakness, odd step, and polyneuropathy after a middle period of a year, according to research by Punchai et al. .[34] With wholesome supplementation, 85% of patients experienced an improvement in their neurologic adverse effects, however it wasn't entirely reversible. Lacks of vitamin B12 are thought to occur after SG as a result of the fundus being removed and a lack of the distinctive ingredient provided by parietal cells, which is essential for B12 absorption. Both folic acid and vitamin B12 require stomach acid to be properly released from food. By performing a gastrectomy and using proton syphon inhibitors postoperatively, gastric acid is reduced. Women of reproductive age should optimise their folate levels since deficiencies may be linked to brain tube

deficiencies, even if the evidence linking bariatric surgery and worse neonatal outcomes is weak and inconclusive. Folate inadequacies are conceivably brought about by food decisions as opposed to a system connected with a medical procedure. Folate stores are exhausted inside the space of months dissimilar to vitamin B12, which can be put away in the liver for 1-2 years. [35]

Accordingly, folate lacks are probably going to show up sooner than B12 lacks because of the distinction in the body's stockpiling limit. Studies with forceful B12 and folic corrosive regimens postoperatively, as well as the utilization of huge portion intra-strong dosages for lacks of vitamin B12 exhibit the most useful results for patients. Intramuscular dosing of B12 permits direct take-up into the circulatory system and keeps away from the issues of retention made by post-SG life structures. Moreover, when inadequacies were revised preoperatively, there were lower paces of lack postoperatively. [36]

Patients with heftiness might encounter lack of vitamin D because of the vitamin D being put away in fat, restricted sun openness, stationary way of life, and mental impacts of covering more skin.Patients with more noteworthy fat tissue are less inclined to participate in exercises like sunbathing where skin is uncovered, regardless of the way that sufficient daylight openness is important for fitting vitamin D levels. An absence of suitable lipid retention can cause vitamin D shortages since vitamin D is a fat-solvent nutrient that should be consumed by the body to work properly.The optional hyperparathyroidism that was found in 39% of postoperative patients may conceivably be made sense of by the vitamin D shortfalls that were seen in those patients.Patients with heftiness experience difficulty utilizing and putting away vitamin D, thus there is a negative connection between's the two. Thus, a large number of these problems seem to be related to postoperative weight loss. In general, more research on the benefits of vitamin D supplementation is necessary to determine if SG patients should take a multivitamin along with aggressive vitamin D therapy.[37]

Generally, most of studies found that vitamin D shortfalls could be treated with supplements and didn't emerge after a medical procedure. In hefty patients, vitamin D lack has been viewed as the nutrient that is most often missing before a medical procedure.Post-SG, there is a dearth of examinations looking for vitamin deficiencies. Additionally, although being nearly universally used, post-SG multivitamin supplementation is reportedly not very effective in terms of follow-up at the moment. This may be partially due to unfavourable patient adherence over time, [38] but the absence of defined and designated mediations also seems to play a role. Overall, Jamil et al. [39] findings indicate the need for immediate, longterm studies to better understand what various intercessions entail for postoperative deficiencies. There should be clear guidelines for preoperative supplementation and scheduled assessments to affect their viability because vitamin B12 and vitamin D deficiencies both decrease when treated before surgery. Infusions administered intramuscularly need to be examined before vitamin B12 administration. Such in-office infusions reduce problems with adherence to dietary plans and prevent the need for natural elements that are lost during bariatric surgery. This is related to the need to promote regulations

relating to the possibility and practicality of vitamin B12 and folate supplementation at offices as opposed to at homes. Therefore, additional tests examining the need for mandatory vitamin D supplementation postoperatively should be conducted.

In a twofold visually impaired, randomized controlled explore, Heusschen et al. [40] evaluated the viability of a SG-explicit multivitamin supplement (MVS) in contrast with a normal MVS.

Anemia and Iron Deficiency

Anemia affected a total of 17 participants in the experiment (12.3%). Additionally, three individuals (2.2%) had iron deficiency anaemia. This is in line with the results of a prospective cohort study by Hakeam et al.[22] that found a low prevalence of iron deficiency anaemia one year after SG (1.6%).

However, as ferritin levels were not mentioned, it is most likely that the latter study employed serum iron concentrations to identify iron deficiency anaemia.Iron insufficiency is the primary cause of post-bariatric anaemia, with vitamin B12 deficiency as a minor factor.Seven patients (5.1%) were found to have iron insufficiency, as evidenced by low blood ferritin levels, by Heusschen et al., [40]To avoid iron deficiency after a sleeve, WLS Optimum 1.0's 21 mg elementary iron dosage needs to be raised. However, the American Society for Metabolic and Bariatric Surgery (ASMBS) recommendations' recommended amount of 45–60 mg for WLS preventative supplements [41] is likely too high given the low number of deficiencies found in the Heusschen et al. study. [40]

Vitamin B12 Deficiency

The loss of HCl and intrinsic factor as a result of the surgery, which is even more pronounced with PPI use, is the primary cause of vitamin B12 shortage after SG. In the study by Heusschen et al., [40] it was discovered that both groups' mean serum vitamin B12 levels significantly decreased during the first year following surgery, proving that the WLS Optimum supplement's 10 g vitamin B12 dose was insufficient.

These results suggest that the amount of vitamin B12 in SG-specific MVS required to prevent deficits is not greater than 100 g. This is not in accordance with the 350–500 g daily advice made by the ASMBS ,[42] perhaps because they do not distinguish between the various types of weight reduction surgery.

Vitamin D Deficiency

At baseline, a vitamin D insufficiency was the most common dietary deficiency (76.1%).

10% of the population was inadequate at the time of the investigation. This study conflicts with others that found deficiencies in 16 to 89% of participants. Heusschen et al preoperative supplementing method, in addition to supplementation and monitoring post-surgery, are most likely to blame for the improvement in vitamin D status.[40] Dix et al.[43] who analysed 17 trials, found that only three of them used additional supplementation to boost vitamin D levels before SG. Prevalence rates of post-operative vitamin D deficits range from 14 to 36%, according to studies using a preoperative therapy method that is closer to their detection.[20] In the first year following a sleeve, calcium and magnesium deficiencies were less common than low levels of phosphate. Hypophosphatemia is primarily brought on by a vitamin D deficiency. Due to the rarity of vitamin D deficiencies in the current study, Heusschen et al. [40] were unable to

support this. But to additionally raise phosphate levels after surgery, the amount of vitamin D in an SG-specific supplement should be increased to the levels suggested for RYGB patients by the ASMBS (75 g per day).[12]

Vitamin B1 Deficiency

Because they are not frequently assessed, vitamin B1 deficits are not frequently reported following SG. Nine patients (7.3%) had decreased vitamin B1 levels over the course of the trial, according to Heusschen et al., [40] but none of them had any clinical symptoms. As opposed to RYGB patients, who hardly ever experience such deficiencies. This might theoretically be explained by the greater likelihood of vomiting and reduced intake following SG as opposed to a RYGB. Thiamin deficiency can have devastating effects on the circulatory and nervous systems, including Wernicke's encephalopathy (WE) and beriberi. Alcohol intake, vomiting, and rapid weight loss are known risk factors for post-bariatric WE, but poor compliance with vitamin supplementation is also a significant risk factor. [44] The amount of thiamin needed to avoid deficits after a sleeve should be raised from 2 to 3 mg for non-vomiting patients. Thus, the ASMBS's [42] 12 mg daily dose recommendation is significantly exaggerated.

Zinc Deficiency

Similar to thiamin, only a small number of studies that primarily focused on one type of surgery have assessed zinc status following bariatric surgery (RYGB). Insufficient zinc levels were found in 13% of participants, which is a very small percentage when compared to the vast range of 5-39% mentioned in the literature. According to some views, protein malnutrition and malabsorption may be the primary causes of zinc deficiency. Albumin was the sole protein status marker used in the investigation by Heusschen et al .[40] Over 50% of those with low albumin levels at 12 months also had low serum zinc levels, and there was a significant association between blood zinc levels and serum albumin levels (r = 0.496). Additionally, low stomach HCl, which hinders zinc absorption, and sensitivity to foods high in zinc, including red meat, contribute to inadequate dietary intake of zinc. [44] WLS Optimum 1.0's 15 mg of zinc wasn't enough to make up for any deficiencies. However, this dosage was already higher than the 8–11 mg daily ASMBS recommended .[41] At the absolute least, SG patients should receive the same guidelines as RYGB patients (8-11 mg/day to 16-22 mg/day).

Hypervitaminosis

Some participants experienced higher serum levels of vitamins B1 (13%) and B6 (27%) during the course of the experiment. [40] For both vitamins, excess cases were more frequent than deficiency cases. Due to the body's ability to remove excess thiamin in the urine, high doses of vitamin B1 rarely result in issues. However, neuropathic symptoms might arise from high serum vitamin B6 levels. There was no appreciable difference in the prevalence of hypervitaminosis between the WLS Optimum group and the sMVS, despite the fact that the WLS Optimum group received more vitamin B6 (143% RDA) than the sMVS (100% RDA). Three individuals had extremely high blood levels of vitamin B6 (> 200 nmol/L). The clinical manifestations of vitamin poisoning are not rigorously assessed in the current investigation. It is difficult to evaluate whether the extra amounts that were

discovered are clinically relevant as a result. High blood levels of vitamin B6 can also be caused by overusing vitamin pills. Blood levels of folic acid immediately increase after consumption.[46] In nations where MVS is not a dietary ingredient that is added, these concentrations can be used as a gauge of adherence to MVS intake. Although Heusschen et al found a significant relationship between blood folic acid and serum vitamin B6 levels after 12 months ($r = 0.494$), it is unclear if patients actually ingested too much MVS. [40]

Conclusions

A growing number of obese people will have bariatric surgery in the future due to the prevalence of obesity and related comorbidities. Furthermore, due to the fact that the majority of patients experience improved disease control following bariatric surgery, this procedure is becoming more and more popular for the treatment of type 2 diabetes mellitus. As a result, practitioners need to learn more about how micronutrient deficiencies reveal themselves and how to treat them following bariatric surgery. The identification of these postoperative problems will continue to be a lifelong learning process. Major clinical research areas include the diagnosis of vitamin insufficiency and the proper preoperative and postoperative vitamin supplementation. Clinicians who care for patients after bariatric surgery must use standardised methods for postoperative assessment and vitamin supplementation. It is necessary to conduct more research to determine whether standard blood tests for micronutrient levels are reliable indicators of clinically significant dietary deficits.

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