9 Diet, Supplements and Medications After MGB: Nutritional Outcomes; Avoidance of Iron Deficiency; MGB in Vegetarians

Sarfaraz Jalil Baig and Pallawi Priya

9.1 Introduction

Obesity is a multifactorial disease. Although chronic caloric excess is a principal cause, other mechanisms such as metabolism, hormonal, genetic, and gut microbes have been identified. The treatment has largely focused on calorie restriction through dieting and increasing calorie expenditure through physical activity. This strategy has been shown to meet often with failures. Bariatric surgery, by influencing food intake and other biological processes, has emerged as the most effective method of significant and sustained weight loss in the obese.

However, the surgery has its limitations if not supplemented by a strict nutritional follow-up. With time, the restriction and malabsorption may lead to a deficiency of essential nutrients. Physiological and functional adaptations slowly take place and may cause weight regain if diet and eating habits are not adjusted and maintained. Therefore, for the long-term success of bariatric surgery, it is important to monitor and follow-up individuals undergoing the procedures. The elements of nutritional follow-up include actively looking for possible deficiencies, correcting them, monitoring the weight, and adjusting the diet to get the optimal results from the surgery.

The first attempt at standardization of screening and supplementation of these patients was done in 2008 in the ASMBS guidelines [1] which were subsequently modified in 2013 [2]. Still, considerable variations occur with BMI, geography, and type of procedure performed. In addition, very little data is available about the nutritional outcome of relatively newer procedures such as MGB-OAGB.

S. J. Baig, MS, FRCS, FIAGES, FALS (✉) · P. Priya, DNB
Department of Minimal Access Surgery, Belle Vue Clinic, Kolkata, India

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9.2 Pathophysiology of Nutritional Changes After MGB and OAGB

MGB-OAGB produces weight loss partly by restriction of food intake but mainly by malabsorption of ingested food by virtue of the bypassed segment of the duodenum and about one-third of jejunum, in addition to gut hormonal manipulation. The decreased absorption coupled with the bypassed gut produces a deficiency of many essential nutrients. Figure 9.1 gives a schematic idea of the nutrient deficiencies due to gut bypass.

Other factors that may play a role in the nutritional outcome are: (1) decreased gastric surface leading to less acid production and alteration of pH; (2) decreased acid and pepsin that leads to insufficient breakdown of protein; (3) gastric exclusion translating into a deficiency of intrinsic factor leading to insufficient absorption of vitamin B12; (4) unhealthy food choices.

Because of the diversion of the proximal gut, the following nutrients are more prone to malabsorption (as shown in Fig. 9.1): (1) amino acids; (2) iron, calcium,

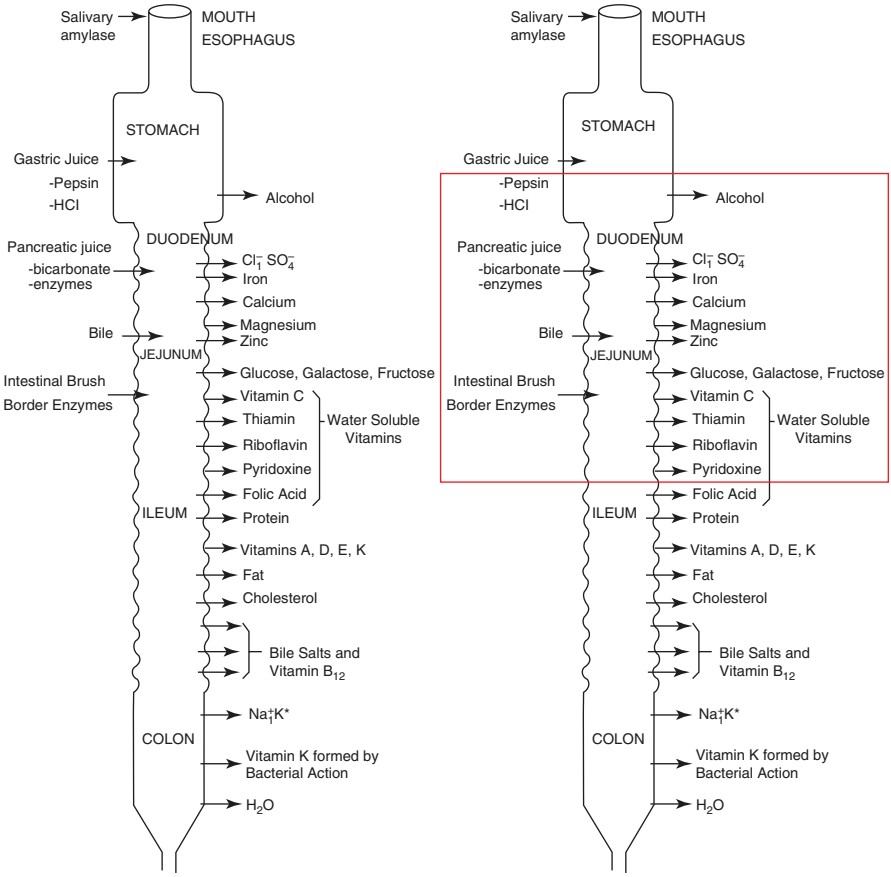

Fig. 9.1 Schematic representation of sites of absorption of various nutrients in the GI tract. Figure on the right shows nutrients absorbed from the excluded portion of GI tract in MGB-OAGB in the red box

magnesium, zinc; (3) water-soluble vitamins such as B1, B2, B6, B12 and folate. It is fair to assume that longer bypass leads to more malnutrition.

Because water-soluble vitamins are not stored in the body, their deficiencies may be seen early in the post-operative period. These deficiencies are more pronounced in patients with post-operative vomiting.

Fat is malabsorbed significantly in MGB and OAGB due to the long biliopancreatic limb. The absorption of fat-soluble vitamins is consequently also affected, although their deficiencies present late since they are stored in the body. Vitamin D deficiency is common after bariatric procedures. Vitamin A deficiency is also seen after the diversionary bariatric procedures.

Another factor that may influence the absorption of nutrients is intestinal adaptation. This is a compensatory response over time, which increases the digestive and absorptive capacity of the non-bypassed gut to compensate for the decreased absorptive area caused by the bypass. This biological process may influence the long-term nutritional outcome. However, the intensity and durability of this mechanism are not fully known. At the end of this chapter, Appendix 9.1 and 9.2 summarize the commonly seen deficiencies after MGB-OAGB.

9.3 Nutritional Assessment of Patients Before MGB

The pre-operative assessment is to understand the patient's motivational level, assess fitness for surgery and anesthesia, screen for nutritional deficiencies, and educate about healthy eating and need for change in eating habits before and after surgery. Our practice has been to send people willing to undergo a bariatric procedure to a nutritionist for a detailed evaluation during the first visit itself. The 2008 ASMBS guidelines [1] give a comprehensive recommendation for the pre-operative assessment.

9.3.1 History and Physical Examination

A thorough assessment needs to consider the individual as a whole and as a unit of the society where the surroundings play as important a role as the diet in the well-being of a person.

Figure 9.2 gives a broad idea of the recommended preliminary assessment. It summarizes the salient points that need to be covered in the history. Referral to appropriate professionals should be considered for mental health evaluation and specialized activity instruction.

9.3.2 Nutritional Education

Nutritional education is an important determinant of long-term success after a well-performed bariatric operation. The components of nutritional education are an assessment of the pre-existing knowledge, expectation management with realistic goal setting, and preparing for the post-operative dietary changes and common gastrointestinal complaints.

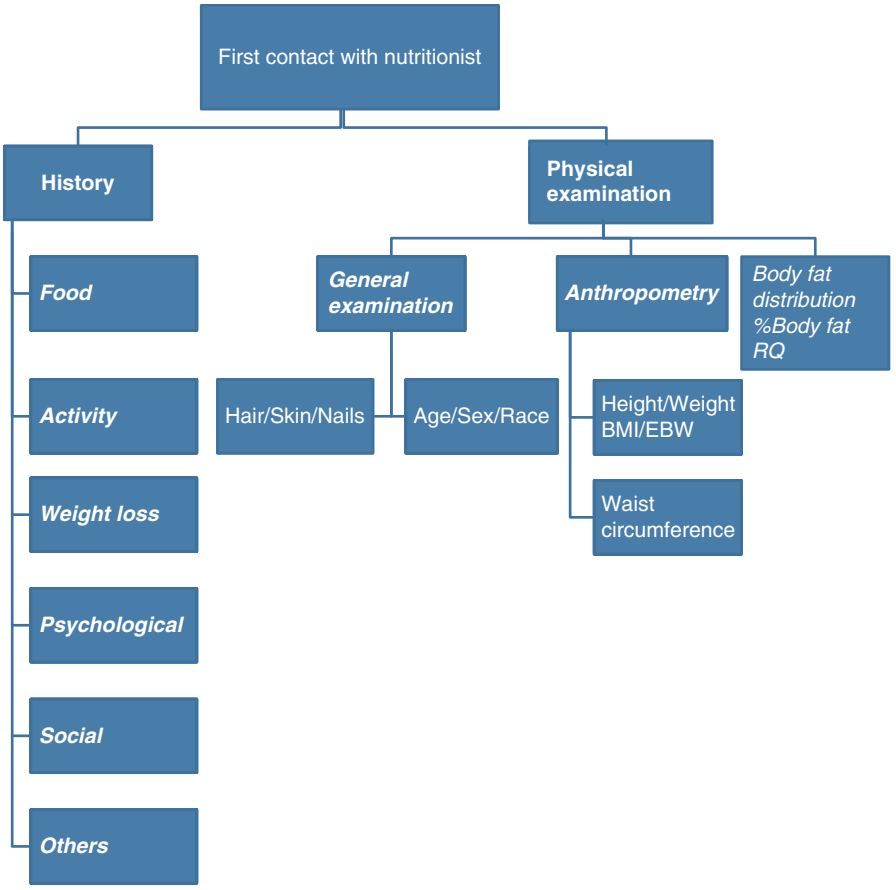

Fig. 9.2 Flow-chart summarizing salient points to be covered in pre-operative nutritional assessment. (Adapted from 2008 ASMBS guidelines by Linda Aills et al. [1])

There are often many unhealthy eating habits and misconceptions deeply rooted in the cultural and social background of the patient, which may get in the way of a successful outcome if not addressed.

As a second step, we teach our patients about post-operative diet. Texture progression, the importance of protein, vitamins, and mineral supplementation, meal planning and spacing, and desired diet composition are discussed. The importance of adequate hydration is emphasized, as lower stomach volume may translate into insufficient water intake. This is a good time to discuss the possibility of weight regain and methods to minimize it.

Patients must be told about the common post-operative complaints, such as dehydration, nausea/vomiting, anorexia, dumping syndrome, reactive hypoglycemia, flatulence, lactose intolerance, hair loss, and the return of hunger.

As a long-term measure, patients need to be taught about self-monitoring measures, healthy cooking techniques, and healthy food choices. Managing the diet in case of restaurant eating is taught.

This phase of pre-operative preparation usually involves more than one sitting and sometimes a psychiatrist and a physical therapist. It is important that patients are not taken for the surgery until they are educated and understand the need for the lifestyle changes to follow.

9.3.3 Pre-operative Nutritional Screening

All patients to undergo bariatric surgery should be evaluated for nutritional deficiencies which are frequently present. Table 9.1 summarizes the deficiencies as reported by various authors [3–8]. There is considerable variation in the reported rates, according to the geography, BMI, and cut-offs.

Apart from complete blood counts for hemoglobin status, and protein assay, the ASMBS [1–9] recommends routine screening of the micronutrients summarized in Table 9.2.

We check complete blood counts, albumin, vitamin B12, vitamin D, iron, ferritin and folate routinely and the rest only if there is any clinical suspicion of deficiency. If any deficiency is detected on pre-operative investigations, it is corrected before surgery is undertaken.

Table 9.1 Nutritional deficiencies in the obese population [3–8]

Nutrient	Deficiency (In percentage)
Albumin	0–12.5
Prealbumin	6.4–27.1
Hemoglobin	2.6–2.2
Ferritin	0–23.9
Iron	9–35.1
Vitamin A	0–16.9
Vitamin D	67.7–92.2
Vitamin E	0
Vitamin K	0
Calcium	0–4.8
Phosphate	0–21.6
Parathyroid hormone	22.6–41
Vitamin B1	7.2
Vitamin B6	15.9
Vitamin B12	2.2–18.1
Folic acid	0–25.2
Zinc	0–73.9
Copper	0–67.8
Magnesium	4.7–35.4
Selenium	3.2

Table 9.2 Pre-operative nutritional screening

Nutrient	Tests	Comments
Thiamine	• Whole blood thiamine diphosphate	• Grade C recommendation, all patients
Vitamin B12	• Serum MMA • Serum vitamin B12	• Grade B recommendation, all patients • Serum B12 levels alone may not be adequate to identify deficiencies
Folic acid	• Low RBC folate along with increased homocysteine and normal MMA are indicative of deficiency	• Grade B recommendation, all patients
Iron	• Serum iron • Serum ferritin (indicative of iron status and not deficiency) • Serum transferrin saturation • TIBC	• Grade B recommendation, all patients
Vitamin D and Calcium	• Serum 25-OH vitamin D • Serum ALP • Serum PTH • 24-h urine calcium • Serum type 1 collagen NTX levels in peri/postmenopausal women	• Grade A recommendation, all patients
Vitamin A, E and K	• Serum vitamin levels	• Grade C recommendation, all patients
Zinc	• Serum zinc levels	• Grade D recommendation, patients undergoing diversionary procedure • To be interpreted as physical signs and symptoms
Copper	• Serum copper • Serum ceruloplasmin • Erythrocyte superoxide dismutase	• Grade D recommendation, patients undergoing diversionary procedure

Adapted from 2008 ASMBS guidelines by Linda Aills *et al.* [1] and 2016 guidelines by Parrot J *et al.* [9]
Abbreviations: *MMA* methylmalonic acid, *TIBC* total iron binding capacity, *ALP* alkaline phosphatase, *PTH* parathyroid hormone, *NTX* N-telopeptide

9.4 Post-operative Care of Bariatric Patients

Guidelines published in 2013 by Mechanick et al. [2] give comprehensive guidelines for post-operative diet and supplementation. We will discuss postoperative care in terms of early post-operative care, diet and supplementations, follow-up, and therapeutic interventions.

9.4.1 Early Post-operative Care: Diet and Texture Progression

- A low-carbohydrate liquid meal is initiated in the early post-operative period. The patient can progress to a pureed diet under a nutritionist's supervision followed by a normal solid diet.

- Hydration needs to be monitored carefully in the early postoperative period.
- Patients are educated regarding chewing food properly and eating and drinking slowly. They are advised not to drink while eating.
- The protein intake is individualized. Recommended is 60–1.5 g of protein/kg ideal body weight per day.
- Patients are advised to avoid concentrated sweets to prevent dumping.
- Nutritional supplements and medications for associated co-morbidities are started as soon as permissible. The dosage of the supplements is given below. A chewable tablet is preferable, to begin with. Iron (Proferrin®, intestinally absorbed polypeptide) and calcium supplements should be consumed at least 2 h apart.
- Medicines in liquid form are preferred. Tablets are crushed, and chewable tablets are desirable. Extended-release drugs to maximize absorption are avoided.

9.4.2 Postoperative Nutritional Deficiencies

Although there are not enough data available to provide clear guidelines yet, reports are slowly coming in. Prevalence of iron deficiency anemia has been reported to be 4.9%–26.6% [10–14] in short to long-term follow-up. Jammu *et al.* [15], in his earlier patients with longer bypassed limbs, found that prevalence of hypoalbuminemia was 13.1%; Luger et al. [16], with a long bypass, also reported 8.1% hypoalbuminemia and 41.7% hypoproteinemia. Vitamin D deficiency was found to be 80% at 1 year [16]. However, the supplementation in that study was well below the currently recommended levels. Severe malnutrition has been reported after MGB-OAGB in rare patients [14, 17, 18]. Two unpublished audits from India report the rates of deficiencies 1 year after MGB shown in Table 9.3.

9.4.3 Nutritional Supplements—Dosage

Currently, we follow the supplementation protocol for MGB and OAGB as per ASMBS 2013 Guidelines. A recent recommendation by Parrot J *et al.* [9] has modified prophylactic doses of certain supplements. We have summarized the recommendations for important nutrients in Table 9.4.

Table 9.3 Nutritional deficiencies after MGB as reported by two unpublished audits from India

	Baig *et al.*	Tantia *et al.*
Number	56	100
Anemia	35.7%	–
Serum Iron	–	43%
Serum ferritin	3.6%	26%
Vitamin B12	10.7%	10%
Albumin	17.8%	5%
Vitamin D3	28.5%	23%

Table 9.4 Prophylactic doses of micronutrients to be given after diversionary procedures to avoid deficiencies

Nutrient	Dose	Level of recommendation
Thiamine	50 mg/d	Grade D
Calcium	1200–1500 mg/d Carbonate is taken with meals Citrate can be taken with or without meals	Grade C
Vitamin D	At least 3000 IU/d to be titrated to keep the blood levels within normal	Grade D
Iron	45–60 mg/d Should be taken separately from calcium supplements and foods reducing acidity	Grade C
Vitamin B12	Given to maintain blood levels within normal limits 350–500 mcg/d orally or, 1000 mcg/month intramuscular/subcutaneous	Grade B
Folic acid	400–800 mcg/d 800–1000 mcg/d in women of childbearing age	Grade B
Copper	2 mg/d	Grade C
Zinc	8–22 mg/d	Grade C
Vitamin A	10,000 U/d	Grade C
Vitamin E	15 mg/d	Grade D
Vitamin K	90–120 mcg/d	Grade D

Adapted from 2008 ASMBS guidelines by Linda Aills *et al.* [1] and 2016 guidelines by Parrot J *et al.* [9]

Medical practitioners should check that the prescribed multivitamin-multimineral tablets for bariatric patients contain micronutrients as per guidelines. Usually, iron and calcium would necessitate additional tablets.

9.4.4 Monitoring and Follow-up

Our patients are seen at 1, 3, 6, 12, 18 and 24 months after surgery and yearly thereafter. Patients follow up with both the surgeon and the nutritionist. Referrals are made to the psychologist, physician, and physical therapist as needed. Support group meetings, when available, help to maintain compliance and adjust to the lifestyle changes.

The following factors are considered at each follow-up:

Evaluation by a surgeon:

- Changes in weight, waist circumference and BMI.
- Co-morbidities are evaluated and their remission response noted.
- Addictions and substance abuse are noted and strongly discouraged. Alcohol interferes with the absorption of nutrients, may exacerbate deficiencies, and is rapidly absorbed.
- The status of physical activity is noted and actively encouraged.

Evaluation by the nutritionist:

- Dietary habits and compliance are noted. The patient is educated regarding the adequacy of protein and fibre intake.
- Assessment of nutritional status. Clinical evaluation is done by noting the condition of skin, hair, nails, eyes and mouth. A thorough search for hair loss, Bitot's spots, glossitis, phrynoderma, brittle nails, pedal edema and muscle strength is made.
- Compliance to supplementation is noted and its importance emphasized.
- Reasons for non-compliance to follow-up are sought and addressed. Ignorance, economic limitations in procuring expensive supplements, and not liking the taste of the changed diet are some of the factors responsible for patients not adhering to diet and supplement.
- Patients are taught to deal with common problems such as dumping, dehydration, and dyspepsia.

The symptoms and signs of nutritional deficiencies are often vague and overlapping. Thus, lab tests are important. Deficiency of one nutrient is usually a surrogate marker of multiple deficiencies. Therefore, one should evaluate completely if one deficiency is detected. The lab tests performed in follow-up are mentioned in Table 9.5.

Table 9.5 Parameters to be checked at each follow-up

Tests	Frequency
Complete blood counts *Should include a peripheral smear examination to know RBC morphology*	At every visit
Serum lipid profile	Every 6–12 months based on risk
Serum Vitamin B12 *May additionally require MMA and HCy for complete evaluation*	At every visit
Serum iron TIBC Ferritin Soluble transferrin receptor if available	At every visit
24-h urinary calcium	At 6 months and then annually
Serum vitamin D PTH Bone density (DEXA)	Serum vitamin D at every visit Bone density at 2 years
Folic acid *RBC folate optional*	At every visit
Vitamin A	At the first visit and 6 monthly thereafter
Copper, zinc and selenium	If clinical suspicion of deficiency
Thiamine evaluation	If clinical suspicion of deficiency

Adapted from 2008 ASMBS guidelines by Linda Aills *et al.* [1] and 2016 guidelines by Parrot J *et al.* [9]
Abbreviations: *MMA* methylmalonic acid, *Hcy* homocysteine, *PTH* parathyroid hormones, *DEXA* dual energy X-ray absorptiometry

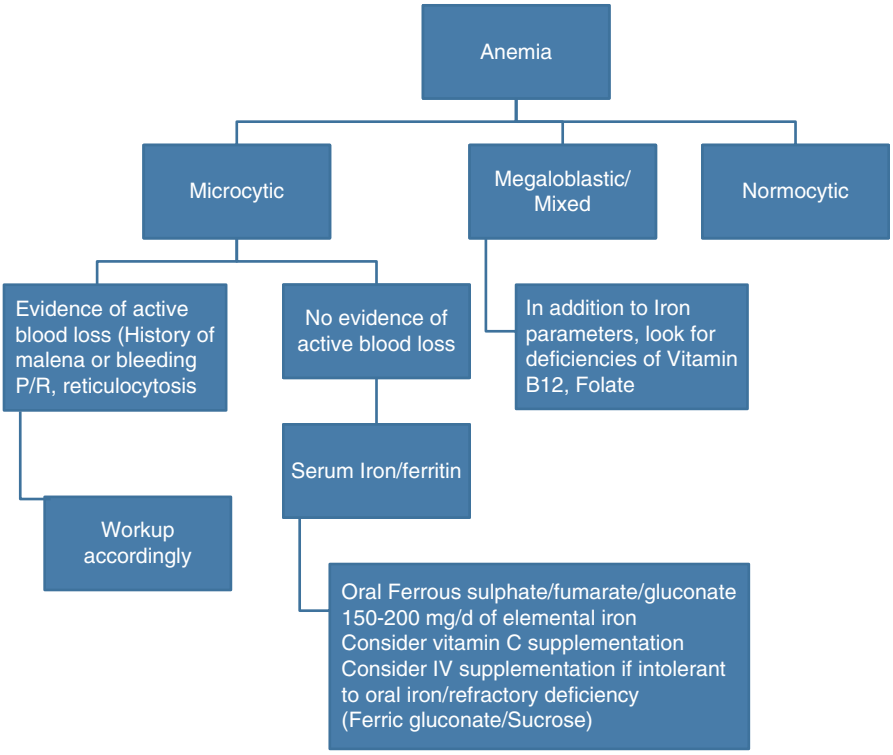

Fig. 9.3 Flow-chart summarizing management of anemia in post-operative period

Owing to a higher incidence of anemia that we see in MGB-OAGB, we give special emphasis to it and follow an evaluation protocol elaborated in Fig. 9.3.

9.4.5 Therapeutic Supplementations

Any patient found deficient during follow-up needs to be supplemented to prevent exacerbation. In the following Table 9.6, we summarize the recommended therapeutic doses for post bariatric surgery patients [2]. It is important to prevent deficiencies rather than treat them, because untreated deficiencies of micronutrients such as vitamin B12 and thiamine [1, 19, 20] can lead to irreversible neurologic damage if not detected in time.

Folic acid supplementation is particularly necessary in women of reproductive age pre-conception, to prevent neural tube defects in the offspring [20].

Any protein deficiency encountered is initially treated by increasing the protein intake. In severe cases, parenteral support and reversal to normal anatomy may be required.

Table 9.6 Therapeutic supplementation in case of deficiencies encountered in follow-up

Nutrient	Recommended supplementation
Thiamine	• 100 mg orally two to three times a day till symptoms resolve • 200 mg IV three times a day to 500 mg once or twice daily for 3–5 days until symptoms resolve followed by 100 mg/d orally • 250 mg IM once daily for 3–5 days followed by 100–250 mg monthly • Consider simultaneous repletion of Magnesium, Potassium, and Phosphorus in patients at risk of repletion syndrome
Vitamin B12	• 1000 mcg/d to achieve normal levels
Folic Acid	• 1000 mcg/d • Do not give more than 1 mg/d to avoid potential masking of B12 deficiency
Iron	• 150–200 mg elemental iron/d. May be increased to up to 300 mg 2–3 times/d • IV supplementation in case of intolerance to oral iron
Vitamin D and Calcium	• Vitamin D3 up to 6000 IU/d, or 50,000 IU one to three times a week • 1200–1500 mg/d of calcium
Vitamin A	• 10,000–25,000 IU/d till clinical improvement in patients without corneal changes • 50,000–100,000 IU/d IM in patients with corneal changes followed by 50,000 IU/d for 2 weeks • Evaluate for copper deficiencies as it can impair resolution of vitamin A deficiency
Vitamin E	• 100–400 IU/d
Vitamin K	• 10 mg/d parenterally • In patients with chronic malabsorption, 1–2 mg/d orally or 1–2 mg/week parenterally
Zinc	• Can be given up to 60 mg/d of elemental zinc carefully to avoid precipitation of copper deficiency
Copper	• Mild to moderate deficiency 3–8 mg copper gluconate or sulphate/d orally till normal levels • Severe deficiency:2–4 mg IV till serum levels normal and neurological symptoms resolved

Adapted from 2008 ASMBS guidelines by Linda Aills *et al.* [1] and 2016 guidelines by Parrot J *et al.* [9]

9.5 Our Experience

We are pleased with the results of MGB-OAGB as a procedure. These patients can eat better, compared to sleeve or RYGB patients. The common deficiencies noted are protein and iron. We have noticed cases of severe malnutrition when a limb length of >200 cm was used. Therefore, in our centre in India, we have limited the BP limb to 150–180 cm and have focused on increasing dietary proteins. We have also been supplementing our patients with 100 mg of elemental iron per day, which is higher than recommended in the guidelines. We have observed that with this protocol, we have been able to decrease iron deficiency in our cohort.

9.6 MGB-OAGB in Vegetarians

The two major deficiencies in MGB are iron and protein. Since meat is an important source of these nutrients, vegetarians are at higher risk of these deficiencies. Because a sizeable percentage of our patients are vegetarians, we have considerable experience on this subject. We have observed an incidence of 17.8% and 13% deficiency of albumin and iron respectively in our series. When we did a subgroup analysis, we found that the following factors influenced nutritional outcome – vegetarian status, limb length and compliance. Based on this observation, we recommend a conservative length of biliopancreatic limb bypass for the vegetarians. These patients need to monitor more closely for protein deficiency with a low threshold for dietary intervention.

Vegetarians consume legumes (lentils, beans, chick peas, peanuts and quinoa), yoghurt, milk, soy (tofu), whey protein, bran, brown rice, etc. Vegetables have incomplete protein, but inclusion of multiple vegetables provides total amino acid requirements [21].

9.7 Future Direction

The subject of bariatric nutrition is continuously evolving. The guidelines may change as more data comes from studies and research. The MGB-OAGB surgeons must publish their data on nutritional outcome. Short and long-term data on the nutritional outcome, vis a vis the procedural details, will help to standardize nutritional policy for MGB-OAGB. It will also help in determining the limb length.

Conclusion

Our experience suggests that we need to change our policy for certain supplements in MGB-OAGB patients, like iron. Protein deficiency needs to be avoided by improving supplementation and employing conservative length of biliopancreatic limb bypass.

Appendix 9.1: Commonly Seen Nutritional Deficiencies After MGB-OAGB

Key Points

Nutritional deficiencies seen after MGB are

- Protein
- Bivalent Ions like Iron, calcium, magnesium, and zinc.
- Water soluble vitamins such as Vitamin B1, B2, B6, B12, folate.

Because water soluble vitamins are not stored in the body, their deficiencies are seen early in the postoperative period.

Severe Thiamin deficiency in the form of irreversible neurological symptoms can be noted as early as 1 month after surgery if there is nausea and vomiting in the postoperative period.

Appendix 9.2: Salient Points to be Covered in History Taking. (Adapted from 2008 ASMBS guidelines by Linda Aills et al. [1])

History Taking in Preoperative Assessment

- ***Food*:**
  24-h food recall
  Food frequency
  Cravings/Grazing/Binge
  Restaurant meal intake
  Food preference
- ***Activity*:**
  Current activity level
  Physical limitations
  Enjoyable/Preferred activities
  Attitude towards physical activity
- ***Weight loss:***
  Successful/failed attempts with diet
  Any precipitating event for weight gain
  Personal goals
- ***Psychological:***
  Emotional connection to food/stress eating
  Eating disorders/Mood disorders
  Willingness for a major lifestyle change
- ***Social:***
  Cultural/religious influences on food
  Economical limitations to taking supplements
  Meal preparation skills
  Marital status/Children
  Identifying enablers/Feeders
  Work schedules
  Support systems
- ***Others:***
  Comorbidities/Medications/Allergies
  Literacy/Language barrier
  Substance abuse
  Dentition/Eyesight

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