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Artigo Revisão

Micronutrient Deficiencies in Post-Bariatric Patients: An Undervalued Consequence

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A B S T R A C T

Bariatric surgery remains the most effective long-term therapy for patients with severe obesity. Micronutrient deficiencies are common problem in post-bariatric patients and a strict follow-up is needed. The goal of this article is to summarize the most frequent deficiencies and the recommendations on their management.
A literature review on the topic was carried out, and 57 articles were included.
The information was organized into eleven sections and subsections: pre-operative evaluation, bariatric procedures, post-operative evaluation, deficiencies after bariatric surgery (thiamine; vitamin D and calcium; vitamin B12 and iron; folic acid; fat-soluble vitamins; minerals – zinc and copper), conclusion.
Late adverse events, namely micronutrient deficiencies, are now challenging the benefit–risk balance of bariatric surgery. It was initially thought that Roux-en-Y gastric bypass could lead to a larger micronutrient deficit when compared to sleeve gastrectomy. Currently, there are no certainties and more studies are needed. Since the majority of patients are relatively young, the long-term follow-up is large. So, there is a need for acquisition of special knowledge and skills by the medical team in primary care setting, once follow-up in specialized centres is limited.
Micronutrient deficiencies are the most common problem in post-bariatric patients and needs to be evaluated, at least yearly, after surgery. Nowadays there are recommendations that can guide clinicians in the management of these patients. However, it is necessary studies with similar methodology approaches to reach more accurate conclusions.

Palavras-chave:
Cirurgia Bariátrica/efeitos adversos;
Suplementos Alimentares;
Micronutrientes/administração e dosagem.

Deficiências de Micronutrientes Pós-Cirurgia Bariátrica: Uma Consequência Subvalorizada

R E S U M O

A terapêutica com maior eficácia, a longo prazo, na obesidade grave continua a ser a cirurgia bariátrica. A deficiência em micronutrientes é uma complicação comum, sendo necessário um acompanhamento rigoroso. O objetivo deste artigo é agrupar e resumir os défices nutricionais mais frequentes e as recomendações para o seu tratamento.
Foi realizada uma revisão da literatura sobre o tema, selecionando-se 57 artigos.
A informação foi organizada em onze secções e subsecções: avaliação pré-operatória, tipo de procedimentos cirúrgicos, avaliação pós-operatória, deficiências após cirurgia bariátrica (tiamina; vitamina D e cálcio; vitamina B12 e ferro; ácido fólico; vitaminas lipossolúveis; minerais - zinco e cobre), conclusão.

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Os eventos adversos tardios, nomeadamente as deficiências em micronutrientes, poderão condicionar o risco-benefício da cirurgia bariátrica. Estes eventos parecem apresentar uma maior prevalência em pacientes submetidos a bypass gástrico em Y-de-Roux, relativamente a gastrectomia vertical. No entanto, mais estudos são necessários. Relativamente ao seguimento dos pacientes submetidos a cirurgia, o seguimento a longo prazo é habitualmente prolongado, devido à idade jovem da população intervencionada. Sendo o seguimento em centros especializados limitado, há a necessidade de aquisição de conhecimento e competências nesta área por parte dos cuidados de saúde primários.
Conclusão: A deficiência de micronutrientes é o problema mais comum em pacientes pós-cirurgia bariátrica, havendo necessidade de avaliação bioquímica, pelo menos uma vez por ano. Atualmente, existem algumas recomendações que devem orientar os profissionais de saúde no seguimento desses pacientes, mas são necessários estudos com abordagens metodológicas semelhantes para conclusões mais precisas.

Introduction

Overweight and obesity are defined by World Health Organization (WHO) as an abnormal or excessive fat accumulation that represents a risk to health.[1] Although we think of obesity as a "modern day" problem, we can find evidence of obesity in humans in primitive art since the Paleolithic age, giving us a much broader view of this problema.[2] Nowadays it acquired epidemic proportions. Based on data from WHO, since 1975, obesity has nearly tripled worldwide.[1] Obesity is a risk factor and a causative factor for other diseases (dyslipidemia, hypertension and type 2 diabetes mellitus (T2DM)), causing a problem for health service providers and increasing the global burden of the disease.[1–3]

Body mass index (BMI) provides the most easy tool for the measurement and evaluation of obesity, being recommended its measurement as a first screening step in evaluating adult and paediatric patients for obesity.[4,5] Nevertheless, the many advantages in the evaluation of BMI, there are many limitations.[6] For a more accurate evaluation of cardiovascular risk, it is important to evaluate the waist circumference, assess the cardiorespiratory fitness and evaluate cardiovascular comorbidities.[7]

Many organizations have developed recommendations for the management of obesity.[4,5,8,9] Lifestyle interventions (multidisciplinary approaches with focus in nutrition, exercise, with psychology and psychiatry guidance) are the first-line treatment. Pharmacological intervention, as adjunct to diet and exercise, is indicated for individuals with a BMI ≥30 kg/m^2 or ≥27 kg/m^2 with at least one obesity-related comorbidity.[4,5,8,9] There are three drugs approved by the Food and Drug Administration (FDA) and European Medicines Agency (EMA): orlistat, liraglutide and naltrexone/bupropion combination. Lorcaserin and phentermine/topiramate extended-release only have FDA approval.[4,5,8–10]

Bariatric surgery (BS) remains the most effective long-term therapy for the management of patients with severe obesity, while changes in lifestyle, such as exercise and diet, do not provide sustained weight loss.[3–11] BS reduces comorbidities and mortality and current guidelines recommend BS according to BMI and obesity-related comorbidities (see below the criteria to BS).[10,12] The number of procedures per year has increased,[13] but this new paradigm in obesity treatment carries out some novel concerns.[14] Regardless of the specific bariatric procedure, the anatomy and function of the gastrointestinal and humoral system are changed. The long-term metabolic effects of these alterations are not fully known.[14] Some of these effects are favourable, such as improvements in insulin resistance with remission of T2DM in some individuals (which became a recommendation to BS in individuals unable to achieve adequate glycaemic control with oral or injectable medications[15]) and improvements in blood pressure and dyslipidaemia. Others, like nutritional deficits, profound changes in drug pharmacokinetics or psychological adaptation to sudden weight loss, might be worrying and should be addressed when monitoring subjects' evolution.[10,14,16,17]

To ensure that the long-term benefits of weight loss are not surpassed to other problems, there is a need to a strict follow-up with a multidisciplinary team – surgeon, endocrinologist, nutritionist and psychologist. Given the increasing number of bariatric patients in need of a strict follow-up, the necessity of specialized clinicians is escalating. So, there is a need for acquisition of special knowledge and skills by the medical team in primary care setting, once follow-up in specialized centres is limited.

Micronutrient deficiencies are one of the most common and compelling problems, becoming extremely important a long-term follow-up to prevent, detect and treat it. The goal of this article is to summarize the most frequent deficiencies and the recommendations on their management.

Methods

A literature search was performed on PubMed using the conjugated keywords: "Bariatric surgery", "gastric bypass", "Roux-en-Y gastric bypass", "sleeve gastrectomy", "micronutrient", "deficiency", "supplementation". Initially 181 articles were included. After investigation and selection, 57 articles, which included original and review articles, were comprised, based on their relevance on the subject.

Pre-Operative Evaluation

Indications for BS include a BMI ≥40 kg/m^2; BMI ≥35 kg/m^2 with at least one obesity related comorbidity (hypertension, T2DM, nonalcoholic fatty liver, obstructive sleep apnea, obesity-hypoventilation syndrome, asthma, or impaired quality of life).[10] As we said previously, since 2016 BS is recommended to treat T2DM in individuals with BMI 30–35 kg/m^2, if they are unable to achieve adequate glycaemic control with oral or injectable medications.[12,15,18] Although the actual guidelines only regard BMI and obesity comorbidities, some investigators reinforced the importance of fat location. The accumulation of fat in abdominal area is associated with higher cardiovascular risk when compared with subcutaneous fat in the gluteo-femoral area.[6,7,19]

Despite these criteria, when BS is considered, it is crucial that the clinician explain the procedure and long-term complications. Also, it is important to evaluate the patient's ability to compliance to dietary changes, exercise and micronutrient supplementation. The majority of micronutrient deficits do not cause immediate consequences and patients tend to undervalue this subject.[16,17] Subsequently, the need to daily micronutrient supplementation for lifetime should be reinforced since the first appointment.

Although micronutrient deficiencies become more prevalent after surgery, accumulating reports have also demonstrated a high prevalence in pre-surgery evaluation, being important to recognize and treat them prior to surgery.[20–32]

Ben-Porat *et al*[25] evaluated micronutrients deficiencies in 192 patients prior and after sleeve gastrectomy (SG) and found that presence of preoperative micronutrient deficiencies was the strongest predictor of their presence postoperatively. In obese patients, it is common to have, at least, one vitamin or mineral deficiency preoperatively.[26] The micronutrients most commonly affected are vitamin D, iron and folate.[14,22–24,27–32] Iron deficiency is more common in women.[29] Lefebvre *et al*[27] also evaluated electrolytes, and magnesium deficiency was the most common, with hypomagnesemia occurring in 35.4% of the patients. Some of these deficiencies have been attributed to poor dietary quality, with low dietary micronutrient sources relative to caloric intake.[21]

A routine presurgical screening is recommended with evaluation for levels of thiamine, vitamin B12, folate, iron, vitamin D, fat-soluble vitamins (A, E, K), calcium, zinc and copper. After identification of nutrient deficiencies, supplementation prior to bariatric surgery should be done with improvement in their surgical outcomes.[16,17,22,33]

Bariatric Procedures

Traditionally, bariatric procedures are classified as restrictive, malabsorptive or a combination of these procedures, based on their mechanisms for weight loss and metabolic control.[34] In general, laparoscopic bariatric procedures are preferred over open bariatric procedures due to lower early postoperative morbidity and mortality.[10]

Worldwide, SG is the most common procedure,[35] followed by Roux-en-Y gastric bypass (RYGB). In the last years, SG surpassed RYGB in number of procedures per year due to easier surgical procedure, with satisfactory weight loss and remission of comorbidities.[36] Nevertheless, some authors argued that SG is less effective, either in weight loss and comorbidities remission.[37,38]

Depending on the bariatric procedure, we can almost predict the frequency and severity of vitamin and mineral deficiencies. They are uncommon after adjustable gastric band (AGB), a purely restrictive procedure, with a higher incidence after malabsorptive procedures – RYGB, biliopancreatic diversion (BPD) and biliopancreatic diversion with duodenal switch (BPD/DS).[39] These two last procedures are rarely performed nowadays. In SG, the greater curvature of stomach is removed creating a tubular stomach. In some trials, a smaller incidence of micronutrient deficiencies in patients submitted to SG have been found, when compared to RYGB.[40] The lack of gastrojejunal anastomosis is the most defended explanation. However, some studies showed different results, with similar proportions of micronutrient deficiencies in these two procedures.[41]

The reasons for micronutrients deficiencies after BS are several. As we said previously, micronutrient deficiencies before surgery are common and increase the post-surgical probability of their occurrence. After surgery, we have an alteration in the digestive anatomy. There is a reduction on stomach's volume, reducing appetite and volume of food and fluids able to be consumed. This can lead to inadequate nutritional intake, poor eating habits and gastrointestinal symptoms (i.e. gastroesophageal reflux, vomiting). In malabsorptive procedures, there are portions of the small bowel that are excluded from the alimentary path. The impact on nutrients absorption is proportional to the reduction in intestinal absorptive surface area.[23] Also, anatomical changes often lead to alterations on optimal digestive ambient. SG and RYGB result in diminished acid production and intrinsic factor, which in turn impairs absorption of important nutrients as iron and vitamin B12. This could explain the similar micronutrient deficiencies found between SG and RYGB.[16,17,41] Another possible cause for micronutrients deficiencies is the higher velocity in the intestinal transit that impairs the absorption of some nutrientes.[39]

Since the two main bariatric procedures worldwide are RYGB and SG, we selected the recommendations for these two. However it is important notice that usually the recommendations do not split the two procedures. Currently, the true specific effect of the procedure is unknown.[16,17]

Post-Operative Evaluation

Current guidelines recommend a biochemical evaluation every three to six months in the first year post-surgery and every 12 months thereafter.[10,16,17,33,42]

To summarise the recommendations:

– Routine monitoring of iron, folate, vitamin D and B12[10,16,17];
– Monitoring of zinc and copper, at least annually, post-RYGB[17];
– Monitoring of vitamin A in all patients in the first year (17), or at least annually following BPD and BPD-DS16;
– Evaluate serum thiamine levels in cases of otherwise unexplained or unresponsive clinical phenomena in all patients post-bariatric surgery.[10]

We systematized the recommendations, dividing, when it exists, preventive supplementation from repletion doses (Table 1).

In patients submitted to RYGB or SG, the European Association for the Study of Obesity (EASO) guidelines suggest supplementation with two adult multivitamin plus mineral supplements (containing iron, folic acid and thiamine), plus 1200-1500 mg of elemental calcium (preferably calcium citrate rather than calcium carbonate), vitamin D (at least 3000 IU, titrated to 25-hydroxyvitamin D levels >30 ng/mL) and vitamin B12 (titrated to maintain normal levels).[16] Also, the American Society for Metabolic and Bariatric Surgery (ASMBS) guidelines and The Clinical Practice Guidelines 2013-update do the same recommendations.[10,17] Thus, particularly in malabsorptive procedures, routine supplementation is a lifelong requirement irrespective of adequacy of oral intake.[10,16,17]

These recommendations are considered to be the minimum ongoing requirement for patients following BS and, according to biochemical evaluation, some adjustments will have to be made. Parrot *et al* provide recommendations with supplement doses to prevent deficiency and repletion doses for patients with deficiencies identified.[17]

Dual-energy X-ray absorptiometry (DEXA) should be done before BS and bi-anually thereafter to monitor bone mineral density (BMD) in patients submitted to RYGB, BPD and BPD/DS.[16]

Primarily, the patient should be carefully evaluated in bariatric centres with a multidisciplinary team and transferred to primary care over time. The most complex subjects should be referred to a bariatric centre, preferably the one performing the original procedure.[16,17]

Deficiencies After Bariatric Surgeries

Thiamine

The majority of deficiencies occur a few months after surgery, except thiamine (or vitamin B1) deficiency, which can occur earlier.[16,17,29] After BS, eating intolerance and vomiting, due to ana-

Table 1. Micronutrient management after bariatric surgery.

Micronutrient		Preventive dosages (daily dose)	Repletion dosages (daily dose)	Notes
Vitamin A	ASMBS	5 000 - 10 000 IU	Without corneal changes: 10 000 – 25 000 IU orally With corneal changes: 50 000 – 100 000 IU IM	
Vitamin D	ASMBS	3 000 IU (until 25(OH)D level >30 ng/mL)	3 000 – 6 000 UI of D3 or 50 000 of D2 1-3 times weekly	- Vitamin D3 is recommended as a more potent treatment that vitamin D2 (17) - Vitamin D deficiency is the most common in pre and postsurgical patients (most frequent after RYGB compared to SG) (17)
	EASO	3000 IU (titrated to 25(OH)D level >30 ng/mL)		
Vitamin E	ASMBS	15 mg (22.4 IU)	90 to 300 mg (100 – 400 IU)	- Optimal therapeutic dose has not been clearly defined - Lactation women: 19 mg (28.4 IU)
Vitamin K	ASMBS	90 - 120 mcg	10 mg parenterally	
Vitamin B1/ Thiamin	ASMBS	12 - 50 mg (from B-complex supplement of multivitamin)	100 mg orally 2-3 times daily 200 mg IV 3 times daily to 500 mg 1-2 times daily	- Thiamin supplementation above the RDA is suggested to prevent deficiency (17) - Simultaneous administration of magnesium, potassium and phosphorus should be given to patients at risk for refeeding syndrome (17) - Prolonged vomiting – neurologic exam + Vitamin B1 (before obtaining confirmatory laboratory data)
	EASO		50-100 mg orally or parenterally	
Vitamin B12	ASMBS	350 to 500 mcg (µg)	1 000 mcg	- Yearly long-term laboratory monitoring is essential
	EASO		–	
Folate	ASMBS	400 – 800 mcg	1 000 mcg	- Women of childbearing age: 800-1000 mcg daily (17) - Folate absorption occurs throughout the entire small bowel
Iron	ASMBS	45 to 60 mg	150 – 300 mg two to three times daily	- Absorption in duodenum and jejunum increases with acid environment - Taking together with vitamin C increases absorption - Calcium supplements, foods containing high amounts of calcium, phytates or polyphenols and acid-reducing medications decrease absorption (17)
Zinc	ASMBS	8 – 22 mg for RYGB 8-11 mg for SG	60 mg twice daily	- Routine supplementation with multivitamins is usually sufficient (16) - To minimize the risk of copper deficiency, it is recommended that for 8 to 15 mg of elemental zinc is added 1 mg copper (17)
Copper	ASMBS	RYGB: 2 mg; SG: 1 mg	3 – 8 mg orally / 2-4 mg IV	- Routine supplementation with multivitamins is usually sufficient (16)
Calcium (daily dose from all sources)	ASMBS	1200 – 1500 mg		- Calcium citrate should be preferred to calcium carbonate because it is better absorbed in the absence of gastric acid - Calcium carbonate should be taken with meals; calcium citrate may be taken with or without meals - Calcium and vitamin D routine supplementation is strongly recommended after gastric bypass and malabsorptive procedures.
	EASO	1200 – 2000 mg		

ASBMS: American Society for Metabolic and Bariatric Surgery; EASO: European Association for the Study of Obesity; 25(OH)D: 25-hydroxyvitamin D; RYGB: Roux-en-Y gastric bypass; SG: sleeve gastrectomy.

tomical reduction of the gastric volume, are common.[10] In patients with persistent vomiting, impairing regular food intake, thiamine deficiency can occur within three weeks after surgery.[43] Since these symptoms can occur after every bariatric procedure, cases of thiamine deficiency have been reported after all types of bariatric surgeries.[16] Peripheral neuropathy or Wernicke's encephalopathy are the typical consequences and can become permanente.[16,17,43] These consequences are rapidly progressive, so thiamine supplementation should promptly be started in every patient suffering from persisting vomiting that interfere with regular nutrition,

even in the absence or before confirmatory laboratory data.[16,17,42] This is even more reinforced, when patient have neurologic alterations.[16,17] Thiamine supplementation can be given oral or parenteral (Table 1) Simultaneous administration of magnesium, potassium and phosphorus should be given to patients at risk for refeeding syndrome.[16,17]

In the absence of thiamine deficiency, every patient should take at least 12 mg daily and, preferably, 50 mg of thiamine from a B-complex supplement or multivitamin.[17]

Vitamin D and Calcium

In the majority of studies, the most common deficiency after RYGB is vitamin D deficiency, which can be as high as 100%.[17] Its prevalence varies, from 25% to 100%, depending on the duration of the study and its defining parameters (25-hydroxyvitamin D <20 ng/dL or 25-hydroxyvitamin D <30 ng/dL).[17] As stated previously, usually hypovitaminosis D already exists prior to surgery in most patients.[27,44] One possible explanation for this, apart the poor eating habits of these patients, is the volumetric dilution of vitamin D in the high amount of adipose tissue.[45]

Calcium and vitamin D deficiencies seem to be the main responsible for the accelerated bone loss after bariatric surgery. This deficiency can result in higher fracture risk.[46] Several clinical studies have reported lower BMD after bariatric surgery, in particular when the duodenum is bypassed, like in RYGB. As a fat-soluble vitamin, vitamin D needs bile and pancreatic enzymes to correct absorption. In RYGB, this only occurs after intestines join in the common channel. Although early publications have defended that skeletal effects after SG were less pronounced, recent studies seem to refute this hypothesis.[47] After surgery, even in patients with normal values of vitamin D (25-hydroxyvitamin D >30 ng/dL), there is a high incidence of secondary hyperparathyroidism, which some authors argued that could evidence a selective calcium malabsorption.[47] The reduction on calcium absorption can be as low as 20% of the dietary calcium.[48,49] In addition, usually patients experience intolerance to dairy products, which exacerbates this deficiency.[50] Recently, some authors defended that over time the gut may compensate the decreased ability to absorb calcium.[51]

To prevent vitamin D deficiency, every patient should take 3000 IU of vitamin D3 (or cholecalciferol) daily, until 25-hydroxyvitamin D level >30 ng/Ml.[16,17,42] In case of deficiency, around 3000 to 6000 IU of vitamin D3 should be taken daily.[17] Vitamin D3 is recommended as a more potent treatment that vitamin D2 (or ergocalciferol).[17]

All patients after bariatric surgery should take 1200-1500 mg/day of elemental calcium from all sources.[16,17,42] To enhance calcium absorption, it should be given in divided doses and calcium citrate should be preferred to calcium carbonate.[16]

As we said previously, DEXA should be done before surgery and bi-anually thereafter to monitor BMD in patients submitted to RYGB, BPD and BPD/DS.[16]

Vitamin B12 and Iron

The development of anemia in post-bariatric patients is another important issue to consider.[14] A meta-analysis published in 2014[40] studied the prevalence of anemia, vitamin B12 and iron deficiency after RYGB and SG. Nine studies were included, 4 of them were randomized controlled trials. The authors' findings suggest that SG is more beneficial than RYGB with regard to postoperative vitamin B12 deficiency risk, whereas the 2 methods are comparable when assessing the risk of postoperative anemia and iron deficiency.

A possible explanation for the greater incidence of vitamin B12 deficiency in patients submitted to RYGB when compared to SG is the greater decrease of intrinsic factor content in the former. Other important factor is the diminished acid production due to reduction in parietal cells contente.[16,17,40] Since vitamin B12 stores are usually high, its deficiency is rare in the first year and tends to increase with time.[42] The dose of supplementation of vitamin B12 is 350-500 µg daily.[16,17]

The prevalence of iron deficiency in post-bariatric patients is around 30% to 60%, and is the most common adverse event after RYGB.[14,52] Iron is predominantly absorbed in duodenum and the upper parts of jejunum,[53] explaining the high prevalence of this deficiency. As said previously, the diminished acid production not only impairs vitamin B12 absorption but also iron.[16,17,40] Another reason that should be valued is the diminished intake of iron rich food (meat, enriched grains and vegetables). Post-bariatric patients commonly develop intolerance for meat, which is a major source of iron.[54]

Parrot *et al*[17] consider patients submitted to RYGB or SG as at high risk to iron deficiency, as well as menstruating females, and at least 45-60 mg of elemental iron per day should be given. Prophylactic empiric iron supplementation is also recommended by other organizations, however did not specify the dose.[16,42] Iron absorption in duodenum and jejunum increase with acid environment, thus acid-reducing medications can reduce it.[17] Calcium supplements, foods containing high amounts of calcium, phytates or polyphenols are also associated with diminished iron absorption.[16,17,42] On the other hand, vitamin C can increase iron absorption.[42]

Folic Acid

Folate absorption occurs throughout the entire small bowel, so its deficiency is uncommon.[42] The reported prevalence of folate deficiency after SG and RYGB is 3.6% and 4.2% respectively.[55] To prevent deficiency, all post-bariatric patient should receive 400-800 µg oral folate daily from their multivitamin.[17,56]

Fat-Soluble Vitamins (Vitamin A, E, K)

The absorption of fat-soluble vitamins is reduced after malabsorptive procedures.[42] Busetto *et al*, recommend routine supplementation in patients submitted to BPD and BPD-DS.[17] ASMBS recommend different doses accordingly to type of procedure. Patients submitted to RYGB and SG should receive 5000-1000 IU/day of vitamin A, vitamin K 90-120 µg daily and 15 mg/day of vitamin E.[17]

Minerals: Zinc and Copper

Zinc deficiency occasionally occurs following SG or RYGB and, more commonly, following BPD. Recently, Kane *et al* suggested monitored if there are unexplained symptoms including anaemia or changes in taste acuity and at least annually following SG, RYGB and BPD/DS.[56] Also, the screening of zinc deficiency yearly is recommended by ASMBS guidelines.[17] On the other hand, the Practical Recommendations of EASO did not mention its routine evaluation.[16]

Mahawar *et al*, in a systematic review of 2017, conclude that clinically relevant zinc deficiency is rare after RYGB, thus routine monitoring of zinc levels is unnecessary for asymptomatic patients after RYGB. Accordingly to these authors, zinc level evaluation should be reserved for patients with skin lesions, hair loss, pica, dysgeusia, hypogonadism or erectile dysfunction in male

patients, and unexplained iron deficiency anemia.[57]

In terms to supplementation, ASMBS recommend 100%-200% of the recommended daily allowance (RDA) in post-RYGB patients (8-22 mg/day) and 100% of the RDA in post-SG patients.[17] EASO did not mention any specific dose, because, accordingly to them, routine supplementation with multivitamins and minerals is usually suficiente.[16]

Routine supplementation with multivitamin is usually sufficient to prevent copper deficiency.[16,17]

Conclusion

Bariatric surgery late adverse events are now challenging the benefit-risk balance, although this procedure represents the most effective long-term therapy for the management of severe obesity. Most of follow-up studies in the literature are medium-term duration (<3 years) and only the early postoperative weight loss and comorbidity improvement are discussed. Moreover, their heterogeneity in methodology impairs comparison among different approaches. More recently, some authors clarified some long-term complications that must be evaluated in a systematic and rigorous way to inform and educate patients prior to bariatric surgery.

Micronutrient deficiencies are the most common problem in post-bariatric patients and needs to be evaluated, at least yearly, after surgery. Since the majority of patients submitted to surgery are relatively young, the long-term follow-up is large. Because of its malabsorptive character, it was initially thought that RYGB could lead to a larger micronutrient deficit when compared to SG. Currently, there are no certainties and more studies are needed. Nowadays, we have recommendations that can guide clinicians in the management of these patients. Unfortunately, the number of patients with micronutrient deficiencies is not encouraging. Therefore, it is necessary studies with similar methodology approaches to reach more accurate conclusions.

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EL, AV, PF e DC: Conceptualização e revisão.
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