Bariatric Surgery in Chronic Kidney Disease: Safety, Efficacy and Nutritional Considerations

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Abstract

The prevalence of obesity has increased, and simultaneously, there has been an increase in the prevalence of chronic kidney disease. Obesity is considered an independent risk factor for the incidence and progression of chronic kidney disease and is also associated with an increased risk of type 2 diabetes and hypertension, which are major causes of chronic kidney disease. Therefore, it is essential to prevent and treat obesity to reduce the incidence of chronic kidney disease and delay its progression. Given the failure of weight loss through lifestyle modification, the hypothesis arises to submit chronic kidney patients with morbid obesity to bariatric surgery. However, considering the specific nutritional requirements of chronic kidney patients, doubts arise about the universal application of current guidelines for patients undergoing bariatric surgery. Thus, the present review aims to assess the safety and efficacy of bariatric surgery in the different stages of chronic kidney disease and the nutritional requirements of chronic kidney patients undergoing bariatric surgery. Through this review, it is possible to conclude that bariatric surgery, particularly sleeve gastrectomy, can be considered for chronic kidney and transplant patients who fail to lose weight through other approaches. However, it is emphasized that randomized clinical trials and the development of guidelines are necessary to ensure proper nutritional management of chronic kidney and transplant patients undergoing bariatric surgery.

Keywords: Bariatric Surgery; Obesity; Kidney Transplantation; Nutritional Requirements; Renal Insufficiency, Chronic

INTRODUCTION

In Portugal, the prevalence of obesity has been increasing, reaching 19.8% of the Portuguese population in 2016 and 21.8% in 2022,[1] with a predicted prevalence of 39.0% in 2035.[2] At the national level, between 2017 and 2018, the prevalence of chronic kidney disease stages 1 to 5 was estimated at 20.9%.[3] In 2014, the prevalence of patients undergoing renal replacement therapy in Portugal was 1794 patients per 1 million inhabitants[4] and, in 2021, this prevalence was 2003 patients per 1 million inhabitants,[5] which may reflect an increase in the prevalence of chronic kidney disease.

Obesity is associated with an increased risk of type 2 diabetes and hypertension,[6] which are major causes of chronic kidney disease.[7] However, obesity is still considered an independent risk factor for the incidence and progression of chronic kidney disease.[8,9] It is therefore essential to prevent and treat obesity to prevent and delay the progression of chronic kidney disease. It is recommended to lose weight through lifestyle changes, intervening in diet and physical activity, but in chronic kidney patients with morbid obesity who are unsuccessful with conventional weight loss, bariatric surgery may be considered.[10] This review aims to assess the safety and efficacy of bariatric surgery in the different stages of chronic kidney disease and the nutritional requirements of chronic kidney patients undergoing this surgical procedure.

METHODS

For this article review, we searched Medline, Scopus and Web of Science using the following search terms: “bariatric surgery”, “obesity surgery”, “metabolic surgery”, “obesity surgical procedures”, “obesity surgical management”, gastrectomy, “gastric bypass”, sleeve, “chronic kidney

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disease, CKD, "chronic renal failure", "renal disease", "renal dysfunction", "dialysis", "dialysis patients", "peritoneal dialysis", "hemodialysis", "extracorporeal circulation", "kidney transplant*", immunosuppress*, "renal rejection", "nutrit*, diet*. When selecting the articles, preference was given to publications in journals with a higher impact factor and some articles cited in the previously selected ones were included so as not to exclude any relevant articles.

OBESITY AND CHRONIC KIDNEY DISEASE

Obesity has been studied for several years as an important risk factor for chronic kidney disease, and a specific kidney disease associated with obesity has been identified, obesity-related glomerulopathy.[9,11,12] In obesity, adipocytes hypertrophy until they reach their limit and toxic lipid species accumulate in different organs, particularly in kidneys.[13] Lipotoxicity interferes with insulin, which is essential for the survival of podocytes, contributing to their apoptosis and, in turn, to hypertrophy of the remaining.[2,14] Obesity is characterised by chronic low-grade inflammation due to the increased production of pro-inflammatory cytokines by adipose tissue, which contributes to endothelial barrier dysfunction and can lead to tubular damage and nephron failure.[15,16] Endothelial and mesangial cells can be affected by the high levels of leptin characteristic of obesity, since they abundantly express leptin receptors. Leptin promotes an increase in TGF-β1 and inflammatory cytokines, which can lead to thickening of the glomerular basement membrane and glomerular hypertrophy.[13,17] Adiponectin is decreased in obesity and has been associated in animal studies with microalbuminuria, renal fibrosis, oxidative stress and podocyte dysfunction.[18,19] Thus, obesity induces an increase in glomerular filtration rate and renal plasma flow, resulting in an increase in sodium and water reabsorption in the proximal tubule and, consequently, a decrease in afferent arteriolar resistance.[20] The increase in intrabdominal pressure caused by the accumulation of visceral fat increases renal pressure and compromises renal perfusion, which promotes activation of the renin-angiotensin-aldosterone system.[21] Furthermore, adipose tissue produces angiotensinogen, which promotes overstimulation of the renin-angiotensin-aldosterone system, which in addition to glomerulomegaly and deregulation of tubular reabsorption, leads to glomerular hypertension and hyperfiltration, and ultimately albuminuria.[12] In addition to the direct impact of obesity on the kidneys, obesity is a known risk factor for hypertension and type 2 diabetes, which are important risk factors for chronic kidney disease, known as diabetic nephropathy and hypertensive arteriolar nephrosclerosis.[22,23]

MANAGING MORBID OBESITY: THE ROLE OF BARIATRIC SURGERY

In addition to bariatric surgery, drug therapy has proven to be a promising treatment option for obese patients who have not responded to lifestyle interventions. Although GLP-1 and GLP-1/GIP agonists have demonstrated benefits in terms of weight loss and cardiovascular and renal protection, the evidence in patients with CKD remains limited, with most studies involving patients with type 2 diabetes mellitus.[24-26] Semaglutide has been shown to have protective effects on cardiovascular and renal health in patients with stage 2 to 4 chronic kidney disease and established heart disease. However, gastrointestinal side effects may limit its use, particularly in advanced chronic kidney disease, as they can be confused with symptoms associated with the progression of the disease.[27] Furthermore, the effectiveness of these drugs depends on their continued use associated with lifestyle changes, and weight regain is common once treatment is stopped.[28,29] Thus, bariatric surgery continues to be considered the most effective long-term procedure for the treatment of morbid obesity.[30] However, bariatric surgery should only be considered if non-surgical measures, namely nutritional monitoring, fail to achieve or maintain weight loss.[31] When a patient is referred for bariatric surgery, they can undergo several procedures, namely sleeve gastrectomy or gastric bypass. Sleeve gastrectomy consists of removing approximately 80% of the stomach, reducing gastric capacity and removing a large part of the organ responsible for producing ghrelin. This procedure reduces the feeling of hunger and increases satiety, controlling energy intake. Gastric bypass involves dividing the stomach into a small upper portion and a larger portion that is bypassed so as not to allocate food. In addition, the intestine is also separated into two parts, one of which connects to the smaller portion, allowing food to pass through, and the initial intestinal part communicates with the larger portion of the stomach. Thus, this procedure reduces gastric capacity, reduces absorption by making it impossible for food to contact the first portion of the intestine, reduces hunger and increases satiety, but can also increase the risk of malnutrition.[32]

BARIATRIC SURGERY IN PRE-DIALYSIS PHASE

In chronic kidney patients with obesity, given that obesity and its comorbidities contribute to loss of kidney function and subsequent end-stage kidney disease, it is necessary to promote weight loss as a preventive measure. Bariatric surgery has rarely been used in chronic kidney patients, as there are questions about the long-term safety of this procedure given the high nutritional risk.[33] In chronic kidney patients, bariatric surgery reduces intra-abdominal pressure, improves renal artery pressure, reduces inflammation markers, increases renal perfusion, improves glomerular filtration rate and plasma creatinine, normalises the activity of the renin-angiotensin-aldosterone system, reduces proteinuria and albuminuria, improves glomerular hyperfiltration, delays the decline in renal function and

the incidence of end-stage kidney disease.[34-40] However, bariatric surgery also has adverse effects, from nutritional deficits to metabolic complications, namely loss of muscle and bone mass, with a consequent increase in the risk of fractures and osteoporosis.[40-42] There is a low rate of complications in chronic kidney patients after sleeve gastrectomy and gastric bypass, still there is an increase in oxaluria, especially after gastric bypass, increasing the risk of nephrolithiasis.[37,40,43,44] In more advanced stages of chronic kidney disease, there is a greater tendency for post-gastric bypass complications.[38,40]

BARIATRIC SURGERY IN DIALYSIS PHASE

The impact of obesity in the dialysis phase is somewhat controversial, sometimes identified as protective, especially in hemodialysis, and sometimes as harmful.

In patients on hemodialysis, a higher body mass index (BMI) and higher serum creatinine, which is used as a predictor of muscle mass in patients with minimal or no residual kidney function, are associated with longer survival. Thus, weight loss and lower serum creatinine are associated with higher mortality.[45-47] Unlike visceral adipose tissue, subcutaneous adipose tissue is not consistently associated with adverse effects, as it can be protective in hypercatabolic situations and can be used as an energy source.[48-50] In peritoneal dialysis, overweight and obesity are associated with longer survival[51,52] and weight gain in the first year of dialysis is associated with improved survival.[53,54] On the other hand, obesity in peritoneal dialysis has been associated with a faster loss of residual kidney function, systemic inflammation, a higher risk of mortality, a higher risk of complications from the technique, infections at the catheter insertion site and a higher risk of ineffective treatment.[51,52,55,56] Despite the lack of consistent evidence, it is known that one of the criteria for access to the kidney transplant list is BMI. However, as there is no evidence to specifically determine what BMI threshold should be considered, this criterion varies depending on the hospital and has tended to increase in order to accommodate a greater number of patients given the rise in the prevalence of obesity.[57,58] Bariatric surgery has been associated with an increased likelihood of receiving a kidney transplant, immediate allograft function and improved allograft survival.[45,59-64] However, this surgical procedure at this stage is associated with a higher risk of mortality, post-surgical complications, longer surgeries and longer hospital stays.[33,59,60,62,65-67]

BARIATRIC SURGERY IN RENAL TRANSPLANTATION

Kidney transplantation is the replacement treatment for kidney function that offers the chronic kidney patient a better quality of life and longer survival. However, it has been observed that post-transplant there is a tendency for significant weight gain, especially in the first year, and consequently an increase in the prevalence of obesity.[68-71] Obesity in transplant recipients is associated with a lower survival benefit for the recipient, a higher risk of allograft failure, higher mortality from various causes, both due to allograft failure and heart disease, and an increased risk of heart failure and chronic allograft nephropathy due to hyperfiltration.[68,72-76] Bariatric surgery in the post-transplant phase has aroused some scepticism. This therapeutic option is associated with improvement or remission of associated comorbidities, improved glomerular filtration rate and lower serum creatinine, reduced risk of allograft failure, reduced mortality and improved allograft and patient survival.[60,77-80] However, there is an increased risk of complications, such as kidney damage and cardiovascular events, hospital readmissions, changes in the pharmacokinetics of immunosuppressants, a greater risk of surgical site infection, allograft failure and increased surgery and hospitalization time.[60,68,77-85]

NUTRITIONAL CONSIDERATIONS: BARIATRIC SURGERY

1. Energy needs

The recommended energy intake after bariatric surgery should be 400 kcal/day in the first week and progress to 800 kcal/day by three to four weeks, after which an energy intake of 1200 to 1500 kcal/day should be maintained.[86]

2. Protein needs

After bariatric surgery is recommended a minimal protein intake of 60 g/day and up to 1.5 g/kg IBW/day. However, higher amounts of protein intake, up to 2.1 g/kg IBW/day, should be considered in some situations.[86]

3. Phosphorus

In patients undergoing bariatric surgery, hypophosphatemia is common due to vitamin D deficiency. Patients with mild to moderate hypophosphatemia (1.5 to 2.5 mg/dL) should be supplemented with oral phosphate.[86]

4. Calcium and vitamin D

Patients undergoing sleeve gastrectomy and gastric bypass should be supplemented with 1200 to 1500 mg/day of calcium and at least 2000 to 3000 IU/day of vitamin D_3. However, in patients with vitamin D deficiency or insufficiency should be administrated up to 6000 IU/day of vitamin D_3. For biliopancreatic diversion with duodenal switch, a contribution of 1800 to 2400 mg/day of calcium, diet and supplements, is recommended.[86]

5. Iron

After bariatric surgery, patients should take elemental and multivitamin supplements. Therefore, these patients should be guaranteed an intake of 45-60 mg of iron through multivitamins and additional supplements.[86]

For patients with anemia, oral supplementation should be increased to provide 150-200 mg/day or up to 300 mg/2-3 times daily. Vitamin C supplementation may be taken to increase iron absorption.[86]

6. Folic acid and vitamin B12

For patients undergoing bariatric surgery, to prevent folic acid deficiency, it is recommended 400-800 µg/day of folate provided from multivitamin and 800-1000 µg/day in women of childbearing age. In patients with folic acid deficiency, it is recommended an oral dose of 1000 µg/day of folate.[86] Doses of vitamin B12 supplementation, to prevent deficiency, vary based on route of administration. It is recommended a dose of 350-1000 µg/day for oral administration or 1000 µg/month for the parenteral route. In patients with vitamin B12 deficiency should be take 1000 µg/day of vitamin B12.[86]

NUTRITIONAL CONSIDERATIONS: CHRONIC KIDNEY PATIENTS

Simultaneously with the progression of chronic kidney disease, nutritional needs also change significantly and put patients at high nutritional risk, which is why careful nutritional monitoring is essential.[87]

1. Energy needs

In stage 1 to 5 chronic kidney disease and post-kidney transplant, assuming that the patient is metabolically stable, an energy intake of between 25 and 35 kcal/kg ideal body weight (IBW))/day is recommended. However, energy needs should be estimated individually, considering the stage of chronic kidney disease, body composition, target weight and maintenance of the patient's nutritional status.[87]

2. Protein needs

About protein intake, a monitored protein restriction is recommended for patients with stage 3 to 5 chronic kidney disease who are metabolically stable to delay the progression of chronic kidney disease, and there is not enough evidence to support the recommendation of any specific type of protein (animal or vegetable). Thus, non-diabetic patients should eat between 0.55 and 0.6 g of protein/kg IBW/day or between 0.28 and 0.43 g of protein/kg IBW/day and, in addition, 0.55 to 0.6 g of ketoacids or amino acid analogues/kg IBW/day. Diabetic patients with stage 3 to 5 chronic kidney disease should eat between 0.6 and 0.8 g of protein/kg IBW/day to maintain good nutritional status and better glycemic control. Finally, the protein intake needed to maintain an adequate nutritional status in patients with stage 5 kidney disease on hemodialysis or peritoneal dialysis, metabolically stable, should be between 1.0 and 1.2 g/kg IBW/day.[87]

3. Phosphorus

In chronic kidney patients with stage 3 to 5 and undergoing dialysis, a dietary intake of phosphorus adjusted to plasma phosphorus levels is recommended. For transplant patients with hypophosphatemia, the prescription of a high-phosphorus diet may be considered.[87]

4. Calcium and vitamin D

The recommended daily intake of calcium varies depending on vitamin D supplementation, since vitamin D enhances calcium absorption. Therefore, the daily intake of calcium should be between 800 and 1000 mg/day, ensuring that plasma levels are monitored to avoid hypercalcemia.[87]Vitamin D deficiency is prevalent in stage 3 and 5 chronic kidney patients due to reduced sun exposure, urinary or dialysate losses of vitamin D-binding protein, dietary restrictions and impaired tubular reabsorption of 25 (OH). Vitamin D supplementation should therefore be prescribed for chronic kidney and transplant patients with deficient plasma levels and should also be considered for chronic kidney patients with nephrotic proteinuria.[87]

5. Potassium

In chronic kidney patients with stage 3 to 5 undergoing dialysis or post-transplant, it is recommended to maintain a dietary potassium intake that could maintain serum potassium within normal ranges.[87]

6. Folic acid and vitamin B12

Folic acid deficits in chronic kidney patients can occur frequently, as folate is mainly obtained through the consumption of green leafy vegetables and fruit. Green leafy vegetables and fruit are the foods most often monitored in chronic kidney disease due to their potassium content. Supplementation with folic acid, vitamin B12 and/or B vitamins is recommended for chronic kidney disease and transplant patients only if they are deficient in these micronutrients.[87]

NUTRITIONAL CONSIDERATIONS: BARIATRIC SURGERY IN CHRONIC KIDNEY PATIENTS

When it is not possible to achieve significant and sustained weight loss in a chronic kidney patient with obesity through adherence to a suitable lifestyle, bariatric surgery should be a therapeutic option for patients with a BMI ≥ 40 kg/m^2 or with a BMI ≥ 35 kg/m^2 and at least one associated comorbidity.[31] The sleeve gastrectomy has been identified as the most suitable procedure for chronic kidney and transplant patients, as it is a restrictive procedure and is associated with a lower risk of complications, as well as less interference with the pharmacokinetics of immunosuppression.[57,82] In view of the growing use of bariatric surgery, there are doubts about the appropriateness of using the current nutritional guidelines[86] for all patients, particularly chronic kidney and transplant patients.

1. Pre-Bariatric Surgery

In the pre-bariatric surgery phase, nutrition consultation, a psychosocial assessment, body composition, the patient's history of weight gain, dietary intake and the patient's knowledge of the surgical technique should be carried out, and dietary recommendations and guidelines for bariatric surgery should be discussed.[88,89] In chronic kidney patients, body composition should be assessed using dual-energy X-ray absorptiometry (DEXA). However, this method is not routinely used in clinical practice, and bioimpedance can be used instead, complying with the requirements defined by KIDOQI.[87] The assessment of food intake should be done by taking a history of the previous 24 hours or food records from three to seven days.[88,89] At this stage, a hypocaloric diet should be prescribed to reduce hepatomegaly and promote weight loss, and nutritional deficits should be screened, with patients at high risk of nutritional deficiencies starting supplementation before bariatric surgery and considering maintaining it afterwards.[88-90] Majorowicz RR *et al* propose a pre-sleeve gastrectomy energy intake of 800 to 1200 kcal/day and a sodium intake <2300 mg/day. Potassium and phosphorus requirements should be calculated individually according to serum values. Protein requirements vary according to the stage of chronic kidney disease and underlying comorbidities. In patients who are not on dialysis, protein requirements are 0.6 g/IBW or adjusted body weight (ABW)/day in non-diabetics and between 0.6 and 0.8 g/kg IBW or ABW/day in diabetics, and patients on dialysis should ingest between 1 and 1.2 g/kg IBW or ABW/day. Patients who are not on dialysis should drink at least 2 to 3 L of water/day, considering their hydration status, and patients on dialysis up to 1 L of fluids/day, according to residual kidney function.[90]

2. Post-Bariatric Surgery

2.1. Energy needs

In patients with chronic kidney disease, Potrykus M *et al* recommend a higher energy intake of 1200 to 1800 kcal/day, especially during the dialysis phase.[88] However, Majorowicz RR *et al* recommend an intake of 800 to 1200 kcal/day.[90]

2.2. Protein needs

Potrykus M *et al* and Ben-Porat T *et al* promote a slightly higher protein intake in chronic kidney patients, around 0.8 to 1 g/kg IBW/day, ≥1.2 g/kg IBW/day in patients on dialysis and ≥1.1 g/kg IBW/day in transplant recipients.[88,89] Majorowicz RR *et al* recommend a protein intake of 60-80 g/day or 1.1 to 1.5 g/kg IBW or ABW/day in chronic kidney patients in the immediate postoperative period, and 0.6 to 0.8 g/kg IBW or ABW/day in the long term. Patients on dialysis in the immediate post-operative period should eat ≥80 g of protein/day or 1.1 to 1.5 g of protein/kg IBW or ABW/day, and in the long term it should remain between 1.0 and 1.2 g/kg IBW or ABW/day.[90]

2.3. Liquid intake

Potrykus M *et al* advocate fluid restriction in advanced chronic kidney disease to prevent overhydration and oedema, limiting intake to 0.75 L/day, and promoting increased fluid intake in stage 1 to 4 chronic kidney patients.[88] Majorowicz RR *et al* state that patients who are not on dialysis should ensure an intake of ≥ 2 L of water, which may require intravenous administration of fluids to prevent dehydration, and patients on dialysis should limit their intake to 1 L/day, according to residual kidney function.[90] Ben-Porat T *et al* mention that due to water and sodium retention in advanced chronic kidney disease, daily fluid intake should be 0.5 to 1 L according to residual kidney function, avoiding an interdialytic weight gain of >4.5%. Stage 1 to 3 chronic kidney disease and transplant recipients should be encouraged to consume fluids in order to optimise hydration status.[89]

2.4. Phosphorus

Ben-Porat T *et al* recommend a phosphorus intake of <800 mg/day in patients with moderate to advanced chronic kidney disease, and this recommendation should be individualised according to the risk of protein energy wasting. In transplant recipients, phosphorus needs should be individualised, as hypophosphatemia is more common.[89] Potrykus M *et al* recommend a phosphorus restriction between 800 and 1000 mg/day and warn of the need to adjust the intervention to the analytical values.[88]

2.5. Calcium and vitamin D

Chronic kidney patients have a high risk of fracture, especially in the more advanced stages of the disease and while on hemodialysis. Besides that, bariatric surgery increases the risk of osteoporosis and fractures due to rapid weight loss, altered intestinal absorption and reduced food intake. Therefore, in chronic kidney patients undergoing bariatric surgery, vitamin D and calcium supplementation should be considered to preserve bone mass.[91,92] In chronic kidney patients in moderate to advanced stages, Ben-Porat T *et al* and Potrykus M *et al* recommend an intake between 800 and 1000 mg of calcium/day and recommend that adequate serum concentrations of 25-hydroxyvitamin D are achieved, carefully monitoring serum levels of calcium and phosphorus.[88,89] Ben-Porat T *et al* emphasise the need to pay particular attention to transplant recipients due to immunosuppression.[89]

2.6. Potassium

Hyperkalemia can occur in chronic kidney disease due to impaired renal function and after bariatric surgery as a consequence of constipation. On the other hand, in patients with recurrent episodes of vomiting or diarrhea or who use diuretics or dialysates with a low potassium concentration, hypokalemia can occur.[93-95] Ben-Porat T *et al* and Potrykus M *et al* warn of the need to adjust potassium

intake to serum values.[88,89] In addition, Ben-Porat T *et al* specify that daily potassium intake should be <3000 mg, and should be more limited in patients with advanced chronic kidney disease, and in transplant recipients potassium intake should be adjusted to renal function and the effects of calcineurin inhibitors.[89]

2.7. Iron

Bariatric surgery predisposes to iron deficits due to decreased iron absorption due to reduced hydrochloric acid secretion, low dietary iron intake, use of antacids and decreased absorption surface. In chronic kidney patients after bariatric surgery, iron deficits accelerate the onset of anemia due to reduced erythropoiesis and in transplant recipients the risk of anemia may be higher due to impaired allograft function and the use of immunosuppressants.[96-98] Ben-Porat T *et al* suggest oral iron supplementation to achieve a transferrin saturation >20% and a serum ferritin >100 ng/mL in patients who are not on dialysis and >200 ng/mL in patients on dialysis, where intravenous supplementation may be necessary.[89] Potrykus M *et al* suggest daily supplementation with ≥200 mg of oral iron, after meals rich in fibre, and 250 mg of vitamin C/day to maximise iron absorption.[88]

2.8. Folic acid and vitamin B12

Bariatric surgery increases the risk of folic acid deficiency due to a decrease in its absorption, either due to an increase in intestinal pH or the bypass of food from the duodenum, where its absorption occurs to a greater extent. In chronic kidney patients, this risk is also associated with dietary restriction of the main sources of folate.[99,100] Potrykus M *et al* recommend an intake of around 400 µg/day and, in the event of a deficit, 1 mg/day.[88] Ben-Porat T *et al* suggest supplementation of 1 mg/day in patients on hemodialysis.[89]After bariatric surgery, vitamin B12 deficiency is also common due to insufficient food intake and inadequate absorption due to a reduction in the number of intrinsic factor-producing cells and an increase in gastric pH.[101] Potrykus M *et al* indicate that, in the event of a deficit, oral supplementation of 350 to 500 µg/day, or 1 mg of vitamin B12 per month intravenously or 3 mg every 3 months or 500 µg by tube should be given.[88] Majorowicz RR *et al* recommend intravenous supplementation of 1 mg of vitamin B12 per month.[90]

Given all the specificities associated with chronic kidney disease and the high nutritional risk of these patients, it is recommended that after bariatric surgery, follow-up is more frequent in the first month and then monthly until pharmacotherapy stabilises and nutritional status is adjusted. In the post-bariatric surgery phase, given the progressive change in the texture and consistency of the diet, regular nutrition consultations are necessary to monitor diet tolerance. Thus, if this monitoring reveals that any food or texture is causing adverse effects at the gastrointestinal level, the progression should be interrupted, and the last tolerated level should be returned to for at least one week.[89]

DISCUSSION

Obesity contributes to the development of various chronic diseases, including type 2 diabetes, hypertension and chronic kidney disease. In chronic kidney patients, obesity can accelerate the progression of the disease and lead to exclusion from the kidney transplant list, and in transplant recipients it can affect the function of the allograft, and the same comorbidities may occur. Investing in obesity prevention should therefore be the first line of action. In chronic kidney and transplant patients with obesity, encouraging weight loss through lifestyle changes is fundamental, promoting the acquisition of appropriate eating habits and daily physical activity. However, weight loss during the dialysis phase has been associated by some authors with an increase in mortality, but it is important to emphasise that these studies did not provide information on the reason for the weight loss, since this increase may only be associated with involuntary and inadequately monitored weight loss. Although no studies were found evaluating the impact of intentional weight loss in patients on dialysis, but studies carried out in pre-dialysis phase and transplant recipients showed that involuntary weight loss was associated with a higher risk of mortality and allograft failure, unlike voluntary weight loss.[102,103] In patients who consistently fail to lose weight through a conventional approach, other treatments should be considered in order to give the patient a better quality of life and longer survival. Several authors have pointed to bariatric surgery as safe and effective in chronic kidney patients. However, some of the results mentioned should be interpreted with caution. Bariatric surgery has been associated with a decrease in serum creatinine and, consequently, an improvement in glomerular filtration rate. However, serum creatinine is also influenced by muscle mass and when there is rapid weight loss, as there is with bariatric surgery, there is a loss of muscle mass and consequently a reduction in serum creatinine. Therefore, it may not be associated with improved kidney function. Although bariatric surgery seems to be a plausible treatment for chronic kidney patients with obesity, the use of BMI as an eligibility criterion should be critically considered, as it has several limitations, since it does not differentiate between percentage lean mass and fat mass, distinguish between visceral fat and subcutaneous fat and its use in certain kidney pathologies is inadequate, particularly in autosomal dominant polycystic kidney disease.[87] In addition to BMI, confirmation of excess body fat should be considered, as is currently recommended for the diagnosis of obesity. In chronic kidney disease, dual-energy X-ray absorptiometry (DXA) is still regarded as the gold standard for assessing body composition. However, it

is an invasive and expensive method, and its results can be influenced by hydration status. Multifrequency bioimpedance may be a more accessible tool for assessing body composition in hemodialysis patients. In addition to methods for directly assessing body fat, measurements that provide information on the distribution of body fat, such as waist circumference, may also be considered.[87] Resorting to bariatric surgery as a solution to unsuccessful weight loss by conventional means is controversial, since if the patient undergoing bariatric surgery fails to acquire adequate eating habits, the lost weight will be regained, which could then culminate in obesity again. Weight regain in patients who have undergone bariatric surgery is relatively common.[104-106]

CONCLUSION

The treatment of obesity usually involves a stepwise approach, beginning with lifestyle interventions, include personalized nutritional guidance and increased physical activity. If conventional interventions prove unsuccessful, pharmacological treatment and/or bariatric surgery may be considered. Bariatric surgery is still considered the most effective long-term treatment option. For chronic kidney and transplant patients who are unsuccessful in losing weight through other approaches, bariatric surgery could be considered. Sleeve gastrectomy has been shown to be the most suitable surgical procedure for these patients, as it is a purely restrictive procedure and is associated with a lower risk of complications, particularly nutritional ones, as well as less interference with the pharmacokinetics of immunosuppressive therapy. However, there is a need to carry out randomized clinical trials that corroborate the findings of observational studies regarding the safety of bariatric surgery in chronic kidney disease and post-kidney transplantation, and to develop guidelines that allow for adequate nutritional monitoring of chronic kidney and transplant patients undergoing bariatric surgery. It is important to emphasize that, regardless of the therapeutic approach chosen, whether pharmacological or surgical, lifestyle changes must be implemented to ensure the long-term success of obesity treatment.

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