Review Article
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Nutritional care for the remission of Type 2 diabetes in adults undergoing metabolic surgery: a narrative review and propose of educational tool

Abstract

Chronic non-communicable diseases (NCDs) are the principal cause of death in the world. In Mexico, type 2 diabetes (T2D) is the leading cause of death. An increase of 5kg/m2 in the body mass index (BMI) significantly increased the mortality by T2D. Metabolic surgery is an alternative treatment for people who are living with obesity and T2D. Metabolic surgical procedures induce anatomo-physiological changes, which improves glycemic control, decreases the risk of mortality due to T2D, promotes weight loss, and body fat, and in some cases, have the potential for the remission of T2D. These surgeries impact nutritional status in the short, medium and long term, therefore, a nutritionist should evaluate and implement nutrition interventions in these individuals. There are no guidelines for nutrition to promote and maintain remission of T2D in individuals with these types of surgeries. The objective of this review is to summarize current scientific evidence to guide the clinical practice in this context. The therapeutic goals include, besides promoting weight loss, monitor waist circumference and body composition, evaluation of glycemic control with regulation of hypoglycemic drugs, and avoiding nutritional deficiencies. For adequate results it is recommended to incorporate behavioral strategies and nutritional education focused on healthy and sustainable eating patterns. Adequate nutritional monitoring favors a better prognosis in the fulfillment of therapeutic objectives of both diseases after metabolic surgery.

Keywords: bariatric surgery, nutritional assessment, nutrition intervention, diabetes mellitus type 2, obesity

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Introduction

Chronic noncommunicable diseases (NCDs) represent the leading cause of mortality in the world,[1] 80% of them are present in people living with obesity [Body Mass Index (BMI) ≥30 kg / m^2].[2] Of adults worldwide, 11% of men and 15% of women live with obesity, the prevalence in Mexican adults is 32.4% (second in the world).[3] Obesity increases all-cause mortality by 30% and mortality from type 2 diabetes (T2D) by 120%,[4] every 5 kg/m^2 increase in BMI significantly increases mortality from T2D.[5] About 422 million adults in the world live with this health problem. In Mexico, 9.4% of adults live with T2D and this is the leading cause of death in the country.[3,6] Metabolic surgery has proven to be an alternative treatment for people living with obesity and T2D.[7] Remission of T2D has been reported in 48% to 95% of patients with this surgery, decreasing the risk of mortality from T2D at 92%, with treatment savings of 1.2 to 31.8 million dollars at 10 years.[8,9] However, these surgeries carry significant risks such as surgical reinterventions, hypoglycemia or nutritional deficiencies.[10]

Obesity and diabetes share pathophysiological mechanisms where there is a chronic low-grade inflammatory state.[11,12] Adipose tissue is an endocrine organ that participates in communication between the brain and the intestine and is capable of signaling pro-inflammatory factors (leptin, adiponectin, interleukin 6, C-reactive protein and tumor necrosis factor).[2,7] When the visceral adipose tissue increases in size, it tends to infiltrate the liver and pancreas, inducing oxidative stress and lipotoxicity, favoring resistance to insulin, promoting endogenous glucose production and apoptosis of pancreatic β cells.[13] It is estimated that 50% of pancreatic β cells have died by the time the diagnosis of T2D is made.[14] The main hypotheses of metabolic surgery on glycemic control focus on two types of action:

I. Immediate post-surgical period: due to the anatomo-physiological changes that lead to the distribution of the content of the diet to the distal portion of the intestine, which increases the production of incretins and postprandial insulin, reducing hepatic glucose production, increasing hepatic synthesis of fatty acids and promoting improvements in lipid control.

II. Late post-surgical period: due to the loss of weight and body fat that decrease systemic inflammation and promotes a better immune response in the large intestine, improving sensitivity to the action of insulin and the production of the first phase of insulin.[15]

After the diagnosis of obesity and T2D, it is recommended to start a treatment based on lifestyle changes (diet and physical activity) for a minimum period of 6 months. When therapeutic goals are not achieved, pharmacological treatment is recommended and those individuals who are potential candidates for metabolic surgery can be evaluated.[16] Bariatric surgery with metabolic impact is classified as: restrictive (gastric sleeve), malabsortive (bilio-pancreatic bypass) or mixed component (Roux Y gastric bypass and gastric Mini-bypass); All of them promote long-term weight loss and maintenance, as well

as better glycemic control, the evidence reports that the effect is greater when they have a malabsortive component.[17]

Although not all subjects achieve remission of T2D, it has been reported that glycemic control is significantly better with these surgeries, for these facts they were called metabolic or bariatric metabolic surgery.[17] Metabolic surgery is recommended as an option to treat T2D in patients with; Class III obesity (BMI>40 kg/m^2), regardless of the level of glycemic control or the complexity of hypoglycemic treatment (Grade U); Obesity class II (BMI 35.0–39.9 kg/m^2), with controlled hyperglycemia or no lifestyle and optimal medical therapy. (Grade A). It should be considered as an option in patients with T2D and class I obesity (BMI 30.0–34.9 kg/m^2) with inadequately controlled hyperglycemia despite optimal medical treatment with oral or injectable medications (including insulin).[16] Currently there are validated predictive scales to assess the likelihood of remission (DiaRem, DRS and ABCD), in these it is considered that the effect of surgery is greater at a younger age, shorter time living with T2D and higher BMI.[18]

Changes induced by metabolic surgeries impact nutritional status in the short, medium and long term,[19] nutritional deficiencies may exist before the surgical procedure due to the poor dietary quality of these individuals, systemic inflammation and sequestration of adipose tissue, and they are exacerbated in 50% of cases in the first year after the surgery.[20,21] In addition, dietary intolerances after surgery alter: dietary preferences, nutrient intake, digestion and absorption.[22] These changes highlight the need for evaluation and monitoring of nutritional equipment in these individuals.[23–27]

Nutritional care

The American Society of Bariatric and Metabolic Surgery identifies the role of the nutritionist as an essential component in the care of individuals undergoing metabolic surgery.[9] Nutritional counseling is associated with less weight gain to two years.[28] The nutritional care of these people includes: nutritional assessment, nutritional diagnosis, nutritional intervention and monitoring.[29]

Nutritional assessment

The nutritional assessment includes the anthropometric, biochemical, clinical, dietary and lifestyle evaluation;[25] The analysis of anthropometric indicators [real weight, ideal theoretical weight (ITW), waist circumference, BMI, percentage of weight loss exceeded (% PWLE), body composition and bone mineral density] is important beacause represents indicators of post surgical - success in weight loss and allow the monitoring of intra-individual changes to maintain it. (26, 27) In this population it is recommended to calculate the ITW based on a BMI of 25 kg/m^2, that is: ITW = [(height in centimeters)^2 x 25 And it is used for the construction of the% PWLE indicator and for the calculation of the requirements of protein; the %PWLE defines the success of the surgery, in relation to weight loss, when the individual achieves and maintains a loss $\geq$ 50% PPE in the 18 to 24 months after surgery, and it is calculated: % PWLE= (100 X (Initial weight - Current weight)) / (Initial weight - ITW)].[27,28] Biochemical data is of the utmost importance, the American Academy of Diabetes in 2009 defined as: "Partial remission" to achieve and maintain HbA1c <6.5% and "Complete remission" to achieve and maintain HbA1c <6.0%. These figures should be maintained without diabetes medication for at least 1 year.[29] The metabolic changes that these surgeries induce favor positive effects such as lipid and glycemic control,[8] however, the rapid turnover and mobilization of reserves that occur in the post-surgical period highlight the need for intra-individual surveillance, because exacerbate nutritional deficiencies and increase some risks, so it is recommended to be alert for: nitrogen balance, liver dysfunction, oxaluria and steatorrhea, hypoglycemia (fasting blood glucose <55 mg / dl) and hematocrit elevation (> 3% at 30 minutes of an oral glucose tolerance test) to confirm Dumping syndrome, parathyroid hormone (PTH), calcium, ionized calcium and vitamin D due to the risk of secondary hypoparathyroidism and confirm the clinical deficiency of micronutrients.[30,31] Nutritional deficiencies before surgery get worse after surgery, the bariatric surgery guidelines recommend monitoring them by biochemical data and physical examination in all patients after the operation, mainly iron, B12, folate, calcium and vitamin D.[21,32] Table 1 summarizes the laboratory tests to detect nutritional deficiencies, as well as the recommended supplementation to prevent and treat them. Clinical data is another important component of the nutritional assessment, and includes the physical examination and the clinical-nutritional history. It seeks to detect nutritional problems associated with surgery, signs and symptoms of nutrient deficiencies, as well as conditions that compromise the fulfillment of dietary goals. Hydration (urine color, fatigue, orostatic hypotension and urinary density) should be monitored,[33] signs associated with Dumping syndrome such as: postprandial palpitation, blood pressure, heart and respiratory rate, temperature, dizziness and weakness,[31] Drug-nutritional interactions (mainly statins and metformin), gastrointestinal signs and symptoms that may compromise dietary intake, and physical examination focused on nutritional deficiencies.[21,34] With regard to physical examination, each individual should be kept under close surveillance, hair loss is frequently observed in the second half after surgery, however, if it persists after the first year, it is recommended monitor deficiencies of iron, essential fatty acids, zinc and protein. It is also important to inquire about the family planning method to prevent pregnancy the first 12 to 18 months after the post-surgery period.[27]

Metabolic surgery not only compromises dietary intake, but also the absorption and utilization of macro and micro-nutrients.[24] The changes induced in these interventions have an impact on the assimilation of nutrients (especially proteins, iron, calcium, vitamin B12, lipids and fat-soluble vitamins) because they limit the production of hydrochloric acid and intrinsic factor, reduce the intestinal absorption surface and the contact time with pancreatic enzymes and bile salts, so that the risk of anemia, fracture and loss of functionality are increased; therefore it is very important to monitor the tolerance, frequency and variety in the consumption of sources of micronutrients (whole grains, vegetables and fruits), protein (lean meats, lactose and skim milk), unhealthy sources of energy (sugary drinks, use of sweeteners and sweeteners) and alcoholic beverages (due to their effect on the reoccurrence of micronutrient absorption).[35]

The evaluation of dietary data should include the estimation of energy and protein consumption, sources and quality, foods rich in micronutrients with risk of deficiency, appetite, preferences, tolerances and dietary allergies, beliefs and attitudes, and meal times, this information can be collected by 24-hour reminder, food diary or usual diet.[36,37] The latest data to be collected are related to lifestyle, it is considered necessary to know the socioeconomic level of the individual and his motivation, to issue accessible and attainable dietary recommendations, thus favoring attachment,[37] in addition to assessing alcohol consumption emphasizing in the highest risk groups (men, youth and sedentary people)[38] and the level of physical activity for the achievement and maintenance of therapeutic objectives.[39]

Table 1 Biochemical Confirmation of Nutrition Deficiencies and Supplementation Post Metabolic Surgery

Nutriment	Confirmation of deficiencies		Supplementation to prevent deficiencies		Supplementation to treat deficiencies	
	Test	Value altered	Dose	Evidence	Dosis	Evidence
Tiamine	Plasma B1 Blood B1 TDP Transketolase ETA	14 to 15 nmol/l* 2.5 to 7.5 µg/dl <70 nmol/l <120 nmol/l >25 %	Minimum 12 mg/day Preferably 50 mg in a MV	C 3 D 4	It depends on the route and severity: Orally: 100 mg, 2 to 3 times a day IV: for 3 to 5 days 200 mg, 3 times a day or 500 mg, 1 to 2/d, the subsequent 3 to 5 days or until symptoms resolve 250 mg/d and maintain oral supplementation of 100 mg/d orally. IM: 250 mg/d, 3 to 5 days or 100 to 250 mg/month	D 4 ◊ C 3
Cobalamine	Serum B12 MMA Htcy	Insufficiency <400 pg/ml, Deficiency <200 pg/ml >0.376 mmol/l >13.2 mmol/l	It depends on the route: Orally, sublingual or liquid: 300 to 500 µg/day Parenteral, IM or subcutaneous: 1 000 µd/month	B 2	1 000 µg/day to reach normal values and resume previous doses	B 2 ◊◊
Folic acid	Folate**	Deficiency <305 nmol/l, Anemia <227 nmol/l	400 to 800 µg/day in an MVI Women of childbearing age: 800 to 1 000 µg/day	B 2	1 000 µg/day to reach normal values and resume previous doses	B 2
Vitamin A	Plasma retinol	< 10 µg/dL	It depends on the type of surgery: BPB: 500 IU/day RYGB and SG: 5,000 to 10,000 IU/day DS: 10,000 IU/day	C 3 B 2	It depends on changes in the cornea: Without changes: 10,000 to 25,000 IU/day per orally for 1 to 2 weeks With changes: 3 days 50,000 to 100,000 IU/day IM and continue 2 weeks with 50,000 IU/day	D 4 ◊◊◊
Vitamin E	Plasma Alpha-tocopherol	<5 µg/ml	15 mg/day in MV	D 4	100 to 400 IU/day (additional dose to MV is required to achieve)	Not defined
Vitamin K	Prothrombin time	It is not a sensitive measure, the normal range 10 to 30 seconds	It depends on the type of surgery: LAGB, BPGYR and GS: 90 to 120 µg/day DS: 300 µg /day	C 3 B 2	It depends on the degree of malabsorption: Acute: a dose of 10 mg parenterally Chronic: 1 to 2 mg/day orally or 1 to 2 mg/week parenterally.	D 4
Vitamin D	25 (OH) D PTH	Insufficiency from 20 to 30, Deficieny <20 ng/ml >65 pg/ml	3000 IU/day to reach 30 ng/ml of 25 (OH) D	D 4▪	D3: 2 000 a 6 000 IU/d D2: 50 000 IU, 3 times at week	A 1
Calcium	Serum calcium PTH	Normal: 9 to 10.5 mg/dl >65 pg/ml***	It depends on the type of surgery: BPD and DS: 1 800-2 400 mg/day LAGB, SG and BPGYR: 1 200-1 500 mg/day			C 3▪ ▪

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Table Continued...

Nutriment	Confirmation of deficiencies		Supplementation to prevent deficiencies		Supplementation to treat deficiencies	
	Test	Value altered	Dose	Evidence	Dosis	Evidence
Copper	Serum/Plasma Cu Ceruloplasmin	<10 mmol/l <75 µg/l	It depends on the type of surgery: BPD, DS and BPGYR: 2 mg/day SG and LAGB: 1 mg/day	C 3▪ ▪ ▪	It depends on the level of deficiency: Wear to moderate: 3 to 8 mg/day of gluconate or Cu sulfate orally until normal recovery. Severe: 2 to 4 mg/day IV for 6 days or until recovery of serum and symptomatic normality.	C 3 ◊◊◊◊
Iron	Iron Transferrin Transferrin saturation Ferritin TIBC	<50 µg/dl <200 µg/dl <20 % <20 µg/dl**** >450 µg/dl	Men: 18 mg/day in MV Women: 45 to 60 mg/day	C 3 C 3▪ ▪ ▪	150 to 200 mg/day of elemental iron orally If it does not remit, infuse IV	C 3
Zinc	Plasma zinc	< 70 µg/dl in women, < 74 µg/dl in men	It depends on the type of surgery: BPD and DS: 16 to 22 mg/day in MV BPGYR: 8 to 22 mg/day in MV SG and LAGB: 8-11 mg/day in MV	C 3	60 mg/day (Choose carefully to avoid copper deficiency)	Not defined

ETA, Erythrocyte transketolase activity; MMA, Methyl Malonic Acid; Htcy, serum homocysteine; TCRB, Total count in red blood cells; MV, multivitamin; IU, international units; IV, intravenous; IM, intramuscular;* Thiamine in plasma has low sensitivity and specificity, it is measured in blood considering that erythrocytes contain They contain 80 to 90% of the total B1 in the body** Test normal values of MMA and Htcy.*** Confirm with changes in baseline DEXA.**** Ferritin fluctuates with inflammation, age and infection. ▪ In divided doses and with food.▪ ▪ Guide supplementation according to serum values. ▪ ▪ ▪ Monitor in radius 1: 15 to 18 mg (Cu: Zn). ▪ ▪ ▪ ▪ In 2 doses, separated from antacids and supplements of Ca. ◊ Until symptoms resolve, administer simultaneously with Mg, K and P in patients at risk of feedback syndrome (C3). ◊◊ Do not overcome due to risk of masking B12 deficiency. ◊◊◊ Monitor Cu and Fe deficiencies as it compromise their resolution. ◊◊◊◊ When reaching Cu levels, control must be maintained 3 to 6 months.

Source: Parrott J. American Society for Metabolic and Bariatric Surgery Integrated Health Nutritional Guidelines for the Surgical Weight Loss Patient 2016 Update: Micronutrients. Surg Obes Relat. Dis. 2017.

Nutritional diagnosis

The analysis of the information collected represents a link between evaluation and nutritional intervention, in this way it is possible to identify and prioritize nutritional diagnoses, that is, nutritional problems detected as well as their causes and their evidence, to address their resolution.[25]

Intervention

The nutritional intervention focuses on solving the problems detected and aims to: promote and preserve post-surgical weight loss, preserve lean mass, minimize reflux and early satiety, ensure an adequate supply of macro and micronutrients, avoid nutritional deficiencies, prevent and treat complications, and promote a healthy eating pattern for adequate glycemic and metabolic control in the short and long term.[24] The energy restriction prevents weight gain and its application is recommended to achieve post-surgical objectives.[40] The adult RDI is the basis for estimating macronutrient requirements among patients undergoing surgery these people.[40] It has been estimated that the requirement of micronutrients in the post-metabolic surgery population is 200% of the RDI. In the months after metabolic surgery, hypocaloric consumption should progress gradually, it is recommended that patients undergoing metabolic surgery cover a micronutrient supplementation, supplementation is not associated with weight gain (Table 1).[41]

A hypocaloric and hyperproteic diet is recommended, considering the changes in satiety that are observed in post-surgical temporality, the increase in caloric intake should be gradual: during the first 3 months of surgery, energy consumption should not exceed 800 kcal and from the 6th month until the 12th, it should not exceed 1000 to 1200 kcal.[42] The dietary progression allows for satisfying the needs of the nutrients, to adapt the texture and to promote the dietary tolerance.[34] The diet by stages after the metabolic surgery aims to satisfy the needs of essential nutrients and to adapt the texture of the foods to promote the tolerance, help with weight loss and continue changing eating habits, such dietary progression extends from 6 to 8 months, depending on individual tolerance, so monitoring dietary tolerance is of paramount importance.[33]

To prevent weight gain, the distribution of macronutrients should have a higher proportion of protein (1.2 to 2.1 g/kg of ITW / day and minimum 60g/day),[40] followed by carbohydrates (100g/d decrease nitrogen loss by 40%) and finally to a lesser extent, lipids (minimum 20g/day).[38] Table 2 points out the energy and macronutrient recommendations according to the timing after metabolic surgery. Focusing the diet of individuals undergoing metabolic surgery on a healthy eating pattern not only favors dietary progression, but also the achievement and maintenance of therapeutic objectives.[35] The progression in fiber consumption should be based on the monitoring of its individual tolerance, it is observed that this is greater from the sixth post-surgical month, however, to favor the consumption of healthy sources of carbohydrates the first year after surgery (mainly whole grains such as corn, amaranth, oats, brown rice among others), it is necessary to include milk and yogurt from the second week, variety of fruits in the first month, and gradually monitor and progress to the consumption of whole grains and legumes from the second semester, considering that those foods that are not well tolerated should Suspend and retest tolerance every 3 to 4 weeks.[33,41] Strategies to promote dietary tolerance are they should be based on promoting adequate chewing, avoiding short times to eat and separating the consumption of liquids from meals.[33]

Anticipating the limitation of absorption of micronutrients, supplementation is the strategy to guarantee the adequate contribution of them, oral requirements vary according to the type of intervention, being mixed surgeries those that represent the greatest risk of deficiencies that, therefore, must be covered and watch for life.[35] Supplementation with complex B intramuscularly every 6 months is recommended, prophylactically supplement with ferrous sulfate, be alert for adjustments in calcium and vitamin D since 80% of its absorption is compromised[42] in these cases, if it occurs steatorrhea, both fat-soluble vitamins and the coexistence of oxaluria should be monitored for the risk of calcium oxalate formation at the renal level (Table 1). [35,43–45] The patient should be directed to the proposal of realistic weight goals.[46]There are strategies that promote the preservation of lean mass, favor the prevention and resolution of gastrointestinal symptoms, signs of deficiencies and management of complications.[34] In Table 3 Dietary strategies for the management of gastrointestinal symptoms and to ensure dietary consumption are described. Consumption of at least 1.5 liters of water per day should be promoted, slowly and spacedly from meals, to ensure hydration and minimize gastrointestinal symptoms, fluids should be consumed 30 minutes before and after eating.[27]

Exercise has been associated with greater weight loss the first year after the operation,[46] with the preservation of lean mass[48] and weight maintenance,[37] a minimum of 150 minutes of moderate activity is recommended per week, progressing to tolerance of 300 minutes per week of moderate physical activity that includes resistance exercises 2 to 3 times per week.[37,47,48] The change in eating behavior is essential for the achievement and maintenance of the patient's goals after metabolic surgery. Statistically significant differences have been observed by including behavioral strategies in the nutritional treatment of these patients, reducing anxiety and stress, and promoting greater self-esteem and success in weight loss.[49] There are several theories and models that have proven to favor behavior change and can be applied by the nutrition professional, exercising its effectiveness through the application of behavioral strategies.[37,50] Table 4 presents the description of the behavioral strategies to promote behavior change.

To meet the objectives of the nutritional intervention, the causes of nutritional problems must be resolved, focusing on patient needs. It is recommended to educate the patient responding to their needs to increase satisfaction and the level of attachment, with emphasis on dietary sources of iron and supplementation schemes of this element.[51] According to the endocrinology society guidelines, the education of these patients should focus on preventing nutritional deficiencies of protein and micronutrients, and rescue strategies to promote dietary tolerance.[52] Figure 1 describes the approach to a healthy eating pattern as an educational tool for achievement and support of the goals of weight and glycemic control in these individuals. The patient must be educated to be able to relate changes in laboratory values, signs and symptoms with respect to dietary choice, adherence to the supplementation scheme, the social support system, stress management and body image.[34]

Table 2 Energy and macronutrient recommendations after metabolic surgery

Stage	Energy	Protein	Carbohydrates	Lipids
Early post surgical (0 to 3 months)	773 to 849 kcal/day with liquid diet that progress to soft	80-120 g/day or 1.05-1.5 g/kg of theoretical weight/day	Not less than 100 g/day	Do not exceed 25-30% of the total energy value per day
Late post surgical (3 months to 1 year)	1 035-1 364 kcal/day. Do not exceed: 1,500 kcal/day in men and 1,200 kcal/day in women	At least 30 g of protein in more than one meal	Cover RDI: 130 g/day	Cover RDI: 20-35 g/day. Saturated fat: less than 10% of total energy value per day
Weight stabilization (1 year or more)	16 kcal/kg current weight/day	35% of the total energy value per day	45% of the total energy value per day	20% of the total energy value per day

Source: Pampilla N. Update of Argentine Nutrition Consensus. Actual en Nutr. 2016; Gargallo Fernández M. Evidence-based nutritional recommendations for the prevention and treatment of overweight and obesity in adults (FESNAD-SEEDO consensus document). The role of diet in obesity prevention. Nutr Hosp 2012.

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Table 3 Food strategies to guarantee dietary consumption and manage symptoms

GUARANTEE MACRONUTRIENT CONSUMPTION		
Hypooglucemia	**Dumping Syndrome**	**Hypereroxalury and Nephropathy by oxalates**
• Promote the consumption of lean animal origin food, rich in protein • Include lean protein sources • Promote the consumption of low-fat dairy • Use dietary supplements (whey or egg white) • Guarantee the consumption of leucine (egg white and casein)	• Promote the consumption of low-fat foods • Avoid eating fried foods and saturated fats • Promote the consumption of healthy fats rich in omega 3	• Limit the consumption of industrialized foods with high amounts of added sugar, sugary drinks, juices and alcohol

MANAGEMENT OF GENERAL AND GASTROINTESTINAL SYMPTOMS	
Hair loss	☐ ensure protein intake ☐ compliance with the supplementation scheme ☐ additional supplementation with biotin and/or zinc (dose higher than rdi)
Dizziness and headache	☐ adequate hydration ☐ hypocaloric fluids with electrolytes
Muscle cramp	☐ supplementation scheme coverage ☐ ensure dietary potassium intake ☐ maintain active lifestyle ☐ adequate hydration
Dysphagia	☐ eat small bites ☐ chew slowly ☐ practice conscious feeding ☐ walk after eating
Sickness	☐ fraction meal times ☐ avoid large portions ☐ separate water consumption from meals ☐ avoid added sugars and lactose ☐ supplement dose of 100 mg/day of thiamine ☐ if it is due to infection, favor compliance with the antibiotic scheme
Threw up	☐ chew slowly ☐ practice conscious feeding ☐ prefer wet foods ☐ separate water consumption from meals ☐ supplement dose of 100 mg/day of thiamine ☐ if it is due to infection, favor compliance with the antibiotic scheme
Reflux	☐ delaying caffeine consumption in at least the 1st year after surgery ☐ divide diet in 5 to 6 meal times ☐ separate liquid consumption from meals 1 hour ☐ avoid lying down 1 hour after eating
Abdominal distension	☐ avoid drinking liquids during the meal ☐ avoid consumption of: lactose, sugary drinks, added sugars and alcohol ☐ maintain active lifestyle
Diarrhea	☐ eat slowly, chew well ☐ identify dietary intolerances ☐ avoid consumption of: lactose, sugary drinks, added sugars, alcohol and spicy foods ☐ use probiotics lactobacillus plantarum and gg ☐ restart liquid diet 1 to 2 days and monitor
Constipation	☐ sufficient fluid consumption (1.5 to 2 liters of water per day) ☐ ensure consumption of at least 15 g/day of fiber ☐ if you consume iron orally, administer a minimum dose of the supplement

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Table Continued...

GUARANTEE MACRONUTRIENT CONSUMPTION			
Hypooglucemia	**Dumping Syndrome**		**Hypereroxalury and Nephropathy by oxalates**
• frequent consumption of clear liquids	• ensure intake of carbohydrate RDI • split diet in 5 to 6 times	• split the diet into 5 to 6 meal times • space water consumption 30 minutes to 2 hours between meals • do not avoid fruits • avoid added sugars, sugary drinks and lactose • avoid hypertonic foods and drinks (> 25 g of sugar per serving)	• guarantee hydration • ensure compliance with oral calcium supplementation • oral potassium citrate • low fat diet • avoid oxalic acid (vegetables, pepper, amaranth, chocolate, oilseeds and legumes) • oxalobacter formigenes probiotics

Table 4 Behavior strategies to promote change of conduct

Behavior strategy	Description
Selfmonitoring	Conduct records of thoughts, emotions, dietary behaviors, exercise and medical measurements, such a record is used to solve problems and achieve goals.
Replacement of structured meals and plans	Control in dietary intake in response to the modification of habits, controlling barriers and portions by replacing specific replacement by type and portion, thus reducing the time to design and prepare meals, exposure to overfeeding or insufficient feeding and avoiding measuring the size of certain food portions
Reward strategies	Systematic process to encourage a specific change that facilitates the definition of goals by specifying financial incentives for acquired skills or weight loss.
Establishment of personal goals	When the patient is ready for the change, they must be involved in deciding and establishing, among the offer that the provider provides about different courses of action, in which to invest energy to achieve the fulfillment of goals, which must be realistic, measurable and in the short term. This process includes defining tools for success and documentation of progress, to monitor opportunities for change, solve problems and celebrate achievements.
Problem resolution	The process is carried out with the collaboration of the patient, to identify barriers and their solution through brainstorming of ideas and balance of pros and cons of potential solutions, their implementation. Evaluate the effectiveness and the need to adjust strategies.
Social Support	Its intention is to include the environment to maintain the changes by developing skills to build and use collaborative networks of emotional support (family, friends, colleagues, health staff).
Stress Management	Planning for the future and using skills to manage time and allow the management of environmental stress through techniques such as relaxation exercises and positive self-talk.
Stimulus Control	Social or environmental modification of signals that trigger or encourage unwanted lifestyle behaviors, reinforcing and rewarding the successful modification of environmental triggers.
Minduleating	Promotion of stress management to control disorderly eating, limit "emotional hunger", favor self-regulation. It favors the rupture of the vicious circle where the author reproaches leads to the diminution of self-efficacy, limits adherence and contributes to the maintenance of stressors such as limited loss and weight gain. It is based on avoiding value judgments, compassion, acceptance and the development of coping skills by recognizing the body context and the surrounding environment, using active meditation (awareness of eating of walking, and emotional and physiological responses), in order to reduce health and promote the control of eating behavior, promote self-efficacy and encourage adherence to changes in lifestyle.

Source: Spahn JM, et al. State of the evidence regarding behavior change theories and strategies in nutrition counseling to facilitate health and food behavior change. J Am Diet Assoc. 2010. Stegen S, Derave W, Calders P, Van Laethem C, Pattyn P. Physical fitness in morbidly obese patients: Effect of gastric bypass surgery and exercise training. Obes Surg. 2011;21(1):61

Monitoring

Finally, the monitoring of the nutritional problems detected is carried out by monitoring the data that support the nutritional diagnosis. Clinical nutritional follow-up in the first 6 months predicts the success of the surgery at two years.[38] This follow-up consists of an initial visit and subsequent visits at constant intervals (every 1 to 3 months) during the first year after surgery.[46] At the beginning of the nutritional attention, the height and the ITP must be known, in each session the waist and neck circumference, the BMI and the percentages of initial and exceeded weight loss, every 3 to 6 months the body composition and the density annually bone mineral.[34] Each month it is advisable to evaluate liver function, glucose, creatinine and electrolytes, every 3 months evaluate the lipid profile, renal function, thyroid profile, glycated hemoglobin, iron kinetics, vitamins (A, B9, B12 and D), calcium and PTH.[24] However, laboratory values should be monitored monthly if deficiencies occur.[21,34] Each session should be

monitored: vital signs, signs and symptoms of nutritional deficiencies and complications (despite supplementation), assistance to visits with the interdisciplinary team, medication scheme and it is suggested to monitor physical functionality.[34,53] The monitoring of dietary data should be performed in each session, monitoring: quality and quantity of dietary intake, sources of the nutrients described above, adherence to the scheme of supplementation and consumption of water and other types of beverages (with sugar or alcohol).[34]

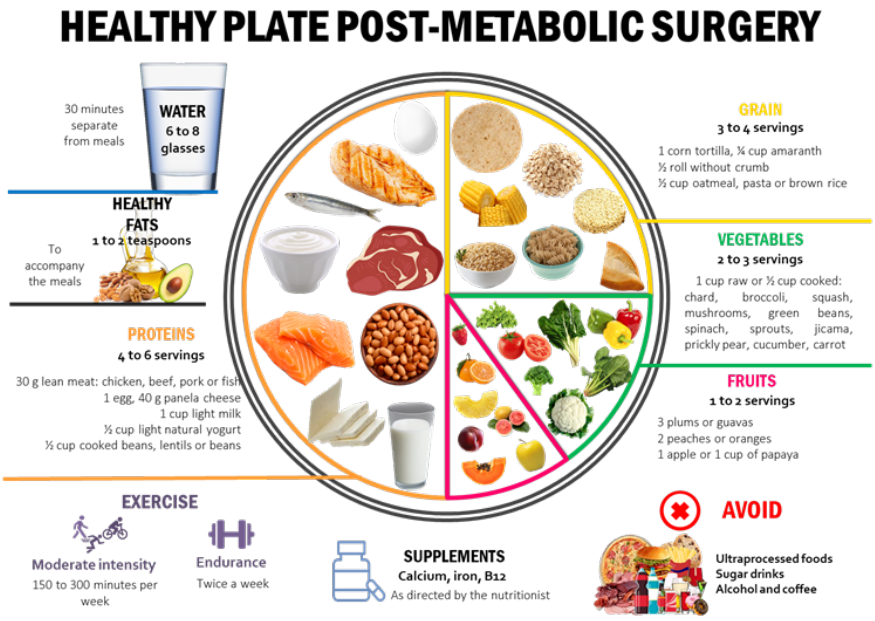

Figure 1 healthy plate post metabolic surgery.
Source: Moizé V, Deulofeu R, Torres F, De Osaba JM, Vidal J. Nutritional intake and prevalence of nutritional deficiencies prior to surgery in a spanish morbidly obese population. Obes Surg. 2011;21(9):1382–8. Ortega J, Ortega-Evangelio G, Cassinello N, Sebastia V. What are obese patients able to eat after Roux-en-Y gastric bypass? Obes Facts. 2012;5(3):339–48. Jastrzębska-Mierzyńska M, Ostrowska L, Wasiluk D, Konarzewska-Duchnowska E. Dietetic recommendations after bariatric procedures in the light of the new guidelines regarding metabolic and bariatric surgery. Rocz Państwowego Zakładu Hig [Internet]. 2015;66(1):13–9. Dispinible en: http://www.ncbi.nlm.nih.gov/pubmed/25813068. Miller GD, Norris A, Fernandez A. Changes in Nutrients and Food Groups Intake Following Laparoscopic Roux-en-Y Gastric Bypass (RYGB). Obes Surg. 2014;24(11):1926–1932.

Through self-monitoring of lifestyle changes (diet records, goal fulfillment), treatment effectiveness is maximized.[54] Monitoring of dietary and exercise habits should be performed at each visit.[54] Barriers should be monitored each session.[54] It is recommended to monitor the motivation and self-efficacy to initiate and maintain a regular active lifestyle.[55] The attachment of a moderate to intense active lifestyle is related to better quality of life, and in Positive reinforcement is necessary to focus on the improvement of physical functionality, quality of life, and the capacity and quality of your daily activities.[56]

Discussion and conclusions

There is currently no guide to nutritional treatment to promote and maintain remission of T2D with these surgical interventions, but current evidence allows us to observe important aspects in the objectives of these individuals. In the context of the anthropometric evaluation, the success of the surgery, in terms of weight loss, is based on the achievement of anthropometric goals, specifically these goals are based on achieving that after the first year the BMI is <35 kg/m^2 and that more than 50% of the exceeded weight is lost, however, the glycemic control evaluation encompasses other components that have been associated not only with lower weight reganance, but with better T2D remission rate; a waist circumference <100 cm (regardless of sex) protects by 40% against recurrence of T2D and maintaining the goal of weight loss percentage exceeded by 18 months increases the remission rate of T2D by 50%.[27,33,57]

In addition, rapid weight loss is another important aspect that considers, changes in body composition are relevant; the 130% increase in the risk of osteoporosis is observed, weight loss may be associated with dehydration and it has been documented that the reduction of 50% of total body fat and 60% of visceral fat mass in the first year after surgery correlates with glycemic control (in research still underway, it has been observed that individuals with the lowest percentage of fat in the first year after surgery are the ones who better remit T2D), in addition, when 75% or more of the total weight loss corresponds to A fat mass prevents a reganance, so monitoring bone mineral density and body composition are aspects to be considered closely for remission of T2D and fracture prevention.[48,58]

Although the exploration of nutritional deficiencies is recommended in all patients, it is important to consider that individuals who resort to this therapeutic alternative for the control of their comorbidities have undergone pharmacological treatments for metabolic control and that, the chronicity of their use can be related to an exacerbation of micronutrient deficiencies, so monitoring and correction of them should start before surgery and be maintained after the intervention, not only because of the health risk but because they can represent an obstacle in achieving the dietary objectives due to the symptoms they generate as weakness and changes in the perception of taste.[21,59] Micronutrient deficiencies usually manifest from the first trimester of the post-surgical period, however, 8% of patients undergoing

these surgeries are never supplemented and only one third of the total cover their supplementation schemes 10 years later.[44] Possibly gastrointestinal symptomatology is related to this context because oral supplements can aggravate it, compromising both adherence to the schemes and dietary intake, therefore, it is necessary to recognize the relevance of the evaluation and monitoring of these symptoms in relationship with the supplementation scheme adjustments, preferring its consumption after meals or at night.[60]

Gastrointestinal symptoms are a niche of opportunity in the evaluation and nutritional care, monitoring the association of their existence with dietary choices can direct their resolution.[34] The therapeutic guidelines recommend avoiding alcohol consumption, both because of the role it plays in limit nutrient absorption as per gastrointestinal symptoms, data from the Swiss obesity cohort have associated that surgery can increase alcohol abuse, monitoring it in relation to stress management is another invitation.[61] Although insufficient energy consumption promotes a rapid initial weight loss, the rapid loss of lean mass, the increase in adiposity and the lower thermogenic effect of the food that this attitude promotes, they represent risk factors for weight loss. and hyperglycemia.[61]

It has been observed that these individuals tend to have lower tolerance of red meat, fish, dairy and whole grains, considering that sufficient protein consumption is related to greater weight loss and maintenance, it is important to monitor the consumption of dietary sources of macro and micronutrients, as well as adherence to supplementation.[62] Considering that vitamin D deficiency is usually observed among people who cross with obesity and T2D, in addition to the fact that after mixed-type interventions only 28% of fats are absorbed and that a decrease of 5 to 10% of the Bone mineral density at 2 years after surgery, fat-soluble vitamins and bone metabolism should be closely monitored in these patients.[20,43,63,64]

Most of the reduction in energy intake in these people responds to the reduction in the consumption of foods with added sugar and saturated fats.[52] Dumping Syndrome is associated with the selection of type, quantity, quality and consistency of ingestion of carbohydrates, it has been observed that the presence of symptoms leads these individuals to limit their selection, subsequently this deprivation promotes episodes of inappropriate choice and overfeeding, exacerbating them.[63] To avoid postprandial hypoglycemia secondary to hyperinsulinemia, it is it is necessary to avoid the consumption of added sugar.[59] Fat consumption should be monitored since excessive consumption delays gastric emptying and promotes gastroesophageal reflux, however, the consumption of healthy sources of fat that promote a correct metabolic profile should be promoted.[59] Finally, it is also important to inquire into the number of meals that are made outside the home, as they are associated with exposure to an obesogenic environment.[41]

The final goal is not only the loss of weight among these patients, it is necessary to consider the prevention of reinterventions and deficiencies that can increase the risk of morbidity and mortality, among these dietary components the protein is of great relevance, from 30 to 50% of These people do not adequately tolerate the consumption of red meat until the sixth month, together the rapid loss of weight compromises the decrease in muscle and bone mass, being related not only to weight loss but to a worse prognosis.[34,65]

At the same time, in order to achieve the therapeutic objectives, the nutritionist's role includes the evaluation of motivation, empathy and adequate body language, to create an adequate relationship with the patient and favor the adherence to the recommendations.[55] One of the first objectives therapeutic is to favor dietary progression, it has been observed that the use of hunger-satiety scales is adequate in this aspect.[66]

Patients with a sedentary lifestyle often refer to body pain, shame, poor motivation and limited resources, therefore, strategies focused on changing this behavior should address the resolution of these barriers.[39] Metabolic surgery promotes the maintenance of weight loss, glycemic control and comorbidities. These surgeries favor a better prognosis in achieving therapeutic goals. Patients should keep a constant monitoring of the nutrition team for the prevention and treatment of nutritional deficiencies. The application of lifestyle and feeding strategies in these patients benefits the achievement and maintenance of therapeutic objectives.

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Conflict of interests

We declare that we have no conflict of interest, economic, personal, political, financial or academic interest, nor have we received any economic benefit that could influence the wording of this article.

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