Metabolic Surgery for the Treatment of Diabetes Mellitus Positioning of Leading Medical Associations in Mexico

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Abstract

Introduction Metabolic surgery (MS) can be a useful therapeutic strategy in patients with type 2 diabetes (DM2) and obesity.

Objective To define the place of MS within DM2 treatment in Mexico.

Methods A committee of experts consisting of internists and surgeons representing the leading Mexican associations involved in the field was created. Each one responded to a specific question regarding mechanisms involved in controlling DM2, surgical

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procedures, and the indications and contraindications for MS. This document was prepared based on the presentation and discussion of such answers.

Results Obesity through insulin resistance, incretins, bile salts, and intestinal microbiota plays a determining role in the appearance of DM2. MS improves glucose homeostasis by reducing weight and intake, increasing incretins, and modifying bile salts and microbiota. MS leads to remission of DM2 and reduces cardiovascular risk factors in well-selected cases. We recommend MS as a therapeutic option in DM2 and grade III obesity regardless of metabolic control and grade II and grade I obesity with poor glycemic control. MS could be considered an option in grade II obesity with good metabolic control in the presence of associated comorbidities. Gastric bypass presents the most favorable risk-benefit profile.

Conclusions Current evidence endorses the inclusion of MS in the algorithm for treatment of DM2 and obesity. The therapeutic approach must be multidisciplinary at experienced centers.

Keywords Metabolic surgery · Diabetes mellitus · Obesity

Introduction

In people with morbid obesity, the results of bariatric surgery (BS) in the loss of weight and the control of comorbid phenomena have led to explore the extension of the surgical indication for metabolically ill patients and a lower degree of obesity. BS indicated with the intent of improving metabolic alterations has been called metabolic surgery (MS) [1].

Concerning DM2, clinical trials [1] have demonstrated the superiority of the surgery over the medical treatment in the normalization of glycemia and HbA1c. The gastrointestinal tract plays a vital role in glucose homeostasis and in anatomical changes that occur as a result of the impact of surgery on mechanisms responsible for such homeostasis [2–4]. In June 2016, the results of the “Second Diabetes Surgery Summit” (DSS-II) were published, in which surgery is included within the treatment algorithm of DM2 [1]. The ADA has officially adopted these DSS guidelines in their 2017 Standards of Care document.

To define the place of MS within the treatment of DM2 patients in our country, the first National Expert Meeting was held within the framework of the XVIII International Congress of the CMCOEM, with the collaboration of three leading associations in Mexico: the SMNE, the CMIM, and the CMCOEM.

Materials and Methods

A group of experts to form an ad-hoc committee consisting of 24 participants of the abovementioned associations was selected (12 internists or endocrinologists and 12 surgeons). Each member of the panel answered a specific question regarding mechanisms involved in the control of DM2, surgical procedures, and indications and contraindications of MS. The proof to support the answers was rated whenever possible pursuant to the “GRADE” system [5], which is a system of rating quality of evidence and grading strength of recommendations in systematic reviews, health technology assessments, and clinical practice guidelines addressing alternative management options. The

GRADE process begins with asking an exact question, including the specification of all relevant outcomes. After the evidence was collected and explicit criteria for rating the quality of evidence was implemented, the authors prepared a document to be analyzed, discussed, and consented by the panel. All participants convened in a meeting where answers were presented and discussed until consensus from all members was obtained. This document was prepared based on the responses consented by the expert panel. Table 1 contains the questions addressed. Six additional Mexican associations that are shown in Table 2 endorsed the work.

Results

Answers Presented and Discussed by the Panel of Experts Are as Follows

How Are Type 2 Diabetes Mellitus, Prediabetes, and Metabolic Syndrome Defined?

Type 2 diabetes mellitus (DM2) is a chronic, progressive, and multifactorial illness, with alterations of the intermediate metabolism (carbohydrates, fats, and proteins), associated to relative or absolute insulin deficiency and with variable degrees of resistance to it. The common denominator is characterized by hyperglycemia. Diagnostic criteria according to the American Diabetes Association (ADA) [6] are shown in Table 3.

Prediabetes comprises individuals with intermediate categories between normal glycemia and DM2 [6], with an increased risk of developing diabetes and its macro- and microvascular complications. Diagnostic parameters are shown in Table 3.

Metabolic syndrome (MS) defines a group of cardiovascular and diabetes factors of metabolic origin. Abdominal obesity and resistance to insulin are considered the pathophysiological basis. In Table 3, the diagnostic criteria proposed by the International Diabetes Federation (IDF), the American

Table 1 Questions to be answered by the panel of experts

How are type 2 diabetes Mellitus, prediabetes, and metabolic syndrome defined?
How is diabetes remission defined?
What is the effect of obesity in the natural history of DM2?
What is the enteroinsular axis and how does it participate in the control of DM2?
What is the role of calorie restriction in the control of DM2?
What is the role of insulin resistance in the control of DM2?
What is the role of other factors (bile salts and microbiota) in the control of DM2?
What are the complications of the strict control of DM2 and how often do they occur?
What is the impact of the early treatment of DM2 in the appearance of complications?
How is metabolic surgery defined?
What are the complications of metabolic surgery (MS) and how frequently do they occur?
What is the effect of RYGB on the factors involved in the control of DM2?
What is the effect of SG on the factors involved in the control of DM2?
What is the effect of BPD on the factors involved in the control of DM2?
Is there superiority of any surgical procedure for the treatment of patients with DM2?
What is the ideal time to evaluate the results of MS?
What are the results of medical vs surgical treatment in obese patients with DM2?
What are the results of medical vs surgical treatment in DM2 non-obese patients?
What are the results of medical vs surgical treatment in the prevention of late complications and mortality of the obese diabetic?
What are the characteristics of patients with DM2 candidates for MS?
Which patients are not candidates for MS?
Indications for MS that require further analysis

Heart Association, and the National Heart, Lung and Blood Institute (AHA/NHLBI) [7] are shown.

How Is Diabetes Remission Defined?

This panel recommends reporting the results as to the evolution of DM2 according to the definitions proposed by ADA in 2009 [8] and the recommendations of the American Association of Bariatric and Metabolic Surgery [9]. These criteria take into consideration HbA1c level, fasting plasma glucose, the need for pharmacological treatment, and a minimum period of time. The different definitions are shown in Table 4.

What Is the Effect of Obesity in DM2 Natural History?

Obesity, mainly characterized by visceral adiposity, is linked to patients genetically predisposed to the activation of

Table 2 Mexican Medical Associations/Academies that supported the positioning of the CMCOEM, the SMNE, and the CMIM

Academia Mexicana de Cirugía/Mexican Academy of Surgery
Academia Nacional de Medicina/National Academy of Medicine
Asociación Mexicana de Diabetes/Mexican Association of Diabetes
Asociación Mexicana de Cirugía Endoscópica/Mexican Association of Endoscopic Surgery
Asociación Mexicana de Cirugía General/Mexican Association of General Surgery
Federación Mexicana de Diabetes/Mexican Federation of Diabetes

inflammatory and metabolic mechanisms that lead to the appearance of DM2 and cardiovascular illness.

A meta-analysis that included 590,251 individuals examined the relative risk (RR) of developing DM2 in populations with overweight and obesity compared to a population of normal weight [10]. A DM2 RR of 7.19 in individuals with obesity and of 2.99 in individuals with overweight (GRADE high) was evidenced. Another work found that gaining weight at an early age (18–24 years) was associated with a DM2 RR of 3.07 [11] (GRADE moderate).

Current evidence supports the association between obesity, especially visceral, and the appearance of new DM2 cases. The effect of weight loss is essential in DM2 remission.

What Is Enteroinsular Axis and How Does It Participate in the Control of DM2?

The enteroinsular axis is a complex hormone, a neural, and substrate interaction system established between the intestine and the pancreas.

The gastrointestinal tract produces plenty of factors and hormones with multiple functions, among which glucagon-like peptide-1 (GLP-1) has been found [12]. GLP-1 is released to circulation in response to food intake and acts on the islet of Langerhans, increasing the release of insulin in relation to the glycemic level and inhibiting the secretion of glucagon. The higher insulin secretory effect generated by oral glucose intake vs intravenous glucose administration [13] is called “incretin effect.” Although in DM2 the “incretin effect” is greatly diminished or abolished, GLP-1 maintains its capacity to stimulate the β cells. Therapeutic efforts have been aimed at developing GLP-1 receptor agonists or enzyme inhibitors that inactivate it, such as dipeptidyl peptidase 4 or DPP4 [14].

What Is the Role of Caloric Restriction in the Control of DM2?

Caloric restriction is useful in DM2 to improve glycemic control and to reduce the need for oral antidiabetic drugs [15] (GRADE high).

Very low-calorie diets (< 800 kcal/day) may be used in well-selected individuals [16] (GRADE moderate).

Table 3 Diabetes mellitus, prediabetes, and metabolic syndrome diagnosis criteriaDiabetes diagnosis criteria^a

- Plasma 8-h fasting glucose ≥ 126 mg/dl (7 mmol/l), in the absence of intercurrent diseases; or
- Plasma 2-h fasting glucose > 200 mg/dl (11.1 mmol/l) after performing an oral glucose tolerance curve (OGTC) with 75 g of glucose pursuant to the guidelines described by the World Health Organization (WHO); or
- Hemoglobin A1C $\geq 6.5\%$, using a method certified by the National Glycohemoglobin Standardization Program (NGSP); or
- Patients with classic symptoms of hyperglycemia (polyuria, polyphagia, polydipsia, weight loss) or hyperglycemic crisis with random plasma glucose > 200 mg/dl.

Prediabetes diagnosis criteria

- Altered basal glucose (ABG): 8-h fasting glycemia between 100 and 125 mg/dl (5.6–6.9 mmol/l); or
- Glucose intolerance (GI): upon using OGTC according to WHO criteria: 2-h post-glucose load ≥ 140 and < 200 mg/dl (7.8–11.0 mmol/l); or
- Hemoglobin A1C ≥ 5.7 – $\leq 6.4\%$.

Metabolic syndrome diagnosis criteria: 3 or more of the following^b

- Abdominal circumference: ≥ 80 cm in women and ≥ 90 cm in men of Latin origin (cutoff points vary according to populations);
- Triglycerides ≥ 150 mg/dl (1.7 mmol/L);
- Systolic blood pressure ≥ 130 mmHg and diastolic ≥ 85 mmHg;
- Cholesterol HDL < 40 mg/dl (1.0 mmol/L) in men and < 50 mg/dl (1.3 mmol/L) in women;
- Fasting glycemia ≥ 100 mg/dl (5.6 mmol/L).

^a In the absence of unequivocal hyperglycemia, results must be confirmed with a second determination

^b According to the International Diabetes Federation (IDF), the American Heart Association, and the National Heart, Lung and Blood Institute (AHA/NHLBI) [24]

Carbohydrate restriction decreases the high glycemic levels without requiring weight loss and may lead to a reduction or elimination of antidiabetic medications [17] (GRADE moderate).

What Is the Role of Insulin Resistance (IR) in the Control of DM2?

IR is defined as the decrease of insulin hypoglycemic activity. Obesity is a determining factor in the development of IR. In individuals genetically predisposed, IR associated with a failure in the function of β cells will set off the appearance of DM2 [18]. Physical activity, weight loss, improvement in body composition, and some medications decrease IR markedly and are the basis for DM2 treatment. Changes in lifestyle have an impact on the results of the surgical treatment.

What Is the Role of Other Factors (Bile Salts and Microbiota) in the Control of DM2?

Microbiota participates in the regulation of food absorption, insulin signaling and secretion, and the development of inflammation [19].

Changes in the microbiota of individuals with obesity generate a thin layer of mucus, favoring the transportation of endotoxins that originate chronic inflammation and IR [20] (GRADE high). In turn, the microbiota of individuals with obesity may mediate IR through the modulation of GLP-1 secretion [21] (GRADE high). Colonization with microbiota coming from patients with thin phenotype increases insulin sensitivity [22] (GRADE moderate).

Bile acids regulate the energetic metabolism through the activation of TGR-5 receptors and the farnesoid factor. Postprandial excretion decreases in patients with obesity. An increase in the concentration of bile salts after the gastric bypass surgery has been observed. This effect is probably due to greater ileal recapture conditioned by a shorter time to mix with food before passing through the ileum. The increase of bile acids generates an independent incretin effect through the activation of TGR-5, which increases the production of GLP-1. Also, this increase has an important effect on the composition of microbiota [23].

Table 4 Definitions of the evolution of DM2 after a metabolic surgery

Result	Definition
Complete remission	A1C $< 6.0\%$, basal glycemia < 100 mg/dl and absence of pharmacological treatment at least in 1 year of follow-up.
Partial remission	DM2 undiagnosed A1C ($< 6.5\%$), basal glycemia between 100 and 125 mg/dl, and absence of pharmacological treatment at least in 1 year of follow-up.
Prolonged remission	Complete remission that is prolonged during a 5-year minimum period.
Improvement	A significant reduction of A1C ($> 1\%$) or plasma fasting glucose > 25 mg/dl or decrease in A1C or plasma fasting glucose accompanied by a decrease in the requirements of antidiabetic medicines (suspension of insulin or an oral drug or half the required dose) at least of 1-year duration.
Without change	The absence of remission or improvement as described previously.
Relapse	Plasma fasting glucose ≥ 126 mg/dl or A1C $\geq 6.5\%$ or need for antidiabetic medication after complete or partial remission.

Table 5 Patients with DM2 who are candidates for MS

	Grade classification
Class III obesity (BMI ≥ 40 kg/m ²), regardless of glycemic control level or the complexity of the glucose treatment regimens.	High
Class II obesity (BMI 35–39.9 kg/m ²). The indication is particularly relevant if glycemia is poorly controlled or if patients present associated comorbid phenomena that may be benefitted by the procedure	High
Class I obesity (BMI 30–34.9 kg/m ²) with poorly controlled glycemia despite changes in lifestyle and optimal medical therapy.	High

When MS is indicated at an early age (<45 years of age at the time of diagnosis of DM2), it is advisable to measure anti-GAD, IA2, and ICA, due to a more frequent incidence of type 1 DM (GRADE low)

What Are the Complications of the Strict Control of DM2 and how Often Do they Occur?

It has been reported an 80–90% of hypoglycemic events in patients with intensive medical treatment compared to a frequency from 64 and 84% in patients with surgical treatment [24] (GRADE moderate). On the other hand, strict control generates weight gain.

What Is the Impact of the Early Treatment of DM2 in the Appearance of Complications?

Few studies have assessed the effect of early treatment, that is, from the time of DM2 diagnosis to the appearance of complications.

A structured treatment strategy in patients with recent diagnosis reduced hyperglycemia, HbA1c, and systolic blood pressure, but did not affect the incidence of retinopathy, albuminuria, or cardiovascular disease [25] (GRADE moderate).

The United Kingdom Prospective Diabetes Study (UKPDS) designed to assess the effect of an intensified treatment over the appearance of complications demonstrated a significant reduction in the incidence of any end-point of microvascular and microalbuminuria complications [26] (GRADE high).

The intensified medical treatment set-up early reduces the appearance of DM2 complications [27].

How Is Metabolic Surgery Defined?

The three BS procedures that are more frequently used today are sleeve gastrectomy (SG), gastrojejunal bypass either using a Roux-en Y (RYGB) or a single anastomosis (SAGB), and

biliopancreatic diversion (BPD). These interventions are associated with hormonal changes that improve glycemic control before significant weight loss occurs. The term MS applies to the use of these BS procedures with the intent of improving metabolic alterations [28]. We propose reserving the name of BS when the primary objective of the surgical indication is weight loss in patients with or without comorbidities and MS when the main target is to control metabolic diseases such as diabetes. Despite the fact that many of the data that support the concepts herein come from studies in which the indication has been mixed, considering the purpose of this work we will use below the general term MS.

What Are the Complications of MS and how Often Do They Occur?

Although the safety of MS has improved significantly throughout the last two decades, it is not exempt from risks. A meta-analysis evidenced 0.08% mortality within days and 0.31% after 30 days; the incidence of complications was 17%, and reoperation was 7% [29] (GRADE high). Serious adverse events were presented with a range from 0 to 37% in surgical patients vs 0 to 25% in non-surgical groups [30] (GRADE high).

Complications after BS can be divided into two groups: medical and surgical. Among medical complications, cardiopulmonary complications, such as myocardial infarction and pulmonary embolism, although infrequent (<1%), constitute causes of mortality [31].

Most common complications of AGB include slip-page, erosion, persisting vomit, and severe reflux. Stasis in a poorly functioning esophagus due to a tight or over-tight band may produce significant dilation of the

Table 6 Which patients are not MS candidates for MS

	Grade classification
General contraindication for the surgical procedure	High
Lack of commitment with long-term follow-up and with the necessary nutritional supplementation after surgery	High

Table 7 Indications for MS that require further analysis

	Comment
Type 1 diabetes	Surgical indication in these patients should need to be based on a cost-benefit analysis, since patients may still require insulin after surgery
Age < 16 years or > 65 years	Given the scarce evidence of the effects of MS in the extremes of age, it is not broadly recommended at present in these age groups, but it can be certainly offered to selected patients
Positive anti-GAD, IA2, ICA antibodies	This group of patients shares the consideration of patients with Type 1 DM
Disease duration of > 5 years and insulin requirement for > 2 years	These conditions are associated with a decrease in pancreatic reserve that may reduce the remission rate and increase the risk of relapse of the disease. However, a decision can be made based on a risk-benefit or a cost-effective analysis

esophagus (pseudo-achalasia). Slippage and erosion require band removal, vomit reflux, and pseudo-achalasia may respond to band deflation, and failure to resolve symptoms may necessitate removal of the band. For procedures involving mobilization, stapling, suture, or both of the stomach or small bowel, the most common early complications are bleeding and leaks. Bleeding can be extra or intraluminal. Acute bleeding may require endoscopic or surgical intervention whereas delayed intraluminal bleeding may resolve spontaneously. The incidence of leaks varies among hospitals, but currently, it is usually inferior to 1%. Most patients present non-specific signs of sepsis (tachycardia, leukocytosis, fever) within the first 10 postoperative days.

Radiological investigations may be complicated. Surgical versus conservative management of leaks is based on the inflammatory response. Main components of the management include IV fluids, antibiotics, analgesics, drainage, and either enteral or parenteral nutrition. Long-term, potential complications include micronutrient deficiencies, gallstones, dumping syndrome, port site hernias, marginal ulcers, small bowel obstruction, and reflux. Occurrence and intensity vary in the different surgical interventions [32]. The safety profile of BS has a close relation to the procedure and patient characteristics. However, perioperative morbidity and mortality rates of bariatric procedures are comparable to those of other low-risk procedures [33]. Leaks and pulmonary thromboembolism may require intense and prolonged management in ICU and are the leading causes of postoperative mortality.

In general, patients with higher complication risks are male, smokers, older, and with higher BMI and multiple comorbidities [34]. The surgeon's experience and aptitude are essential factors that determine the result of the surgery. Each institution must individualize the decisions regarding its expertise and its complication figures.

What Is the Effect of RYGB on the Factors Involved in DM2 Control?

Restriction and malabsorption have been recognized for many years as the key putative factors to induce weight

loss and diabetes control. Weight loss reduces insulin resistance, and the acute calorie restriction immediately after BS and before patients reach substantial weight loss also improves insulin sensitivity. [35, 36] (GRADE high). However, it has been demonstrated that RYGB has effects beyond weight loss to improve glucose homeostasis [1–4, 36, 37]. RYGB increases the release of early satiety hormones, such as GLP-1, oxyntomodulin, and peptide YY [14] (GRADE moderate) associated to earlier ileal stimulation by food and that produce rapid fullness after small meals. The substantial reductions in lipotoxic and glucotoxic effects and decreased inflammation achieved quickly after RYGB result in a better β cell function. Suggested mechanisms for this phenomenon are gluconeogenesis, and an incretin effect *RYGB* reduces intake of sweet and fatty foods and possibly increases vegetable consumption. There is an increase in bile acid levels with impact on the receptor of the farnesoid factor and the TGR5 (a G-protein-coupled receptor for bile acids), as well as on the intraluminal environment and the gut microbiota [36–39] (GRADE moderate). Changes in the proportion of the gut microbiota related to the dihydroxylation of bile acids may contribute to the reduction of inflammation.

What Is the Effect of SG on the Factors Involved in DM2 Control?

SG has demonstrated remission of DM2 from 50 to 70% of patients, decreasing at 24 months postoperatively. By removing the gastric fundus, ghrelin secretion is reduced, and there is a restrictive factor related to the gastric resection which induces a caloric deficit. The intragastric pressure increases upon ingestion of foods which, in turn, increases the tension of the gastric wall and both gastric emptying and intestinal transit are markedly increased after SG. Metabolic mechanisms involved in DM2 control also relate to changes in the gut hormone profile. There is an increase of GLP-1 and PYY and a decrease in the levels of Leptin [40].

What Is the Effect of BPD on the Factors Involved in DM2 Control?

The improvement of glycemic control is related to changes in intestinal hormones and weight loss with caloric restriction. Although the magnitude of the gastrectomy in BPD is less than in SG as a stand-alone procedure, gastric capacity is reduced, the speed of gastric emptying is higher, and chyme gets directly to the ileum, and it has also been noticed that BPD reduces fat intake [41]. An increase of GLP-1, PYY, ghrelin, and adiponectin is observed in BPD, while leptin and insulin decrease [42, 43]. Due to intestinal dysmotility after surgery, an enrichment of microorganisms and their association with gene expression and mutation in white fat tissue [44, 45] have been observed. These variations may be associated with the altered production of gastrointestinal hormones in charge of the energetic balance.

Is There Superiority of any Surgical Procedure for the Treatment of DM2 Patients?

Current scientific data shows an efficacy gradient among the three surgeries: BPD > RYGB > SG. Regarding the safety of the procedures, we observe an inverse gradient [1].

Studies that compare RYGB with SG show different results with a low evidence level [30, 46]. A study reported DM2 remission in 93% with RYGB vs 47% with SG (although SG was associated with a lower complication rate [47]).

BPD is more effective for the metabolic control and resolution of DM2 than RYGB [30]. The remission at 2 years was 95% with BPD and 75% with RYGB and at 5 years 63% with BPD versus 37% in RYGB [48, 49]. However, the incidence of complications and reoperations was higher in BPD, while the quality of life was better with RYGB.

RYGB is a well-standardized intervention with a more favorable risk-benefit profile in relation to other procedures.

What Is the Ideal Time to Assess the Results of MS Surgery?

Patients who undergo MS require follow-up for life, but there is no standardized approach to define postoperative follow-up [9, 50, 51].

Short-term follow-up is defined when it is less than 3 years after the intervention; medium-term when it is from 3 to 5 years and long-term when it is more than 5 years after the intervention [9].

Although there is significant scientific literature demonstrating the effects of MS at short and medium term, the studies that report results at more than 5 years are still limited [1, 9]. We suggest a period of surveillance of more than 5 years to be able to evaluate the occurrence of prolonged remission.

What Are the Results of Medical Vs Surgical Treatment in DM2 Obese Patients?

Different studies have highlighted the decrease in mortality from 30 to 40% in subjects with morbid obesity in surgical vs conventional medical treatment [52, 53].

A greater MS efficacy in weight loss and reduction of glycemia compared to the best medical interventions and lifestyle [1] (GRADE high) have been demonstrated consistently. Although the antidiabetic benefits of surgery have been declining in prevalence over time, the relative superiority of surgery over medical treatment is maintained at a range of 1 to 5 years.

What Are the Results of Medical Vs Surgical Treatment of DM2 Non-Obese Patients?

Few studies have included patients with BMI < 30 kg/m². In a recent meta-analysis of studies that included 290 patients with DM2 and BMI < 30 kg/m², a significant improvement in HbA1c, fasting glycemia, postprandial glycemia, and HOMA-IR after surgery [54] was observed. Remission was 42%, but the higher complication rate was 6.2%, almost double that reported in patients with higher BMI levels.

Surgery effectiveness is not established in non-obese patients with DM2; their treatment is essentially medical. It is necessary to have more information before being able to recommend this type of surgery in non-obese patients with DM2.

What Are the Results of Medical Vs Surgical Treatment in the Prevention of Late Complications and Mortality of Obese Diabetic Patients?

A recent study compared patients with DM2 and BMI of 45.9 kg/m² in medical treatment and patients with DM with BMI of 49.9 kg/m² treated with GJB. In 10 years, a significant decrease in the development of microvascular complications in patients surgically treated (11.5% vs 46.3%) was observed as well as in macrovascular complications (5% vs 20.3%). 74.5% of patients operated had DM2 partial or complete remission, while none under medical treatment experienced remission of the disease [55].

Prior studies have demonstrated a legacy effect in which the optimization time of metabolic control of DM2 with medical treatment was associated with a decrease of long-term risk of microvascular complications. A recent study evidenced a 29% decrease in the risk of developing microvascular complications among patients surgically treated whose disease went into remission. In those that experienced a relapse after remission, the time they remained in remission was related inversely to the risk of microvascular complications [55]. These results would support a legacy effect for MS. However, for the time being, there are no long-term randomized studies that

compare MS directly to modern pharmacological therapies concerning the complications of DM2.

What Are the Characteristics of DM2 Patients Who Are and Who Are Not Candidates for MS?

BMI ranges will continue to be the primary parameter to select patients that may benefit from MS [1] until we have studies that identify more robust predictors. Characteristics of candidates for MS are presented in Table 5, characteristics of non-candidates are shown in Table 6, and indications still under debate are shown in Table 7.

Some authors have proposed the use of scoring systems to predict the evolution of DM2 after MS, such as the DiaRem system and ABCD scoring. These scores may be useful to offer realistic expectations to patients regarding the results of MS [56–58].

Discussion

Because the surgical treatment of patients with diabetes has undergone extensive debate in recent years, the CMIM, SMNE, and the CMCOEM determined the need to develop an evidence-based positioning to enhance the safe treatment of diabetic patients with different degrees of obesity. These evidence-based guidelines provide a broad-based understanding of the physiology of the disease, the clinical spectrum of diabetes, the mechanisms involved in the different surgical procedures, and the outcomes. Although our recommendations do not represent the only acceptable approach, they serve as a sound template for the effective surgical management of diabetic patients to achieve the best results in the safest and more efficient possible way.

Primary MS surgery has been proven to be effective in weight loss and improvement of diabetes. However, some patients may experience either weight regain or have persistent or relapsing hyperglycemia after initial remission. Revisional MS has been extensively evaluated for weight recidivism, but since the bulk of information for diabetes recurrence is more limited, it was not included in our analysis. However, in order to provide complete information, it may be appropriate to mention a recent review of 30 articles [59], where Yan and colleagues found that 14 to 38% of patients who underwent revisional surgery presented persistent or recurrent diabetes. Conversion to a different procedure induced 20 to 80% additional excess weight loss, and diabetes improvement was documented in 65 to 100% of patients. The highest improvement of diabetes (79%) occurred in patients converted to RYGB or BPD.

In conclusion, MS success will depend to a great extent on patient analysis and selection, as well as a choice of the adequate procedure. MS indication must be the result of a

consensual decision among surgeons, internists, and other health team members. MS must be performed at centers with a high volume of surgical procedures that have experienced staff and the necessary equipment available. Our conclusion concurs with DSS for the criteria for surgical selection and adds a discussion of some conditions where MS requires further analysis. Mexican organizations participating in this work agree to what is now a worldwide standardization on this particular aspect.

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Compliance with Ethical Standards

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Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

Consent Statements Non-applicable.

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