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REVIEW

Therapeutic Options for Recurrence of Weight and Obesity Related Complications After Metabolic and Bariatric Surgery: An IFSO Position Statement

Ashraf Haddad[1] · Michel Suter[2] · Jan Willem Greve[3] · Scott Shikora[4] · Gerhard Prager[5] · Barham Abu Dayyeh[6] · Manoel Galvao[7] · Karen Grothe[6] · Miguel Herrera[8] · Lilian Kow[9] · Carel Le Roux[10] · Mary O'Kane[11] · Chetan Parmar[12] · Luiz Gustavo Quadros[13] · Almino Ramos[14] · Josep Vidal[15] · Ricardo V Cohen[16]

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Abstract

Obesity is a chronic disease that may require multiple interventions and escalation of therapy throughout the years. Until recently, no universal definition existed for recurrent weight gain and insufficient weight loss. Standardization of reporting is key so outcomes can be compared and data can be pooled. The recent IFSO consensus provided standard terminology and definitions that will likely resolve this in the future, and publishers will need to enforce for authors to use these definitions. This current IFSO position statement provides guidance for the management of recurrent weight gain after bariatric surgery.

Keywords Metabolic bariatric surgery · Recurrent weight gain · Suboptimal clinical response gastric bypass · Roux-en-Y gastric bypass · One anastomosis gastric bypass · Revision · Revisional bariatric surgery

Abbreviations

AEs	Adverse events
APC	Argon plasma
APMC-TORe	Argon plasma mucosal coagulation alone
AWL	Alterable weight loss
BMI	Body mass index
BPD-DS or DS	Biliopancreatic diversion with duodenal switch
BPL	Biliopancreatic limb
DRYGB	Distal Roux-en-Y gastric bypass
EBMIL	Excess BMI loss
EBMTs	Endoscopic bariatric and metabolic therapies
ESG	Endoscopic sleeve gastroplasty
EWL	Excess weight loss
ft-TORe	Full-thickness suturing plus argon plasma mucosal coagulation
GERD	Gastroesophageal reflux disease
GLP1-RA	Glucagon-like peptide type 1 receptor agonist
GJ	Gastrojejunal
HTN	Hypertension
IWL	Insufficient weight loss
LAGB	Laparoscopic adjustable gastric band
LSG	Laparoscopic sleeve gastrectomy
MBS	Metabolic and bariatric surgery
NA	Non-available
NW	Nadir weight
OAGB	One anastomosis gastric bypass
OMM	Obesity management medication:
OSA	Obstructive sleep apnea
PWL	Poor weight loss
RBS	Revisional bariatric surgery
RWG	Recurrent weight gain
RYGB	Roux-en-Y gastric bypass
SADI-S	Single anastomosis duodenal-ileal bypass with sleeve gastrectomy
SoCR	Suboptimal clinical response
T2DM	Type 2 diabetes mellitus
TALL	Total alimentary limb length
TORe	Transoral outlet reduction
TWL	Total weight loss
VBG	Vertical banded gastroplasty

Extended author information available on the last page of the article

Introduction

The obesity pandemic has been growing steadily with increasing prevalence (https://www.who.int/news-room/fact-sheets). This has been associated with a parallel growth in metabolic and bariatric surgery (MBS)worldwide. The Obesity Medicine Association defines obesity as a "chronic, relapsing, multi-factorial, neurobehavioral disease," multiple treatments or interventions may be needed in the long term (https://obesitymedicine.org/definition-of-obesity), including reoperations, whether for recurrent weight gain, for suboptimal treatment response, or to fix procedure-related complications [1]. Revisional bariatric surgery (RBS) is complex and technically challenging, with more options than primary procedures. High-quality published data with long-term follow-up are scarce. Treatment must be individualized, and the patient's response is difficult to predict [2]. This narrative review aims to evaluate the currently available evidence on RBS and recommend options in the most common and typical clinical situations.

Methods

An IFSO task force gathered to produce a position statement addressing the topic of RWG and/or SoCR. A final document, revised by all authors, was produced and approved by the IFSO scientific committee, then submitted to IFSO's Executive Board for final approval.

Definitions

A unified nomenclature is essential if reported data is to be consolidated. Over the years, several definitions have been used to describe suboptimal results, such as insufficient weight loss, weight regain, and failure, and various metrics have been utilized, including remission/improvement/recurrence of obesity-related complications. This has led to confusion and difficulties in comparing results between procedures or series with different definitions or metrics. Recently, IFSO organized an international Delphi consensus on definitions and clinical practice guidelines for patients considering metabolic-bariatric surgery [3]. Among others, the following definitions were consensual:

1. Total weight loss (TWL): The percentage of total weight loss compared with preoperative weight is the accepted metric to define weight loss after MBS. This metric is chosen because it is least affected by the importance of baseline weight and remains relatively constant for a given procedure across obesity classes.
2. Revisional procedure: Revision or modification for any procedure that does not encompass conversion to a new procedure with a new mechanism of action or reversal of the anatomy. This includes correction or enhancement of the same procedure, such as revision of the gastric pouch or distalization after gastric bypass.
3. Conversion procedure: Such procedures entail converting one procedure to another with a different mechanism of action.
4. Reversal procedure: This term describes reversing a procedure to the normal anatomy.
5. Adequate weight loss: Optimal clinical response following the TWL criterion $\geq$ 20% and/or improvement of obesity-related complications. This term must be used instead of "success."
6. Suboptimal clinical response (SoCR): This term describes a suboptimal clinical response, meaning a TWL outcome of $<$ 20% or no improvement or worsening of any obesity complications that were part of the indication for surgery. The SoC R must be used instead of "insufficient weight loss" or "weight loss failure." SoCR implies that weight loss was never adequate after the initial procedure.
7. Recurrent weight gain (RWG) means late weight regain after an optimal clinical response. Some RWG occurs and is normal after all procedures.
8. Late clinical deterioration: This term describes a secondary deterioration after an initial period of optimal clinical response. A late clinical deterioration is characterized by RWG $>$ 30% of the initial TWL or recurrence/worsening of obesity-related complication(s) that was(were) significant before surgery.

The above terminology will be used as much as possible throughout the present narrative review and will be the basis for recommendations.

What Has Changed Since 1991?

In 1991, the National Institutes of Health (NIH) held a consensus conference on gastrointestinal surgery for the treatment of obesity [4]. This meeting set the guidelines and selection criteria for gastrointestinal surgery for people with obesity or "obesity surgery." These guidelines remained in place for 30 years. In 2022, the leadership of IFSO and the American Society for Metabolic and Bariatric Surgery (ASMBS) have jointly produced updated guidelines reflecting the vast body of literature and the medical community's better understanding of both the disease of obesity and MBS (https://obesitymedicine.org/definition-of-obesity).

The 2018 IFSO worldwide survey reflected the current changes in procedure trends. SG, RYGB, and the OAGB were the most commonly performed operations, almost exclusively by laparoscopy [1], as opposed to open procedures like VBG, which were recommended in 1991 but are rarely used today. This report also highlighted the introduction of even less invasive endoluminal and endoscopic techniques [1, 4].

In 1994, Wittgrove and Clark performed the first laparoscopic RYGB, a major field advancement [5]. A meta-analysis comparing laparoscopic vs. open MBS reported lower postoperative pulmonary complications in the laparoscopic group, a major concern in the open surgery era [6]. The introduction of laparoscopy also allowed for earlier discharge while maintaining a low (< 5%) 30-day readmission rate [7, 8]. Furthermore, analysis of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) (2005–2013) reported a low 30-day post-discharge complication rate of 3.2%, decreasing over the study period [9]. Robotic surgery is another addition to the bariatric field. A network meta-analysis compared open, laparoscopic, and robotic approaches for RYGB, including 19 studies and 276,732 patients reported lower rates of 30-day overall complications, surgical site infection, pulmonary complications, and mortality in the laparoscopic and robotic groups, demonstrating their superiority and safety compared to the open approach [10].

Another cohort study of adult patients undergoing MBS in England between 2006 and 2012 reported inpatient mortality of ≤ 0.15% for all procedure types [11]. This aligned with the French nationwide cohort study (2007–2012), which reported 0.12% 90-day mortality. On top of that, the study reported that mortality has decreased over the past few years [12]. These reported mortality data are similar to the Scandinavian Obesity Registry data. They reported 0.06% 30-day mortality and 0.19% 1-year mortality over 10 years (2008–2017). Again, mortality rates decreased over the study period [13]. The meta-analysis by Buchwald et al. reported 30-day mortality of 0.1 – 1.1% depending on the procedure type (included studies from 1990 to 2003) [14]. Another meta-analysis of 361 studies reported a total 30-day mortality of 0.28%. Thirty-day mortality rates for open vertical banded gastroplasty, open RYGB, and open biliopancreatic diversion were 0.3%, 0.41%, and 0.76% versus 0.07%, 0.16%, and 1.11%, respectively, for the laparoscopic approach [15].

Definition of Success After MBS

Successful weight loss after surgery may be defined based on the amount and durability of weight loss and control of obesity-related complications. There is, however, some confusion in the literature regarding the definition of SoCR and RWG, as most reports do not differentiate those two conditions [16]. SoCR has no universal definition regarding the metrics used and cutoff values. Using TWL is superior to employing EWL as it is less influenced by preoperative weight [17]. Maximum weight loss is usually reported at 1–2 years postoperatively. RWG may be defined as progressive weight gain after successful weight loss, although some argue that weight regain should only be defined if there is a concomitant recurrence of comorbidities [18, 19].

Definition of SoCR

According to IFSO's accepted nomenclature, SoCR is a condition in which adequate weight loss is not reached at the time of nadir weight or if there is no or inadequate improvement or worsening of any given comorbidity that was a significant indication for surgery. Regarding weight loss, the accepted threshold for SoCR is TWL < 20% at nadir. Other definitions of "insufficient weight loss" that should not be used anymore but are important to know for comparison between series have been utilized in the past. They are summarized in Table 1. Unfortunately, translating these old definitions into the current ones is often impossible.

Table 1 Summary of definitions of insufficient weight loss used in the recent literature <p 15.9 is defined as below percentile 15.9 of the distribution of the achievable weight loss distribution for a particular surgical technique

Metric	Threshold	Time since MBS	Nomenclature
EWL [24–29]	<50%	12-, 18-, 24- months; at nadir weight	IWL, PWL, InWL
TWL [17, 24, 28, 29]	<20%	12 months, at nadir weight, over time	Suboptimal WL, IWL
TWL [19]	<25%	Nadir weight	NA
%AWL [17, 24]	<p 15.9	12 months, at nadir weight, over time	IWL

MBS Metabolic bariatric surgery, *EWL* excess weight loss, *TWL* total body weight loss, *AWL* Alterable weight loss, *NA* non-available, *IWL* insufficient weight loss, *PWL* poor weight loss, *InWL* inadequate weight loss

Definition of RWG

Normally, after nadir weight has been achieved, some RWG occurs with all treatment options for obesity, including MBS. The rate of RWG is usually highest during the first years after reaching nadir weight [19] and stabilizes after 8–10 years [20]. Although lifestyle intervention programs were not shown to prevent RWG [21], a systematic review of 22 studies reported a multifactorial associated interplay of modifiable factors contributing to RWG, including poor dietary adherence (higher carbohydrate and alcohol intake), behavioral, psychological issues (binge eating or grazing), lack of support (by bariatric professionals), and physical inactivity [22]. However, the disease is more complex, with central nervous signaling, hormonal, and genetic factors governing these behaviors [23].

As for SoCR, multiple metrics have been used for RWG, with various thresholds for meaningful RWG from nadir [19]:

- Regain of > 10 kg
- Regain of > 5 BMU units
- Regain of > 10% of pre-surgery weight
- Regain of > 10% or > 15% of nadir weight
- Regain of > 10% or > 20% or > 25% of maximum TWL at nadir [19]. For example, a loss of 50 kg followed by a regain of 10 kg means a 20% RWG.

All five RWG measures are associated with the progression of diabetes, hypertension, decline in the physical health-related quality of life (QoL), and the decline in satisfaction with surgery [19]. RWG, measured by the percentage of maximum weight loss, had the strongest association with clinically related outcomes and has therefore been adopted by IFSO as the preferred metric for RWG [19]. Clinical deterioration after MBS is defined either by RWL > 30% of maximum TWL or by worsening of an obesity complication that was a significant indication for surgery [3].

The Difference Between SoCR and RWG

SoCR defines a below-average initial response to therapy, while RWG corresponds to a clinical situation in which an initially good response is not sustained over time. Both can co-exist in the same patient. Although an initially successful WL should be part of the definition of RWG, it is noteworthy that the distinction between SoCR and RWG is unclear in the literature [32]. Depending on the criterion used, SoCR prevalence ranges from 3 to 16% [17, 19, 25–31], whereas RWG ranges from 43.6 to 86.5% 5 years after nadir weight has been reached [19]. Despite the theoretical framework for the distinction between SoCR and RWG, data supporting the clinical relevance for the daily practice of these two WL outcomes following MBS as separate entities is lacking.

The Importance of Preoperative Nutritional and Behavioral Counseling Prior to Revisional Surgery

SoCR and/or RWG after a primary MBS, with recurrence of obesity-related complications, is alarming. RWG may involve many factors, including hormonal changes, eating behaviors, psychosocial challenges, physical activity, and anatomical changes [32]. Assessments by the multidisciplinary team are essential to help determine treatment options and the best ways of supporting the patient. All assessments should be undertaken sensitively with the recognition that obesity is a chronic relapsing disease.

Dietary/Nutritional Assessments

Nutritional Laboratory Assessment

MBS may adversely affect nutritional intake and, eventually, the absorption of some micronutrients. Following the RYGB and LSG, there is an increased risk of developing vitamin and micronutrient deficiencies and, in the long term, deficiencies of trace minerals [33, 34]. In addition, hypoabsorptive procedures increase the risk of fat-soluble vitamin deficiencies [35–37].

A dietitian specializing in bariatric surgery should undertake a comprehensive nutritional and dietary assessment [38]. The recommended nutritional blood tests are listed in Table 2. The aims of the nutritional and dietetic assessment are to:

Table 2 Suggested preoperative nutritional blood tests 35, 36

Nutritional blood assessment for revisional procedures
Complete blood count, ferritin, transferrin saturation, folate, vitamin B1, vitamin B6, vitamin B12,
Vitamin D3, calcium, parathyroid hormone, thyroid stimulating hormone
Zinc, copper and selenium
Vitamins A, E, and K if the primary procedure was hypoabsorptive or a hypoabsorptive procedure is being considered

- Determine the current nutritional status and optimize nutritional status
- Assess current diet and eating behaviors
- Discuss the role of revisional surgery and its impact on nutrition

Dietary Assessment/Eating Behaviors

MBS may not result in better food choices for patients who continue to keep the same eating patterns but with smaller portions [39–41]. Several factors may influence patients' food choices, including culture, social circumstances, employment status, work shift patterns, and financial issues. Eating slowly and chewing food well are encouraged. Some patients may struggle to chew because of poor dental conditions or because they eat too fast. This may result in maladaptive eating, such as grazing on soft foods and sweets [42]. Disordered eating before surgery may present as grazing or loss of eating control after surgery [43, 44]. Proper eating patterns and behaviors, such as eating meals regularly, avoiding grazing, not eating past fullness/satiety, self-monitoring, and being physically active, are associated with better weight loss and maintenance at 3 years [45].

Encouraging the patient to speak about his/her routine can give insights into eating behaviors and diet quality in a non-judgmental manner. Some patients may be more susceptible to alcohol misuse [46, 47]. Information about alcohol consumption (including its caloric content) and frequency should be gathered. Areas to consider in the dietary assessment and discussion with patients are listed in Table 3.

Increased satiety and decreased hunger after MBS due to the consequential physiological changes help to influence eating behaviors [48]. However, it is unknown whether RBS will have the same impact. Hypoabsorptive procedures are often associated with more significant weight loss. However, this may be at the expense of nutritional status, with a greater risk of protein malnutrition and deficiencies of fat-soluble vitamins and trace minerals [35–37]. Restrictive procedures, such as adding an adjustable or a silastic gastric band, may trigger food intolerances and maladaptive eating.

Patients must receive objective information about the impact of RBS on predicted weight loss, nutrition, and eating behaviors. The patient should be able to access the appropriate postoperative diet vitamin and mineral supplements and attend follow-up and nutritional monitoring visits. The dietitian should participate and discuss the assessment outcomes with the multidisciplinary team. Ideally, areas of concern should have been discussed with the patient, and an action plan should be developed if appropriate.

Behavioral Health Assessments

Psychosocial challenges are a potential factor associated with the variability in weight loss response and adherence to the regimen following primary MBS [32, 49, 50]. Patients seeking RBS may be dealing with anxiety about RWG. Thus, evaluation should be undertaken with sensitivity. Psychological disorders such as depression and anxiety are more common in patients seeking RBS and can be chronic, recurrent, or undertreated, suggesting it is important to screen patients for these conditions before performing a RBS [51, 52]. There is moderate quality evidence that higher rates of depression are prevalent in patients before the index MBS and that depressive symptoms may improve in the first 1–3 years following surgery [53]. However, depression is often a recurrent condition, and some studies suggest it can recur in the long term following MBS and negatively impact weight outcomes [54] and rates of self-harm [55, 56]. Therefore, assessment and treatment of moderate to severe symptoms of depression and anxiety should be undertaken

Table 3 Dietetic assessment

Areas to consider	
Weight history before and following primary procedure	Weight trajectory. Weight loss attempts. Life events.
Diet history	Structure of the day. Meal planning. Timing of meals, food, snacks, and liquids consumed, meals out, takeaways, types and textures of meals eaten. Food allergies and food intolerances.
Vitamin and mineral supplements	Frequency. Adherence.
Alcohol	Amounts and frequency.
Satiety	Feelings of hunger/satiety, eating past fullness.
Employment status	Hours of work, shift patterns.
Finance	Financial circumstances. Ability to afford postoperative diet and vitamin and mineral supplements. Food insecurity.
Self-monitoring	Which self-monitoring tools (if any) are used?
Social support	What access is there to social support from family and friends?
Patient's expectations	Views on different options available and how they may work.

prior to RBS. These assessments typically occur via behavioral health interviews that may include standardized measures of symptoms and should always include a suicide risk assessment.

Studies have demonstrated accelerated alcohol absorption, higher maximum alcohol concentration [57], and higher rates of alcohol use disorder [47, 48, 58–60] after MBS. Opioid consumption may increase as well for some patients [61]. Undergoing surgery after the primary MBS procedure increased the risk of post-bariatric opioid initiation in the prospective LABS-2 (longitudinal assessment of bariatric surgery) study [61]. Therefore, patients should be assessed regarding their experience with opioids since primary MBS, chronic pain issues, and pain management strategies before RBS. While limited data exists regarding the use of cannabis and surgical outcomes [62], some data suggest that cannabis use before surgery can impact pain management or eating behaviors, and its use after surgery could lead to RWG [63]. Consistent with recommendations for optimization prior to primary MBS [64], current substance use disorders (as opposed to longstanding sobriety from a previously resolved substance use disorder) are contraindications to RBS due to concerns about perioperative and general health risks [64].

MBS and its significant long-term weight loss may lead to psychosocial, interpersonal, body image, and lifestyle changes that require adjustment, and patients' responses to these changes are diverse [49, 65, 66]. In large, prospective, longitudinal studies, the Swedish Obese Subjects Study (SOS) and Scandinavian Obesity Surgery Registry found that relationship changes are common after MBS, such as ending a pre-existing relationship or beginning a new one [67]. These life changes can be stressful and create an environment promoting maladaptive coping responses. Eating disorders can recur or occur de novo following primary MBS and compromise weight outcomes and QoL [64, 68]. Meta-analyses have examined the impact of behavioral interventions after surgery on weight loss, QoL, and eating disorder behaviors, demonstrating small but positive impacts [69, 70]. Collectively, the literature examining eating disorders pre- and post-primary bariatric surgery suggests that they often recur and impact surgical outcomes but that intervention can be effective. This suggests that treatment for eating disorders should also be considered prior to or following revisional procedures. Table 4 highlights important aspects of behavioral health assessment to consider prior to surgery.

Addressing Patients' Expectations

Unrealistic weight loss expectations are common in obesity treatments [71] and may be true for patients seeking RBS, which has lower average weight loss than primary MBS [49]. Additionally, the expectations of patients and healthcare professionals regarding surgical outcomes may differ. A multidisciplinary, international consensus meeting composed of people living with obesity and healthcare professionals explored which patient-reported outcomes were considered important by each group. Physical health was classified as the most important outcome for healthcare professionals, and self-esteem was considered the most important outcome for people living with obesity [72].

The amount of weight loss required to improve comorbidities may be less than that the patient wishes to lose to improve their mental well-being. SoCR or RWG can

Table 4 Behavioral Health Assessment

Areas to consider	
Aspects of prior weight loss	Positive and negative. Social anxiety, body changes, excess skin
Adherence to bariatric regimen	Vitamins, protein, and fluid intake, avoidance of carbonation or NSAIDS. Barriers and agents of adherence.
Eating behaviors	Binge, loss of control, nighttime, secretive, or emotional eating
Compensatory behaviors	Purging, laxative use, excessive exercise, restriction, chewing and spitting
Mood disorders	Current symptoms, severity, related functional impairment
Trauma history	PTSD symptoms, severity, safety concerns
Suicidal ideation	Frequency, plan, intent, history of attempts, access to means, reasons for living
Self-injurious behavior	Frequency, triggers, history
Alcohol and other substances	Amount, frequency, personal or others concern about use, negative consequences
Stressors	Describe, severity
Coping	Strategies, frequency of use
Relationships	Support, changes since surgery
Behavioral health treatment	Current, past medications, therapy, inpatient hospitalizations, ECT, substance use disorder
Health behaviors	Sleep, pain management, tobacco use, physical activity

contribute to a sense of failure and cause patients to be reluctant to seek timely support or share their concerns [73]. The amount of weight loss, impact on hunger and satiety, experience of postoperative pain, nutritional guidelines, and requirements for post-procedure vitamin supplementation may differ for RBS compared to a primary procedure [40–42, 74]. Therefore, it is important to establish patients' personal goals and expectations, potential risks, and benefits, and discuss the mechanism of action of the revisional procedure beforehand.

Multidisciplinary Discussion

Patients undergoing RBS need access to and support from an experienced multidisciplinary team who can undertake the preoperative assessment and provide objective information regarding different procedures and treatment options, management of comorbidities, and dietary and psychological support [3, 75, 76]. Generally, the multidisciplinary team comprises the bariatric surgeon, dietitian, obesity physician, behavioral health provider, and other specialties as required.

The comprehensive pre-operative assessment is important to identify areas for optimization to improve outcomes, actively mitigate risk, and enhance patient QoL following RBS, similar to index procedures [64, 77].

Surgical options and Outcomes

Management of RWG After RYGB

Endoscopic Techniques

Although RYGB has proven effective in providing sustained weight loss, RWG will occur in many patients. RWG is challenging for the surgeon and the patient. Several options are available for patients deemed good candidates for RBS, including endoscopic interventional therapy.

Changes in the original anatomy after RYGB surgery have been closely correlated with RWG. Patients with standard anatomy regained less weight than patients with "unconventional" post-RYGB anatomy [78]. Although controversial, abnormal anatomical findings such as a dilated gastrojejunostomy (GJ) or enlarged pouch were identified in more than 71% of patients with RWG [79]. Thus, RYGB anatomy should be evaluated before RBS to check whether defaults are amenable to endoscopic correction using endoscopic suturing with the Overstitch (Apollo Endosurgery® Inc., Austin, TX) and/or coagulation of the GJA with argon plasma mucosal coagulation (APC) [80].

Endoscopic Suturing

Transoral outlet reduction (TORe) is an endoscopic treatment option for post-RYGB RWG with a dilated GJ. Thompson et al. reported a 23.4% EWL 5 months after decreasing the GJ diameter by 68% using endoscopic suturing [81]. In a series of 331 RYGB patients with significant RWG, TORe with a significant reduction of the GJ size was followed by 8.5 ± 8.5%, 6.9 ± 10.1%, and 8.8 ± 12.5% TWL at 1, 3, and 5 years, respectively, but 39.4% of patients required additional therapy. The authors concluded that TORe appears safe, effective, and durable when treating RWG after RYGB [82]. In 2018, a systematic review included 26 articles reporting full-thickness endoscopic suturing. The pooled TWL were 7.3 ± 2.6%, 8.0 ± 3.9%, and 6.6 ± 5.0% after 3, 6, and 12 months respectively. The authors demonstrated better outcomes with suturing combined with APC compared with suturing alone ($p < 0.0001$) and concluded that full-thickness suturing effectively treats RWG after RYGB and that performing APC before suturing results in superior weight loss [83]. Another recent systematic review and meta-analysis comparing full-thickness suturing plus APC (ft-TORe) with APC alone (APMC-TORe) showed %TWL after 3, 6, and 12 months of 8.0%, 9.5%, and 5.8% after ft-TORe, and 9.0%, 10.2%, and 9.5% after APMC-TORe, concluding that TORe was safe and effective [84].

Argon Plasma Coagulation (APC)

The first successful case report using APC after RYGB showed a 30-kg weight reduction after 12 months [85]. In 2015, Baretta et al. reported a 15-kg mean weight loss in 30 post-RYGB patients submitted to three APC sessions at 2-month intervals [86]. In a prospective randomized trial, Quadros et al. compared the 14-month results of APC (every 2 months) plus multidisciplinary team support to those of an isolated multidisciplinary team approach in 42 patients, with crossover to APC after 6 months for patients initially assigned to the control group. APC was associated with better weight loss (−9.8% TWL vs. ± 1.3% TWL after 6 months and 15% TBWL after 14 months) without complications. Patients resumed the early sensation of satiety and better QoL, which they experienced shortly after the RYGB procedure [87].

In a randomized trial, Brunaldi et al. compared the effectiveness and safety of APC alone versus ft-TORe with APC in performing TORe. Both groups experienced significant reductions in body weight and metabolic parameters (LDL and triglycerides levels) and improved eating behavior and QoL. They concluded that APC alone is similar to FtTORe-APC in terms of technical and clinical outcomes at 1 year [88].

Endoscopic methods for treating RWG after RYGB are minimally invasive, reproducible, likely safe, and superior to lifestyle interventions alone, providing a weight loss of 7.63–8 kg at 12 months [84, 89]. Most published outcomes are short to mid-term, with no long-term weight loss outcomes reported.

Surgical Revision Options

Management of RWG After RYGB As discussed above, the causes of RWG after RYGB not only may be related to the progression of the disease of obesity but can also be due to correctable surgical factors. Thus, technical problems need to be excluded. The most common anatomic derangements are pouch dilatation, pouch outlet dilatation, dilation of the proximal jejunum, and gastro-gastric fistula. The diagnosis can usually be made with an X-ray with oral contrast swallow. CT scan and/or upper gastrointestinal endoscopy is also beneficial.

A gastro-gastric fistula is treated by (laparoscopic) resection of the fistula tract and pouch revision ± resection of the fundus. As for dilatation of the pouch outlet, it can be treated surgically or endoscopically by reducing the outlet size with sutures or stapling, but the long-term results of repairing the outlet endoscopically are suboptimal [90]. A systematic review by Nahas et al. reported that pouch revision ± revision of the GJ, including the GJ sleeve technique, was ineffective, as adding restriction does not add up to the physiological mechanisms after RYGB [91].

Endoscopic revision is an option in pouch dilatation, but surgical pouch resizing with or with the addition of a silicon ring may be preferred [90]. Results may depend on the indication, as patients who have lost early satiety may benefit from restoring restriction, whereas patients who still have good satiety may need conversion to a distal RYGB, as was shown by the group of Higa [92]. Few publications specifically focus on pouch resizing and adding a ring for RWG. In a review by Tran et al., it was found that conversion to distal bypass or revision by adding a ring to the pouch had a similar outcome reporting %EWL at 1 and 3 years of 47.6% and 47.3%, respectively for banding in their systematic review [93]. Boerboom et al. reported on the effect of adding a ring, but they initially had many ring removals, probably due to inexperience with the technique. Moreover, no resizing of the pouch was done [94]. In this study, it was shown that patients with initial good weight loss benefitted most from adding a ring. Placing an adjustable band on the pouch, as reported by Dillemans and others, shows varying results and does add significant problems with the risk of erosion or herniation over the tubing of the band [95, 96].

The other option is changing limb lengths of the RYGB or "distalization." For this section, distalization or distal bypass will be defined as lengthening of the BPL. Conversion to distal RYGB (DRYGB) ± pouch/GJ revision has been reported to provide %EBWL at 1 and 3 years of 54% and 52.2%, respectively [93]. Lessons from the past have shown that a distal bypass may result in faster weight loss, but in the end, there is no relation between bowel length and outcome, mainly due to bowel adaptation, as shown by Brolin and colleagues [97]. Moreover, the total alimentary limb length (TALL) needs to be considered [95, 98]. Several studies have shown that a minimal TALL is required. Even though some authors suggest a minimum of 300 cm [99, 100], it should probably be at least 400 cm, as reported by Higa et al. [92]. In their study, a 250–300-cm TALL was initially used, which resulted in severe protein malnutrition requiring revision in seven out of 11 patients. The technique was adapted to 100-cm Roux and 300-cm common channel (TALL of 400 cm). Nimeri et al. reported protein malnutrition needing limb lengthening in 3.4–63.6% of the patients when the TALL was less than 400 cm and a common channel of less than 200. The review concluded that weight loss is affected by shortening the TALL. However, the TALL should be over 400 cm and the CC over 200 cm [99].

The DRYGB results in a significant decrease in BMI at 1 year. However, at 3 years, the most significant BMI decreases were seen after the DS, SADI-S, DRYGB, and banding of the pouch. The least effective procedures for weight loss were pouch reduction and GJ revision, respectively [101]. At 5 years, DRYGB had the highest BMI decrease [101]. Distalization has been shown to provide around an 8-unit decrease in BMI and 65.7% EBWL at 3 years follow-up [92].

Management for RWG After LSG For patients with SoCR or RWG after LSG or with persistent or recurrent significant comorbidities, especially T2D, despite dietary and behavioral optimization, redo surgery may be discussed. Before conversion, complete evaluation is mandatory by upper gastrointestinal endoscopy and upper GI series, looking for possible technical defects or complications of the SG. The volume of the sleeve and its distribution can be estimated by CT scan volumetry. A technical defect such as a sleeve torsion or stricture requires converting the sleeve to a RYGB. In patients with only SoCR or RWG, RYGB is one option that must be discussed and compared to alternatives, such as re-sleeving, DS, SADI-S, or OAGB.

Conversion to RYGB: Short and Long Biliopancreatic Limb The decision to convert a SG to RYGB depends on several factors, including postoperative complication rate, the expected further weight loss, and the possible additional effects on obesity complications compared to other options. In patients with GERD as a complication of LSG, the chances of RYGB improving GERD-related symptoms play an important role. Results from the literature regarding conversion to RYGB after LSG are somewhat conflicting since many studies include patients reoperated for several different indications. Most papers report only a short-term follow-up (1-2 years), although a few authors report mid-term results up to 5 years after revisional RYGB. RYGB effectively improves GERD in most patients by reducing acid and alkaline reflux. Even though a minority of patients with GERD do not respond as well, RYGB is considered the best option for LSG revision in patients with GERD after SG, whether they have RWG or not. Other options, such as DS or SADI-S, do not correct GERD, and OAGB also includes the risk of adding alkaline reflux. An extremely high risk of reflux was reported at 5 years, even after primary OAGB, to be as high as 41% in the YOMEGA trial published recently [102].

The results of RYGB for SoCR/RWG after LSG are more controversial, varying across studies, and are more difficult to interpret because of the heterogeneity of the data. Whether weight loss is reported compared with pre-LSG or pre-conversion weight is not always clear. Most series include only a small number of patients, with only eight groups reporting on more than 50 patients and one on more than 100. In many studies, follow-up is limited to 1–2 years, although a few describe results up to 5 years after revision. A recent systematic review and meta-analysis reported results after conversion to RYGB in a total of 1515 patients in 44 studies [103]. A total of 295 and 219 patients had an average of 53.9% EBWL and 22.7% TBWL, respectively, 12 months after revision. In the mid-term, after conversion to RYGB, 154 and 206 patients had an average of 45.8% EBWL and 20.6% TBWL, respectively, with low heterogeneity. Considering TBWL compared to baseline before LSG, 712 and 740 patients demonstrated 54.6% EBWL and 19.9% TBWL respectively 1 year after conversion. Four hundred seventy-eight patients lost 7.4 kg/m^2 (95%CI, 8.5–6.3) BMI units prior to conversion and an additional 7 kg/m^2 (95%CI, 8.8–5.2) BMI units 1 year after conversion, for a total of 13.5 kg/m^2 (95%CI, 15–12 kg/m^2) BMI units loss combining the two procedures. Another recent meta-analysis, which included 309 patients converted to RYGB after LSG, showed that pooled BMI at revision was 39.9 kg/m^2. Further reduction was 7.5 BMI units (95%CI, 3.51–11.67) after 12 months and 7.4 BMI units (95%CI, − 20.17 to 35.11) after 48 months [16]. Table 5 summarizes the findings of recent papers not included in the reviews that also showed acceptable weight loss after conversion to RYGB for SoCR/RWG after LSG.

Several studies have demonstrated that a longer BPL in the primary RYGB is associated with increased weight loss with BPL length between 150 and 200 cm, compared to the usual 50–100 cm. However, there is a higher risk of nutritional deficiencies and diarrhea [109–113]. Two studies, including one randomized controlled trial, also showed a better metabolic response with a longer BPL, notably regarding diabetes remission and improvement/resolution of dyslipidemia [111, 113]. One may reasonably assume that the same should happen with reoperative RYGB after LSG. One study compared different BPL lengths in RYGB after LSG and found more weight loss with longer BPL. Patients with a longer BPL also had a short common channel of 100 cm, so it is impossible to conclude about the isolated effect of the longer BPL [114].

Conversion to RYGB can also have a favorable effect on obesity-related complications. In a recent review, Fehervari et al. identified 17 studies reporting diabetes remission/improvement after conversion from LSG. Of 139 persons with T2D before RYGB, 53% achieved remission after conversion [112]. In a small study by Yorke et al., four out of five patients were in remission after conversion [115]. Carmeli et al. showed a 25% remission and a 75% improvement rate for diabetes after conversion [116]. These studies also showed that conversion can lead to remission or improvement of HTN and OSA.

The morbidity of RBS is generally higher than index operations. Up to 36% of patients may develop complications

Table 5 Outcomes of series summarizing the outcomes of conversion of LSG to RYGB for SoCR/RWG (formerly/WR)

Study	Number of patients	Outcome
Dias del Gobbo et al. [104]	32 patients converted to RYGB for IWL	Additional 17,3% TBWL after conversion, with BMI changing from 55kg/m2 before SG to 44kg/m2 before RYGB and 36kg/m2 2 years after conversion
Felsenreich et al. [105]	45 patients converted from LSG to RYGB	BMI dropped from 49,3 before SG to 39,9 before conversion and 28,4 at nadir after RYGB, for a 41,5% TBWL.
Hany et al. [106]	80 patients converted from LSG to RYGB	RCT comparing RYGB and OAGB for IWL after LSG showed very satisfactory weight loss, with BMI changing from 48,8 kg/m^2 before LSG to 44,9 kg/m^2 before RYGB and 27,8 2 kg/m^2 years after conversion.
Roach et al. [107]	33 patients converted to RYGB after LSG for IWL/WR	28% TBWL after 1-3 years, with a BMI change from 62 before LSG to 48 before RYGB and 42 at mid-term.
Zadeh et al. [108]	62 patients	Additional 29 % EBWL (from 31% before RYGB to 60 % after 1 year and 53 % after 2 years)

after conversion to RYGB [117], but most authors report overall complication rates between 0 and 20%, with major complication rates usually below 10% but up to 15%, depending on the definition of major complications. An extensive review by Spivak et al. based on the MBSAQIP (Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program) database identified 5348 patients converted to RYGB after LSG. Overall morbidity was 6.5%, 30-day mortality was 0.12%, readmission rate was 7.3%, and 30-day reoperation rate was 2.9% [118].

Conversion to OAGB One of the options to be considered is a conversion into OAGB. Studies have shown that OAGB is an effective and safe procedure for patients who have experienced RWG or SoCR after LSG. A systematic review and meta-analysis stated that OAGB with a BPL from 170 to 220 cm is a good alternative when compared to the endoscopic sleeve gastroplasty (ESG), Re-Sleeve, RYGB, SADI-S, and DS, reaching 17.8 units of BMI decrease at 48 months [18]. In a study with 28 patients who underwent revisional OAGB after failed SG, EBWL was 79%, and patients with IWL and persistent fundus lost more weight than those with RWG and those with diffuse stomach dilation or non-dilation [30]. Additionally, in a retrospective analysis of 72 patients who underwent conversion of LSG to OAGB, evaluated in two groups according to bowel length diversion, 150 and 200 cm BPL, both lengths were feasible and safe. Both BPL lengths resulted in significant and similar weight loss and improved comorbidities from when OAGB was performed as a revisional procedure after LSG up to 2 years follow-up. A 200 cm added a higher risk of chronic diarrhea and nutritional impairment [119].

Another 5-year study including 23 patients converted to OAGB following LSG reported remission/improvement of comorbidities, statistically significant reduction of BMI, and weight loss up to the second postoperative year but showed a 10% weight increase up to 3–5 years after the revision [120]. Additionally, a prospective study of 77 patients who underwent revisional surgery from SG to OAGB with vertical pouch re-sleeving in all cases reported significant weight loss and low morbidity rates, with maximum weight loss in the second year reaching 80% EWL [121].

In a comparative analysis with RYGB, OAGB has a shorter operative time and length of hospital stay, just one anastomosis, one mesenteric space, and slightly superior weight loss [122, 123]. This was confirmed in a systematic review and meta-analysis comparing OAGB and RYGB as revisional alternatives to LSG. In total, 499 individuals were followed. Patients submitted to OAGB had approximately 6% more TBWL with similar early complication rates between procedures [124]. Compared to the RYGB however, OAGB, as a revisional procedure, has a significantly greater incidence of reflux, regurgitation, and proton pump inhibitor (PPI) use [125].

In a systematic review including 1075 patients with revisional OAGB, the mean operative time was 119.3 min, the mean leak rate was 1.54%, and mortality was 0.3%. The marginal ulcer rate was 2.44%, and the anemia rate was 1.9%. The mean %EBWL at 1 year, 2 years, and 5 years were 65.2%, 68.5%, and 71.6%, respectively. The T2DM remission was 80.5%, and the HTN remission rate was 63.7%, showing the procedure's good safety and efficacy profile [126].

OAGB is an effective and safe alternative for patients who experience RWG or SoCR after LSG. Due to its hypoabsorptive nature and the uncertainty about risks related to biliary reflux, a structured follow-up with strict nutritional supervision is recommended. In the case of severe reflux, hiatal hernia, or Barrett's esophagus, RYGB is a better alternative as it has better GERD outcomes when compared to OAGB.

Table 6 Summarizing studies that report DS and SADI-S outcomes when used as revisional procedures

Author, year	Type	Months of FU	# pts at max FU	TWL at max FU, %	EWL at max FU, %
Carmeli et al. 2015 [116]	SADI-S	30	9		80
Balibrea et al. 2016 [127]	SADI-S	24		46.26	44.25
Zaveri et al. 2018 [128]	SADI-S	48	44		85.7
Bashah et al. 2020 [129]	SADI-S	18	7	26.40	65.7
Dijkhorst et al. 2021 [130]	SADI-S	60	9	15.0	
Liagre et al. 2021 [131]	SADI-S	48	10	22.6	78.2
Andalib et al. 2020 [132]	SADI-S	10	11	13.6	23.2
	BPD	14	12	17.2	27.3
Sánchez-Pernaute et al. 2020 [133]	SADI-S	60	17	41	79
Osorio et al. 2021 [134]	SADI-S	24	38	35.3	64.1
	BPD	24	38	41.7	75.3
Jen et al. 2022 [135]	BPD-DS	24	27	23.6	38.6
Lourensz 2022 [136]	BPD-DS	60	25	30.9	

Conversion to SADI-S and DS Due to their high effectiveness in both weight loss and metabolic effects, DS and SADI-S have been used as revisional procedures in patients with RW. Unfortunately, long-term results in this setting are scarce. Table 6 summarizes the weight loss when used as revisional procedures, mainly after failed LSG.

Regarding the metabolic impact, DS and SADI-S have shown the highest impact on diabetes control. Long-term diabetes remission exceeds 90% [137]. Physiological studies have shown insulin sensitivity, improved glucose homeostasis, and reduced risk of reactive hyperinsulinemia and hypoglycemia. Despite the high similarities between DS and SADI-S, the post-prandial hormone secretion profile after SADI-S is characterized by increased GLP-1, glucagon, and insulin secretion compared to DS [138, 139].

Perhaps the downsides of hypoabsorptive procedures are the higher technical complexity and the higher incidence of long-term complications and reoperations. Patients often develop steatorrhea, and nutritional deficiencies are more prevalent, leading to severe anemia and/or hypoalbuminemia if not adequately supplemented. Therefore, close long-term surveillance is mandatory.

Pharmacotherapy for RWG

The Endocrine Society's clinical practice guidelines on managing post-bariatric surgery patients recommend that pharmacotherapy be included in the multidisciplinary treatment of RWG [140]. However, most RCTs aiming to evaluate OMM have excluded participants with previous MBS. Indeed, OMM in post-MBS patients has been primarily used in retrospective studies with heterogeneous study designs. Thus, it should be acknowledged that although some data support the use of OMM in this situation, reliable data is lacking.

Istfan et al. [141] present a retrospective study on using phentermine and topiramate, individually or combined, to mitigate RWG after RYGB. Despite the lack of a unified protocol for the timing of using OMM, the three statistical models employed converged to show that phentermine and topiramate, used individually or in combination, can significantly reduce RWG after RYGB. In another multicenter retrospective study [142] in patients who previously underwent RYGB or LSG, there were several high responders, with 30.3% of patients losing ≥ 10% of their total weight. Topiramate was the only medication that demonstrated a statistically significant response for weight loss, with patients being twice as likely to lose at least 10% of their weight when placed on this medication. Interestingly, RYGB patients responded better than SG to adjuvant pharmacotherapy. Schwartz et al. [143] retrospectively reviewed 65 patients who experienced postoperative RW or weight plateau and were treated with phentermine or phentermine-topiramate. Patients receiving phentermine weighed significantly less than those on phentermine-topiramate throughout this 90-day study.

The introduction of glucagon-like peptide 1 receptor agonists (GLP-1-RA) changed the landscape of treating obesity and even RWG or SoCR after surgery. The largest series to date by Wharton et al. [144], although not specifying the timing of the drug's introduction (weight plateau or RWG), showed that after 12 months on liraglutide 3 mg/day injections and lifestyle counseling, 75% of patients lost > 5%, and 25% lost > 10% of total body weight. The GRAVITAS trial [145] is one of the few RCTs published in the field. This study examined the effects of liraglutide 1.8 mg/day versus placebo in patients with persistent or recurrent T2D at least 1 year after RYGB or LSG. The primary endpoint was glycemic control, which was significantly better with liraglutide. However, weight loss (a secondary outcome) was also better in that group. At each of the four study visits over 26 weeks, participants taking liraglutide lost progressively more weight than those on placebo. Another small RCT [146] addressed the effect of the early addition of liraglutide to SG prospectively compared with placebo on weight loss and other obesity-related comorbidities from 6 weeks until 6 months after surgery. All patients had a BMI > 30 kg/m^2, with or without obesity-related comorbidities. The percentages of TBWL at 6 months were 28.2 ± 5.7 and 23.2 ± 6.2 ($p = 0.116$) in the liraglutide and placebo groups, respectively. Liraglutide added earlier after LSG significantly augments weight loss from SG in people with obesity, with few adverse events.

The Bari-Optimise RCT was recently published and addressed the efficacy and safety of liraglutide, 3.0 mg, compared to placebo as an adjunct to a lifestyle intervention in people with 20% or less total body weight loss after SG or RYGB. Liraglutide, 3.0 mg, for 24 weeks led to a significant reduction in percentage body weight compared to placebo, improving cardiovascular risk factors and quality of life. Change in mean (SD) percentage body weight from baseline to week 24 was − 8.82 (4.94) with liraglutide, 3.0 mg ($n = 31$), versus − 0.54 (3.32) with placebo ($n = 26$). The mean difference in percentage body weight change for liraglutide, 3.0 mg, versus placebo was − 8.03 (95%CI, − 10.39 to − 5.66; $p < 0.001$). After 24 weeks, 71.9% of participants treated with liraglutide, 3.0 mg, compared with 8.8% in the placebo group, lost 5% or more of their baseline body weight [147].

There is very little information in the literature on using semaglutide in SoCR/RWG. A retrospective study by Lautenbach et al. [148] used an arbitrary definition for SoCR and RWG. RWG was defined as continuous regain of weight after an initially successful weight loss (EBWL > 50%), and IWL was described as achieving a nadir weight with

EWL < 50% after surgery. Patients reached a mean TBWL of 10.3%, with 85% achieving a weight loss of ≥ 5% after 6 months. GLP-1-RA therapy was reported with semaglutide, 0.5 mg, weekly subcutaneous injection. Analogous to the results of the semaglutide Phase III trial STEP-1 (the Semaglutide Treatment Effect in People with Obesity) [149], post-bariatric patients that showed more than a 2% reduction in body weight within only the first 4 weeks of treatment initiation with semaglutide (early responders) continued to lose weight throughout the 6-month follow-up period.

Jensen et al. [150] defined RWG as any weight gain following the weight nadir at least 12 months after bariatric surgery. As it was a retrospective chart study, the indication to initiate GLP-1-RA therapy was at the treating physician's discretion, considering the overall weight status, cardiovascular risk profile, and patient preferences. The median percentage of TBWL following 6 months of GLP1-RA therapy was 8.8%. More than three in four patients lost over 5% of their baseline weight, and more than one in three lost more than 10%. The median patient had lost 67.4% of the weight regained after the bariatric procedure. The authors did not report serious adverse events.

There is no data on the use of OMMs before the plateau. This aligns with the lack of standard definitions of IWL and the ideal timing to start adjuvant pharmacotherapy. Ideally, OMMs should be tailored to the patient's needs as an adjunct to dietary modifications and behavioral changes to optimize weight loss and help the resolution of obesity-associated comorbidities [151].

Finally, we are living in the dawn of a new era of OMMs, with excellent weight loss outcomes and acceptable safety profiles [152–154]. These new agents will likely be important in treating patients with SOCR after MBS. It must be stressed, however, that most studies with OMM report only on short-term results after 6–12 months, rarely after 2 years. These medications' long-term safety profile, efficacy, and cost–benefit ratio are yet to be demonstrated.

Conclusions and Recommendations

1. Obesity is a chronic disease that may require multiple interventions and escalation of therapy throughout the years.
2. Until recently, no universal definition existed for RWG and IWL. Standardization of reporting is key so outcomes can be compared and data can be pooled. The recent IFSO consensus provided standard terminology and definitions that will likely resolve this in the future, and publishers will need to enforce for authors to use these definitions,
3. Before any RBS, a multidisciplinary team must thoroughly evaluate all patients. This must include an evaluation of the anatomy of the primary procedure, especially screening for problems that may warrant surgical correction. Preoperative nutritional and behavioral counseling is important before RBS and should continue postoperatively. Both nutritional deficiencies and expectations need to be appropriately addressed pre- and postoperatively.
4. Management of RWG after RYGB can be complex and includes endoscopic options like ft-TORe and APMC-TORe, which are less invasive and less potent than surgical interventions. Surgical options include pouch revision with or without ring placement, conversion to BPD-DS, or distalization. Distalization is effective and technically less complicated but can be dangerous if the TALL or common channel is too short. More robust data is needed.
5. Revision for RWG after LSG includes conversion to RYGB, OAGB, DS, or SADIS-S. For revisional cases, a longer BPL in the cases of RYGB and OAGB may be considered, provided the common channel/TALL remains long enough. More robust data is needed.
6. The new and continuous developments of OMMs suggest they may represent an excellent adjunct treatment of RWG and/or SoCR after MBS, but data on their mid to long-term use is very limited for the time being.

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Declarations

Informed Consent For this type of study formal consent is not required.

Competing Interests The authors declare no competing interests.

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Authors and Affiliations

Ashraf Haddad[1] · Michel Suter[2] · Jan Willem Greve[3] · Scott Shikora[4] · Gerhard Prager[5] · Barham Abu Dayyeh[6] · Manoel Galvao[7] · Karen Grothe[6] · Miguel Herrera[8] · Lilian Kow[9] · Carel Le Roux[10] · Mary O'Kane[11] · Chetan Parmar[12] · Luiz Gustavo Quadros[13] · Almino Ramos[14] · Josep Vidal[15] · Ricardo V Cohen[16]

✉ Ashraf Haddad
drajhaddad@gmail.com

Michel Suter
michelsuter@netplus.ch

Jan Willem Greve
grevejw@gmail.com

Scott Shikora
sshikora@bwh.harvard.edu

Gerhard Prager
gerhard.prager@meduniwien.ac.at

Barham Abu Dayyeh
AbuDayyeh.Barham@mayo.edu

Manoel Galvao
galvaon@gmail.com

Karen Grothe
Grothe.Karen@mayo.edu

Miguel Herrera
miguelfherrera@gmail.com

Lilian Kow
Lilian.Kow@flinders.edu.au

Carel Le Roux
carel.leroux@nhs.net

Mary O'Kane
marywasokane@googlemail.com

Chetan Parmar
drcparmar@gmail.com

Luiz Gustavo Quadros
gustavo_quadros@hotmail.com

Almino Ramos
ramos.almino@gmail.com

Josep Vidal
JOVIDAL@clinic.cat

Ricardo V Cohen
rvcohen@mac.com

1 Gastrointestinal Metabolic and Bariatric Surgery Center -GBMC- Jordan Hospital, Amman, Jordan

2 Hôpital Riviera-Chablais, Vevey, Switzerland

3 Maastricht University Medical Centre, Maastricht, Netherlands

4 Harvard University, Cambridge, MA, USA

5 Vienna General Hospital, Vienna, Austria

6 Mayo Clinic, Rochester, NY, USA

7 Orlando Health Weight Loss and Bariatric Surgery Institute, Orlando, FL, USA

8 Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán, Mexico City, Mexico

9 Flinders University, Adelaide, Australia

10 University College Dublin, Dublin, Ireland

11 Leeds Teaching Hospitals NHS Trust, Leeds, UK

12 University College London, London, UK

13 Kaiser Clinic, Sao Jose Do Rio Preto, Brazil

14 GastroObesoCenter - Institute for Metabolic Optimization, São Paulo, Brazil

15 Hospital Clínic de Barcelona, Barcelona, Spain

16 Hospital Alemão Oswaldo Cruz, São Paulo, Brazil