BJS, 2024, znae284
https://doi.org/10.1093/bjs/znae284
Cutting Edge Review

Role of obesity-management medications before and after metabolic bariatric surgery: a systematic review

Ricardo V. Cohen[1,*], Ji Yeon Park[2,3], Gerhard Prager[4], Marco Bueter[5], Carel W. le Roux[6], Chetan Parmar[7], Mohammad Kermansaravi[8], Paulina Salminen[9,10] and Alexander D. Miras[11]

[1]The Center for Obesity and Diabetes, Hospital Alemao Oswaldo Cruz, Sao Paulo, Brazil
[2]Department of Surgery, School of Medicine, Kyungpook National University, Daegu, Korea
[3]Department of Surgery, Kyungpook National University Chilgok Hospital, Daegu, Korea
[4]Division of Visceral Surgery, Department of General Surgery, Vienna Medical University, Vienna, Austria
[5]Department of Surgery and Transplantation, University Hospital Zurich, University of Zurich, Zurich, Switzerland
[6]Diabetes Complications Research Centre, University College Dublin, Dublin, Ireland
[7]Bariatric and Emergency Surgery, Whittington Hospital, University College London, London, UK
[8]Minimally Invasive and Bariatric Surgery, Hazrate Rasool Akram Hospital at Iran University of Medical Sciences, Tehran, Iran
[9]Department of Surgery, University of Turku, Turku, Finland
[10]Division of Digestive Surgery and Urology, Turku University Hospital, Turku, Finland
[11]School of Medicine, Ulster University, Derry, UK

*Correspondence to: Ricardo V. Cohen, The Center for Obesity and Diabetes, Hospital Alemao Oswaldo Cruz, Rua Treze de Maio, 1.815—Torre D—1° Andar—Bela Vista—CEP, São Paulo, 01327-001, Brazil (e-mail: ricardo.cohen@haoc.com.br)

Introduction

Metabolic bariatric surgery (MBS) induces weight loss through a complex interplay of mechanisms, including alterations in humoral and neural signals in the gut–brain axis, bile acid metabolism pathways, and gut microbiota[1]. However, weight loss outcomes following MBS are highly variable at the individual level, similar to other modalities for the treatment of obesity[2].

The landscape of obesity treatment is rapidly evolving with the advent of a newer generation of obesity management medications (modern OMMs). These exhibit remarkable weight loss efficacy similar to MBS while maintaining acceptable safety profiles[3]. Since 2005, gastrointestinal peptide-based agents have emerged as essential therapeutic options for managing obesity-related complications, like type 2 diabetes. Among these, glucagon-like peptide-1 receptor agonists (GLP-1RAs) have been widely integrated into the treatment regimens of obesity and diabetes due to their efficacy[4,5]. Currently, liraglutide and semaglutide are the most frequently used GLA-1RAs, but promising new drugs are on the horizon, including tirzepatide, a once-weekly glucose-dependent insulinotropic polypeptide (GIP) and GLP-1 receptor agonist, and other compounds are being evaluated in phase 3 clinical trials[6–8].

OMMs can be integrated into the treatment of patients undergoing MBS through (1) preoperative OMMs administration to optimize patients' health for MBS, (2) postoperative concurrent OMMs usage to enhance overall outcomes regarding additional weight reduction to improve obesity complications, and (3) postoperative OMMs utilization as adjunctive therapy for patients with a suboptimal initial response to MBS (weight loss and remission of obesity-related complications) or recurrent weight gain. This systematic Cutting Edge Review aims to examine current research on OMMs use in patients after MBS.

Methods

A systematic search was performed in Medline (PubMed), EMBASE, Cochrane (CENTRAL), from inception to February 2024 based on the PRISMA on the research questions that included the combined terms (Obesity OR Overweight) AND (Bariatrics OR Bariatric Surgery OR Bariatric Surgical Procedures OR Bariatric Surgical Procedure OR Bariatric Surgeries OR Stomach Stapling OR Gastric Bypass OR Gastroplasty OR Sleeve gastrectomy) AND (Recurrence OR Recurrences OR Recrudescence OR Recrudescences OR Relapse OR Relapses OR Weight gain OR Weight regain OR Insufficient weight loss OR Failed OR Regain OR pharmacotherapy OR Obesity medications) AND Weight loss (OR Total weight loss OR total body weight loss OR Excess weight loss OR Excess Body mass index loss) were applied.

One reviewer conducted title and abstract screening with 10% cross-checked by a second reviewer. Both reviewers examined articles identified for full-text review, and disagreements concerning inclusion were resolved by joint review. Manual search approaches were also used, and no language restrictions were established. *Figure 1* displays the PRISMA search process for the current review with the original review studies added. Due to the scarcity of robust level of evidence on the use of OMMs before and after MBS, prospective and retrospective series and RCTs were included in the search. As all analyses were performed based on previously published studies, no ethical approval or patient consent was required.

Levels of evidence

A standard Level of Evidence (LoE) descriptor was employed, defined as follows: IA—evidence from a meta-analysis of RCTs; IB—evidence from at least one RCT; IIA—evidence from at least one controlled study without randomization; IIB—evidence from at least one other type of quasi-experimental study; III—

Received: September 30, 2024. **Accepted:** October 20, 2024

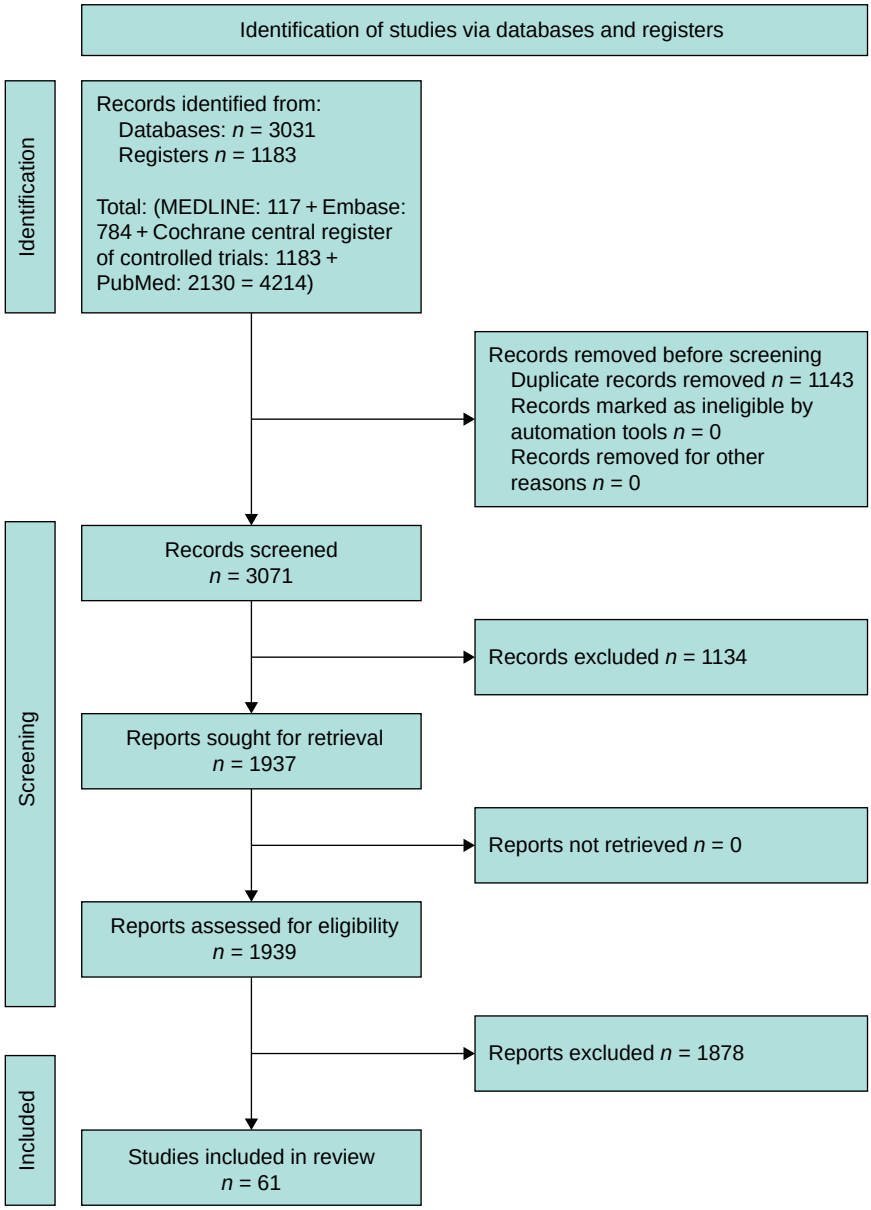

Fig. 1 PRISMA statement

evidence from non-experimental descriptive studies, such as comparative studies, correlation studies, and case–control studies; and IV—evidence from expert committee reports, opinions, or clinical experience of respected authorities, or both.

Risk of publication bias

The risk of bias tools employed was the Joanna Briggs Risk of Bias Tool[9,10]. The risk of bias in all outcomes was considered 'not serious', but the heterogeneity remained quite high.

Preoperative use of obesity management medications

Impact of preoperative obesity management medications on perioperative complications

Preoperative weight loss likely poses little to no risk to patients. However, the impact of OMMs-induced preoperative weight loss on perioperative complications, such as surgical morbidity and mortality rates, remains insufficiently investigated (LoE III). Although some studies report that preoperative weight loss does not reduce mortality rate or improve long-term weight loss results[11], others showed that even moderate weight loss (that is, >0% to <5%) before MBS was associated with a lower risk of 30-day mortality[12] and reduction in surgical complications[13]. Preoperative weight loss programs may benefit perioperative performance (that is, technically easier operation)[14]. A recent prospective open-label study has investigated the efficacy of liraglutide, including a dose of up to 1.8 mg in combination with a hypocaloric diet and leucine-based amino acid infusion, as preoperative bridging therapy in 26 patients with 'inoperable' obesity necessitating emergent MBS[15]. Patients had a BMI over 70 kg/m^2 and concurrent obesity complications that were considered life-limiting, rendering them unsuitable for intragastric balloon bridging therapy. Laparoscopic operability was objectively assessed with ultrasound findings and subjectively by two highly experienced bariatric surgeons, enrolling only those deemed inoperable. Throughout the preoperative treatment, all 26 patients

remained hospitalized due to obesity-related complications requiring inpatient care. Leucine-rich amino acid infusion expedites liver volume reduction, promotes faster weight loss, and prevents muscle wasting during the hypocaloric diet. The termination of preoperative bridging therapy was contingent upon the bariatric surgeons' evaluation of technical operability. All 26 patients attained technical operability by achieving a median total body weight loss (TWL) of 11.4% within 20.7 ± 6.7 days and underwent laparoscopic sleeve gastrectomy (SG) without immediate complications. Compared to the matched historical cohort receiving standard 6-month bridging therapy using an intragastric balloon, the utilization of liraglutide facilitated technical operability within a significantly shorter treatment duration, suggesting this approach as a potential option for technically inoperable patients with BMI over 70 kg/m^2.

A retrospective study comparing intragastric balloon insertion ($n = 44$) or administration of 3.0 mg liraglutide ($n = 42$) in patients with a BMI over 50 kg/m^2 before SG[16] found that liraglutide used preoperatively for 24 weeks resulted in a median TWL of 6.7%, although this was significantly less than the TWL of 15.5% observed with intragastric balloons. The incidence of postoperative complications was lower with preoperative liraglutide use than with intragastric balloons, although not statistically different (7.1% *versus* 15.9%, $P = 0.31$).

Another retrospective study found that treatment with GLP-1RA, including liraglutide 3.0 mg and semaglutide 1.0 mg, for at least 6 months in patients awaiting MBS caused an average TWL of approximately 16% at 52 weeks, which was similar for both medications[17]. Interestingly, 68.6% of participants opted to withdraw temporarily from the MBS waiting list. Their decision to undergo MBS was significantly influenced by achieving a TWL > 15% after 52 weeks of pharmacotherapy while on the waiting list.

These findings collectively suggest (LoE III) that preoperative OMMs usage holds promise as a bridging therapy, facilitating faster and more effective weight loss compared to conventional non-pharmacological interventions. This is particularly relevant for optimizing patients before surgery, especially for those with either high BMI or severe obesity-related complications who are at increased surgical and medical risks. Although there are a limited number of studies specifically investigating the impact of OMMs-induced preoperative weight loss on perioperative morbidities, it is reasonable to infer that preoperative OMMs use could be beneficial in reducing surgery-related morbidity or mortality. This warrants clarification in future RCTs.

Association between response to preoperative obesity management medications and postoperative weight loss outcomes

The impact of preoperative weight loss on overall weight loss outcomes following MBS remains contentious. Some authors have shown enhanced postoperative weight loss in those patients who received preoperative OMMs, especially patients with a BMI > 60 kg/m^2. Cunningham *et al.*[18]. compared the outcomes of patients receiving phentermine and/or topiramate before MBS with those not receiving OMMs preoperatively. Using the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) curve for comparison, patients receiving medication preoperatively weighed 2.4% less than expected, whereas patients receiving medication during the first postoperative year weighed 4.8% more than expected[18]. Despite variation in its definitions, in a meta-analysis encompassing 3404 patients across 15 studies, preoperative weight loss was associated with a mean increase of 5% excess weight loss (95% c.i.: 2.68 to 7.32) at one year post surgery[19]. However, others argue that mandatory preoperative weight loss programmes or achieving preoperative TWL ≥ 5% is not associated with improved weight loss outcomes following MBS[11,20].

Another aspect of utilizing preoperative OMMs in patients considering MBS is their potential to predict response to surgery. GLP-1RAs mimic post-surgery weight loss mechanisms, potentially identifying patients likely to experience suboptimal outcomes. One study indicated that preoperative gut hormone responses, particularly fasting levels of GLP-1 and PYY, do not correlate with weight loss after Roux-en-Y gastric bypass (RYGB)[21]. Another study found similar postprandial hormone levels between patients with optimal and suboptimal weight loss after RYGB, suggesting that an impaired central response to gut hormones may contribute to suboptimal outcomes[22]. Further research is needed to validate these findings, especially regarding small bowel bypass procedures, which enhance gut hormone responses. *Table 1* summarizes the current literature on the preoperative use of OMMs.

Table 1 Summary of the evidence of preoperative use of OMMs

Study	Medication	Patients	Follow-up	Outcomes
Lo and Hsu[23]/retrospective	Orlistat, 360 mg/day	55/baseline BMI not informed	14 weeks	1.7% TWL
Malone *et al.*[24]/prospective matched paired	Orlistat 180 mg/day	19 orlistat × 19 placebo, BMI range 39–60 kg/m^2	6 months	2% TWL orlistat 5.4% placebo
Morton *et al.*[25]/RCT	Phentermine 8 mg × placebo	14 phentermine 10 placebo, BMI 44–52 kg/m^2	3 months	6.3 ± 1.5% *versus* phentermine 1.4 ± 1.5%, placebo. $P = 0.0465$
Martines *et al.*[16]/ retrospective	IGB/Liraglutide 3 mg	42 liraglutide and 44 IGB, BMI > 50 kg/m^2	12 months	15.5% TWL IGB 6.71% TWL liraglutide
Rubio-Herrera *et al.*[17]/ retrospective	Liraglutide 3 mg or semaglutide 1 mg	BMI ≥ 40 kg/m^2 or BMI ≥ 35 kg/m^2 + related complications, 102 patients on the waiting list for MBS	12 months	16.9 ± 7.2% TWL sema 1 mg* 16.1 ± 5.8% TWL Lira 3 mg*
Wilmington *et al.*[26]/ retrospective	Liraglutide 3 mg	50 patients, BMI.40 kg/m^2	12 months	85.7% TWL > 5% 33.3% TWL > 10%†
Cunningham *et al.*[18]/ retrospective	Phentermine and/or topiramate × no OMMs	98 patients, BMI > 60 kg/m^2	24 months	31.3% TWL OMMs pts 25.3% TWL without OMMs

IGB, intragastric balloon; MBS, metabolic bariatric surgery; OMMs, obesity management medication; TWL, total body weight loss. *68.6% of participants were satisfied with the achieved weight loss and withdrew from the waiting list for MBS. †10% of participants discontinued medication due to tolerability issues.

An important preoperative issue with GLP-1RAs is their effects on delaying gastric emptying and the potential development of aspiration pneumonia during anaesthesia. It is advisable that this class of medication is be stopped before MBS[27]. The American Society of Anesthesiologists recommends that patients on daily dosing refrain from using GLP-1RAs on the day of the procedure/surgery. For patients on weekly dosing, the recommendation is to refrain from their use for one week before the procedure/surgery[28] (LoEIII).

Postoperative use of obesity management medications

Understanding the need for combined strategies

In RCTs, MBS has been consistently superior to medical treatment regarding weight loss and control of type 2 diabetes (T2D)[29]. However, adopting a multimodal approach to care, including combining OMMs with MBS, warrants investigation given the likelihood of suboptimal initial clinical response or recurrent weight gain and T2D relapse following a period of remission[30,31]. Data from RCTs address the potential for combining MBS with OMMs are scarce. However, this appears to be a novel therapeutic approach, particularly given the recent developments in pharmacotherapy with significant weight loss and T2D management.

The Surgical Therapy and Medications Potentially Eradicate Diabetes Efficiently (STAMPEDE) study compared intensive medical therapy (without modern OMMs) to MBS plus medical treatment[32]. A 5-year follow-up found that the surgical arms plus the best medical treatment achieved significantly more weight loss than the medical arm alone, further supporting combining medications with surgery (LoE Ib).

The 'Microvascular Outcomes after Metabolic Surgery'[33] is an RCT comparing best medical therapy, including liraglutide, with RYGB in patients with T2D and established microalbuminuria to examine remission of albuminuria, weight loss, and glycaemic control among other secondary endpoints. Medications with recognized benefits for macro- and microvascular were continued in both the medical and RYGB arms. OMMs were stopped in the RYGB arm. At 60 months, albuminuria remission was similar between groups, but weight loss and glycaemic control were better after the RYGB plus medications group, demonstrating the safety of combining medication with surgery and its efficacy compared to medical therapy alone. (LoE Ib).

The Alliance of Randomized Trials of Medicine *versus* Metabolic Surgery in Type 2 Diabetes (ARMMS-T2D)[34] pooled the results of four separate RCTs, all designed to evaluate the effectiveness of MBS compared with combined medical therapy and lifestyle management, in improving glycaemic control in people with T2D and a BMI of 27–45 kg/m^2 for up to 12 years of follow-up[33]. Its importance relies on the superiority of MBS in terms of weight loss and T2D control. However, the effects of surgery decreased over time, suggesting the potential need for adjunctive pharmacotherapy to maintain optimal long-term outcomes (LoE Ib).

As seen with other chronic diseases, not only are lifelong treatment strategies needed, but disease processes also inevitably progress. Nevertheless, learning from best clinical practice in oncology, treatment intensification at the outset appears attractive, which may include additional pharmacotherapy as an adjuvant treatment to MBS to maintain or improve disease control. There is no published literature on the outcomes and safety of continuous or intermittent use of OMMs after MBS.

Optimal timing of initiation of obesity management medications

There is controversy on when to start adjunctive pharmacotherapy after MBS. Some advocate waiting for the occurrence of a weight plateau or early weight recurrence to be able to disclose the effects of MBS before adding OMMs. Others start medications sooner in specific situations, such as for individuals with a baseline BMI > 50 kg/m^2, or early suboptimal initial clinical response, a proxy of greater severity of the disease[35,36].

A prospective study with phentermine and topiramate (phen/top) combined with SG compared to SG alone in patients with BMI > 50 kg/m^2 showed better weight loss after the early association of phen/top than surgery alone[37] (LoE III). Two RCTs, one with phen/top and the other associated with liraglutide plus SG compared with SG alone, concluded that the early addition of OMMs after SG significantly augmented weight loss compared to SG alone without any significant adverse event[38,39] (LoE Ib).

Historically, a conservative approach for using OMMs in people undergoing MBS has been upheld, typically reserving them for patients who attain weight stability or once recurrent weight gain becomes evident. However, recent advancements in novel OMMs with good efficacy and safety profiles offer compelling grounds for a more proactive pharmacological approach in earlier stages. Nevertheless, given the lack of robust evidence, well-designed clinical trials are needed to substantiate such clinical practice. These trials must delineate short-term efficacy and elucidate long-term health benefits, extending beyond mere weight loss.

Obesity management medications for suboptimal initial clinical response or recurrent weight gain

A higher preoperative BMI has been associated with recurrent weight gain and a worse weight trajectory after surgery[40]. Patients with a baseline BMI ≥ 50 kg/m^2 are at a higher risk for recurrent weight gain, and may therefore benefit from earlier initiation of OMMs, whereas there is no convincing information on the role of dietary and behavioural interventions in promoting additional weight loss, mitigating suboptimal initial clinical response, or preventing recurrent weight gain in the long term[41].

Only two RCTs have addressed the safety and efficacy of using GLP-1RA after recurrent weight gain or suboptimal initial clinical response after MBS (LoE Ib). The GRAVITAS trial[42] compared liraglutide (1.8 mg/day) *versus* placebo in patients with persistent or recurrent T2D at least one year after RYGB or SG. The primary endpoint was glycaemic control, which was significantly better with liraglutide ($P < 0.0001$). The change in HbA1c at 26 weeks from the baseline was −11.4 mmol/mol (95% c.i.: −13.7 to −9.1) with liraglutide 1.8 mg ($n = 48$) *versus* 4.1 mmol/mol (95% c.i.: 0.8 to 7.5) with placebo ($n = 23$; mean difference −13.3 mmol/mol; 95% c.i.: −19.7 to −7.0) (LoE Ib). Moreover, a significant reduction in body weight by −5.3 kg (95% c.i.: −6.2 to −4.4) was noted at 26 weeks in the liraglutide group compared with no significant change (−0.9 kg, 95% c.i.: −2.1 to 0.4) in the placebo group (mean difference −4.2 kg; 95% c.i.: −6.8 to −1.6). Furthermore, 46% of patients in the liraglutide group lost >5% of their body weight compared with only 9% in the placebo group. Adverse events were similar to those observed in unoperated patients receiving liraglutide.

The BARI-OPTIMISE trial[43] compared daily liraglutide (3.0 mg) to placebo over 24 weeks in patients with suboptimal weight loss and GLP-1 response after bariatric surgery (MBS). Among 57

Table 2 Summary of the current literature on postoperative OMMs for suboptimal initial clinical response and/or recurrent weight gain, including traditional and modern agents

Authors/study type	Medication	Index operation and time since the intervention	Patients	Follow-up	Outcomes
Zoss *et al.*[49] Prospective	Orlistat 240 mg daily	AGB, at least 12–24 months postop	19 orlistat + diet counselling 19 Diet counselling	8 months, with 9 months extension in the orlistat group	8 ± 3 kg orlistat group 3 ± 2 kg counselling group
Hanipah *et al.*[50] Retrospective	Phentermine Phentermine/topiramate extended-release Lorcaserin Naltrexone slow-release/ bupropion slow-release*	RYGB, SG, AGB Median of 38 months postop	126 RYGB 52 SG 21 AGB	12 months	% of patients > 10% TWL RYGB 17.2% AGB 23.5% SG 2.4% $P < 0.001$
Stanford *et al.*[51] Retrospective	Among 15 agents, topiramate, phentermine, metformin, bupropion, and zonisamide were the most prescribed	RYGB, SG At least 12 months postop	258 RYGB 61 SG	Not available	Topiramate was the only medication that demonstrated a 2× more chance of >10% TWL RYGB pts achieved more TWL than SG
Schwartz *et al.*[52] Retrospective	Phentermine or phentermine–topiramate extended-release	RYGB, AGB Time since MBS not available	51 RYGB 14 AGB	3 months	Phentermine (6.35 kg, 12.8% EWL) and phentermine–topiramate extended-release (3.81 kg, 12.9% EWL $P < 0.001$
Istfan *et al.*[53] retrospective	Topiramate, phentermine	RYGB, 6 months to 6 years	350	Up to 11 years	Topiramate and phentermine decrease cumulative WR by about 10% relative to nadir weight and reduce the odds of rapid WR after RYGB
Pajecki *et al.*[54] Retrospective	Liraglutide 1.8 mg	RYGB, AGB, BPD-DS, SG, 2–13 years	9 RYGB 4 AGB 1 SG 1 BPD-DS	28 weeks	A mean of 7.3% TWL among all patients
Rye *et al.*[44] Retrospective	Liraglutide 3 mg	RYGB, SG, VBG, AGB. Time since MBS not available	7 RYGB 7 SG 3 VBG 3 AGB	28 weeks	Median of 9.7% TWL
Vinciguerra *et al*[55] Retrospective	Liraglutide 3 mg	RYGB, SG, AGB, OAGB	119 patients	28 weeks	Mean TWL 9.3 ± 3.6%
Suliman *et al.*[56] Prospectively collected chart data	Liraglutide 3 mg	SG, RYGB, others	120 SG, 47 RYGB, 21 other	4 months	Mean 6.1% TWL
Muratori *et al.*[57] Retrospective	Liraglutide 3 mg	RYGB, SG, AGB 70.7 months ± 43.7	17 RYGB 22 AGB 23 SG	28 weeks	Mean of 12.2% TWL
Wharton *et al.*[45] Retrospective	Liraglutide 3 mg	RYGB, AGB, SG 7.8 ± 5.7 years	53 RYGB 50 AGB 14 SG	Up to 12 months	RYGB 6.6% TWL AGB 4.9% TWL SG 4.5% TWL|
Jamal *et al.*[58] Retrospective	Liraglutide 3 mg	SG, 1–10 years	57	3 months	8.10% TWL
Horber and Steffen[59] Prospective†	Liraglutide 3 mg	RYGB > 6 years	95	24 months	Liraglutide group lost 4.8 ± 2.9 kg/m^2 and pouch trimming plus silastic ring, 5.5 ± 2.9 kg/m^2
Hany *et al.*[60] RCT	Liraglutide up to 3 mg	Conversions of SG into RYGB	38 Liraglutide 31 placebo	12 months	24.1% TWL for Liraglutide 22.7% TWL placebo ($P < 0.001$)
Mok *et al.*[43] RCT	Liraglutide up to 3 mg × placebo	SG or RYGB with ≤20% body weight loss, >12 months after MBS	Lira 35 Placebo 35	6 months	Liraglutide group 8.8% TWL Placebo group 0.5% TWL
Miras *et al.*[42] RCT	Liraglutide 1.8 mg × placebo	SG RYGB > 1 year since MBS	19 SG 51 RYGB	6 months	Mean difference in weight change from baseline to week 26 for liraglutide *versus* placebo of –4.23 kg ($P = 0.0017$) TWL was a secondary endpoint
Lautenbach *et al.*[61] Retrospective	Semaglutide from weekly 0.25 mg. The maximum dose reached was not disclosed	SG and RYGB 64.7 ± 47.6 months	29 SG 15 RYGB	6 months	10.3 ± 5.5% for both operations

(continued)

Table 2 (continued)

Authors/study type	Medication	Index operation and time since the intervention	Patients	Follow-up	Outcomes
Bonnet *et al.*[62]*‡ Retrospective	Semaglutide up to 2.4 mg	SG and RYGB Time since surgery not disclosed	28 SG 8 RYGB	6 moths	Median of 9.1% TWL for both operations
Jensen *et al.*[47] Retrospective	Semaglutide 2.4 mg × Liraglutide 3 mg	RYGB and SG 43–90 months since MBS	29 Sema 21 Lira	6 months	9.8% TWL Sema 7.1% Lira ($P < 0.001$)
Murvelashvili *et al.*[48] Retrospective	Semaglutide 1 mg × Liraglutide 3 mg	SG and RYGB Time since surgery not disclosed	115 Semaglutide 92 Liraglutide	12 months	12.9%TWL Sema 8.8%TWL Lira ($P < 0.001$)
Jamal *et al.*[58] Retrospective	Semaglutide 2.4 mg Tirzepatide up to 15 mg	115 SG 1–15 years	70 Semaglutide 45 Tirzepatide	6 mo	10.3%TWL Semaglutide 15.5% TWL Tirzepatide ($P < 0.05$)
Gazda *et al.*[63]	GLP-1RA × non-GLP1-RA × Lifestyle interventions	80 SG 73 RYGB 54 GB		12 months	1.6%TWL lifestyle interventions 5.6% non-GLP-1RA 6.9% GLP-1RA N.S.§

AGB, adjustable gastric banding; BPD-DS, biliopancreatic diversion with duodenal switch; GLP-1RA, Glucagon-Like Peptide-1 Receptor agonist; MBS, metabolic/bariatric surgery; OAGB, one anastomosis gastric bypass; RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy; VBG, vertical banded gastroplasty; TWL-total weight loss. *The co-morbidities and the relative contraindications present in each patient often govern the choice of weight loss medications. †Liraglutide patients were compared to two other interventions—gastric pouch trimming + silastic ring and endoscopic anastomosis narrowing. Liraglutide was as efficient as the surgical option, with significantly fewer complications. Both had significantly better weight loss than the endoscopic approach. ‡Bonnet *et al.* compared semaglutide in two groups, with and without prior MBS. %TWL was the same. §In a multiple regression analysis, regardless of MBS type, GLP-1RA treatment was the only significant predictor of percentage weight change.

patients who completed the study, the liraglutide group experienced significant weight loss at 24 weeks, 8.8% ± 4.9% with liraglutide 3.0 mg ($n = 31$) *versus* 0.5% ± 3.3% with placebo ($n = 26$; $P < 0.001$), corresponding to a mean difference of 8.0% (95% c.i.: −10.4 to −5.7) in %TWL. Greater than 5% TWL was achieved in 71.9% of cases in the liraglutide group compared to 8.8% in the placebo group. The liraglutide group achieved greater improvements in fasting glucose, HbA1c, blood pressure, and cholesterol. Although gastrointestinal side effects were more common with liraglutide, they were milder than in non-surgical patients, and no serious adverse events occurred.

Differences in weight loss between the BARI-OPTIMISE and GRAVITAS trials may be due to GRAVITAS including only patients with T2D and lower liraglutide doses. Both trials suggested that weight loss continued without plateauing, indicating that longer trials are needed to evaluate liraglutide's long-term efficacy. Several retrospective studies have shown that liraglutide (3.0 mg) effectively promotes weight loss after MBS in patients with suboptimal results[44,45]. Weight loss ranged from 5.5% to 9.7% across treatment periods of 3–12 months, similar to the results in the BARI-OPTIMISE trial. In one study of 145 patients, liraglutide resulted in comparable weight loss for those who had primary surgery (6.0%–6.9% at 6 and 12 months) and revisional surgery (5.0%–6.4%)[46].

No RCTs have been published on the use of semaglutide following MBS. Two retrospective studies (LoE III) compared the effectiveness of 3.0 mg liraglutide and 1.0 mg semaglutide for weight loss. The first study[47] involved 50 patients undergoing MBS who were treated for suboptimal weight loss or recurrent weight gain. Patients received either daily 3.0 mg liraglutide or weekly 1.0 mg semaglutide for 6 months. Results showed that semaglutide led to significantly greater weight loss (median: 9.8%) compared to liraglutide (median: 7.8%), with a higher proportion of patients in the semaglutide group achieving more than 5% total weight loss (86% *versus* 69%). The second study[48], with a larger cohort of 207 patients treated for 12 months, also found that 1.0 mg semaglutide was more effective, resulting in more significant weight loss (12.9%) compared to 3.0 mg liraglutide (8.8%). Both studies indicate that semaglutide at 1.0 mg is more effective for weight loss than liraglutide at 3.0 mg. *Table 2* summarizes the current literature on postoperative pharmacotherapy, including conventional and modern OMMs.

Although there is some evidence on the use of OMMs as adjuncts to MBS in suboptimal initial clinical response or recurrent weight gain, there are no data on starting OMMs before the weight plateau. Ideally, OMMs should be tailored to the patient to optimize weight loss and help improve obesity-associated complications[64].

Obesity management medications *versus* revisional surgery

Deciding between pharmacotherapy, revisional surgery, or conversional surgery for recurrent weight gain after MBS is challenging, as the level of evidence for each strategy is low (LoE III). A retrospective study compared outcomes in 150 patients treated with pharmacotherapy and 27 who underwent conversional surgery[65]. The most common surgery was SG-to-RYGB conversion. Pharmacotherapy involved four medications: phentermine, topiramate, liraglutide, and orlistat, resulting in a mean of 0.7% and 1.9% TWL in patients with suboptimal initial clinical response and recurrent weight gain respectively. In contrast, conversional surgery achieved 23.8% and 17.2% TWL respectively.

Another retrospective study examined liraglutide's effectiveness in patients with recurrent weight gain over 6 years post-RYGB, comparing it to lifestyle modifications, endoscopic transoral outlet reduction, and surgical pouch resizing with Fobi-ring implantation[59]. Liraglutide reduced BMI by 4.8 kg/m² over 24 months, similar to the 5.5 kg/m² reduction seen with pouch resizing. Unlike the endoscopic group, both liraglutide and surgical revision demonstrated significant improvements in obesity-related complications.

The variability in outcomes between pharmacotherapy and surgical interventions across studies is influenced by the specific medications and types of surgeries used. Revisional surgeries carry higher risks of complications compared to primary surgeries, making modern pharmacotherapy a promising option for those at high surgical risk[66].

Discussion

This review of the existing literature highlights the evidence about the use of traditional and modern OMMs before and after MBS. OMMs have been shown to accelerate preoperative weight loss and provide a non-surgical alternative for patients post-MBS that may reduce the need for revisional surgery. However, the current evidence base is limited by the retrospective nature of most studies with inconsistent protocols and few RCTs. Therefore, more well-designed RCTs are needed to validate these findings.

There are several unresolved issues. Long-term benefits of traditional and modern OMMs are not well-documented, with follow-up typically limited to 6–24 months, except the SELECT trial that showed positive cardiovascular outcomes after around 4 years of follow-up[67]. There is evidence that patients may regain weight after stopping OMMs, similar to the patterns observed in chronic disease management, suggesting that continuous medication use may be necessary, as shown in the STEP 1 extension and Surmount 4 trial, which investigated the impact of discontinuing treatment following an initial lead-in period with semaglutide and tirzepatide respectively. These found substantial regain of lost weight during the additional 1-year follow-up after stopping the medications[68,69].

Moreover, individual responses to MBS vary, with many patients experiencing some degree of RWG, complicating the standardization of management guidelines.

Earlier reluctance to use OMMs stemmed from their modest efficacy and safety concerns. However, modern OMMs show improved efficacy and tolerability, potentially revolutionizing obesity management. Early data support integrating OMMs with MBS to optimize long-term outcomes. There is a need for further research into patient selection, timing, and long-term efficacy of these combined strategies, along with addressing cost and accessibility issues to improve patient outcomes.

Although modern OMMs are emerging as valuable options in managing obesity, their role appears to be complementary to MBS, requiring a tailored, multimodal approach to optimize both short-term and long-term outcomes.

Funding

The authors have no funding to declare.

Acknowledgement

R.V.C. and J.Y.P. contributed equally as joint first authors of this study. P.S. and A.D.M. contributed equally as joint last authors of this study.

Disclosure

RVC: received research grants from Johnson&Johnson Medtech and Medtronic. Paid lectures from Johnson&Johnson Medtech, Medtronic and NovoNordisk. GP: educational grants from NovoNordisk, Johnson&Johson Medtech, Olympus and Medtronic. Speakers fees from Medtronic, Meril and Olympus and scientific advisory bord for Lilly and NovoNordisk. MB: Honoraria from Johnson&Johnson Medtech and Medtronic. ClR: grants from the Irish Research Council, Science Foundation Ireland, Anabio, and the Health Research Board; he serves on advisory boards and speakers panels of Novo Nordisk, Herbalife, GI Dynamics, NovoNordisk, Lilly, Johnson & Johnson Medtech, Glia, Irish Life Health, Boehringer Ingelheim, Currax, Zealand Pharma, and Rhythm Pharmaceuticals; PS: lecture fees from Novo Nordisk, grants from Academy of Finland, European Research Council, and Sigrid Juselius Foundation. ADM: Research grants from the Medical Research Council, National Institute for Health and Care Research, Jon Moulton Charitable Foundation, Anabio, Fractyl, Boehringer Ingelheim, Gila, Randox, and Novo Nordisk. ADM has received honoraria for lectures and presentations from Novo Nordisk, AstraZeneca, Currax Pharmaceuticals, Boehringer Ingelheim, Screen Health, GI Dynamics, Algorithm, Eli Lilly, Johnson&Johnson Medtech, and Medtronic. ADM and CWlR are shareholders in the Beyond BMI clinic, which provides clinical obesity care. JYP, CP and MK have nothing to disclose.

Data availability

No data are presented.

Author contributions

Ricardo Cohen (Conceptualization, Methodology, Writing—original draft, Writing—review & editing), Ji Yeon Park (Conceptualization, Methodology, Writing—review & editing), Alexander D Miras (Conceptualization, Methodology, Writing—review & editing), Gerhard Prager (Writing—review & editing), Marco Bueter (Writing—review & editing), Carel Le Roux (Conceptualization, Writing—review & editing), Chetan Parmar (Methodology, Writing—review & editing), Mohammad Kermansaravi (Methodology, Writing—original draft), and Paulina Salminen (Writing—original draft, Writing—review & editing)

References

1. Akalestou E, Miras AD, Rutter GA, le Roux CW. Mechanisms of weight loss after obesity surgery. *Endocr Rev* 2022;**43**:19–34
2. Lingvay I, Cohen RV, Roux CWL, Sumithran P. Obesity in adults. *Lancet* 2024;**404**:972–987
3. Coutinho W, Halpern B. Pharmacotherapy for obesity: moving towards efficacy improvement. *Diabetol Metab Syndr* 2024;**16**:6
4. Pi-Sunyer X, Astrup A, Fujioka K, Greenway F, Halpern A, Krempf M *et al.* A randomized, controlled trial of 3.0 mg of liraglutide in weight management. *N Engl J Med*. 2015;**373**:11–22
5. Wilding JPH, Batterham RL, Calanna S, Davies M, Van Gaal LF, Lingvay I *et al.* Once-weekly semaglutide in adults with overweight or obesity. *N Engl J Med* 2021;**384**:989–1002
6. Jastreboff AM, Aronne LJ, Ahmad NN, Wharton S, Connery L, Alves B *et al.* Tirzepatide once weekly for the treatment of obesity. *N Engl J Med* 2022;**387**:205–216
7. Jastreboff AM, Kaplan LM, Frías JP, Wu Q, Du Y, Gurbuz S *et al.* Triple–hormone-receptor agonist retatrutide for obesity—a phase 2 trial. *N Engl J Med* 2023;**389**:514–526. NEJMoa2301972
8. Melson E, Ashraf U, Papamargaritis D, Davies MJ. What is the pipeline for future medications for obesity? *Int J Obes (Lond)* 2024. doi:10.1038/s41366-024-01473-y. Online ahead of print
9. Barker TH, Stone JC, Sears K, Klugar M, Tufanaru C, Leonardi-Bee J *et al.* The revised JBI critical appraisal tool for

the assessment of risk of bias for randomized controlled trials. *JBI Evid Synth* 2023;**21**:494–506
10. Munn Z, Barker TH, Moola S, Tufanaru C, Stern C, McArthur A *et al.* Methodological quality of case series studies: an introduction to the JBI critical appraisal tool. *JBI Evid Synth* 2020;**18**:2127–2133
11. Kushner BS, Eagon JC. Systematic review and meta-analysis of the effectiveness of insurance requirements for supervised weight loss prior to bariatric surgery. *Obes Surg* 2021;**31**:5396–5408
12. Sun Y, Liu B, Smith JK, Correia MLG, Jones DL, Zhu Z *et al.* Association of preoperative body weight and weight loss with risk of death after bariatric surgery. *JAMA Netw Open* 2020;**3**: e204803
13. Mocanu V, Dang J, Ladak F, Switzer N, Birch DW, Karmali S. Predictors and outcomes of leak after Roux-en-Y gastric bypass: an analysis of the MBSAQIP data registry. *Surg Obes Relat Dis* 2019;**15**:396–403
14. Chinaka U, Fultang J, Ali A, Rankin J, Bakhshi A. Pre-specified weight loss before bariatric surgery and postoperative outcomes. *Cureus* 2020;**12**:e12406
15. Stier C, Koschker AC, Kim M, Stier R, Chiappetta S, Stein J. Fast-track rescue weight reduction therapy to achieve rapid technical operability for emergency bariatric surgery in patients with life-threatening inoperable severe obesity—a proof of concept study. *Clin Nutr ESPEN* 2022;**50**:238–246
16. Martines G, Dezi A, Giove C, Lantone V, Rotelli MT, Picciariello A *et al.* Efficacy of intragastric balloon *versus* liraglutide as bridge to surgery in super-obese patients. *Obes Facts* 2023;**16**:457–464
17. Rubio-Herrera MA, Mera-Carreiro S, Sánchez-Pernaute A, Ramos-Levi AM. Impact of treatment with GLP1 receptor agonists, liraglutide 3.0 mg and semaglutide 1.0 mg, while on a waiting list for bariatric surgery. *Biomedicines* 2023;**11**:2785
18. Cunningham JG, Szoka N, Tabone LE, Cox S, Aylward L, Abunnaja S. Preoperative and early adjuvant weight loss medications in bariatric surgery patients with body mass index over 60 or suboptimal initial response to surgery. *Surg Obes Relat Dis* 2023;**19**:832–840
19. Livhits M, Mercado C, Yermilov I, Parikh JA, Dutson E, Mehran A *et al.* Does weight loss immediately before bariatric surgery improve outcomes: a systematic review. *Surg Obes Relat Dis* 2009;**5**:713–721
20. Conaty EA, Bonamici NJ, Gitelis ME, Johnson BJ, DeAsis F, Carbray JM *et al.* Efficacy of a required preoperative weight loss program for patients undergoing bariatric surgery. *J Gastrointest Surg* 2016;**20**:667–673
21. Werling M, Fändriks L, Vincent RP, Cross GF, le Roux CW, Olbers T. Preoperative assessment of gut hormones does not correlate to weight loss after Roux-en-Y gastric bypass surgery. *Surg Obes Relat Dis* 2014;**10**:822–828
22. Bojsen-Møller KN, Svane MS, Martinussen C, Dirksen C, Jørgensen NB, Jensen JEB *et al.* Primary weight loss failure after Roux-en-Y gastric bypass is characterized by impaired gut-hormone mediated regulation of food intake. *Int J Obes (Lond)* 2023;**47**:1143–1151
23. Lo HC, Hsu SC. Effectiveness of a preoperative orlistat-based weight management plan and its impact on the results of one-anastomosis gastric bypass: a retrospective study. *PLoS One* 2023;**18**:e0289006
24. Malone M, Alger-Mayer SA, Lindstrom J. Use of orlistat 60 mg in the management of weight loss before bariatric surgery. *Ann Pharmacother* 2012;**46**:779–784
25. Morton J, Rivas H, Garcia L, Azagury DE. Utilizing low-dose phentermine for preoperative weight loss prior to bariatric surgery: a prospective, randomized, and placebo-controlled trial. *Surg Obes Relat Dis* 2018;**14**:S33
26. Wilmington R, Ardavani A, Simenacz A, Green C, Idris I. Liraglutide 3.0 mg (Saxenda©) for weight loss and remission of pre-diabetes. Real-world clinical evaluation of effectiveness among patients awaiting bariatric surgery. *Obes Surg* 2024;**34**: 286–289
27. Silveira SQ, da Silva LM, de Campos Vieira Abib A, de Moura DTH, de Moura EGH, Santos LB *et al.* Relationship between perioperative semaglutide use and residual gastric content: a retrospective analysis of patients undergoing elective upper endoscopy. *J Clin Anesth* 2023;**87**:111091
28. Joshi GP, Abdelmalak BB, Weigel WA, Soriano SG, Harbell MH, Kuo CI *et al.* American Society of Anesthesiologists Consensus-Based Guidance on Preoperative Management of Patients (Adults and Children) on Glucagon-Like Peptide-1 (GLP-1) Receptor Agonists. https://www.asahq.org/about-asa/newsroom/news-releases/2023/06/american-society-of-anesthesiologists-consensus-based-guidance-on-preoperative (accessed 8 July 2024)
29. Lingvay I, Sumithran P, Cohen RV, le Roux CW. Obesity management as a primary treatment goal for type 2 diabetes: time to reframe the conversation. *Lancet* 2022;**399**:394–405
30. Mingrone G, Panunzi S, De Gaetano A, Guidone C, Iaconelli A, Capristo E *et al.* Metabolic surgery *versus* conventional medical therapy in patients with type 2 diabetes: 10-year follow-up of an open-label, single-centre, randomised controlled trial. *Lancet* 2021;**397**:293–304
31. Salminen P, Grönroos S, Helmiö M, Hurme S, Juuti A, Juusela R *et al.* Effect of laparoscopic sleeve gastrectomy vs Roux-en-Y gastric bypass on weight loss, comorbidities, and reflux at 10 years in adult patients with obesity: the SLEEVEPASS randomized clinical trial. *JAMA Surg* 2022;**157**:656666
32. Schauer PR, Bhatt DL, Kirwan JP, Wolski K, Aminian A, Brethauer SA *et al.* Bariatric surgery *versus* intensive medical therapy for diabetes—5-year outcomes. *N Engl J Med* 2017;**376**:641–651
33. Cohen RV, Pereira TV, Aboud CM, Zanata Petry TB, Lopes Correa JL, Schiavon CA *et al.* Gastric bypass *versus* best medical treatment for diabetic kidney disease: 5 years follow up of a single-centre open label randomised controlled trial. *eClinicalMedicine* 2022;**53** 101725
34. Courcoulas AP, Patti ME, Hu B, Arterburn DE, Simonson DC, Gourash WF *et al.* Long-Term outcomes of medical management vs bariatric surgery in type 2 diabetes. *JAMA* 2024;**331**:654–664
35. Redmond IP, Shukla AP, Aronne LJ. Use of weight loss medications in patients after bariatric surgery. *Curr Obes Rep* 2021;**10**:81–89
36. Cohen RV, Cummings DE. Weight regain after bariatric/metabolic surgery: a wake-up call. *Obesity* 2020;**28**:1004–1004
37. Ard JD, Beavers DP, Hale E, Miller G, McNatt S, Fernandez A. Use of phentermine–topiramate extended release in combination with sleeve gastrectomy in patients with BMI 50 kg/m^2 or more. *Surg Obes Relat Dis* 2019;**15**:1039–1043
38. Jayaprakash MS, Beavers DP, Miller GD, McNatt S, Fernandez A, Edwards–Hampton SA *et al.* Impact on cardiovascular health of using phentermine/topiramate in combination with laparoscopic sleeve gastrectomy in super obesity. *J Surg Res* 2023;**286**:41–48
39. Thakur U, Bhansali A, Gupta R, Rastogi A. Liraglutide augments weight loss after laparoscopic sleeve gastrectomy: a randomised, double-blind, placebo-control study. *Obes Surg* 2021;**31**:84–92
40. King WC, Hinerman AS, Courcoulas AP. Weight regain after bariatric surgery: a systematic literature review and comparison across studies using a large reference sample. *Surg Obes Relat Dis* 2020;**16**:1133–1144

41. Rudolph A, Hilbert A. Post-operative behavioural management in bariatric surgery: a systematic review and meta-analysis of randomized controlled trials: post-operative behavioural management. *Obes Rev* 2013;**14**:292–302
42. Miras AD, Pérez-Pevida B, Aldhwayan M, Kamocka A, McGlone ER, Al-Najim W *et al.* Adjunctive liraglutide treatment in patients with persistent or recurrent type 2 diabetes after metabolic surgery (GRAVITAS): a randomised, double-blind, placebo-controlled trial. *Lancet Diabetes Endocrinol* 2019;**7**: 549–559
43. Mok J, Adeleke MO, Brown A, Magee CG, Firman C, Makahamadze C *et al.* Safety and efficacy of liraglutide, 3.0 mg, once daily vs placebo in patients with poor weight loss following metabolic surgery: the BARI-OPTIMISE randomized clinical trial. *JAMA Surg* 2023;**158** 1003–1011
44. Rye P, Modi R, Cawsey S, Sharma AM. Efficacy of high-dose liraglutide as an adjunct for weight loss in patients with prior bariatric surgery. *Obes Surg* 2018;**28**:3553–3558
45. Wharton S, Kuk JL, Luszczynski M, Kamran E, Christensen RAG. Liraglutide 3.0 mg for the management of insufficient weight loss or excessive weight regain post-bariatric surgery. *Clin Obes* 2019; **9:**e12323
46. Elhag W, El Ansari W. Effectiveness and safety of liraglutide in managing inadequate weight loss and weight regain after primary and revisional bariatric surgery: anthropometric and cardiometabolic outcomes. *Obes Surg* 2022;**32**:1005–1015
47. Jensen AB, Renström F, Aczél S, Folie P, Biraima-Steinemann M, Beuschlein F *et al.* Efficacy of the glucagon-like peptide-1 receptor agonists liraglutide and semaglutide for the treatment of weight regain after bariatric surgery: a retrospective observational study. *Obes Surg* 2023;**33**:1017–1025
48. Murvelashvili N, Xie L, Schellinger JN, Mathew MS, Marroquin EM, Lingvay I *et al.* Effectiveness of semaglutide *versus* liraglutide for treating post-metabolic and bariatric surgery weight recurrence. *Obesity* 2023;**31**:1280–1289
49. Zoss I, Piec G, Horber FF. Impact of orlistat therapy on weight reduction in morbidly obese patients after implantation of the Swedish adjustable gastric band. *Obes Surg* 2002;**12**: 113–117
50. Hanipah ZN, Nasr EC, Bucak E, Schauer PR, Aminian A, Brethauer SA *et al.* Efficacy of adjuvant weight loss medication after bariatric surgery. *Surg Obes Relat Dis* 2018; **14**:93–98
51. Stanford FC, Alfaris N, Gomez G, Ricks ET, Shukla AP, Corey KE *et al.* The utility of weight loss medications after bariatric surgery for weight regain or inadequate weight loss: a multi-center study. *Surg Obes Relat Dis* 2017;**13**:491–500
52. Schwartz J, Suzo A, Wehr AM, Foreman KS, Mikami DJ, Needleman BJ *et al.* Pharmacotherapy in conjunction with a diet and exercise program for the treatment of weight recidivism or weight loss plateau post-bariatric surgery: a retrospective review. *Obes Surg* 2016;**26**:452–458
53. Istfan NW, Anderson WA, Hess DT, Yu L, Carmine B, Apovian CM. The mitigating effect of phentermine and topiramate on weight regain after roux-en-Y gastric bypass surgery. *Obesity* 2020;**28**:1023–1030
54. Pajecki D, Halpern A, Cercato C, Mancini M, Cleva RD, Santo MA. Tratamento de curto prazo com liraglutide no reganho de peso após cirurgia bariátrica. *Rev Col Bras Cir* 2013;**40**:191–195
55. Vinciguerra F, Piazza L, Di Stefano C, Degano C, Pulvirenti A, Baratta R *et al.* High-dose liraglutide improves metabolic syndrome in poor responders to bariatric surgery. *Front Nutr* 2023;**10**:1183899
56. Suliman M, Buckley A, Al Tikriti A, Tan T, Le Roux CW, Lessan N *et al.* Routine clinical use of liraglutide 3 mg for the treatment of obesity: outcomes in non-surgical and bariatric surgery patients. *Diabetes Obes Metab* 2019;**21**:1498–1501
57. Muratori F, Vignati F, Di Sacco G, Gavazzi L, Pellegrino D, Del Prete M. Efficacy of liraglutide 3.0 mg treatment on weight loss in patients with weight regain after bariatric surgery. *Eat Weight Disord* 2022;**27**:2775–2781
58. Jamal M, Alhashemi M, Dsouza C, Al-hassani S, Qasem W, Almazeedi S *et al.* Semaglutide and tirzepatide for the management of weight recurrence after sleeve gastrectomy: a retrospective cohort study. *Obes Surg*. 2024;**34**:1324–1332
59. Horber FF, Steffen R. Reversal of long-term weight regain after Roux-en-Y gastric bypass using liraglutide or surgical revision. A prospective study. *Obes Surg* 2021;**31**:93–100
60. Hany M, Torensma B, Ibrahim M, Zidan A, Agayabya ASS, Abdelkhalek MH *et al.* Boosting weight loss after conversional RYGB with liraglutide and placebo use. A double-blind randomized controlled trial. *Int J Surg* 2023;**110**:1546–1555
61. Lautenbach A, Wernecke M, Huber TB, Stoll F, Wagner J, Meyhöfer SM *et al.* The potential of semaglutide once-weekly in patients without type 2 diabetes with weight regain or insufficient weight loss after bariatric surgery—a retrospective analysis. *Obes Surg* 2022;**32**:3280–3288
62. Bonnet J, Tournayre S, Anitcheou J, Faivre M, Boegner C, Jalek A *et al.* Semaglutide 2.4 mg/wk for weight loss in patients with severe obesity and with or without a history of bariatric surgery. *Obesity* 2024;**32**:50–58
63. Gazda CL, Clark JD, Lingvay I, Almandoz JP. Pharmacotherapies for post-bariatric weight regain: real-world comparative outcomes. *Obesity* 2021;**29**:829–836
64. Vosburg RW, El Chaar M, El Djouzi S, Docimo S, Choi D, LaMasters T *et al.* Literature review on antiobesity medication use for metabolic and bariatric surgery patients from the American Society for Metabolic and Bariatric Surgery Clinical Issues Committee. *Surg Obes Relat Dis* 2022;**18**:1109–1119
65. Dharmaratnam VM, Lim E, Eng A, Chan WH, Tan HC, Ho E *et al.* Revisional surgery or pharmacotherapy for insufficient weight loss and weight regain after primary bariatric procedure: a descriptive study. *Obes Surg* 2022;**32**:3298–3304
66. Bastos ELS, Salgado W, Dantas ACB, Onzi TR, Silva LB, Albano Á *et al.* Medium and long-term weight loss after revisional bariatric surgery: a systematic review and meta-analysis. *Obes Surg*. 2024;**34**:1917–1928
67. Lincoff AM, Brown-Frandsen K, Colhoun HM, Deanfield J, Emerson SS, Esbjerg S *et al.* Semaglutide and cardiovascular outcomes in obesity without diabetes. *N Engl J Med* 2023;**389**:2221–2232
68. Wilding JPH, Batterham RL, Davies M, Van Gaal LF, Kandler K, Konakli K *et al.* Weight regain and cardiometabolic effects after withdrawal of semaglutide: the STEP 1 trial extension. *Diabetes Obes Metab* 2022;**24**:1553–1564
69. Aronne LJ, Sattar N, Horn DB, Bays HE, Wharton S, Lin WY *et al.* Continued treatment with tirzepatide for maintenance of weight reduction in adults with obesity: the SURMOUNT-4 randomized clinical trial. *JAMA* 2024;**331**:38–48