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BARIATRIC SURGERY (M. KLIGMAN, SECTION EDITOR)

The Case for Bariatric Surgery in Patients with Class 1 Obesity

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Abstract

Purpose of Review This mini-review reports the current research and arguments for extending the inclusion criteria to offer bariatric surgery in the treatment of class 1 obesity (body-mass index of 30–35 kg/m^2) and obesity-related comorbidities.

Recent Findings Recent studies have described the benefit of bariatric surgery in the treatment and resolution of obesity-related comorbidities in patients with class 1 obesity, notably, type 2 diabetes.

Summary Bariatric surgery cremains the single most effective intervention to effectively reduce excess weight and ameliorate metabolic comorbidities. Patients with class 1 obesity have largely been excluded from bariatric surgery due to longstanding guidelines. As societal recommendations for bariatric surgery candidacy have recently broadened, this mini-review examines the most common currently offered bariatric procedures, guidelines and indications, procedure selection, outcomes of notable random control trials and observational studies, safety and cost considerations, as well as medical management and endobariatrics specifically in the context of treating patients with class 1 obesity.

Keywords Bariatric surgery · Diabetes · Overweight · Class 1 obesity · Sleeve gastrectomy · Gastric bypass

Introduction

It is currently estimated that in the United States, 40% of American adults are obese, defined as having a body-mass index (BMI) greater than 30 kg/m^2, and that 18% of adult Americans have class 2 or greater obesity, defined as having a BMI greater than 35 kg/m^2 [1, 2]. In 2017 alone, four million deaths were directly related to sequelae of obesity [3••]. Obesity is now recognized as a chronic and multifactorial disease where an increase in body fat promotes adipose tissue dysfunction, systemic inflammation and results in increased morbidity and mortality. Epidemiologically, the incidence of diabetes, hypertension, dyslipidemia, and other medical comorbidities all increase with weight gain, and decrease with weight loss [4]. Multiple bariatric operations have been developed or have evolved to aid in the patient's ability to achieve significant and sustainable weight loss, leading resolution of their obesity-related comorbidities, when lifestyle interventions have failed to provide sufficient weight loss [5••]. Bariatric procedures, however, have typically been reserved for patients with class 2 or 3 obesity, and often exclude patients with class 1 obesity, with a BMI between 30 and 35 kg/m^2 [6], though more than half of all obese patients fall into the class 1 category [3••]. Herein, the current literature regarding bariatric surgery in patients with class 1 obesity, the outcomes of surgical intervention in the treatment of the patient's obesity, obesity-related comorbidities, and the societal impact of offering bariatric procedures to these patients is concisely reviewed. It is further argued, in agreement with recent evolving national recommendations, that bariatric surgery represents a viable option in patients with Class 1 obesity who have failed medical and lifestyle interventions [7].

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Current Bariatric Procedures

As the incidence of obesity has increased, there have also been considerable advances in the strategies employed to treat obesity. Diet counseling, behavioral therapy, and pharmacological interventions have all been offered as options for improved weight management. Bariatric surgery, however, remains the most efficient treatment intervention to consistently achieve adequate and sustained weight loss in obese patients [8]. Among available bariatric interventions, the Roux-en-Y gastric bypass (RYGB) and vertical sleeve gastrectomy (VSG) have become the most popular [4]. Of the 252,000 bariatric procedures performed each year in the United States, 61% of the procedures are VSG, 17% are RYGB, and gastric bands, duodenal switch or single-anastomosis duodenal switch comprise the small remaining fraction [8].

The RYGB, in which the receptive stomach is converted to a small pouch and an intestinal rearrangement bypasses alimentary surface area, has long been considered the "gold standard" intervention to facilitate excess weight loss [4]. Technically, the RYGB has been modified over the years and, since the turn of the century, has most commonly been performed minimally invasively, via laparoscopy or with robotic assistance [9]. While there has been no observed difference in the percentage of weight loss and the resolution of obesity-related comorbidities between laparoscopic and open RYGB [10], minimally invasive surgery has improved postoperative pain, shortened bowel recovery, decreased length of stay, improved safety and minimized wound complications, allowing the RYGB to be offered to patients older than 65 [11–14].

VSG, where the stomach is tubularized along the lesser curvature to create a "sleeve" of stomach, has since overtaken RYGB as the most popular bariatric procedure over the last decade [4]. Compared to a RYGB, the VSG is technically simpler and quicker to perform, consisting of removal of a portion of the stomach, such that a narrower "sleeve" abutting the lesser curvature is left behind. This ultimately reduces the volume capacity of the stomach, leading to mechanical calorie restriction, as well as a reduction in hunger signals. The safety profile of the VSG is also attractive, with a lower incidence of post-surgical complications than the RYGB [9], although intractable reflux can manifest [15–17].

There has been conflicting evidence, however, between the short and long-term outcomes of the VSG [9]. Some studies suggest that the short-term outcomes of a VSG are equivalent to that of a RYGB, only to show a divergence in weight loss and control of obesity-related comorbidities in the long-term [18–22]. Shoar et al. found that, in 5264 patients evaluated retrospectively, there was not significant difference in excess weight loss (EWL) between VSG and RYGB at 1 and 3 years, however, by 5 years post-procedure the VSG patients had an EWL of 57.3%, inferior to that of RYGB patients (65.7%) [19]. The rate of early and late complications, however, has been found to be overall higher in RYGB compared to VSG [23, 24]. Hu et al.'s systematic review in 2020 found that the rate of early and late complications was much higher in laparoscopic RYGB vs. laparoscopic VSG, although major and minor complications were not separated due to non-uniform complication classifications across the studies analyzed [25]. The observed difference in complication rates has been attributed to the increased technical difficulty of the RYGB, despite the VSG being potentially less potent in EWL than RYGB [4, 8].

Current Bariatric Surgery Guidelines

In 1991, the *National Institute of Health* developed guidelines for the use of bariatric surgery in the treatment of obesity [7, 8]. It was recommended that bariatric surgery be considered for patients that either have a BMI of at least 40 kg/m^2 or have a BMI of at least 35 kg/m^2 with the presence of an obesity-related comorbidity, such as hypertension and diabetes. These guidelines were developed when bariatric surgery was primarily done via laparotomy, with an increased risk and morbidity profile. Therefore, at the time, appropriately balancing the risk and benefit ratios ultimately led to the recommendation of reserving bariatric procedures for patients with class 2 and class 3 obesity [3••].

In the 31 years since the NIH guidelines were published, bariatric procedures have seen considerable advancement, including, most notably, the replacement of open surgery with minimally invasive techniques [3••]. Additionally, the pathophysiology and metabolic effects of obesity have been better scientifically characterized [26, 27]. Considering these advances, the *American Society for Metabolic and Bariatric Surgery* (ASMBS) and the *International Federation for the Surgery of Obesity* (IFSO) jointly released updated guidelines in 2022, recommending bariatric surgery for patients with a BMI of 35 or greater, regardless of the presence or severity of any obesity-related comorbidities [7]. Additionally, it was recommended that bariatric surgery be considered for patients with a BMI between 30 and 34.9 kg/m^2 in the presence of metabolic disease, including diabetes, hypertension, dyslipidemia, and to prevent the progression of liver disease [7]. These new guidelines also recommend considering bariatric intervention in individuals with a BMI of 30 kg/m^2 that do not achieve substantial weight loss or otherwise improve obesity-related conditions using non-surgical interventions. In summary, liberalization of the original NIH criteria represents an evidence-based recalibration of the risk–benefit ratio of bariatric surgery, reflecting advances in safety and postoperative morbidity, resulting in the recommendation for increased access surgical treatment of obesity [28].

Insurance Challenges

Bariatric surgeries remain costly, ranging from $7423 to $33,541, and often require patients to rely on third-party insurers to financially ensure access [29]. Private health insurers and Medicare widely continue to utilize the NIH's 1991 guidelines when considering patient eligibility for coverage of bariatric surgery. As such, most insurance policies require the patient to have the prerequisite class 3 obesity or class 2 obesity with obesity-related comorbidities [6]. A preoperative period of documented weight loss effort through lifestyle and medical management, ranging between 3 and 18 months, is also frequently required [30, 31]. With various insurance hurdles patients must navigate, it is unsurprising that the ASMBS reports that a quarter of patients seeking bariatric intervention are denied three times before obtaining insurance approval [32]. These insurance challenges have also been shown to impact a provider's decision to recommend bariatric interventions to their patients. Funk et al. reported that providers surveyed in Wisconsin indicated they would not feel confident initiating or discussing bariatric surgery due to the uncertainty of whether the patient's insurance would cover the cost of the bariatric surgery [33].

Patients with Class 1 obesity currently face the most significant challenge in getting approval for bariatric surgery, as they are frequently denied coverage solely due to the existing guidelines [3••, 6, 29]. Private insurers regard bariatric surgery as not medically necessary in patients with class 1 obesity, regardless of the presence of obesity-related comorbidities [34]. Wider acceptance of the benefits of bariatric surgery in Class 1 obesity, coupled with the updated guidelines are two steps forward toward removing barriers to insurance coverage, though demonstration of long-term financial benefit must still be demonstrated.

Diabetes as an Indication

Bariatric operations have a positive effect in controlling metabolic disorders, particularly Type 2 diabetes, with between 30 and 72% of patients achieving and maintaining full remission postoperatively [35]. There is compelling evidence that bariatric operations are effective in controlling Type 2 diabetes in patients with class 1 obesity when non-surgical treatment with antihyperglycemic medications and nutritional interventions fail [36]. Studies frequently refer to bariatric operations in the treatment of type 2 diabetes as "metabolic surgeries" to underscore the benefit these procedures have on a patient's metabolic profile [24]. The Diabetes Surgery Summit has also included metabolic surgeries as a treatment in the management of type 2 diabetes in patients with class I obesity [37].

Halpern and Mancini suggest, however, that caution is still warranted when recommending bariatric surgical intervention for Type 2 diabetics in class 1 obesity [37]. These authors note insufficient evidence to broadly include bariatric interventions in diabetic patients. They also identify that several randomized controlled trials have shown that a patient's baseline BMI is unable to accurately predict long-term outcomes, including the estimated EWL and ability to obtain diabetic remission [37]. The resolution of metabolic comorbidities is strongly tied to a patient's percent weight loss. However, it is difficult to accurately determine the actual weight loss a patient will experience following bariatric intervention prior to performing the surgery itself, though advanced estimates can be obtained [38]. As such, one can also not predict the exact impact or resolution of the patient's metabolic comorbidity following the bariatric intervention. The inability to accurately predict the precise impact of an invasive procedure may serve as a barrier for some physicians in recommending surgical intervention in the treatment of class 1 obesity.

Other indications

In addition to type 2 diabetes, obesity can cause myriad other comorbidities including hypertension, cardiovascular diseases, obstructive sleep apnea, and lead to the development of certain cancers [39–41]. Sunborn et al. in a 2017 study of 26,119 patients, reported that RYGB led to improvement in obesity-related comorbidities with a significant reduction in hypertension, dyslipidemia, sleep apnea, as well as fasting glucose within 5 years of surgery [42]. Shoar and Saber, in 2016, reported analogous findings regarding comorbidity reduction for patients that had VSG [19]. Considering these comorbidities are associated with obesity of any stage, as is an overall increase in mortality, physicians should be empowered to initiate a conversation about bariatric surgical intervention for class 1 obese patients. Currently, though, this is often not the case due ostensibly to a combination of a misperception of surgery eligibility, misperception of benefits in Class 1 obesity, and the expected barrier of insurance coverage [43].

Procedure Selection

The choice of procedure in made between the patient and bariatrician, with multiple factors considered. While RYGB has been shown to potentially result in a more robust weight loss in observational studies, the actual difference between

EWL may be minimal and of arguable clinical significance [9]. It is important to note that both VSG and RYGB achieve sustained EWL of at least 50% after 7 years [44]. When considering the impact of comorbidities, particularly type 2 diabetes, bariatric surgery results in greater resolution compared to non-surgical interventions, regardless of the type of bariatric procedure performed [8]. However, the metabolic improvements may be seen earlier with RYGB, even before a substantial weight loss is observed, whereas the comorbidity resolution in VSG is typically observed only after a substantial weight loss [45]. In some studies, the earlier rate of comorbidity resolution observed in RYGB compared to VSG is equalized after 3 years of follow up when patients in either procedure have lost substantial amounts of weight [35].

Howard et al.'s 2021 analysis of Medicare beneficiaries that received bariatric surgery found that while VSG has a lower cumulative incidence of mortality, complications, and reintervention than a RYGB, VSG had a higher incidence of bariatric revision at 5 years [23]. Revisions are most commonly performed due to inadequate weight loss or weight regain, which can occur in either VSG or RYGB. Additionally, no difference has been found in the quality of life of between VSG and RYGB patients as quantified by the gastrointestinal quality of life index or the Moorehead–Ardelt quality of life questionnaire II in the domains of social relationship, self-esteem, physical activity, and satisfaction concerning work, sexuality, and eating behaviors [25]. In Class 1 obesity, the discussion should be focused on current data examining diabetes resolution in particular, as this is currently the principle indication for bariatric surgery in these patients. There has been a progressive interest in studies examining the impact of bariatric surgery on patients with class 1 obesity, with multiple randomized control trials and observational studies demonstrating significant weight loss and the resolution of diabetes and other obesity-related comorbidities (Table 1). Ultimately, decision of the most appropriate bariatric operation is nuanced, and relies on a multitude of factors that should be explored in shared decision-making between a physician and a patient.

Bariatric Surgery vs Medical Weight Management: Seminal Studies

The Swedish Obese Subjects (SOS) study was the first long-term, controlled trial that provided evidence on the benefits bariatric surgery over medical weight management [5••]. In this study, 2010 patients underwent various bariatric procedures, including gastric banding and RYGB, and were matched with control subjects with obesity that received standard medical care. The mean total body weight loss percentages in participants at 2, 10, 15 and 20 years were – 23%, – 17%, – 16% and – 18% in the bariatric surgical group, and 0%, 1%, – 1% and – 1% in the control group, respectively. The surgical cohort was also associated with a greater reduction in mortality and obesity-associated comorbidities (diabetes, myocardial infarction, stoke, and cancer) compared to standard medical care [5••]. While subjects in the SOS study had BMI's of ≥ 34 kg/m^2, a high BMI did not predict a favorable treatment effect. High baseline glycemic index, however, did predict positive bariatric treatment outcomes, suggesting that bariatric interventions in patients with class 1 obesity with metabolic disorders, such as type 2 diabetes, would benefit from bariatric surgery.

The Surgical Treatment and Medications Potentially Eradicate Diabetes Efficiently (STAMPEDE) trial is an important randomized control trial that compared the efficacy of bariatric surgeries (VSG and RYGB) to medical management in patients with type 2 diabetes with BMI's ranging from 27 to 42 kg/m^2 [35, 70]. Over 5 years, VSG and RYGB in conjunction with medical therapy provided a greater effect in reducing obesity-related comorbidities than medical management alone. Only 5% of patients in the medical management group achieved the study's target end point of a hemoglobin A_{1c} value of 6% or less, compared to 29% in the RYGB and 23% in the VSG groups. The surgical patients also experienced a reduced cardiovascular risk, improved quality of life (via general health scores), and used fewer medications compared to those with only medical management. Though these studies cannot be directly extrapolated to patients with class 1 obesity at the time of surgery, they allow inference of a highly beneficial effect of bariatric surgery as an indispensable adjunct to medical weight management, particularly in those patients with class 1 obesity with insufficient weight loss or glycemic control with medical therapy alone.

Randomized-Controlled and Observational Studies

In 2013, an ASMBS statement reviewed the randomized trials and observational studies that examined the metabolic impact of bariatric surgery in patients with class 1 obesity, concluding that bariatric surgery should remain an accessible intervention, provided non-surgical weight loss attempts are unsuccessful [27]. Notable reviewed studies included O'Brien et al.'s examination of 80 patients with class 1 obesity that were randomized to either non-surgical management (low-calorie diet, pharmacotherapy, and lifestyle changes), or laparoscopic adjustable gastric banding. The surgical cohort had an 21.6% total body weight loss and 87.2% EWL (95% CI, 78–97%) after 2 years with a mean BMI reducing from 33.7 to 26.4 kg/m^2, superior in comparison to the non-surgical group (5.5% initial weight loss and 21.8% EWL) [71]. In Dixon et al.'s

Table 1 Summary of weight loss outcomes in studies of bariatric surgery vs. controls in patients with class 1 obesity

Study*	Type of study	Procedure comparison	N	Study duration/follow Up	Weight loss: bariatric group vs MM group
Horwitz et al. [46]	RCT	(RYGB, VSG, AGB) vs MM	57	3 Years	TBWL: 21.4% vs. 10.3% ($P = .025$)
Chong et al. [47]	RCT	RYGB vs MM	71	3 Years	TBWL: 21.2% vs. 24.5% ($P = .45$)
Schauer et al. [35]	RCT	RYGB vs SG vs MM	150	5 Years	TBWL: 23% vs 18% vs 5% ($P < .05$)
Cummings et al. [48]	RCT	RYGB vs MM	32	1 Years	TBWL: 25.8% vs 6.4% ($P = .009$)
Ikramuddin et al. [49]	RCT	RYGB vs MM	120	3 Years	TBWL: 21.0% vs 6.3% ($P < .001$)
Ding et al. [50]	RCT	AGB vs MM	40	1 Years	TBWL: -− 13.5 kg vs − 8.5 kg ($P = .027$)
Courcoulas et al. [51]	RCT	RYGB vs AGB vs MM	61	3 Years	TBWL: 25% vs 15% vs 5.7% ($P < .01$)
Halperin et al. [52]	RCT	RYGB vs MM	38	1 Years	BMI reduction: 10 kg/m^2 vs 2 kg/m^2
Wentworth et al. [53]	RCT	AGB vs MM	51	5 Years	TBWL: 12% vs. 2%
Parikh et al. [54]	RCT	(RYGB, VSG, AGB) vs MM	57	6 mo	EWL: 60% vs 7%; BMI Reduction: 7 kg/m^2 vs 1 kg/m^2; ($P < .0001$)
Liang et al. [55]	RCT	RYGB vs MM vs MM with exenatide	101	1 Years	BMI Reduction: 15 kg/m^2 vs 0 kg/m^2 vs -3 kg/m^2 ($P < .05$)
O'Brien et al., [56]	RCT	AGB vs MM	80	10 Years	EWL 63% vs 0%; BMI reduction: 14 kg vs 0.4 kg; ($P < .001$)
Dixon et al.'s, [57]	RCT	AGB vs MM	60	2Years	TBWL: 20% vs 1.7% ($P < .001$)
Stenberg et al. [58]	Retrospective	VSG vs MM	1216	5 Years	TBW: 24.4% vs 12.8% ($P < .001$)
Studer et al. [59]	Retrospective	RYGB vs VSG	37	5 Years	EWL: 89.4% vs 86.6%; TBWL: 22.4% vs 21.2; ($P = .4$)
Sen et al. [60]	Retrospective	VSG	143	5 Years	TBWL: 31.8%, EWL: 95.5%; ($P < .005$)
Singh et al. [61]	Retrospective	VSG	20	5 Years	TBWL: 18%; EWL 65.1%
Baldwin et al. [62]	Retrospective	RYGB vs VSG	30	2 Years	TBWL: 18.7% vs 16.5%, ($P = 0.7$); EWL: 84.4% vs. 65.4%, ($P = 0.5$)
Wu et al. [63]	Retrospective	VSG	26	1 Years	TBWL: 26.8%,
Vitiello et al. [64]	Retrospective	(RYGB, VSG, AGB) vs MM	76	10 Years	EWL: 69.1 vs. 14.6%; ($P < 0.001$)
Berry [65]	Retrospective	VSG	252	3 Years	TBWL: 22%, EWL: 75% ($P < .0001$)
Kular [66]	Retrospective	AGB	128	7 Years	EWL: 78%
Noun [67]	Retrospective	VSG	541	1 years	TBWL: 24%
Cohen [68]	Retrospective	RYGB	66	5 Years	TBW: 36%
Parikh [69]	Prospective	AGB	93	3 Years	EWL: 54%

Outcomes of comorbidity resolution not reported in this Table

RCT randomized controlled trial, *RYGB* Roux-en-Y gastric bypass, *VSG* vertical sleeve gastrectomy, *AGB* adjustable gastric banding, *TBWL* total body weight loss, *EWL* excess weight loss (over BMI of 25 kg/m^2), *BMI* body-mass index

trial, 60 patients with recent onset type 2 diabetes were randomly assigned to either laparoscopic adjustable gastric banding, or strictly medical management of diabetes with a focus on lifestyle interventions to lose weight [57]. The surgical group achieved a 20% EWL compared to the 1.4% in the medical management group. Importantly, the surgical group experienced a 73% rate of diabetes remission over 2 years, with a hemoglobin A1c of 6.2% without glycemic therapy compared to 13% of the medical management group. Also reviewed was a double-blind randomized control trial by Lee et al. of 60 patients with uncontrolled diabetes that either received laparoscopic loop "mini" gastric bypass or laparoscopic VSG, reported that 70% of total patients (93% in "mini" gastric bypass and 47% in VSG) achieved diabetes remission, defined in the study as achieving a fasting glucose of 126 mg/dL and a hemoglobin A1c of 6.5% without glycemic therapy at 1 year follow up [72]. The 16 observational studies reviewed in the 2013 ASMBS statement all reported resolution or improvement of obesity-associated comorbidities [27]. The improvements in glycemic control and diabetes remission rates in patients with class 1 obesity were *consistent* with the rates seen in patients with class 2 or class 3 obesity that also underwent bariatric surgery. Additionally, in these 16 studies, cardiovascular risk factors and measures of quality of life also improved following bariatric intervention [27, 73].

Glycemic Control

Ikramuddin et al.'s seminal 2015 Diabetes Surgery Study demonstrated the durability of bariatric surgery's effect on three critical physiologic and metabolic outcomes. A "triple endpoint" (hemoglobin A1c less than 7.0%, LDL cholesterol less than 2.59 mmol/L and systolic blood pressure lower than 130 mm Hg) was evaluated after 2 years among VSG and RYGB patients versus a a cohort who underwent lifestyle and medical management (non-surgical), with BMI's between 30 and 39.9 [36]. In this study, the surgical patients were significantly more likely to achieve the triple endpoint compared to the lifestyle and medical management group (43% vs 14%). Additionally, 75% of the bariatric group obtained a hemoglobin A1c < 7.0% compared to 24% in the non-surgical group. Glycemic control was not sustained in the non-surgical group at 2 years, and none of these patients achieved remission of diabetes, whereas 25% of the bariatric group achieved full remission of and 42% achieved partial remission of their diabetes at 2 years. At 3 years, 28% of the surgical group sustained the triple endpoint compared to 9% of the lifestyle and medical management group [49]. Additionally, at 3 years, 17% of the collective surgical cohort achieved full remission and 19% had partial diabetes, whereas none of the non-surgical cohort achieved full remission. In both the initial and a 3-year follow up study, bariatric surgery was associated with significant improvement of glycemic control, including hemoglobin A1c, fasting blood glucose, and fasting C-peptide. These data collectively suggest a compelling case for the benefits patients with class 1 obesity may derive from bariatric surgery, with particular respect to improvement in glycemic control, a finding corroborated over the next several years.

2018 ASMBS Position Statement

The association with comorbidities, mortality, and impairment in quality of life, along with evidence that medical management is insufficient, were the impetus for the ASMBS statement in 2018 endorsing bariatric surgery in patients with class 1 obesity when non-surgical attempts at weight loss have failed [3••]. In this position statement, 11 systemic reviews and meta-analyses and 12 randomized controlled trials were summarized, demonstrating that bariatric interventions are effective, durable, and safe as weight loss and comorbidity resolution treatments for patients with class 1 obesity.

Several systematic reviews since ASMBS's 2018 statement have also reported the benefits of bariatric surgery in class 1 obesity, finding particular utility in bariatric surgery as a treatment for diabetes. These systematic reviews have observed a significant reduction of hemoglobin A1c and diabetes remission rate as well as improvement in overall cholesterol and triglyceride levels, with no difference between RYGB and SG in achieving Type 2 diabetes remission [26, 74, 75]. Data continues to evolve largely in support of the metabolic benefits of bariatric surgery in patients with Class 1 obesity; the risk–benefit profile of surgery in these patients, however, must also be considered.

Safety and Costs

Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) 30-day data outcomes have shown that the safety profile of VSG and RYGB are excellent in patients with class 1 obesity [76]. Feng et al.'s 2018 study analyzed 8,628 patients where 21.3% received a RYGB and 72.4% received a VSG, with 6.1% receiving gastric banding, and 0.2% receiving a duodenal switch. In this cohort, 33.9% patients had diabetes and 75% had hypertension. The 30-day mortality rate was 0.05%, totaling only 4 cases. The composite morbidity rate over all the bariatric procedures performed on the patients with class 1 obesity was 3.8%. The composite morbidity rates between VSG and RYGB were 2.9% and 7.8%, respectively. The most common postoperative complication was the need for a blood transfusion (0.9% overall), with 0.7% VSG and 1.9% of RYGB requiring one perioperatively [76]. There was also an overall intensive care units admission rate of 0.6%; specifically, 0.4% of VSG patients and 1.4% of RYGB patients. 30-day re-intervention rate, a key outcome measure used in part to confer "Center of Excellence" designations upon bariatric centers in the United States, was 1.3% over the entire cohort. While long-term safety outcomes must still be demonstrated as equivalent as or better than observed in patients with class 2 and class 3 obesity, the incidence of 30-day complications is acceptably low in surgical patients with class 1 obesity.

Additionally, bariatric surgery in patients with class 1 obesity must be cost-effective. Perioperative costs are estimated to be $14,942 for a SG and $15,016 for a RYGB [77]. Bariatric surgery is regarded as being cost-effective in patients with class 2 and class 3 obesity, due to the decreased medical costs associated with long-term comorbidity resolution [78]. In class 1 obesity, cost effectiveness has still been observed due to the resolution of obesity-related comorbidities [18]. While bariatric surgery can address these obesity-related comorbidities, resolution of type 2 diabetes has been reported as the greatest contributor to the observed cost effectiveness [78]. Compared to medical management, the estimated cost effectiveness of bariatric surgery for patients with class 1 obesity ranges between $40,000 and $60,000 gained per quality-adjusted life year (QALY) [3••, 79]. As the commonly accepted ranges for cost effectiveness usually fall between $50,000 and $100,000 per QALY gained, bariatric surgery in class 1 obesity represents a cost-effective option in the treatment of obesity-related comorbidities [79].

Medical Management of Obesity

Medical management and pharmacological intervention options have grown *substantially* in recent years, and these advancements collectively constitute the primary argument against expansion of eligibility of bariatric surgery. While promising, never medications have shown modest impacts in weight management, ranging from 3 to 7% EWL [80]. Several medications used in the reduction of weight were originally developed to treat diabetes, including sodium-glucose cotransporter-2 inhibitors and glucagon-like peptide receptor agonists (GLP-1RAs), and therefore also provide mechanisms for glycemic control [81]. GLP-1RAs have particularly become increasingly popular among providers as a tool for weight loss. GLP-1RAs have an established safety profile and a minimal risk for causing hypoglycemia, even when used for indications not related to glucose control, such as weight loss [81]. A systematic review of eight randomized control trials investigating the GLP-1Ra semaglutide's impact on weight loss reported that a patient can expect an average relative body weight reduction of 10% and an average BMI reduction of 3.7 kg/m^2 [82]. Additionally, a recent systematic review comparing GLP-1RA to bariatric surgery, comprised six randomized controlled trials and 332 patients, reported that mean difference in bariatric interventions vs GLP-1Ras EWL was − 22.7 kg and a mean difference in hemoglobin A1c of − 1.3% [83].

Tirzepatide has emerged as a new medication in the management of obesity and obesity-related comorbidities [84•]. Like other medication targeting obesity, tirzepatide was initially created to treat diabetes, but received United States Food and Drug Administration approval to treat obesity in 2022. One double-blind, randomized, control trial of patients where 94.5% of participants had a BMI of 30 or greater observed an average weight loss on 5 mg, 10 mg, and 15 mg dose of tirzepatide to be a 15.0%, 19.5%, and 20.9% respective percent reduction in total body weight over 72 weeks [85]. This demonstrated superiority of tirezpatide to semaglutide, another common GLP-1RA, in reducing body weight [84•].

Other pharmacological interventions available to treat obesity also include orlistat, phentermine, topiramate and bupropion, often in combination [86], with each of these interventions showing significant weight loss [82, 87–89]. One review observed at least a 5% weight loss on any of these medications, with the combination drug of phentermine-topiramate and liraglutide demonstrating the highest odds of achieving 10% weight loss [86]. These medications are effective tools for augmenting weight loss and, considering the invasive nature of bariatric surgery, it is reasonable to pursue pharmacological interventions prior to electing surgery. However, medications do have side effect profiles and weight regain is frequently observed upon their cessation. While pharmacotherapy is nonetheless critical, severe diabetics with class 1 obesity may require a more aggressive intervention such as surgery to optimally manage their metabolic disease, and may be better served using medication as an *adjunct* to surgical intervention.

Endobariatrics

Endoscopic bariatric interventions have expanded the treatment options of overweight and obesity, with intragastric balloon (IGB) therapy and endoscopic sleeve gastroplasty (ESG) being the most popular procedures [90]. The IGB uses an endoscope to deploy a spherical balloon into the stomach, which is then filled with saline and serves to occupy space and create a sensation of early satiety. The largest review of the efficacy of IGB reported a modest EWL of 33.8% ± 18.7% at 6 months [91]. A subsequent meta-analysis of seven studies, with 409 patients, reported that the IGB has questionable durability, with only 25% of patients maintaining weight loss at 30-month follow up [92]. Chan et al. found, in a randomized control study of 49 IGB patients with a BMI < 35 kg/m^2, that modest weight loss did occur in the first 2 years following IGB, however there was no significant improvement in obesity-related comorbidities, including fasting glucose, systolic blood pressure, or lipid profile at a 10-year follow up post-procedure [93]. While an option for those with class 1 obesity, endoscopic bariatric procedures are typically not covered by insurance, and patients should be counseled of both their high rate of weight recidivism and their lack of established efficacy in improving a patient's metabolic profile.

ESG is an endoluminal vertical gastroplasty where full-thickness sutures are weaved through the greater curvature of the stomach to restrict the volume by 70%, analogous to VSG anatomy [94]. The MERIT study, a multicenter, randomized trial that investigated ESG outcomes in 209 patients with class 1 or class 2 obesity, found after 1 year, ESG patients experienced an EWL of 49.2% compared to 3.2% in a control group [95]. Additionally, at 1 year, 80% of the 51 participants in the ESG group experienced an improvement in the metabolic comorbidities, although 45% of the control group also witnessed a similar improvement. After 2 years, 68% of the ESG group participants maintained an EWL of at least 25%. These results are promising for patients that prefer less invasive interventions, but currently do not produce the same results as bariatric surgery, in terms of EWL durability and long-term improvement in a patient's metabolic profile. Endobariatrics, while still in its infancy, may prove to be a good option for patients with class 1 obesity. As its weight loss outcomes are less robust than with surgery, it is posited ESG may also as a bridge to definitive surgery in the treatment of obesity [93, 96]. Since it is not widely offered, its optimal and most practical role in class 1 obesity remains to be seen.

Conclusion

Class 1 obesity is associated with multiple metabolic comorbidities, an increase in mortality, and a decrease in a patient's quality of life [7, 27]. Moreover, lifestyle and medical management often fail in providing long-term and sufficient weight loss [3••, 36]. As promising medications and endoscopic procedures continue to be developed, bariatric surgery currently remains the single most effective intervention to effectively reduce patients' weight and metabolic comorbidities with an acceptable safety profile [27, 93]. As half of patients with obesity are within class 1, it is necessary that they be availed of high-quality interventions [6], although future studies are warranted to better define the level of benefit these patients can expect in the long-term. Though there is less excess weight to be lost, the metabolic benefits, particularly glucose control, are particularly attractive. The newly updated eligibility guidelines, and continued physician advocacy are two indispensable factors for the progressive acceptance of patients with class 1 obesity to undergo bariatric surgery, a paradigm of obesity treatment that is now sufficiently evidence-based [6, 33].

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- • Of importance
- •• Of major importance

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