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Mini-Review

Long-term Outcomes Following Adolescent Metabolic and Bariatric Surgery

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Abstract

Severe obesity in adolescence negatively impacts upon health and wellbeing. Lifestyle modifications do not usually achieve a sufficient degree or durability of weight loss to mitigate the risk of medical complications. In recent years, metabolic and bariatric surgery (MBS), already a well-established treatment for adults with severe obesity, has emerged as an option in adolescents. Controlled studies in this age group have demonstrated substantial and sustained weight loss, improvements in associated health parameters, and a safety profile surpassing that observed in adult patients. This review aims to present published data on the results of MBS in adolescents with a focus on long-term outcomes. Indications for bariatric surgery and aspects of timing in the young person's life are also presented, along with safety considerations and factors influencing patient selection for surgery. We conclude, predominantly from short- to medium-term outcomes data, that MBS is a safe and valuable therapeutic option for adolescents with severe obesity. Considering the poor health and social wellbeing prognosis in this group, MBS appears to be underutilized. The need for continued research, multiprofessional specialist provision, coherent contemporary clinical guidelines, and routine long-term follow-up in adolescents undergoing MBS is highlighted.

Key Words: adolescents, bariatric surgery, children, guidelines, metabolic and bariatric surgery, obesity

Abbreviations: AMOS, Adolescent Morbid Obesity Study; ASMBS, American Society for Metabolic and Bariatric Surgery; BMI, body mass index; FABS, follow-up of adolescent bariatric surgery; GLP-1, glucagon-like peptide-1; MBS, metabolic and bariatric surgery; RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy; Teen-LABS, Teen-Longitudinal Assessment of Bariatric Surgery; TBW, total body weight.

The prevalence of obesity in adolescents continues to increase globally (1). Adolescents with severe obesity have a greater risk of cardiometabolic disease, impaired quality of life, and shorter life expectancy than peers with normal weight (2, 3). As severe obesity has become more prevalent, extreme disease profiles have emerged. Type 2 diabetes mellitus is increasingly being identified in adolescents and worryingly appears to take a substantially more aggressive form in the young (4), with an earlier need for escalation of pharmacological treatments than in adults (5), and frequent end-stage complications in early adulthood (6). Hypertension, dyslipidemia, and obstructive sleep apnea are all commonplace in adolescents with severe obesity (7, 8).

Bariatric surgery, frequently referred to as metabolic and bariatric surgery (MBS), is now an accepted standard treatment for severe obesity and obesity-associated diseases in adults. Randomized trials (9, 10) and large observational cohort studies, including the controlled Swedish Obese Subjects study (11, 12), have unanimously demonstrated long-term weight loss, improvement in cardiometabolic risk factors, and reduced incidence of cardiovascular disease, cancer, and mortality after MBS in adults.

Initial interventions in children and adolescents with obesity focus on lifestyle modifications (13, 14). However, the effectiveness of such programs is modest, less pronounced than in adults (15), and generally insufficient either as a treatment for obesity or to prevent obesity-related comorbidities, especially in adolescents with severe obesity (16-19). Novel and promising pharmacological treatments are emerging. Their associated weight loss has, thus far, been less than after MBS and achieved by a smaller proportion of patients than MBS. Furthermore, weight gain occurs after treatment discontinuation (20-22). Current usage has also been limited by a reluctance to use medications off license (15).

The weight loss effect and safety profile of MBS in adolescents have been similar to adults in observational studies (7, 8, 23-26). The single existing randomized trial involving MBS in adolescents completed recruitment in 2008 and

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compared weight outcomes over 2 years after laparoscopic gastric banding or intensive nonsurgical treatment (25). Since that trial completed, the field of adolescent MBS has progressed, and alternative procedures are typically favored today. Although an important milestone in the field, the trial's generalizability to adolescents in secondary and tertiary care has been questioned as participants were recruited through advertising (27, 28). A Swedish study comparing adolescents randomized to gastric bypass or intensive nonsurgical treatment, Adolescent Morbid Obesity Study 2 (AMOS2), is ongoing (29).

A number of concerns exist surrounding the use of MBS in the adolescent population. Recognizing the increased risk of nutritional deficiencies (30) and bone health impairment (31), along with heightened psychosocial vulnerability (28, 31, 32) and more risk-taking behaviors (33, 34), it is crucial to consider the mental and social aspects of health and well-being, in addition to the physical aspects that are more frequently reported (35). The potential requirement for additional surgical intervention should also be recognized (8, 23, 26).

For this mini-review, we identified published original data in adolescent MBS outcomes from PubMed. We focus on data beyond 2 years postoperative follow-up.

Indications and Guidance

The indications for surgical intervention of obesity in the adolescent population have largely mirrored those for the adult population, as outlined in the 2018 American Society for Metabolic and Bariatric Surgery (ASMBS) Pediatric guidelines (18).

ASMBS recommends consideration of MBS for adolescents with a body mass index (BMI) ≥140% of the 95th percentile, or a BMI ≥120% of the 95th percentile with an associated comorbidity (hyperlipidemia, hypertension, type 2 diabetes mellitus or insulin resistance, gastroesophageal reflux disease, obstructive sleep apnea, fatty liver disease, orthopedic disease, or idiopathic intracranial hypertension). The guidelines refrain from setting a fixed age, skeletal maturity, or pubertal stage to qualify for bariatric surgery. The patient and family should have the ability and motivation to comply with the preoperative and postoperative treatment regimen. Contraindications to surgery include a medically correctable cause of obesity, an ongoing substance abuse problem, and insufficiently treated psychological or psychiatric challenges. However, while medical, psychiatric, cognitive, or psychosocial conditions that would prevent adherence may delay MBS in order to achieve better stability, such conditions do not usually represent a fixed contraindication to surgery. Also factors outside standard indications may be considered, and adolescents who are candidates for MBS are therefore usually evaluated on a case-by-case basis (18).

The position outlined by ASMBS has been reiterated in the 2022 update to eligibility criteria, jointly endorsed by the International Federation for Surgery for Obesity alongside ASMBS (36). This update also specifically highlights that syndromic obesity, developmental delay, autism spectrum disorder, and history of trauma are increasingly being considered not to be contraindications to surgery (37). Still, results of MBS in patients with syndromic obesity, such as Prader–Willi syndrome, remain controversial (38, 39), and further studies are needed.

Procedures and Mechanisms

The 2 procedures currently in common use are the laparoscopic Roux-en-Y gastric bypass (RYGB) and laparoscopic sleeve gastrectomy (SG). Prior to around 2010, RYGB was the predominant procedure in adolescent patients (7, 8, 24). Subsequently, a global trend has positioned SG as the most performed procedure in adolescents.

In RYGB a loop of jejunum is brought up to a small pouch of the proximal stomach that has been separated from the rest of the stomach using a stapling device. Food enters the small intestine almost directly, bypassing most of the stomach, the duodenum, and the first part of the jejunum (40). The RYGB is reversible, as the gastrointestinal tract is reorganized rather than removing any part of it, although some residual effects would be expected upon reversal.

In SG more than 75% of the stomach is resected using a stapling device along the greater curvature, to create a tube-shaped remnant stomach (40). The resected part of the stomach is removed from the abdominal cavity, making the procedure irreversible.

Another procedure, the adjustable gastric band, has also been used in adolescents. However, this has become less popular, predominantly owing to the frequent need for revisional surgery (41). Figure 1 demonstrates each surgical technique.

There is an urgent need for well-designed trials to guide the choice of procedure and, more specifically, to compare the outcomes of RYGB and SG in adolescents.

Setting of Surgery and the Role of the Multidisciplinary Team

Safe and effective surgery requires an experienced multidisciplinary team in a specialist tertiary MBS center (18, 42). The multidisciplinary team must be able to provide preoperative, perioperative, and postoperative care alongside pharmacological, behavioral, and nutritional support (18).

Supporting adolescents psychologically during MBS is vitally important (31, 43). A suitably experienced pediatric psychologist or psychiatrist should be part of the multidisciplinary team, providing support to both the patient and family. Concomitant psychopathology, including neurodevelopmental disorders, are highly prevalent in adolescents with obesity and professionals should be suitably trained to care for this vulnerable cohort (32, 40, 43-45). For each center, there should be a key contact who coordinates the multidisciplinary team (40). When appropriate, there should be a clear plan for transition to adult care (18).

Alongside an appropriate team, the infrastructure of an MBS center should be suitable for patients with a high BMI. This includes, for instance, larger beds, chairs and wheelchairs, and x-ray equipment, as well as floor-mounted toilets and secure grab rails (18, 46).

Outcomes

Studies of MBS in adolescents have typically focused heavily on weight-related outcomes, sometimes also reporting cardiometabolic and other physical health outcomes, and less commonly describing psychosocial outcomes and quality of life (32, 43, 45, 47, 48). The majority of outcomes data have been limited to the short-term, but medium- to long-term

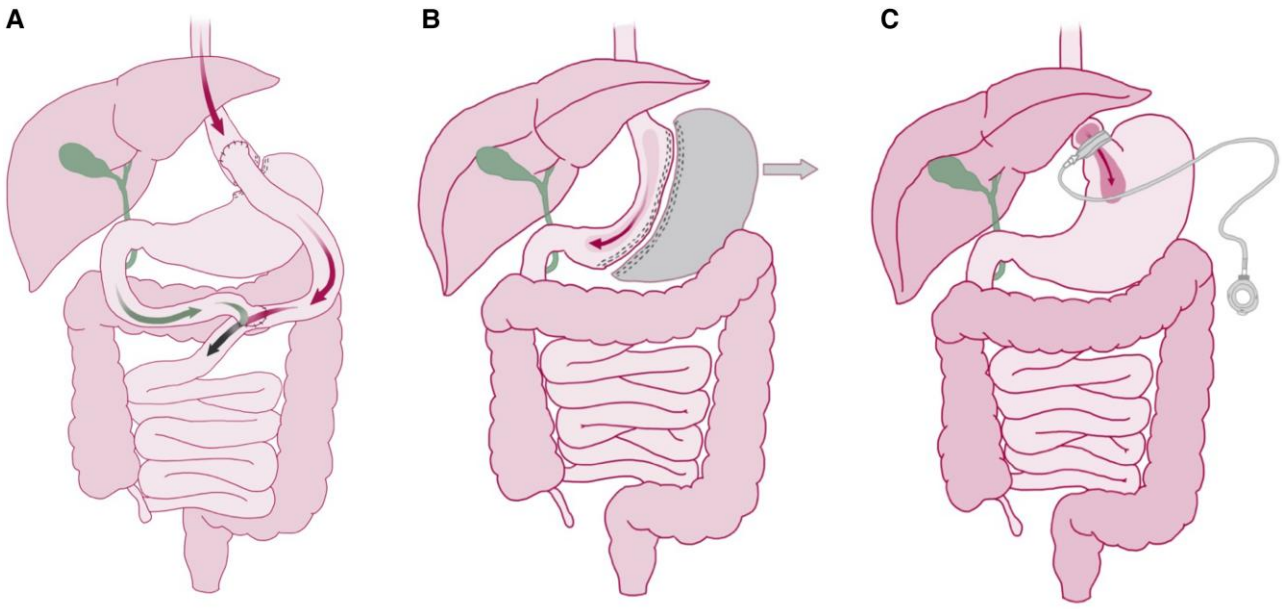

Figure 1. Metabolic and bariatric surgical procedures. (A) Roux-en-Y gastric bypass (RYGB), (B) sleeve gastrectomy (SG), and (C) adjustable gastric band.

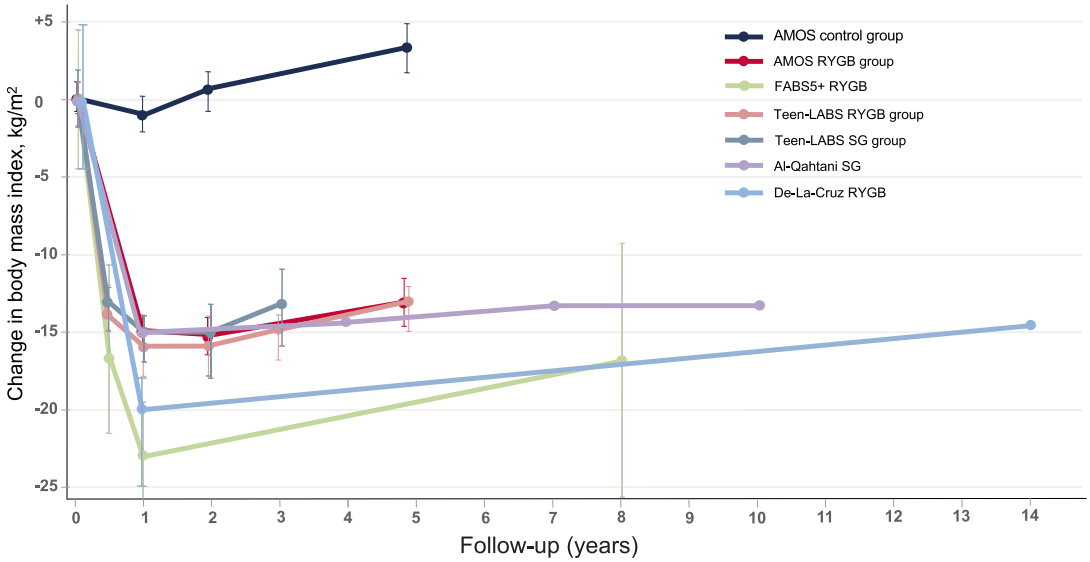

Figure 2. Change in BMI in in studies reporting outcomes to medium to long-term outcomes after adolescent metabolic and bariatric surgery (7, 8, 22, 46, 47). AMOS, Adolescent Morbid Obesity Surgery study; RYGB, Roux-en-Y gastric bypass; FABS-5+, Follow-up of Adolescent Bariatric Surgery after 5+ years study; Teen-LABS, Teen-Longitudinal Adolescent Bariatric Surgery study; SG, sleeve gastrectomy.

outcomes have begun to emerge, including some from high-quality prospective studies (7, 8, 24).

Weight Outcomes

Weight outcomes following MBS vary by procedure but are comparable with those of adults (7, 8). A summary of studies with at least 3-year data on BMI reductions is presented in Fig. 2.

Five years after RYGB, percentage total bodyweight (TBW) losses of 28% and 26% were observed in the Adolescent Morbid Obesity Surgery (AMOS) and Teen-Longitudinal Assessment of Bariatric Surgery (Teen-LABS) studies, respectively (7, 8). This equated to a BMI reduction of around 13 kg/m^2 in each study. After a mean of 8 years following RYGB, the Follow-up of Adolescent Bariatric Surgery at 5+ years (FABS5+) study reported a TBW reduction of 29% and BMI reduction of 16.9 kg/m^2 (24). De la Cruz-Muñoz and colleagues recently reported the longest follow-up to date in 96 young people with a median age of 19 years, making for a slightly older adolescent group. Mean TBW reduction was 31.3% among 96 participants, 87 of whom underwent RYGB, representing a 14.5 kg/m^2 BMI reduction (49).

Following SG, Teen-LABS participants lost a mean 27% TBW over the first 3 years, also representing a 13 kg/m^2 reduction in BMI (23). Alqahtani and colleagues have reported

outcomes from a large cohort, comprising 2504 children and young people (age 5-21 years) undergoing SG. Within the cohort, 932/2504 (37%) were followed to at least 4 years, experiencing a mean BMI reduction of 17.9 kg/m^2, and 559/2504 (22%) of these had been followed to 7 or more years, with a mean BMI reduction of 16.3 kg/m^2 (50).

Additional analysis of participants in the FABS5+ study sought to identify factors associated with long-term weight loss response, finding that none of the measured behavioral factors predicted the strength of the weight response of adolescents. It was observed, however, that higher quality of life scores were associated with greater weight loss (51). While this provokes intrigue regarding the potential relationship between weight-related quality of life and weight response, no causal relationship has been demonstrated, and subsequent data from the AMOS study have shown that improvement in mental quality of life parameters after MBS appears transient, as mean levels return toward baseline status after 2 years (32).

Cardiometabolic Outcomes

A focus on offering early MBS is to improve overall health outcomes in an adolescent cohort. Cardiometabolic risk factors proven to benefit from MBS include hyperinsulinemia, impaired fasting glucose, type 2 diabetes mellitus, dyslipidemia, a chronic inflammatory state, and hypertension (8).

The Teen-LABS study demonstrated that the greater the postsurgical weight loss, the better sustained the reversal of cardiometabolic risk factors and disease processes, and also that adolescents experienced greater improvement in cardiometabolic risk than adults (7). This ongoing prospective study reports outcomes following RYGB, SG, and adjustable gastric band at 3 years, RYGB at 5 years, and with 8-year outcomes expected in the near future.

At 5 years, the overall prevalence of diabetes reduced in the adolescent RYGB cohort, with no participant requiring antidiabetic medication at follow-up, whereas 13/81 (16%) had prediabetes and 3/81 (4%) had diabetes at baseline (7).

With fewer years of exposure, adolescents with obesity less commonly experience hypertension than adults with obesity. Despite this, 15% to 47% of participants had an elevated blood pressure in the AMOS, FABS5+, Teen-LABS, and other observational studies (7, 8, 21, 49, 50). These studies have shown a 58% to 100% remission of elevated blood pressure following MBS, with a concurrent reduction in antihypertensive prescription postoperatively.

In the AMOS study, the cardiorespiratory fitness, measured as maximal oxygen consumption and walking distance, improved at 1 and 2 years after gastric bypass. The improvement in oxygen consumption was greater than could be explained by the loss of fat mass alone (52). Improvement or remission of other comorbidities and cardiometabolic risk factors is seen, both early and into long-term follow-up, within all the studies examined herein. A summary of the proportions experiencing these improvements is given in Table 1.

Psychosocial and Quality of Life Outcomes

Adolescents seeking MBS represent a vulnerable population from a mental health perspective. They report more internalizing problems, such as depression and anxiety, than adolescents from the general population (54, 55). Neuropsychiatric problems are also commonly reported (44). However, mental health problems are also overrepresented in adolescents with severe obesity seeking lifestyle-based interventions (55). So far there is no indication that preoperative mental health problems affect weight outcomes after MBS (32, 56). However, this vulnerability reinforces the importance of follow-up of psychological status and, where required, provision of specialist psychological support.

A 2014 review article highlighted the importance of high-quality literature within this field, identifying only 12 studies meeting criteria for inclusion (45). Early studies suggested that postoperative levels of depressive disorder symptoms significantly improved (46). However, more recent and long-term data suggest that the relationship is more complex and that early improvements are not sustained (32). At 5 years, the overall mood score did not significantly differ from baseline. Five-year weight outcome was associated with mental health at the 2-year follow-up as patients with a higher self-reported mood and self-esteem at 2 years had a greater relative reduction in BMI after 5 years. A conclusion from the AMOS study was that mental health problems persist regardless of treatment pathway (32, 42), again emphasizing the importance of psychosocial support throughout the process of MBS.

Furthermore, sustained improvements in eating-related problems are seen at 4 and 5 years after MBS, including less loss of control over eating, binge eating, and emotional eating than at baseline (32, 57). Eating-related problems reported after MBS are associated with a suboptimal weight outcome, but when such problems are reported before MBS, no association with relative weight loss is evident 4 and 5 years after surgery (32, 57). This suggests that most adolescents with eating-related problems should not be denied MBS, but also suggests, crucially, that special attention should be given to adolescents who struggle to control their eating after MBS.

Overall, however, the improvement in health outcomes following MBS is linked to improved quality of life, and it appears that the physical aspects of quality of life are where participants stand to gain the most benefit (18, 32).

Adverse Effects

There is a risk of long-term nutritional deficiencies following both SG and RYGB, possibly to a greater degree after RYGB (8, 30, 58). Patients require life-long micronutritional supplementation after either procedure; in particular vitamin B_{12}, iron, calcium, and vitamin D.

Long-term bone health in adolescents after MBS is an area requiring further investigation. Studies have demonstrated decreases in bone mineral density across 2 years after MBS in adolescence, although it typically remains within the normal range (31, 59). The reduction in bone mineral density can, in part, be related to a major weight loss. However, alterations in bone turnover related to surgery have also been demonstrated (60) and long-term follow-up of bone health is needed, especially as increased long-term fracture risk has been reported in adults after MBS (61).

Although weight loss can improve symptoms of gastroesophageal reflux, there is a substantial risk of developing reflux after SG partly due to the transformation of the low-pressure normal stomach into a high-pressure sleeve (62). The potential development of chronic esophagitis, Barrett's esophagus, and esophageal dysplasia are of particular relevance to younger patients with a long remaining lifespan (63).

Table 1. Long-term outcomes in cardiovascular risk factors following adolescent MBS (7, 8, 23, 49, 50, 53)

	Baseline					Maximal Follow-up					Resolution at longest follow-up				
Variable	Teen-LABS	AMOS	FABS-5+	Alqahtani et al	de la Cruz-Munoz et al	Teen-LABS	AMOS	FABS-5+	Alqahtani et al	de la Cruz-Munoz et al	Teen-LABS	AMOS	FABS-5+	Alqahtani et al	de la Cruz-Munoz et al
Follow-up (years)	—	—	—	—	—	5	5	8	7 to 10	14.3	5	5	8	7-10	14.3
n	242[a] 161[b]	81	58	2504	96	141	81	58	559	96	—	—	—	—	—
Sex (f)	75%[a] 78%[b]	65%	64%	55%	83%	79%	65%	64%	—	83%	—	—	—	—	—
Age (years)	17	16.5	17.1	15.7	18.8	22	18.5	25.1	—	—	—	—	—	—	—
BMI (kg/m^2)	53[a] 50[b]	46	59	44.8	44.9	37	46	42	31.8	31.7	—	—	—	—	—
Elevated hs-CRP	75%	87%[c] 59%[d]	—	—	—	—	25%[c]	—	—		71%	74%[c]	—	—	—
Hypertension	43%[a] 57%[b]	15%	47%	15%	14%	11%	3%	16%	—	1%	68%[b]	100%	76%	58%	92%
Impaired fasting glucose	26%	20%	—	—	—	—	0%	—	—	—	76%[a]	100%	—	—	—
Hyperinsulinemia	74%	71%	—	—	—	—	4%	—	—	—	79%	94%	—	—	—
Type 2 diabetes	13%[a] 14%[b]	4%	16%	11%	5%	2%	100%	2%	—	0%	86%[b]	100%	88%	72%	100%
Dyslipidemia	76%[a] 36%[b],[e]	69%	86%	9%	15%	6%[e]	15%	38%	—	0%	81%[e]	83%	64%	57%	100%
Renal dysfunction	17%[a]	—	—	—	—	—	—	—	—	—	86%[a]	92%	—	—	—
Liver dysfunction	—	31%	—	—	—	—	5%	—	—	—	—	92%	—	—	—

Missing data within studies resulted in some follow-up resolution percentages that differ from the sum of baseline and follow-up values.
Abbreviations: BMI, body mass index; hs-CRP, high-sensitivity C-reactive protein.
[a]Value based on all Teen-LABS participants.
[b]Value based on Teen-LABS participants undergoing Roux-en-Y gastric bypass and included in 5-year follow-up analyses
[c]hsCRP ≥2 mg/dL.
[d]hsCRP ≥5 mg/dL.
[e]Hypertriglyceridemia reported, not dyslipidemia.

Emerging Therapies

Alternative procedures, increasingly used in adults, have not yet been studied in adolescents. One-anastomosis gastric bypass is such an example where few well-designed comparisons against standard RYGB have been presented. Although a randomized trial in adults reported similar weight outcomes, it failed to demonstrate one-anastomosis gastric bypass to be noninferior to RYGB, as higher incidences of diarrhea, steatorrhea, and nutritional adverse events were observed after one-anastomosis gastric bypass (64). Therefore, it does not appear justified to investigate one-anastomosis gastric bypass procedures in adolescents prior to further comparisons and follow-up data in adults.

Endoscopically inserted gastric balloons have been use for decades and there are some early experiences in pediatric setting (65-67). Balloons have, however, been difficult to integrate into clinical practice, especially due to substantial initial side effects and intolerance that may prompt early removal. Weight regain is expected following balloon removal after the maximal treatment time of 6 to 12 months. In addition, there have been concerns regarding safety and regulators have posted warnings (68).

Advanced endoscopic approaches are now feasible as a result of technological advances. Endoscopic sleeve gastroplasty involves suturing via a transoral endoscope to narrow the stomach from within its lumen and thereby reduce its capacity. This is suggested to offer benefits compared with the SG including its less invasive approach, and greater potential for reversal or revisional surgery later, if necessary (69). A recent randomized trial in adults demonstrated 13% greater weight loss at 1 year than a control group receiving lifestyle treatment (70). However, compared with SG, endoscopic sleeve gastroplasty appears to confer no short-term benefit in risk and inferior reduction of excess weight (62% vs 80%) (70). Thus far, little is known about the long-term safety and durability of endoscopic sleeve gastroplasty.

New and exciting incretin-based pharmacological therapies, such as the glucagon-like peptide-1 (GLP-1) analogs liraglutide (20) and semaglutide (Novo-Nordisk) (71), and the GLP-1 and glucose-dependent insulinotropic polypeptide analog tirzepatide (Eli Lilly) (72), have opened up pharmacological options for weight loss in adolescents, with results in adults showing 15% to 20% weight loss, and emerging data in adolescents. Despite positive findings of around 10% weight loss in adolescents vs placebo (21), the combined medication phentermine/topiramate was recently denied approval by the European Medical Association. Thus far, the only approved incretin-based medication in Europe for obesity is Liraglutide, which has demonstrated modest weight loss (about 5%) (20, 73).

Although results from the use of new medications give rise to high hopes, it remains to be demonstrated that the weight loss effect persists over time. Eventually, data regarding improvements in health outcomes and quality of life over the long-term will be necessary to assess the efficacy and safety compared with MBS.

Multimodal Weight Management

The importance of the suitably qualified specialist multidisciplinary team with experience in the provision of adolescent care has been discussed (18). The breadth of this team is all the more important considering the various adjuncts in the treatment of adolescents with obesity.

As with diseases such as cancer or cardiovascular conditions, no single treatment in isolation is a panacea for all individuals. It is also important to acknowledge that MBS should not be considered a last resort. Adolescents should be referred for surgery in a timely manner when they meet eligibility criteria (74).

When referring for consideration of MBS, the patient must be considered holistically. Medical optimization of the patient preoperatively is crucial. A full assessment must be carried out in order to involve appropriate specialties to address, for instance, cardiovascular, respiratory, or endocrine comorbid disease, depending on patient comorbidity (40).

Early involvement of dietetic teams allows for preoperative optimization of nutrition. The patient and caregivers must understand the importance of long-term dietary modification, vitamin and mineral monitoring, and nutritional supplementation (40).

As previously mentioned, encouraging results from novel medical obesity therapies have recently been reported. However, there is a substantial difference in effect size for weight loss between medications and MBS. Normally >90% of surgical patients lose ≥10% of initial BMI over several years, and often life-long after surgery, compared with 26% with liraglutide and 42% with phentermine/topiramate after 1 year (20, 21). Medications appear attractive as the treatment can be interrupted, not least in adolescent patients. However, data suggest that weight regain should be expected after treatment cessation. Crucial questions in the future will include the sustainability of weight loss in medical therapies and costs and safety for medical therapy from a lifetime treatment perspective.

Medications, including GLP-1 analogs, metformin, and orlistat, can be used as adjuncts to weight loss if MBS has not achieved satisfactory weight loss and in cases of weight regain (19, 75). Further studies are required to assess the efficacy of additional weight loss medications in this population both as a "bridge to surgery" and as a support after surgery.

The Future of MBS

While the use of MBS in adolescents has increased in recent years, only a minor proportion of adolescents who fulfill the indications, and would be expected to benefit, actually have access to surgery. Based on current data, we would expect further expansion of provision within appropriate programs, specifically designed for young people, around the world. MBS should be embedded into the pathway of specialist obesity services treating adolescents with severe obesity.

Although both RYGB and SG have been shown to be safe and effective in adolescents, the procedure of choice remains debated, even in adults. The added complexities surrounding adolescence will be important to investigate beyond the evidence from adults. We have an intention to launch a European randomized trial comparing RYGB and SG in adolescents, the Teen Bypass Equipoise Sleeve Trial (Teen-BEST) (76). Such a trial would add invaluable insights to inform this decision-making.

The optimal timing of MBS in the young person's life is under debate. Long-term follow-up suggests that operating early in adolescence is not harmful to physical development (50). The randomized AMOS2 trial will imminently report

Table 2. Expected data from studies on outcomes from adolescent metabolic and bariatric surgery (8, 23, 29)

Study (ClinicalTrials.gov identifier)	Study design	Reported data	Expected data
AMOS (NCT00289705)	Prospective matched controlled study comparing adolescent RYGB to nonsurgical treatment	5-year outcomes (2017)	10-year outcomes
AMOS2 (NCT02378259)	Randomized controlled trial comparing bariatric surgery to intensive nonsurgical treatment	–	2-year outcomes
Teen-LABS (NCT00474318)	Observational cohort study following up adolescent MBS	3-year outcomes (2016) 5-year outcomes (2019)	8-year outcomes

Full reported data are provided in Table 1.
Abbreviations: AMOS, Adolescent morbid obesity surgery study; AMOS, Adolescent Morbid Obesity Surgery 2 randomized controlled trial; Teen-LABS, Teen Longitudinal Adolescent Bariatric Surgery study; RYGB, Roux-en-Y gastric bypass; MBS, metabolic and bariatric surgery.

outcomes in younger adolescents, aged 13-16 years, undergoing MBS, compared with intensive nonsurgical management (2). Data are also anticipated from 10-year follow-up in the AMOS study (8) and 8-year follow-up in the Teen-LABS study (7) (Table 2). The "silo" approach, where medical and surgical therapies for adolescents with severe obesity are delivered in separate parallel systems, should be challenged. The authors suggest a shift to an approach similar to the oncological multidisciplinary team. All available therapies should be considered on merit and combination therapies, akin to both adjuvant and neoadjuvant therapies in cancer treatment, should be decided upon by a multidisciplinary team. Trials are needed to explore combinations of lifestyle-based interventions, pharmacological agents, and MBS.

The field also needs prospective research to establish prediction models where phenotypes likely to respond to the various therapies can be defined. Genetic profiling, disease status or other factors may inform such prediction models, permitting the advent of precision obesity medicine, to allow avoidance of unnecessary risk, and facilitate early intervention using approaches with the highest likelihood of success. In an approach of personalized medicine, very early identification of children at risk of developing severe obesity and, therefore, most likely to benefit from comprehensive prevention, is most desirable. This would, of course, be preferrable to any invasive procedure.

Conclusion

Although many areas for further investigation remain, the evidence thus far firmly suggests that MBS should be considered standard of care for adolescents with severe obesity. International guidance documents have reinforced this position. It is crucial that a suitably experienced multidisciplinary team should guide the preoperative work-up, the decisions regarding appropriate timing of MBS in the young person´s life, and the postoperative follow-up. Where MBS is indicated, surgery should not be unnecessarily delayed because further weight gain is highly likely, and the final attainable postoperative weight is likely to increase.

Acknowledging the incomplete understanding of the influence of preoperative factors on outcomes, we suggest a relative shift from extensive preoperative evaluation to prioritizing resources for postoperative support to optimize outcomes during follow-up. The delivery of presurgical investigations, surgical interventions, and follow-up should be centralized to specialized multidisciplinary teams.

Future studies in adolescent MBS should continue to assess outcomes in the long-term, in younger adolescents, and in patients with syndromic obesity. The role of pharmacological treatments, such as GLP-1 and combined receptor agonists, including multimodal therapy alongside surgical interventions, must be explored. In addition, comparative outcomes between various surgical techniques need further investigation in adolescents.

Disclosures

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Data Availability

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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