Review Article

Current treatment landscape for obesity in Singapore

Phong Ching Lee[1], MBChB, FRCP, Chin Hong Lim[2], MB BCh BAO, FRCS, Ravishankar Asokkumar[3], MBBS, FRCP, Marvin Wei Jie Chua[4], MBBS, MRCP

[1]Department of Endocrinology, Singapore General Hospital, [2]Department of Upper Gastrointestinal and Bariatric Surgery, Singapore General Hospital, [3]Department of Gastroenterology and Hepatology, Singapore General Hospital, [4]Department of Endocrinology, Sengkang General Hospital, Singapore

Abstract

The rising prevalence of obesity in Singapore is a harbinger for a corresponding increase in obesity-related complications such as type 2 diabetes mellitus (T2DM) and coronary heart disease. Obesity is a complex disease driven by multiple factors, and hence, treatment cannot follow a 'one-size-fits-all' approach. Lifestyle modifications involving dietary interventions, physical activity and behavioural changes remain the cornerstone of obesity management. However, similar to other chronic diseases such as T2DM and hypertension, lifestyle modifications are often insufficient on their own, hence the importance of other treatment modalities including pharmacotherapy, endoscopic bariatric therapy and metabolic–bariatric surgery. Weight loss medications currently approved in Singapore include phentermine, orlistat, liraglutide and naltrexone–bupropion. In recent years, endoscopic bariatric therapies have evolved as an effective, minimally invasive and durable therapeutic option for obesity. Metabolic–bariatric surgery remains the most effective and durable treatment for patients with severe obesity, with an average weight loss of 25%–30% after one year.

Keywords: Endoscopic bariatric therapy, lifestyle modification, metabolic–bariatric surgery, treatment of obesity, weight loss pharmacotherapy

INTRODUCTION

Obesity is defined as a state of abnormal or excessive fat accumulation that may impair health. It is a burgeoning problem not just worldwide, but also locally. Based on the National Population Health Survey 2020, the prevalence of obesity in 2019–2020, denoted by a body mass index (BMI) of 30 kg/m^2, had increased from 8.6% in 2013 to 10.5% in 2017.[1] As the risk for cardiovascular diseases and type 2 diabetes mellitus (T2DM) starts at a lower BMI for Asians, BMI ≥27.5 kg/m^2 denotes a high-risk category for public health action in our local population. Also, 20.7% of our residents were in this high-risk category in 2019–2020,[1] which is an alarming statistic. In fact, it is likely that the prevalence of obesity will continue to increase due to the impact of the coronavirus disease 2019 (COVID-19) pandemic measures imposed to reduce viral transmission, culminating in an increasingly sedentary lifestyle.[2]

The greatest concern with these statistics is the impact on obesity-related complications including T2DM, coronary heart disease, non-alcoholic fatty liver disease and obstructive sleep apnoea.[3] Thus, it is not surprising that the prevalence of T2DM, hypertension and hyperlipidaemia in Singapore has increased from 2017 to 2020, in parallel with the increase in the prevalence of obesity.[1] Obesity also leads to increased mortality and reduced life expectancy.[4] This highlights the urgent need for us to take action to identify and treat obesity. While managing the various physical ailments, we should not forget the adverse effects of obesity on mental health — obesity is associated with an increased prevalence of depression, anxiety and eating disorders.[5] It is important to identify and address these mental health issues for the long-term treatment of obesity to be successful.

The treatment landscape of obesity has evolved over the last few years. The current treatment options for obesity (in order of increasing magnitude of weight loss) include lifestyle modification, anti-obesity pharmacotherapy,

Correspondence: Dr. Phong Ching Lee,
Senior Consultant, Obesity Centre, Singapore General Hospital,
20 College Road, 169856, Singapore.
E-mail: lee.phong.ching@singhealth.com.sg

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endoscopic bariatric therapies (EBTs) and metabolic–bariatric surgery (MBS). In this review, we provide updates on recent evidence in these modalities, with a focus on local data and experience, where available.

LIFESTYLE MODIFICATION

Lifestyle modifications remain the cornerstone of successful weight management. The importance of this can be reinforced through the obesity treatment pyramid, in which lifestyle modifications are at the base, without which the rest of the pyramid (other treatment modalities) would figuratively crumble down. Lifestyle modifications include three main components: dietary interventions, physical activity and behavioural changes.

Dietary interventions

The essential component of all dietary interventions for weight loss is reduction in caloric intake. A diet that contributes to a daily caloric deficit of at least 500 kcal below the estimated daily energy requirements should be recommended.[6,7] Many different diets that claim specific benefits with weight loss have emerged, such as the ketogenic diet, Atkins diet, Mediterranean diet and paleo diet. In general, these diets lead to a significant alteration in the dietary macronutrient composition. For example, the ketogenic diet provides the majority (65%–80%) of calories from fat, 20%–25% of calories from proteins and just 5%–10% of calories from carbohydrates.[8] The major concern is the risk of nutritional imbalance due to omission or excess of certain food groups; for instance, ketogenic diets have been reported to lead to severe hyperlipidaemia.[8] These diets are also highly challenging to maintain for a long term, particularly in our local context in which food choices tend to be predominantly carbohydrate based. Studies have shown that overall caloric restriction, rather than any specific dietary macronutrient composition, is the key factor in determining weight loss.[9] Intermittent fasting is a method of time-restricted energy restriction. However, compared to conventional energy restriction, the weight loss is similar while adherence may be poorer.[10,11] In short, it is important that doctors advise patients to focus on achieving caloric restriction, rather than any specific diet or method.

Meal replacements (MRs) are another useful weight loss modality. They come in various forms including shakes and bars. MRs are hypocaloric (200–250 kcal per serving), yet nutritionally complete. They can be used to replace one or two main meals a day and are particularly convenient when healthy food options are not readily available. MRs can also be used as part of a very-low-calorie diet (VLCD) of <800 kcal/day to replace all meals. The DiRECT study underscored the feasibility of using VLCD in the primary care setting.[12] In this trial, patients with T2DM and obesity took a low-energy formula diet (825–853 kcal/day) for 3 months, followed by structured food reintroduction for 2–8 weeks and then a weight maintenance phase.[12] After 1 year, their mean body weight fell by 10.0 kg. More importantly, 46% of subjects achieved remission of T2DM, defined as glycated haemoglobin (HbA1c) <6.5% after ≥2 months off all anti-diabetic medications.[12] At the end of 2 years, although there was some weight regain with a total weight loss of 7.6 kg, 36% of subjects continued to have remission of T2DM.[13]

Physical activity

Physical activity is an essential component of weight loss and has numerous other weight-independent health benefits, including reducing the risk of cardiovascular disease. We recommend at least 150–300 min of moderate-intensity aerobic exercise or 75–150 min of vigorous aerobic exercise a week, together with strength training exercises for 2 days or more in a week.[6,7] Individuals who are inactive should first start off with light-intensity exercise before progressing to higher-intensity exercise.[7] Instead of a continuous single session, physical activity can also be accumulated in bouts of at least 10 min, which may be useful for our patients with busy schedules and may improve their compliance.[7] In addition, just 10 min of daily exercise has been shown to lead to decreased mortality.[14]

Another meta-analysis has shown that 30–40 min of daily exercise can mitigate the mortality risk associated with a sedentary lifestyle.[15] Physical activity is essential for long-term weight maintenance, as evidenced by the finding that participants who maintained weight loss 6 years after 'The Biggest Loser' competition had increased physical activity compared to their counterparts who regained weight.[16] It should, however, be emphasised that physical activity in the absence of dietary interventions is unlikely to lead to significant weight loss, thus underscoring the importance of combined lifestyle modifications.[17]

Behavioural changes

The third component of lifestyle modifications, behavioural changes, is the key ingredient for weight loss to occur. Research has shown it takes 18–254 days to develop a new habit,[18] underscoring the importance of sustained effort to establish new behavioural patterns. Thus, a multidisciplinary team (MDT) comprising dietitians, physiotherapists, psychologists and nurses is pivotal to the success of any weight management programme. Relevant aspects include education, goal setting, self-monitoring (weight, food intake and exercise), stimulus control and stress reduction.[6] Of note, cognitive behavioural therapy (CBT) was effective in increasing adherence to recommended weight loss behaviour, and weight loss programmes that included CBT strategies were found to achieve greater weight loss.[19]

Studies have shown that patients who attended a higher percentage of treatment sessions and lost more weight early on during a programme had greater long-term weight loss.[6]

This is relevant when designing the structure of a weight management programme; it may be beneficial to have sessions closer together during the early 'intensive' phase. An excellent illustration is the Look AHEAD study.[20] In this trial, the main objective was to achieve and maintain weight loss of ≥7% through comprehensive lifestyle intervention. In the first year, individual or group meetings were arranged every 1–2 weeks, after which the frequency of contact was reduced to once per month.[20] After 8 years, subjects maintained a weight loss of 4.7%, which is more than half the weight loss achieved at the end of the first year (8.5%).[21]

PHARMACOTHERAPY

Pharmacotherapy is an important adjunct to lifestyle modification in the management of obesity, similar to other chronic diseases. Medications may be considered in patients with a BMI of ≥30 kg/m^2, or a BMI of ≥27 kg/m^2 with obesity-related complications.[22] Apart from orlistat, all other weight loss medications work by suppressing appetite and hunger. Pharmacotherapy should be used together with lifestyle intervention as they work synergistically with additive weight loss benefits. Weight loss medications currently approved for use in Singapore include phentermine, orlistat, liraglutide and naltrexone–bupropion combination [Table 1].

Phentermine

Phentermine is a sympathomimetic amine approved for short-term use for treatment of obesity. Due to its low cost and easy administration, it is the most widely prescribed anti-obesity drug in the USA.[23] It leads to placebo-subtracted weight loss of about 3.6–4.5 kg after 6 months.[24] The side effects of phentermine are due to its effects on the sympathetic nervous system and can include insomnia, palpitations and constipation.[25] These side effects are usually mild and can be mitigated by starting at a low dose of 15 mg daily and using the lowest effective dose, uptitrating only as needed.

Phentermine may also variably increase the heart rate and blood pressure, and hence is contraindicated in those with cardiovascular disease or uncontrolled hypertension.[25] Regular blood pressure monitoring should be performed for those on phentermine. Despite the lack of randomised controlled trial (RCT) data, a large cohort study showed that long-term phentermine use is associated with greater weight loss without increased cardiovascular risk.[26] Hence, long-term phentermine use may be considered in low-risk individuals if it is well tolerated and effective.

Orlistat

Orlistat is a lipase inhibitor which reduces the absorption of dietary fat by up to 30%. It is taken at a dose of 120 mg three times a day with meals. Mean placebo-subtracted weight loss of 2.9%–3.4% is observed after 1 year of treatment with orlistat.[27,28] Gastrointestinal side effects, such as steatorrhoea, diarrhoea, oily spotting and faecal incontinence, are common and limit the use of orlistat. Adopting a low-fat and high-fibre diet can reduce some of these side effects.

Liraglutide

Liraglutide is a glucagon-like peptide 1 receptor agonist (GLP-1 RA) approved in Singapore for chronic weight management in adults and adolescents ≥12 years old. It is administered via daily subcutaneous (SC) injections. A large RCT has demonstrated weight loss of 5.6 kg (5.4%) over placebo with 3.0 mg of liraglutide over 1 year.[29] Liraglutide is also favoured to treat T2DM as it does not cause hypoglycaemia or weight gain. The side effects are primarily gastrointestinal and include nausea, vomiting, diarrhoea and constipation; these are usually transient and can be mitigated with gradual dose escalation. Tolerability can be improved by slower dose escalation (e.g. dose increase every 2–3 weeks instead of weekly), as this has only minor impact on the weight loss trajectory.[30] Cardiovascular safety is well established, with demonstrated reduction in cardiovascular events in T2DM patients at high cardiovascular risk.[31]

Naltrexone–bupropion combination

A fixed-dose combination of naltrexone (an opioid antagonist) and bupropion (a dopamine and noradrenaline reuptake inhibitor) recently approved in Singapore has shown an average placebo-subtracted weight loss of 4.8% after 1 year.[32] Common side effects include nausea, headache, insomnia and dry mouth. These side effects can be mitigated with gradual dose escalation, with a maximum total daily dose of 32 mg naltrexone–360 mg bupropion. It is contraindicated in patients with uncontrolled hypertension, seizure disorders, use of monoamine oxidase inhibitors, eating disorders, and drug or alcohol withdrawal.

Next-generation GLP-1 RA

In recent years, newer GLP-1 RA compounds that allow for easier administration and show greater weight loss have been developed. One example is semaglutide, a GLP-1 RA currently available in Singapore in two forms for treatment of T2DM: a daily oral tablet and a weekly SC injection. SC semaglutide 2.4 mg weekly has also been approved in the USA to treat obesity, with demonstrated placebo-subtracted weight loss of 12.4%.[33] A head-to-head study comparing weekly semaglutide 2.4 mg with daily liraglutide 3.0 mg showed that weight loss with semaglutide (15.8%) was more than double that of liraglutide (6.4%).[34] The side effects are commonly gastrointestinal (nausea, diarrhoea, constipation) and typically mild and transient. Semaglutide has also been demonstrated to reduce cardiovascular events in T2DM patients.[35]

Tirzepatide is a dual glucagon-like peptide 1 (GLP-1) and glucose-dependent insulinotropic polypeptide (GIP) administered via weekly SC injection, recently approved for treatment of T2DM in the USA. Various Phase 3 RCTs have shown consistent robust improvements in glycaemic control and body weight without increased risk of hypoglycaemia.[36-38]

Table 1. Pharmacotherapy used for obesity management in Singapore.

	Class of drug	Placebo-subtracted weight loss	Potential side effects	Cardiovascular effects	Glucose-lowering effect	Route
Licenced for short-term use						
Phentermine	Sympathomimetic agent	3.6–4.5 kg	Dry mouth, insomnia, agitation, palpitation	Not suitable in CV disease	Neutral	Tablet (once daily)
Licenced for long-term use						
Orlistat	Lipase inhibitor	2.9%–3.4%	Oily stool, diarrhoea, faecal incontinence	Safe	Neutral	Tablet (up to three times a day)
Liraglutide	GLP-1 receptor agonist	5.4%	Nausea, vomiting, diarrhoea, constipation	Safe, may be of benefit	Benefit	Daily SC injection
Naltrexone–bupropion	Opioid antagonist (naltrexone)/dopamine and noradrenaline reuptake inhibitor (bupropion)	4.2%	Nausea, vomiting, constipation, headache	Safe	Neutral	Tablet (twice daily)
Semaglutide[a]	GLP-1 receptor agonist	14.5%	Nausea, vomiting, diarrhoea, constipation	Safe, may be of benefit	Benefit	Weekly SC injection

[a]Subcutaneous semaglutide is currently approved only for treatment of T2DM in Singapore. CV: cardiovascular, GLP-1: glucagon-like peptide 1, SC: subcutaneous, T2DM: type 2 diabetes mellitus

A recent 72-week RCT in participants with obesity showed impressive weight loss of 20.9% with tirzepatide 15 mg versus 3.1% with placebo.[39] Also, 36.2% of participants achieved weight loss of ≥25%, which approaches the weight loss observed in bariatric surgery. Like other incretin-based therapies, adverse events observed are mostly mild to moderate transient gastrointestinal symptoms.

The 'efficacy–safety' stopping rule

Patients should be reviewed within 3 months of commencement of anti-obesity pharmacotherapy for its safety, tolerability and efficacy.[24] Safety or significant tolerability concerns should prompt immediate cessation of the medication. As with all weight loss interventions, the amount of weight loss induced by pharmacotherapy varies between individuals and follows a largely normal distribution. In patients unable to maintain ≥5% weight loss after 3–4 months of maximum tolerated doses, the medication should be stopped.[6,40] On the other hand, if the medication is well tolerated and effective, it is reasonable to continue it as a long-term management for obesity, similar to treatment of other chronic diseases such as T2DM.

How is the most appropriate pharmacotherapy option selected?

The choice of anti-obesity medication for a given patient should be individualised based on several factors such as the desired weight loss, cost, mode of administration, contraindications, side effects and cardiovascular safety. For example, GLP-1 RA-based therapies provide superior weight loss and have excellent cardiovascular safety and metabolic benefits, but they are more expensive and require SC injections (albeit only once a week for semaglutide and tirzepatide). The 'efficacy–safety' rule may be used to guide the decision to continue or stop the medication in the course of the weight loss journey.

ENDOSCOPIC BARIATRIC THERAPIES

EBTs have evolved as an effective, minimally invasive and durable therapeutic option for obesity and can be classified into gastric and small bowel interventions.[41] They were adapted from bariatric surgical procedures and attempt to mimic the mechanisms of the procedures. The gastric EBTs that are widely performed include intragastric balloons (IGBs) and endoscopic gastroplasties (EGs). In Singapore, both options are available for patients with obesity who show a suboptimal response to lifestyle modifications.

The key determinants of energy intake and eating behaviour are hunger, satiation (volume of food needed to reach fullness) and satiety (duration of fullness), regulated by the gut–brain axis.[42] Most obesity therapies, including IGBs and EGs, have focused on altering the gastric function and/or volume to reduce food intake, induce satiety and promote weight loss in obesity.

EBTs could be considered for a select group of patients after careful assessment by an MDT. The indications for EBT include: (1) patients with BMI ≥27 kg/m^2 with or without medical comorbidities; (2) patients who are unsuitable for or who decline bariatric surgery; and (3) patients with significant weight regain post-bariatric surgery.[43]

Intragastric balloons

IGBs are the most well-established EBTs with substantial supporting evidence. They work by delaying gastric

emptying and inducing early satiety.[44] IGBs differ in their design, filling volume, filling content (air vs. fluid), mode of deployment (endoscopic vs. fluoroscopy) and indwelling time (4–12 months).[45] The Orbera, Spatz and Elipse IGBs are currently available in Singapore.

In the short term (12 months), IGBs effectively induce weight loss ranging between 6% and 15%, compared to a lower weight loss (1%–5%) achieved with lifestyle intervention alone.[46] A meta-analysis demonstrated weight loss of 13.2% at 6 months with Orbera IGB.[47] Likewise, two large real-world studies of IGB demonstrated a favourable safety profile with no mortality, further confirming that IGB is a safe treatment option for obesity.[48,49] However, intolerance symptoms, including nausea and abdominal discomfort, are common in the early phase following IGB implantation and range in incidence between 2.8% and 16.6%.[48,49] A possible solution to minimise these symptoms includes early initiation of analgesia and antiemetics before IGB implantation.

Most of the weight loss occurs in the first few months after treatment with IGB, which is followed by a plateau, likely related to compensatory gastric dilatation, behaviour fatigue and change in resting energy expenditure.[50] Similarly, weight recidivism could occur following IGB removal. Continued follow-up with the MDT, concomitant use of adjuvant pharmacotherapy and personalisation of treatment would assist in weight loss maintenance.

Endoscopic gastroplasty

EGs are non-surgical procedures that involve suturing the stomach lumen and reducing its volume by 75%–80%, similar to surgical sleeve gastrectomy. This technique preserves the gastric anatomy and neurovascular supply. There are currently two EG platforms — endoscopic sleeve gastroplasty (ESG; Apollo Endosurgery, Austin, TX, USA) and primary obesity surgery endoluminal 2.0 (POSE-2.0; USGI Medical, San Clemente, CA, USA). Both interfere with gastric motility and accommodation, resulting in satiation.[51-53] We have pioneered the ESG procedure in Singapore, while POSE-2.0 will be introduced by 2023. The differences between the two procedures are the suture pattern (continuous vs. intermittent) and the suture material. ESG is generally associated with a significantly lower adverse event rate compared to laparoscopic sleeve gastrectomy (LSG). The pooled rate of all adverse events with ESG was 2.9% compared to 11.8% with LSG.[54] The reported adverse events with ESG include pain or nausea (1.08%), gastrointestinal bleeding (0.56%), perigastric collection (0.48%), pulmonary embolism (0.06%) and pneumoperitoneum (0.06%).[55]

In our extensive experience of performing ESG [Figure 1], we found weight loss of 16.2% and 20% at 6 and 12 months, respectively. Additionally, the patients showed significant improvement in T2DM, hypertension and fatty liver disease. The average period of stay was 24 h, and all patients recovered immediately without requiring prolonged bed rest or medications. None developed serious complications.[56] Our experience is aligned with the MERIT RCT and other published studies describing the short- and medium-term efficacy (5 years) of ESG together with an excellent safety profile (complication rate <2%).[57-59] The reversible nature of ESG and its positive impact on quality of life have extended its application to the adolescent population. Nonetheless, adherence to lifestyle modifications and multidisciplinary follow-up is essential for weight loss maintenance.[60]

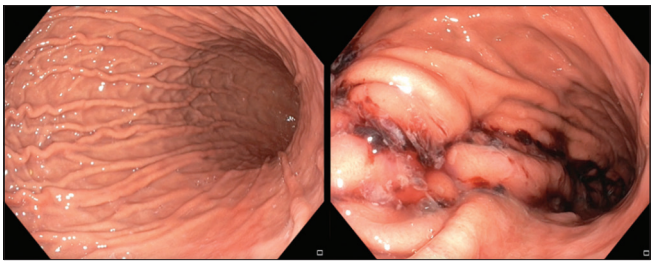

Figure 1: Endoscopic images of the stomach before and after endoscopic sleeve gastroplasty for a patient with obesity.

METABOLIC–BARIATRIC SURGERY

From 2004 to 2020, the number of MBS procedures performed in Singapore increased significantly and the procedure had evolved during that period [Table 2]. Earlier procedures such as the laparoscopic adjustable gastric banding (LAGB) have been replaced by procedures with better efficacy. The most popular procedure in Singapore and worldwide is the LSG, followed by the Roux-en-Y gastric bypass (RYGB), while one-anastomosis gastric bypass (OAGB) has regained popularity due to recent endorsement by the American Society of Metabolic and Bariatric Surgery.

MBS remains the most effective and durable treatment for patients with severe obesity, with the average weight loss documented being 25% and 30% for LSG and RYGB, respectively,[22] achieving significant improvement of obesity-related complications such as T2DM.[61] The weight loss of patients is also sustained, with an average weight regain of 5%–10% documented from their lowest weight after 10 years.[62,63] Data from our cohort has shown that 55.9% of patients with T2DM could achieve diabetes remission (HbA1c ≤6% without DM medications) 1 year after bariatric surgery.[64] The significant glycaemic benefit of MBS has led to its endorsement as a recommended treatment option for patients with T2DM and obesity.[65]

The large, sustained weight loss and metabolic improvements observed with MBS are not just due to restriction or malabsorption, but also due to changes in gut hormones, bile acids and gut microbiome, which lead to reduction in hunger and increased satiety.[66] The safety of MBS

Table 2. Metabolic–bariatric surgery procedures from 2004 to 2020 in Singapore.[a]

Type of procedure	2004	2005	2006	2007	2008	2009	2013	2014	2015	2016	2017	2018	2019	2020
LAGB	102	131	52	12	15	17	0	0	0	0	0	0	0	0
LSG	0	0	3	3	5	27	189	193	252	277	292	363	373	256
RYGB	0	0	0	1	2	8	70	103	93	108	110	80	84	61
OAGB	0	0	0	0	0	0	14	0	0	0	0	0	1	19
BPD	0	0	0	0	0	1	1	0	2	0	0	0	0	0
Gastric plication	0	0	0	0	0	0	1	0	0	1	0	0	0	0
Revisional surgery	0	0	0	0	0	0	0	0	0	15	17	21	17	15
Total	102	131	55	16	22	54	275	296	347	401	419	464	475	351

[a]Data from the Obesity & Metabolic Surgery Society of Singapore. BPD: biliopancreatic diversion with duodenal switch, LAGB: laparoscopic adjustable gastric banding, LSG: laparoscopic sleeve gastrectomy, OAGB: one_anastomosis gastric bypass, RYGB: Roux-en-Y gastric bypass

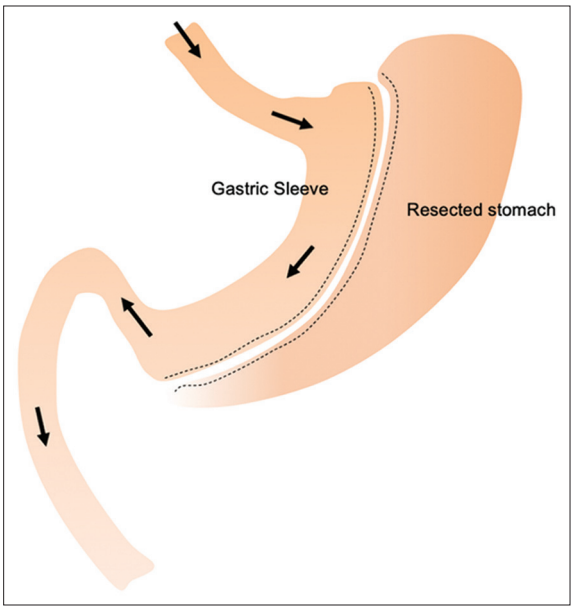

Figure 2: Diagram shows sleeve gastrectomy anatomy.

has improved significantly with a ten-fold decrease in mortality — from 0.5% with RYGB in a meta-analysis published in 2004[67] to 0.05% for LSG in a more recent meta-analysis.[68]

Indications for MBS

Indications for MBS are primarily based on BMI as follows: >40 kg/m^2, or >35 kg/m^2 with obesity-related complications. Locally, these BMI cut-offs are lowered by 2.5 kg/m^2 due to higher propensity for metabolic complications at lower BMI in Asians.[69] Due to better benefit–risk profile of MBS over the years, there have been recent recommendations to further lower the BMI threshold to >35 kg/m^2, or >30 kg/m^2 with comorbidities.[70]

Types of bariatric surgery

Laparoscopic sleeve gastrectomy

In LSG, 60%–80% of the stomach is removed along the greater curvature to create a 'sleeve' of stomach along the lesser curve[71] [Figure 2]. LSG is popular owing to its efficacy and low surgical risk, which is comparable to cholecystectomy.[68]

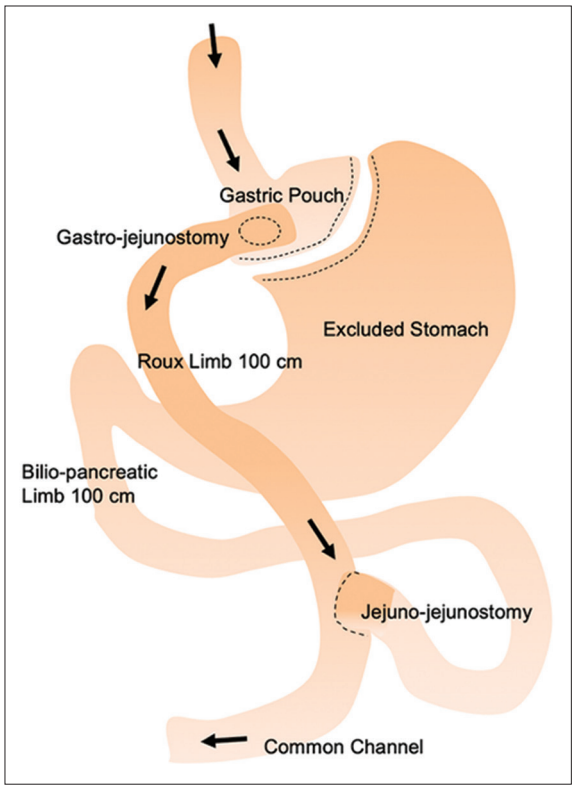

Figure 3: Diagram shows roux-en-Y gastric bypass anatomy.

Because of its quick postoperative recovery, LSG can be done as a short-stay procedure, with most patients requiring just an overnight stay in the hospital.

Roux-en-Y gastric bypass

The RYGB procedure consists of creation of a gastric pouch, which is connected to the distal jejunum to form the Roux limb. The disconnected bilio-pancreatic limb is then anastomosed 75–150 cm along the Roux limb, forming a Y-configuration [Figure 3]. The distal stomach, duodenum and proximal jejunum are thus bypassed, triggering changes in gut hormones and bile acid metabolism. Meta-analyses showed greater weight loss, improved metabolic outcomes and lower incidence of postoperative gastro-oesophageal reflux disease (GERD) with RYGB compared to LSG.[22,72]

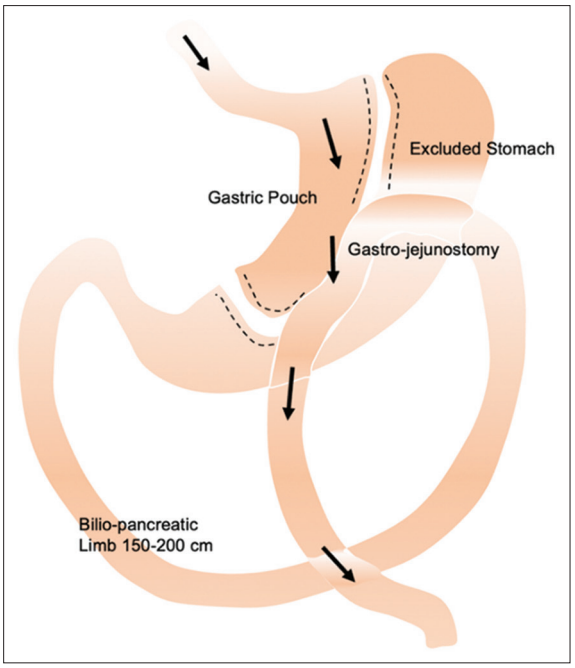

Figure 4: Diagram shows one-anastomosis gastric bypass anatomy.

One-anastomosis gastric bypass

The OAGB operation consists of two components. A narrow lesser-curvature gastric pouch is created, followed by a jejunal bypass with a gastro-jejunostomy anastomosis, bypassing the duodenum and proximal jejunum [Figure 4]. The OAGB is a simpler and safer operation compared to RYGB,[73] with comparable weight loss and metabolic outcomes.[74] Our long-term data showed OAGB achieved greater excess weight loss (EWL) (62.5% in 5 years) and T2DM resolution (71.9%) compared to RYGB and LSG.[75]

Revisional surgery

Revisional surgery is the fastest growing category of MBS worldwide, and the number of revisional surgeries performed tripled from 6% in 2013 to 16.7% of all procedures in 2019. Common indications of revisional surgery are GERD and weight regain following primary surgery. Conversion from LSG to RYGB may engage additional neurohormonal mechanisms that alter energy homeostasis, leading to weight loss.[76] We found that revisional surgery was highly effective in treating GERD post-LSG and produced an additional weight loss of 24% in patients with insufficient weight loss.[77]

Procedure selection and preoperative workup

Once a decision has been made for MBS, systematic nutritional, psychosocial and anatomical assessments should be organised. Screening and optimisation of obesity-related complications should be performed, together with assessment of commitment to lifestyle change and expectations post-surgery via an MDT approach. The choice of procedure depends on factors such as initial BMI, presence of diabetes, GERD, perioperative risk, and patient and surgeon preferences. Although RYGB can result in greater weight reduction and T2DM resolution, mortality and morbidity are higher with the procedure. LSG has a lower rate of perioperative complications, but higher rates of weight regain, which may necessitate future revisional surgery. VLCD of <800 kcal/day is usually prescribed 2 weeks before surgery to reduce hepatic steatosis and improve the technical aspects of surgery.[78]

Complications

Surgical complications or nutritional deficiencies may arise following MBS. Serious surgical complications such as leaks or haemorrhage are rare (<2%). Erosive oesophagitis is common after LSG,[71] and it can be treated with proton pump inhibitors or revisional surgery to RYGB in refractory cases.[77] The pillars of managing surgical complications post-MBS are early diagnosis and a multidisciplinary 'step-up' approach. First-line treatment consists of supportive measures including transfusion and sepsis control, followed by radiological or endoscopic therapy if feasible. Reoperations are reserved for life-threatening complications or if other measures fail.

Through alteration or shortening of the tract, MBS can cause nutritional deficiencies. Thorough nutritional assessment is advised as vitamin D, B_{12}, folate and iron deficiencies are common in patients with severe obesity, and these should be corrected before surgery.[79] Routine supplementation of multivitamin, calcium and vitamin D is recommended after MBS.[80]

Adequate protein intake is essential to mitigate the loss of lean muscle mass, and protein intake of at least 60 g/day and up to 1.5 g/kg ideal body weight/day is recommended.[81] Liquid protein supplements and MR may be considered to achieve target protein intake, especially in the early postoperative period.

DISCUSSION

It is increasingly recognised that obesity is a disorder of the energy homeostasis system, rather than simply due to passive fat accumulation from energy excess.[82] Weight loss is accompanied by a reduction in energy expenditure and resting metabolic rate and changes in appetite-regulating hormones, causing increased hunger and reduced satiety.[83,84] In response to weight loss, these adaptive mechanisms create the perfect 'metabolic storm' for subsequent weight regain.

There are three main considerations in obesity management: efficacy, risks and cost. Lifestyle modification is cheap and accessible and remains the cornerstone of obesity management. However, as lifestyle modifications alone typically achieve only modest long-term weight loss, other treatment modalities are essential. Recent advances in anti-obesity pharmacotherapy show promising results with weight loss, similar to bariatric surgery. However, in the long term, surgery is likely to be more cost-effective, given the high costs of these drugs.[85,86]

EBTs can be considered in those who prefer less-invasive options; they can induce reasonable weight loss and improve the comorbid conditions.

Given that obesity is a complex disease driven by multiple factors, treatment cannot follow a 'one-size-fits-all' approach. Most of the management options discussed may be employed synergistically — pharmacotherapy plays an important role as an adjunct to lifestyle intervention in the weight maintenance phase after initial weight loss with lifestyle intervention[87,88] or in settings of inadequate weight loss or weight regain after bariatric surgery.[89] Endoscopic revisions could be performed to augment weight loss in patients with insufficient weight loss after bariatric surgery.[90]

CONCLUSION

Obesity is a chronic disease associated with multiple systemic complications, and it is increasing in prevalence and starting at a younger age. Stigma is a common, yet under-recognised barrier to the timely treatment of obesity. Although lifestyle modifications remain the cornerstone of successful weight management, they are often insufficient on their own, hence the importance of other treatment modalities including pharmacotherapy, EBTs and bariatric surgery. In particular, the newer pharmacological agents and EBTs are promising modalities that can achieve more weight loss at a lower risk. Weight regain following initial weight loss is extremely common, and multiple treatment modalities may be synergistically adopted to mitigate this.

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Conflicts of interest

There are no conflicts of interest.

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