Original Article

Surgical Management of Obesity – National University Hospital Experience

Asim Shabbir,[1] *MMed, FRCS, FAMS*, Tsuan Hao Loi,[1] *MBBS, MRCS*, Davide Lomanto,[1,2] *MD, PhD*, Thiow Kong Ti,[1,2] *FRCSE, FRACS, FAMS*, Jimmy BY So,[1,2] *MBChB, FRCS, FAMS*

Abstract

Introduction: The Singapore National Survey of 2004 reported the prevalence of obesity to have increased to 6.9%, thus reflecting the profound changes in our society's lifestyle and eating habits. Bariatric surgery has steadily been increasing to counter the ill effects of obesity. Materials and Methods: We audited our prospective series of 31 patients who had laparoscopic adjustable gastric banding (LABG) for morbid obesity performed by our multidisciplinary team at the National University Hospital, Singapore, between August 2004 and December 2006. Results: The median age at presentation was 40 years old including 6 males and 25 females. Their median BMI was 42.35 kg/m^2. At a median follow-up of 26 months, the median percentage of excess weight loss (%EWL) was 41.95%. The positive impact of gastric banding on comorbidities are evident whereby 15 (94%) of the diabetics had improved glycaemic control with HbA_1C of 7.7% preoperatively improving to 5.9% postoperatively, and also 8 (58%) now take smaller doses of oral hypoglycaemic agents. Hypertension improved in 4 patients and 2 (11%) were cured. All our patients with dyslipidaemia had their statin doses reduced with marked lowering of serum lipid levels. We had 2 patients (6.45%) with band erosion and another 2 with reflux oesophagitis. Our article also summarises the available surgical procedures while discussing the pros and cons of each. Conclusion: Our results showed that a multidisciplinary programme can achieve significant weight loss for obese patients in Singapore. To achieve long-term weight loss, a commitment of both the medical team and the patient is necessary. Laparoscopy has revolutionised the practice of bariatric surgery worldwide. LAGB is an effective and safe procedure.

Ann Acad Med Singapore 2009;38:882-90

Key words: Laparoscopic adjustable gastric banding, Outcomes, Surgical technique review

Introduction

The Singapore National survey of 1992 reported the prevalence of obesity to be 5.1%, increasing to 6.0% in 1998, and in the 2004 survey it had increased to 6.9%.[1] The increase reflects the profound changes in our society's lifestyle and eating habits. Today, obesity is not only a threat for the developed nations but is fast eating into the health resources of developing nations. Obesity which was once thought to have resulted from a lack of eating discipline is now increasingly being recognised as a disease that roots from in-born errors of metabolism thus resulting in impaired satiety and increased conversion of calories to fats.[2]

Deurenberg-Yap et al studied the relation between body fat percentage and body mass index (BMI) among Singaporean adults. They found that in comparison to Caucasians, Asians had a higher percentage of body fat at lower BMI. They recommended the obesity cut-off point for Singaporeans to be lowered from 30 kg/m^2 to 27kg/m^2.[3,4] A re-calculation based on a BMI of 27 kg/m^2 would raise the prevalence of obesity in Singapore from 6% to 16%.[5]

Obesity not only results in an increased risk of mortality for matched age[6-8] but these individuals are at a risk for important comorbidities including diabetes, hypertension, obstructive sleep apnoea, depression and impaired quality of life.[9,10] The economic implications in terms of cost for treating these comorbidities are overwhelming.[11] Treatment of morbidly obese individuals with diet, exercise and behavioural intervention results in modest and transient weight loss, so not surprisingly the results of such studies are poor.[12,13] Although we live in hope, currently there is no drug either commercially available or in the research pipeline that promises to be as effective as surgery in

[1] University Surgical Centre, National University Hospital, Singapore
[2] Department of Surgery, National University of Singapore
Address for Correspondence: A/Prof Jimmy So, University Surgical Centre, National University Hospital, 5 Lower Kent Ridge Road, Singapore 119074.
Email: jimmyso@nus.edu.sg

controlling morbid obesity. For today and in the near future, bariatric surgery seems to be the best means of achieving a sustained weight loss and is also effective in reducing associated comorbidities with prolongation of life.[14,15] In a study on gastric bypass outcomes, Pories et al[16] reported an 83% cure of Type II diabetes mellitus at 14 years follow-up. An enormous literature on obesity surgery testifies to improvement and, in many cases, cure of dyslipidaemia, hypertension, obstructive sleep apnoea and joint problems after surgery.[17-19] Also, successful weight loss surgery has been shown to normalise the risk of death and prolong life span in morbidly obese patients.[7,8]

National University Hospital Experience

When compared to the solo practice model, the multidisciplinary team model has the advantage of offering the patient the benefit of a treatment that covers all necessary areas by participation of members of different disciplines. Each individual team member has an ownership and plays a pivotal role in the patient's long-term counselling and behavioural modification. Sharing of information is free within our multidisciplinary group.

On the first visit apart from obtaining a detailed medical history and ordering the necessary investigations, patients are reviewed by the dietician and physiotherapist. The patients continue with medical treatment and monitoring until a point where a decision has to be made for a change in the management plan such as when it is deemed necessary for surgery or medications are thought of.

As dietary changes need to be long-term, the dietician has a fundamental role in management. Our dietician generates and counsels patients on dietary prescriptions, adherence and changes in lifestyle. They cater to the needs of patients who suffer from obesity-associated comorbidities like diabetes and who require a different composition of diet regardless of calorie levels. Moreover, monitoring of patients' dietary patterns to uncover any nutritional deficiency and institute appropriate measures also fall within their domain. Exercise is crucial in obesity for weight loss and maintenance. In our team, the physiotherapist assesses the patient's baseline fitness level, and then develops, monitors and modifies the exercise plan while bearing in mind the impact of obesity- related comorbidities on exercise capacity. Obesity being the resultant of a complex interplay between various causal factors requires the expertise of a physician for assessment, management, counselling and coordination of the multidisciplinary team. In our team, the physician also conducts preliminary screening for eating and mood disorders and is also entrusted with the task of orders for trials of medications. Patients who fail medical management and suitable candidates for surgery are discussed for surgical intervention and counselled for the same. The day-to-day requirements of an obese patient can vary much from those of the general population, and our nursing staff, besides carrying out their traditional functions, are tasked to educate and counsel obese patients as well.

Results

At the National University Hospital, Singapore, between August 2004 and December 2006, we had treated 31 patients with laparoscopic adjustable gastric banding (LAGB) for morbid obesity. Their median age at presentation was 40 years (range, 19 to 62). In this cohort, there were 6 (20%) males and 25 (80%) females with a median BMI (range) of 43.5 kg/m^2 (36.1-54.5) and 41.2 kg/m^2 (30-57), respectively. After a median follow-up of 26 months, the median percentage of weight loss (%EWL) was 41.95% with 45.1% for females and 38.8% for males. In our series, 24 patients had more than one comorbid condition. Hypertension was noted in 18 (58%) of the 31 patients, 16 (51%) were diabetic requiring medical treatment, while 9 (29%) had dyslipidaemia. Fifteen (48%) patients each were afflicted with obstructive sleep apnoea and osteoarthritis. The positive effect of gastric banding on comorbidities are evident in Table 1, Student's *t*-test was used to compare the pre- and postoperative median values with significance set at $P < 0.05$. We noted that 15 (94%) of the diabetics had improved glycaemic control, their HbA1C improved from a median of 7.7% preoperatively to 5.9% postoperatively ($P = 0.001$) with 8 (58%) with their dose of oral hypoglycaemic agents reduced. About a quarter, 4 (22%) of the hypertensive now take lesser doses of anti-hypertensive drugs and 2 (11%) were cured of their hypertension. All 9 (100%) patients with hyperlipidaemia had their statin doses reduced and their serum cholesterol, triglycerides and low-density lipoprotein (LDL) were significantly lowered (Table 1). We had 2 patients (6.45%) with band erosion. Two of our patients also had symptoms of reflux.

Discussion

In our series, 1 patient failed to comply with lifestyle modifications and had a %EWL of only 0.23% that has skewed the data analysis. If his data point is excluded from analysis, the median EWL for males would be 46.0%. However, the median %EWL was 41.95% in our series which is in keeping with those reported in literature of 45% at 24 months median follow-up.[20] In our series, 24 patients had more than one comorbid condition. Obesity is known to be associated with comorbid conditions such as hypertension, diabetes and dyslipidaemia. Not surprisingly, the figures for obesity-related comorbidities of our series are prominently different from the general Singapore population. In the 2004 National Health survey, diabetes, hypertension and dyslipidaemia were reported to be 8.2%, 20.1% and 19.8%[21] versus our obesity related figures of 51%, 58% and 29%,

Table 1. Effect of Laparoscopic Adjustable Gastric Banding on Comorbidities

Comorbidity	n	Parameter	Pre-LAGB	Post-LAGB	*P* value
Diabetes	16	HbA1C (%)	7.7 (5.5-11.4)	5.9 (5.2-9)	0.001
Hyperlipidaemia	9	S. Cholesterol (mmol/L)	5.42 (4.36-6.3)	4.3 (3.6-4.9)	0.001
		S. Triglyceride (mmol/L)	1.7 (0.8-3.1)	1.3 (0.5-1.7)	0.021
		S. LDL (mmol/L)	3.47 (3.08-4.36)	2.50 (2.05-3.24)	0.022
Hypertension	18	Number of medications	2 (1-4)	1 (1-3)	

All values are reported as median (range)

respectively. The positive effect of gastric banding on comorbidities are evident from this study and our results are akin to those in a meta-analysis by Buchwald et al[22] who reported improvements in 80.8% of diabetics, 71.1% of hyperlipidaemics and 70.8% of hypertensives after LAGB. If weight loss and improvement in comorbid conditions are added up, it would not be wrong to say that weight loss surgery has led to a cut in the total cost that could have been spent on lifelong management of our patient's obesity and its related problems. LAGB is deemed a safer procedure with overall mortality of 0.05%.[23] In their series of 1120 patients undergoing Lap banding, O'Brien and Dixon[24] reported an overall complication of 1.5%. However, the figures for morbidity vary ranging from 3.9% to 11.3% in other series.[25,26] The commonly encountered preoperative complications include injuries to structures such as liver and stomach, atelectasis and wound/port site infections. We have no operative adverse events or mortalities to report. The incidence of band slippage which is a late complication has been reported to be 4% to 16%, but there is none in our series. We routinely use the pars flaccida technique which has been shown to have resulted in lowering the incidence of band slippage.[27] Another long-term complication of LAGB is the band eroding into the stomach cavity. The incidence of band erosion ranges from 7.5% to 11.1%.[28,29] We had 2 patients (6.45%) who presented at 7 and 12 months with port site infection and on endoscopy found to have band erosion. These patients complained of mild pain over the port site with associated tenderness and were noted to have increasing weight. The 2 cases had stable band volumes and none went for recent tightening of the band to suggest a source of infection. A computed tomography scan was performed in both cases and these showed fat stranding along the abdominal wall next to the tubing to the reservoir port. Both cases were later confirmed on oesophagoduodenoscopy to have band erosions. Their bands were taken out laparoscopically with an uneventful postoperative course. Two of our patients also had symptoms of reflux. They had oesophago-gastroduodenoscopy that confirmed them to have reflux oesophagitis, which was treated successfully with proton pump inhibitors and dietary modifications without the necessity of loosening the band. The incidence of reflux oesophagitis has been reported to be high in some LAGB series due to its restrictive nature. The general recommendation has been to deflate the band and dietary modification. However, loosening of the band is associated with an increase in weight.[30,31]

Conclusion

Our results showed that a multidisciplinary programme involving surgeons, physicians and paramedical therapists can achieve significant weight loss for obese patients in Singapore. The advent of laparoscopy has revolutionised the practice of bariatric surgery worldwide. LAGB is an effective and safe procedure. To achieve long-term weight loss, a commitment of both the medical team and the patient is necessary.

Literature Review

Multidisciplinary Approach

Bariatric surgery should not be staged as a cosmetic procedure but offered to obese patients as a therapeutic procedure that aims at prolonging life by reducing the chances of premature death.[32] It can never be stressed enough that surgery by itself does not produce long-term favourable results. It has to be coupled with modification in lifestyle to obtain the best outcomes. Thus, management of obesity has to be the domain of a multidisciplinary team. This team can tailor and cater to the needs of individual patients. The essentials of this multidisciplinary team would be a physiotherapist, dietician, physician, bariatric surgeon, anaesthetist, radiologist and dedicated nursing staff.

Goals of Surgery

The goals of surgery in obesity are to achieve a sustained weight loss over a prolonged period of time with least complications and to improve the outcomes of associated comorbid conditions.

Eligibility Criteria

The criteria for eligibility of adult bariatric surgery as per

the National Institute of Heath guidelines are[33]

1. Young patients who are 18 to 55 years old, who are fit for surgery
2. BMI >40 or 35-39 with comorbidities that can be improved with surgery
3. Agreeable to lifelong follow-up
4. Failed conservative treatment

Surgery is contraindicated in patients suffering from major psychiatric illnesses such as depression, psychosis, drug/alcohol dependence and those with prohibitive anaesthetic risk.

Perioperative Management

Prior to surgery, patients need to be educated on what surgery can achieve for them, so that they have realistic expectations. It is important for the patients to understand their commitment to lifelong follow-up, adherence to dietary restrictions and exercise. The anaesthetic risk of surgery is less objective and decisions are usually on ad hoc basis after weighing the risks and benefits of weight reduction. However, this does not go without saying that it is prudent for all patients to be optimised to the maximum prior to surgery. In the postoperative period, patients may need to be nursed in high dependency or intensive care units, antibiotics are advisable and anti-thrombosis prophylaxis is mandatory.[34] Surgery, ideally, should be performed in a high volume centre that not only has the expertise but is also equipped to look after the needs of this special group of patients. This approach has been shown to reduce morbidity and mortality and results in better outcomes.[35]

Open versus Laparoscopic Bariatric Surgery

Interest in bariatric surgery has waxed and waned over the years. The first bariatric procedure, that is, the jejunoileal bypass was performed in 1954 by Kerman.[36] The migration of bariatric procedures from open to laparoscopy technique has been a big step forward in the struggle to decrease postoperative complication rates. Advantages of the laparoscopic approach including decreased postoperative pain, shorter length of hospital stay and early return to work are well established. Open surgery especially in obese patients is known to be associated with an increased risk of wound infection, pulmonary complications and incisional hernias, yet the occurrence of these complications is remarkably low if bariatric surgery is done laparoscopically.[37]

Bariatric Surgical Procedures

Bariatic surgical procedures are broadly divided into restrictive and malabsorbtive procedures based on the primary mechanism by which they accomplish weight loss. Some procedures such as gastric bypass effectively utilise the benefits of both components. While restriction of calorie intake and malabsorbtion are important mechanisms in bariatric surgery, postoperative alterations in the neuroendocrine hormones that regulate appetite, satiety and energy expenditure have been shown to be instrumental in augmenting weight loss.[38,39]

Restrictive Procedures

The pure restrictive procedures are vertical banded gastroplasty and gastric banding. They achieve weight loss by restricting the volume of intake as a result of reduced stomach reservoir capacity after surgery. They are relatively easy to perform as compared to their more complex malabsorbtive counterparts and are associated with fewer complications. After restrictive procedures, strict dietary discipline is prudent for a successful sustained excess weight loss. Patients who consume liquid and semi-solid high calorie diets have high procedural failure rates as these foods easily flow into the remnant stomach without achieving much satiety.

Vertical Band Gastroplasty (VBG)

The VBG involves the creation of a 20 mL proximal gastric pouch. A Gortex mesh is used to create a collar to restrict out flow from the pouch (Fig. 1). The ends of the mesh are overlapped for 1 cm so that in future should dilatation be required, the sutures will give way during dilatation without the need for surgery. VBG is now less commonly performed and this is largely because it is technically more challenging with a higher incidence of complications when compared to gastric banding.

Laparoscopic Adjustable Gastric Banding

The number of gastric banding cases has been steadily rising worldwide. There are many types of bands available for commercial use; all of them have an infusion reservoir, tubing and an adjustable silicone band with a bladder. On the operating table, the patient is placed in Lloyd-Davis position with the upper abdomen upright and the leg fitted with intermittent pneumatic compression devices. The patient is strapped to the table to prevent a fall. A 10-mm port is

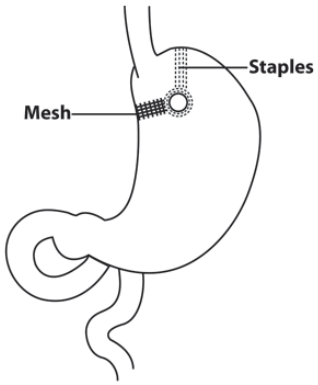

Fig. 1. Vertical band gastroplasty.

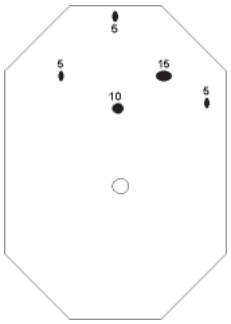

Fig. 2. Laparoscopic adjustable gastric banding port placement.

Fig. 3. Laparoscopic adjustable gastric band.

inserted midway between the xyphoid and the umbilicus with the aid of the optiview trocar. Pneumoperitonium is created and the remaining ports as shown in Figure 2 are inserted under direct vision. A snake liver or Nathanson's liver retractor is used to elevate the liver through the sub-xyphoid port. We use the pars flaccida technique for the creation of a retrogastric tunnel. Starting at the angle of His the gastrophrenic attachments to the left crus are taken down. The pars flaccida of lesser omentum is entered and the right crus identified. The peritoneum over the base of the right crus is divided for a short distance and the dissection deepened. Using a grasper, a retrogastric tunnel is dissected from right to left emerging at angle of His staying as close to the stomach as possible. A Gold finger (Obtech Medical GMBH, Germany) is threaded through this tunnel. The gastric band is inserted through the 15 mm port and retrieved through the retrogastric tunnel after mounting a retrieving suture on the Gold finger's tip. Care needs to be taken to orientate the band so that the bladder faces the stomach and then the buckle is fastened. Four interrupted intracorporeal gastrogastric sutures are placed to cover the band taking care to avoid covering the buckle (Fig. 3). The tubing is retrieved through one of the port and fixed to the reservoir which itself is anchored to the anterior rectus sheath over distal sternum. The patient is allowed to recover and is started on a low calorie liquid diet. The band is adjusted to provide adequate restriction 6 to 8 weeks after surgery. A few sessions may be required before an adequate adjustment is possible.

Malabsorbtive Procedures

The weight loss observed after malabsorbtive surgery results from the minimal contact of digested food with secretions from the liver, pancreas and intestine along with impaired nutrient absorption from the shortened length of the functional small intestine. The malabsorbtive procedures suit people with a sweet tooth well. After consumption of a high sugar meal, the altered anatomy results in a dumping syndrome characterised by light-headedness, nausea, perspiration, abdominal pain and diarrhoea. These unpleasant symptoms generate a negative conditioning bio-feedback.

The length of the common channel has significant bearing on the mixing of ingested food with digestive juices and also on the absorptive surface area. So a shorter common channel will have a shorter contact time for digestion and lesser surface area of absorption. This will translate into greater weight loss with a higher risk of malnutrition.

Commonly performed malabsorbtive procedures are

1. Gastric bypass or more commonly termed Roux en Y gastric bypass (RYGB)
2. Biliopancreatic diversion (BPD)
3. Duodenal switch (DS)

These procedures are more suited for patients with gastroesophageal reflux disease, for diabetics and people who like to eat sweet food.

Jejunoileal bypass was fraught with multiple severe complications such as liver failure, renal stone formation, nutritional deficiencies and high mortality.[40,41] Its importance lies in the caring of those who had undergone jejunoileal bypass and survive to date.

Gastric Bypass

RYGB is technically considered the simplest of the malabsorbtive procedures. The procedure involves creating a 30 mL proximal gastric pouch using a linear cutting stapler leaving the distal gastric remnant separate from the pouch. Then 50 to 100 cm away from the ligament of Trietz, the jejunum is divided and this creates a proximal biliopancreatic limb. Jejunum 150 cm distal from the divided end is anastomosed to the biliopancreatic limb, thus forming a distal common channel and proximal alimentary limb called the "Roux limb". The proximal end of the Roux limb is anastamosed to the gastric pouch creating a tight gastrojejunostomy (Fig. 4). The lengths of the Roux limb and common channel vary depending on the surgeon's choice and patients' BMI.

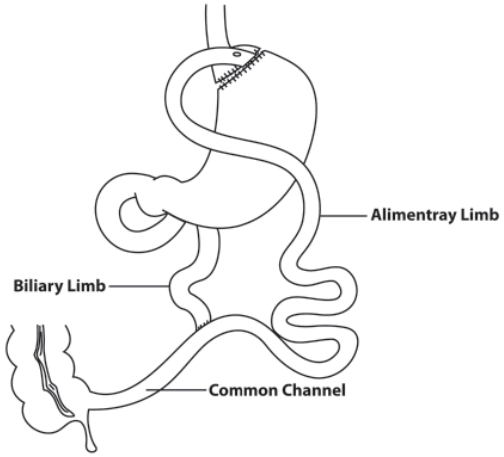

Fig. 4. Roux en Y gastric bypass.

Biliopancreatic Diversion

BPD was pioneered by Scopinaro to address some of the shortcomings of the jejunoileal bypass.[42] The anatomy post-surgery is much like that of RYGB with a few differences (Fig. 5):

1. The gastric pouch has a capacity of about 150 mL. This bigger pouch inherits with it an increased risk of developing stomal ulcers at the gastrojejunostomy site.
2. The remnant stomach is re-sected, which obviates the need for surveillance of the remaining stomach as in RYGB.
3. A longer alimentary limb of 200 cm results in greater weight loss.
4. The common channel is shorter and predisposes patients to severe protein and calorie malnutrition which requires chronic dietary supplements.

This procedure is highly effective but may have higher risks. Considering the challenges posed to surgeons and patients, the role of BPD as a primary procedure for morbid obesity has to be carefully thought out prior to recommending it to patients. However, its place in revisional obesity surgery for those who failed other surgical procedures might be more appropriate.

Biliopancreatic Diversion with Duodenal Switch

Technically, this is the most demanding and complex bariatric procedure with greater perceived preoperative and malnutrition risk in comparison to others.[43] It was designed to overcome nutritional problems associated with BPD. The first step is to perform a sleeve gastrectomy, the technique of which is described further in the text under discussion of sleeve gastrectomy. Following a sleeve gastrectomy, the duodenum is mobilised and transected with a cutting stapler 3 to 5 cm distal to the pylorus; 250 cm from the ileocaecal valve, the ileum is divided with a cutting stapler. The distal ileal loop is anastamosed

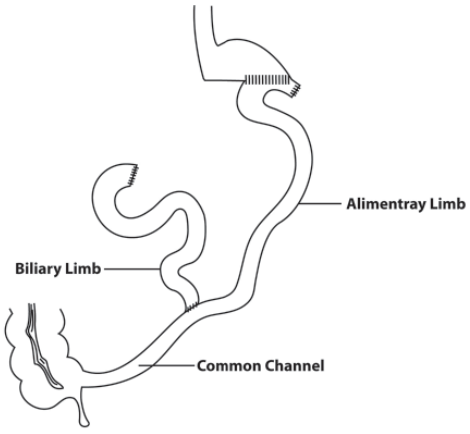

Fig. 5. Biliopancreatic diversion.

end to end to the gastroduoenal stump creating the alimentary loop and, 50 to 100 cm from the ileocaecal valve, the proximal ileal loop is anastamosed to the ileum creating a common channel distally. The proximal loop forms the biliopancreatic loop with an oversewn duodenal stump (Fig. 6).

Miscellaneous Procedures

Sleeve Gastrectomy

In super obese patients with life threatening comorbidities, poor quality of life and high risk for surgery, sleeve gastrectomy offers a safer and less invasive procedure for initial weight loss.[44] Following this when the patient is more stable, a completion procedure can be done as a stage II. The use of sleeve gastrectomy as a definitive restrictive bariatric procedure is increasingly being studied and practiced, but long-term results are still pending.[45] In this procedure, the greater curve of the stomach starting at appoint 6 to 10 cm proximal to the pylorus all the way to the angle of His is freed of greater omentum and vessel secured. Over a 36 French orogastric bougie, a gastric tube is created by resecting the greater curve of the stomach using a cutting stapler along a line joining the initial point of dissection and the angle of His. The reservoir capacity of the stomach is reduced to 200 mLs with the advantage of preserving most of the normal digestive stomach function (Fig. 7).

Results of Bariatic Surgical Procedures

Bariatric procedures are no longer only assessed by the %EWL and complications but, increasingly, the improvement in comorbidities is being recognised as an indicator of success.

Percentage of Excess Weight Loss

Dietel et al[46] reported VGB to achieve 58% EWL at 5 years. In a study by Zinzindohoue et al, [47] the EWL at 3 years follow-up for LAGB was 54.8% which is comparable to VGB. However VGB has fallen in favour of gastric

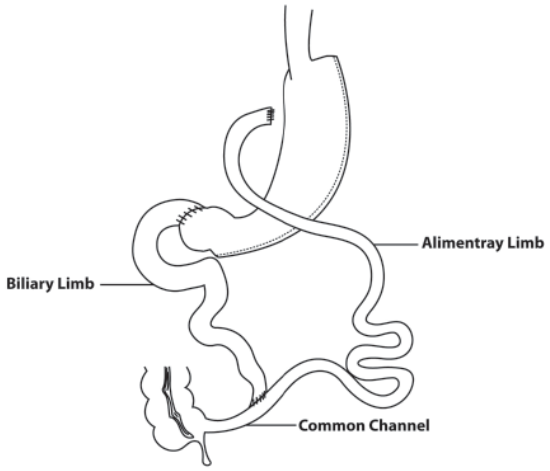

Fig. 6. Biliopancreatic diversion with duodenal switch.

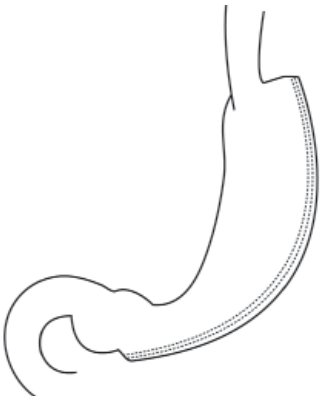

Fig. 7. Sleeve gastrectomy.

banding not only because it is technically simple, but because LAGB has a lower mortality, is adjustable, reversible, and able to achieve good EWL with improvement in comorbidities.[15,48-51] A series from O'Brien and Dixon et al[23] had a 50% EWL up to 6 years follow-up after LAGB. The percentage EWL after malabsorbtive procedure is higher; EWL after gastric bypass is reported to be 68% at 5 years.[52] EWL for BPD and BPD with DS at 8 years are 77% and 70%, respectively.[53,54] Ti et al[55] in their series of 26 patients undergoing VBG or RYGB reported EWL of 56.3% and 48.3% at 4 and 8 years, respectively. The use of laparoscopic sleeve gastrectomy as a primary bariatric surgical procedure is a relative new concept with paucity in literature of long-term follow-up. In a prospective trial of 163 patients, Nocca et al[56] reported 61.25% EWL at 2 years follow-up. They proposed to use the technique for volume-eaters and as a bridging procedure to definite surgery like BPD or DS.

Improvement in Comorbidities

Bariatric surgery is associated with improvements in associated comorbid conditions. In a meta-analysis by Buchwald et al,[22] it was reported that there was improvement in 80.8% of diabetics, 71.1% of hyperlipidaemics and 70.8% of hypertensives after LAGB. The results of malabsorbtive procedures in this meta-analysis were even better with 98.9% and 83.4% having resolution of DM and hypertension, respectively.

Complications

Higher incidence of complications after VGB surgery such as staple line disruption, stomal stenosis, mesh erosion, reflux disease and vomiting had called for revisional surgery in 20% to 56% of patients.[57-59] In a local series of 22 patients undergoing VBG in Singapore, Ti et al[55] reported 1 patient to have had a wound infection and 3 patients complained of vomiting but none of them required any surgical intervention at 10 years' follow-up.

In the initial phase, the general complications associated with malabsorbtive surgery are no different from those seen in obese patients undergoing other forms of surgeries. The construction of multiple anatomises in malabsorbtive procedure increases the potential risk of leak. Anastamotic leak have been reported to occur in 2.2% and 1.8% of patients after RYGB and BPD[60] surgeries, respectively. As RYGB incorporates a restrictive procedure with the creation of a small gastrojejunostomy stoma, it exposes the patient to a risk of stenosis. Irrespective of technique of anastomosis, that is hand-sewn or stapled, the incidence of gastrojejunostomy stenosis has been reported to be as high as 5%.[61] The dramatic differences in EWL and improvement in comorbidities between restrictive and malabsorbtive procedures cannot go without notice in Buchwald et al's report.[22] What one needs to understand also are the long-term implications of these procedures. Altering the gastrointestinal anatomy to achieve weight loss predisposes patients in the long term to increased risk of nutritional deficiencies. In particular, the common deficiencies seen are those of iron, vitamin B12, Vitamin D, calcium and thiamine. Hypocalcaemia is the result of decreased intestinal absorption and deficiency of Vitamin D.[62] In the meta-analysis by Maggand et al which analysed 70 RYGB, 41 LAGB and 7 BPD trials, postoperative gastrointestinal side effects were significantly higher in the malabsorbtive group when compared to the restrictive surgery group with reports of 7%, 16.9%, and 37.7% after LAGB, RYGB and BPD/Ds, respectively.[60] Also, in the RYGB group, 16.9% patients were diagnosed to have nutritional complications while 5.9% patients presented with ongoing vomiting after BPD. These are long-term complications that require continuous monitoring and intervention. The overall perioperative complication rate of sleeve gastrectomy is 7.36%. The classical complications are haemorrhage of staple line, gastric stenosis and staple line failure leading to leak and fistula formation postoperatively. Also reported is a high incidence of reflux oesophagitis of 11.8% to 21.8%, making sleeve gastrectomy a less attractive procedure for this group of patients.[63]

REFERENCES

1. Ministry of Health. National health survey 2004, Singapore; research and evaluation department. Singapore: Ministry of Health, 2005:24-36.
2. Stephens TW, Basinski M, Bristow PK, Bue-Valleskey JM, Burgett SG, Craft L, et al. The role of neuropeptide Y in the antiobesity action of the obese gene product. Nature 1995;372:425-8.
3. Deurenberg-Yap M, Schmidt G, van Staveren WA, Deurenberg P. The paradox of low body mass index and high body fat percentage among Chinese, Malays and Indians in Singapore. Int J Obes Relat Metab Disord 2000;24:1011-7.
4. Deurenberg-Yap M, Deurenberg P. Is a re-evaluation of WHO body mass index cut-off values needed? The case of Asians in Singapore. Nutr Rev 2003;61(5 pt 2):S80-7.
5. Foo CS,Tay KH, Ravintharan T. Treatment of obesity with laparoscopic adjustable gastric banding in Singapore: an initial experience. Singapore Med J 2005;46:465.
6. Flegal KM, Graubard BI, Williamsom DF, Gail MH. Excess deaths associated with underweight, overweight, and obesity. JAMA 2005;293:1861-7.
7. Sjostrom L, Narbro K, Sjostrom CD, Karason K, Larsson B, Wedel H, et al. Effects of bariatric surgery on mortality in Swedish obese subjects. N Engl J Med 2007;357:741.
8. Adams TD, Gress RE, Smith SC, Halverson RC, Simper SC, Rosamond WD, et al. Long-term mortality after gastric bypass surgery. N Engl J Med 2007;357:753-61.
9. Christou NV, Sampalis JS, Liberman M, Look D, Auger S, McLean AP, et al. Surgery decreases long-term mortality, morbidity, and health care use in morbidly obese patients. Ann Surg 2004;240:416.
10. Zeller MH, Roehrig HR, Modi AC, Daniels SR, Inge TH. Health-related quality of life and depressive symptoms in adolescents with extreme obesity presenting for bariatric surgery. Pediatrics 2006;117:1155.
11. Monk JS Jr, Dia Nagib N, Stehr W. Pharmaceutical savings after gastricbypass surgery. Obes Surg 2004;14:13.
12. Berkowitz RI, Fujioka K, Daniels SR, Hoppin AG, Owen S. Effects of sibutramine treatment in obese adolescents: a randomised trial. Ann Intern Med 2006;145:81.
13. Chanoine JP, Hampl S, Jensen C, Boldrin M, Hauptman J. Effect of orlistat on weight and body composition in obese adolescents: a randomised controlled trial. Jama 2005;293:2873.
14. Ballantyne GH. Measuring outcomes following bariatric surgery: weight loss parameters, improvement in co-morbid conditions, change in quality of life and patient satisfaction. Obes Surg 2003;13:954.
15. Dixon JB, Dixon ME, O'Brien PE. Quality of life after lap-band placement: influence of time, weight loss, and comorbidities. Obes Res 2001;9:713.
16. Pories WJ, Swanson MS, MacDonald KG, Long SB, Morris PG, Brown BM, et al. Who would have thought it? An operation proves to be the most effective therapy for adult-onset diabetes mellitus. Ann Surg 1995;222:339-52.
17. Cowan GSM, Buffington CK. Significant changes in blood pressure, glucose and lipids with gastric bypass surgery. World J Surg 1998;22:987-92.
18. Kyzer S, Charuzi I. Obstructive sleep apnoea in the obese. World J Surg 1998;22:998-1001.
19. Karason K, Wallentin I, Larsson B Sjöström L. Effect of obesity and weight loss on cardiac function and valvular performance. Obesity Res 1998;6:422-9.
20. Jan JC, Hong D, Pereira N, Patterson EJ. Laparoscopic adjustable gastric banding versus laparoscopic gastric bypass for morbid obesity: a single-institution comparison study of early results. J Gastrointest Surg 2005;9:42-3.
21. Ministry of Health. National health survey 2004. Singapore: Research and Evaluation Department, Ministry of Health, 2004.
22. Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrbach K, et al. Bariatric surgery: a systematic review and meta-analysis. JAMA 2004;292:1724-37.
23. O'Brien PE, Dixon JB. Laparoscopic adjustable gastric banding in the treatment of morbid obesity. Arch Surg 2003;138:376-82.
24. O'Brien PE, Dixon JB. Weight loss and early and late complications – the international experience. Am J Surg 2002;184:42S-45S.
25. Favretti F, Cadière GB, Segato G, Himpens J, De Luca M, Busetto L,et al. Laparoscopic banding: selection and technique in 830 patients. Obes Surg 2002;12:385-90.
26. Angrisani L, Alkilani M, Basso N, Belvederesi N, Campanile F, Capizzi FD, et al. Laparoscopic Italian experience with the lap-band. Obes Surg 2001; 11:307-10.
27. O'Brien PE, Dixon JB, Laurie C, Anderson M. A prospective randomized trial of placement of the laparoscopic adjustable gastric band: comparison of the perigastric and pars flaccida pathways. Obes Surg 2005;15:820-6.
28. Westling A, Bjurling K, Ohrvall M, Gustavsson S. Silicone-adjustable gastric banding: disappointing results. Obes Surg 1998;8:467-74.
29. Silecchia G, Restuccia A, Elmore U, Polito D, Perrotta N, Genco A, et al. Laparoscopic adjustable silicone gastric banding: prospective evaluation of intragastric migration of the lap-band. Surg Laparosc Endosc Percutan Tech 2001;11:229-34.
30. Suter M, Calmes JM, Paroz A, Giusti V. A 10-year experience with laparoscopic gastric banding for morbid obesity: high long-term complication and failure rates. Obes Surg 2006;16:829-35.
31. Camerini G, Adami G, Marinari GM, Gianetta E, Pretolesi F, Papadia F. Thirteen years of follow-up in patients with adjustable silicone gastric banding for obesity: weight loss and constant rate of late specific complications. Obes Surg 2004;14:1343-8.
32. Spraul M, Ravussin E, Fontvieille AM, Rising R, Larson DE, Anderson EA. Reduced rate of energy expenditure as a risk factor for body-weight gain. N Engl J Med 1988;318:467-72.
33. NIH conference: Gastrointestinal surgery for severe obesity. Consensus Development Conference Panel. Ann Intern Med 1991;115:956.
34. Hamad GG, Choban PS. Enoxaparin for thromboprophylaxis in morbidly obese patients undergoing bariatric surgery: findings of the prophylaxis against VTE outcomes in bariatric surgery patients receiving enoxaparin (PROBE) study. Obes Surg. 2005;15:1368-74.
35. Nguyen NT, Paya M, Stevens MC, Mavandadi S, Zainabadi K, Wilson SE. The relationship between hospital volume and outcome in bariatric surgery at academic medical centres. Ann Surg 2004;240:586-93.
36. Kremen AJ, Linner JH, Nelson CH. An experimental evaluation of the nutritional importance of proximal and distal small intestine. Ann Surg 1954;140:439-48.
37. Mun EC, Blackburn GL, Matthews JB. Current status of medical and surgical therapy for obesity. Gastroenterology 2001;120:669.
38. Patriti A, Facchiano E, Gullà N, Aisa MC, Annetti C. Gut hormone profiles following bariatric surgery favour an anorectic state, facilitate weight loss, and improve metabolic parameters. Ann Surg 2006;243:108.
39. Korner J, Bessler M, Cirilo LJ, Conwell IM, Daud A, Restuccia NL, et al. Effects of Roux-en-Y gastric bypass surgery on fasting and postprandial concentrations of plasma ghrelin, peptide YY, and insulin. J Clin Endocrinol Metab 2005;90:359.
40. Griffen WO Jr, Bivins BA, Bell RM. The decline and fall of the jejunoileal bypass. Surg Gynecol Obstet 1983;157:301.
41. Deitel M, Shahi B, Anand PK, Deitel FH, Cardinell DL. Long-term outcome in a series of jejunoileal bypass patients. Obes Surg 1993;3:247.
42. Scopinaro N, Adami GF, Marinari GM, Gianetta E, Traverso E, Friedman

D, et al. Biliopancreatic diversion. World J Surg1998;22:936-46.

43. Tonstad S, Sundfør T, Myrvoll EA. Nutritional status after surgical treatment of obesity. Tidsskr Nor Laegeforen 2007;4;127:50-3.
44. Crookes PF, Almogy G, Hamoui N, Anthone GJ. Isolated sleeve gastrectomy for high-risk morbidly obese patients (abstract). International Federation for the Surgery of Obesity. Obes Surg 2003:Abstract 534.
45. Cottam D, Qureshi FG, Mattar SG, Sharma S, Holover S, Bonanomi G, et al. Laparoscopic sleeve gastrectomy as an initial weight-loss procedure for high-risk patients with morbid obesity. Surg Endosc 2006;20:859-63.
46. Dietel M. Overview of operations for morbid obesity. World J Surg 1998;22:913-918.
47. Zinzindohoue F, Chevallier JM, Douard R, Elian N, Ferraz JM, Blanche JP, et al. Laparoscopic gastric banding: a minimally invasive surgical treatment for morbid obesity. Ann Surg 2003;237:1-9.
48. O'Brien PE, Dixon JB. Lap-band: outcomes and results. J Laparoendosc Adv Surg Tech A 2003;13:265.
49. Dixon JB, O'Brien PE. Changes in comorbidities and improvements in quality of life after LAP-BAND placement. Am J Surg 2002;184:51S.
50. Dixon JB, Chapman L, O'Brien P. Marked improvement in asthma after Lap-Band surgery for morbid obesity. Obes Surg 1999;9:385.
51. Dixon JB, O'Brien PE. Health outcomes of severely obese type 2 diabetic subjects 1 year after laparoscopic adjustable gastric banding. Diabetes Care 2002;25:358.
52. Marceau P, Hould FS, Simard S, Lebel S, Bourque RA, Potvin M, et al. Biliopancreatic diversion with duodenal switch. World J Surg 1998;22:947-54.
53. Scopinaro N, Gianetta E, Adami GF, Friedman D, Traverso E, Marinari GM, et al. Biliopancreatic diversion for obesity at eighteen years. Surgery 1996;119:261-8.
54. Hess DS, Hess DW. Biliopancreatic diversion with duodenal switch. Obes Surg 1998;8:267-82.
55. Ti TK. Singapore experience in obesity surgery. Obes Surg 2004;14: 1103-7.
56. Nocca D, Krawczykowsky D, Bomans B, Noël P, Picot MC, Blanc PM, et al. A prospective multicentre study of 163 sleeve gastrectomies: results at 1 and 2 years. Obes Surg 2008;18:560-5.
57. Superman HJ, Starkey JV, Birkenhauer R. A randomised prospective trial of gastric bypass versus vertical banded gastroplasty for morbid obesity and their effects on sweets versus non-sweets eaters. Ann Surg 1987;205:613.
58. Balsiger BM, Poggio JL, Mai J, Kelly KA, Sarr MG. Ten and more years after vertical banded gastroplasty as primary operation for morbid obesity. J Gastrointest Surg 2000;4:598.
59. Van Gemert WG, Van Wersch MM, Greve JW, Soeters PB Van. Revisional surgery after failed vertical banded gastroplasty: restoration of vertical banded gastroplasty or conversion to gastric bypass. Obes Surg 1998;8:21.
60. Maggard MA, Shugarman LR, Suttorp M, Maglione M, Sugerman HJ, Livingston EH, et al. Meta-analysis: surgical treatment of obesity. Ann Intern Med 2005;142:547-59.
61. Go MR, Muscarella P, Needleman BJ, Cook CH, Melvin WS. Endoscopic management of stomal stenosis after Roux-en-Y gastric bypass. Surg Endosc 2004;18:56-9. Epub 2003 Nov 21.
62. Torgerson JS. [The "Swedish Obese Subjects"; (SOS) Study. What does weight loss really accomplish?]. MMW Fortschr Med 2002;144:24.
63. Himpens J, Dapri G, Cadiere GB. A prospective randomized study between laparoscopic adjustable gastric banding and laparoscopic isolated sleeve gastretcomy: results after 1 and 3 years. Obes Surg 2006;16:1450-6.