Laparoscopic adjustable gastric banding for severe obesity

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ABSTRACT

Introduction: Severe obesity is an increasing problem in Singapore. Laparoscopic adjustable gastric banding (LAGB) was introduced at our hospital in 2001 as part of a comprehensive weight management programme. To assess the effectiveness of this procedure, our results to date have been reviewed.

Methods: A prospective database was kept of all patients undergoing LAGB and this was used to retrieve the information.

Results: 256 consecutive patients underwent LAGB from January 2001 up to December 2005. There were 163 females and 93 males, with a median age of 36 years (range 18-63 years). Median preoperative weight was 112.7 kg (range 71.5-204 kg) and median body mass index (BMI) was 41.9 (range 32-73). Three patients were converted from laparoscopic to open laparotomy (1.2 percent). 91 percent of patients were discharged home on the first postoperative day. There were seven hospital morbidities (2.7 percent) with one mortality (0.4 percent). During follow-up, 20 patients (7.8 percent) developed late complications requiring revision surgery. Ten were band complications, requiring revision or removal of the band. The other ten were minor access port or tubing complications. Median weight loss at one year was 27.6 kg (range 5.6-71.2 kg) and median excess weight loss, using a BMI of 23 as a baseline, was 51.7 percent (range 9-117.5 percent). Easily measurable comorbidities such as diabetes mellitus and hypertension improved or resolved in 85.4 percent of patients.

Conclusion: There is a clear demand for LAGB in Singapore. This has increased since the BMI thresholds for severe obesity were reduced in Asian patients. The surgery provides effective, lasting weight loss with improvement or resolution of comorbidity for most patients. LAGB has the advantages of allowing controlled weight loss and life-long treatment while being easily reversible. When compared to other bariatric surgical procedures, low hospital morbidity has to be offset against the closer follow-up required and the need for secondary surgical procedures in some patients.

Keywords: bariatric surgery, gastric band, laparoscopic adjustable gastric banding, laparoscopy, obesity

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INTRODUCTION

Obesity is a fast-growing pandemic[1]. In many western countries, it is overtaking cigarette smoking as the leading preventable cause of premature death[2]. Singapore has not been spared[3-5]. Recent recognition of the differing fat distribution in Asian patients and their susceptibility to obesity-related disease at lower body mass index (BMI)[6-9] has led to a reduction in the BMI threshold for the diagnosis of severe obesity[10]. Based on the Asia-Pacific consensus of March 2005, Asian patients with BMI 37 and above, or with a BMI 32 and above with associated comorbidities, are now classified as severely obese. There are about 156,000 people in Singapore with a BMI of 32 and above (based on our hospital's unpublished health screening results) and most have obesity-associated comorbidities. Severe obesity is a disease of chronic positive calorie imbalance. While some of these patients can lose weight temporarily by dieting, exercising, taking anti-obesity medication or trying one of the many dubious options widely advertised in newspapers and magazines, the weight loss achieved is often inadequate to make an impact on health. In addition, the chance of sustained weight loss is only about 5%[11,12].

Bariatric surgery is defined as gastrointestinal surgery to help severely obese patients lose weight[13]. It offers the only realistic chance of long-term weight reduction, and resolution or improvement of comorbidity for the majority of these patients[14-16]. The original purely malabsorptive procedures such as jejuno-ileal bypass are no longer performed due to their unacceptably high late complication rate. They have been replaced by restrictive or combined operations. Open surgery has largely been replaced by a laparoscopic approach. The most common operations performed were gastroplasty (purely restrictive) and Roux-en-Y gastric bypass (restrictive and malabsorptive). They have been adapted for laparoscopic surgery but remain technically complex operations.

The advent of laparoscopic adjustable gastric banding (LAGB) has provided another option for restrictive surgery. It is likely to become the most popular bariatric surgical procedure worldwide. The operation was designed for ease of laparoscopic insertion. It involves no anastomoses and is therefore associated with lower hospital morbidity[15,17]. The speed of weight loss can be carefully controlled and, although initial weight loss may be slower than that seen with the other bariatric operations, eventual weight loss can be similar[16,17]. The band is intended as a life-long treatment but it can easily be removed if needed. LAGB was introduced at our hospital in January 2001 as part of a comprehensive weight management programme based within our Health for Life facility. We have reviewed the first five years of our experience.

METHODS

All patients referred for LAGB went through our formal weight management programme for assessment. To be considered for surgery, patients must meet the criteria agreed by the Society of American Gastroenterological Surgeons (SAGES) and the American Society of Bariatric Surgeons (ASBS)[18,19] and subsequently modified for Asian use[3,13]:

1. Aged 18-55 years (patients outside this range can still be operated as per ASBS/SAGES guidelines)[13,18].
2. Failure to lose weight despite a genuine attempt as defined in the Ministry of Health of Singapore Clinical Practice Guidelines on Obesity[3].
3. From 2001-2003, BMI of 35 and above with co-morbidity, or BMI of 40 and above. Since 2003, BMI of 32 and above with comorbidity, or BMI of 37 and above.
4. Motivated and accepting of the associated risks.

Patients with concurrent major psychiatric illness, substance abuse or eating disorder, and patients with serious organ dysfunction, were excluded.

A detailed history and examination was undertaken documenting any comorbidity using our pro forma weight management programme. The surgical procedure and its consequences were discussed at length with the patient. Possible complications and the need for life-long follow-up were emphasised. If the patients still wished to consider surgery, they were subjected to standardised investigations[13], consisting of full blood count, fasting lipids, glucose and insulin, renal and liver panels, thyroid function tests, 24-hour urinary cortisol, ECG and chest radiography. Sleep history was taken and an overnight polysomnography was arranged to quantify any obstructive sleep apnoea (OSA). Anaesthetic review was routine. Written informed consent was obtained from all patients, often after several visits with the surgeon and after information leaflets had been read to reinforce the patient's clinic explanations. Patients with moderate or severe OSA, as defined by an apnoea-hypopnea index of 15 per hour or greater, were required to undergo continuous positive airway pressure therapy (CPAP) at night for at least two weeks leading up to their admission for surgery. They were told to bring the CPAP machine to the hospital to use during the pre- and postoperative period and to continue using the machine for at least two weeks after discharge.

Since early 2004, patients with BMI of 50 or above have been put on a very low calorie diet (VLCD). This comprised three daily meal replacements of Optifast® (Novartis, Mulgrave, VIC, Australia) plus liberal water, and selected salads and vegetables. This approximated to 456 kilocalories per day for two to four weeks prior to their surgery. They were given a target weight reduction of 10-15 kg. For the first four days of VLCD, the patients were admitted to hospital for close supervision by physicians and dieticians, and metabolic and ECG monitoring to ensure the diet was understood and safely tolerated. Preoperative psychiatric or psychological and cardiac evaluation were offered selectively rather than routinely as per ASBS, SAGES and Ministry of Health of Singapore clinical practice guidelines[3,13,18]. Patients were admitted one day pre-operatively for the final assessment. During hospitalisation, patients were encouraged to stay out of bed as much as possible. Subcutaneous heparin 5,000 U 12-hourly, graduated compression stockings and peroperative calf pumps were also used for deep venous thrombosis prophylaxis.

Surgery was undertaken on a wide, ultra-low operating table (Eschmann motorised T-20a, Lancing, England) using padded adjustable leg supports (Yellowfins, Acton, MA, USA) with the patient in a 20-degree head-up position. The operator stood between the legs. Broad-spectrum intravenous antibiotics were given at induction of anaesthesia and 80 mg of Gentamicin was put into the access port site before skin closure as prophylaxis against infection of the LAGB. Suppositories of paracetamol and voltaren were given for analgesia and the port sites were infiltrated with a local anaesthetic agent. A nasogastric tube may be inserted if the stomach was distended but this was removed before the retrogastric tunnel was created.

We used a five port laparoscopic technique. We entered the peritoneal cavity under vision using a zero degree laparoscope inside a disposable 15 mm optical port. Five and ten millimetre non-disposable ports were used at the other four sites. Pneumoperitoneum was maintained at 14-16 mm Hg. A Nathanson's retractor for the left lobe of the liver was introduced through the epigastric port site. We followed the Pars Flaccida technique and brought the band around the upper stomach with minimal posterior dissection. In all cases, we took care to place the band above the lesser omental sac. Four different band types were used in our series of patients. We now prefer a 10-cm band for patients BMI <42 with an 11-cm band used for patients with BMI over 42.

The oesophago-gastric fat pad was not routinely dissected off, but some dissection of this fat and the lesser curve fat was used at times to ensure that the band was properly placed and not too tight. A small "virtual" 7.5 ml gastric pouch was left above the band. Initially, a transoral calibration balloon was used in the upper stomach, but later, we could create a pouch of a reliable size without using the balloon. The anterior aspect of the band was covered with a loose gastro-gastric wrap created with three or four interrupted, non-absorbable, braided sutures (Ethibond®Excel, size 0, Ethicon, Somerville, NJ, USA). The first of these stitches was taken as far back as possible on the patient's left side to reduce the risk of subsequent gastric slippage through the band. The band closing mechanism was rotated to the patient's right and was not included in the gastro-gastric suturing. The band was left empty.

The adjustment port was sutured to the deep fascia of the anterior abdominal wall at the end of the procedure using Prolene size 0 sutures (Ethicon, Somerville, NJ, USA) after enlarging one of the port sites. Initially, all the ports were located in the left subcostal area in the mid-clavicular line, but we later located the port on the anterior rectus sheath above and to the left of the patient's umbilicus. Postoperatively the patients were kept strictly nil by mouth until early the next morning. They then underwent a contrast swallow with diluted barium sulphate suspension (EZEM®, Westbury, NY, USA) in the radiology department to ensure good band placement. If this was satisfactory, they were allowed a liquid diet. Before discharge, they were seen by a dietician and by a physiotherapist from the weight management team. Liquid diet was continued for two weeks, followed by blended (pureed) diet for a further two weeks. From week five, patients were allowed to gradually introduce a solid diet and were asked to abide by the "nine golden rules" (Table I). All patients were advised to take long-term oral multivitamin supplements.

Table I. The "Nine Golden Rules" given to patients following LAGB.

1.	Eat only three small meals a day.
2.	Eat slowly and chew well.
3.	Stop eating as soon as you feel full.
4.	Eat a balanced and varied diet.
5.	Do not eat between meals.
6.	Do not drink while you are eating.
7.	Drink enough fluids during the day.
8.	Drink only low calorie liquids.
9.	Exercise for at least 30 minutes each day.

First outpatient review was at week two. Patients were then seen four- to six-weekly during the first year, and less often once they had reached a stable and satisfactory weight. We aimed to achieve a steady weight loss of 0.5-1.0 kg per week during the first year. Band adjustments were undertaken in the outpatient clinic unless access proved difficult, in which case fluoroscopy was used. After injection of local anaesthetic over the access port site, a non-coring 20 gauge deflected point Huber needle (Inamed, Santa Barbara, CA, USA) was used to add or remove saline. Fluid was added in small increments to maintain adequate weight loss and an adequate feeling of early satiety. If the patients felt the band was too constrictive or if weight loss was excessive, the volume in the band was decreased slightly. The band was emptied during pregnancy[20].

Patients were made aware of the risk of complications and the need for prompt action. They were encouraged to return immediately to the weight

management clinic or to the emergency room if they developed severe dysphagia, vomiting, reflux or abdominal pain. Our patients carried cards indicating the type of band in-situ. If complications were suspected, the band was immediately emptied of fluid. Suspected pouch dilatation or slippage was evaluated by a dilute barium swallow; suspected erosion by gastroscopy. If patients complained of loss of early satiety, a radiograph was arranged to look for a tubing problem and, if this appeared normal, a contrast "bandogram" was arranged to try and identify a leak site.

Regular feedback from our dieticians was ensured and all our patients were encouraged to attend meetings of our patient support group – the "Singapore Lapbandits"! A detailed, computerised and prospective database of all patients undergoing LAGB was kept. Ethical committee approval was obtained for this study.

RESULTS

From January 2001 to December 2005, 256 patients underwent LAGB. After a cautious start, the number of procedures performed annually is currently around 100 (Table II). Three patients had undergone revision to LAGB following previous failed bariatric surgery at another hospital many years ago (two open vertical banded gastroplasties, one open gastric bypass). Demographical data of the patients is given in Table III. The median age was 36 years (range 18-63 years). 63.7% of our patients were female. The proportion of Malay and Indian Singaporeans was higher than their respective proportions of the total Singaporean population. The median preoperative weight was 112.7 kg (range 71.5-204 kg) and median BMI was 41.9 (range 32-73).

95% of the patients completed overnight polysomnography and 120 (46.9%) had moderate or severe OSA and were given CPAP therapy perioperatively. Since 2004, 24 super-obese patients were put on VLCD for two to four weeks prior to surgery. All patients achieved a preoperative weight loss target of at least 10 kg except one patient who lost only 9 kg. Obesity-associated comorbidity was very common and usually multiple. 218 patients (85.2%) complained of orthopaedic problems including backache, hip, knee or ankle pains and plantar fasciitis. 110 patients (42.1%) were on treatment for hypertension and 54 (21.1%) were on treatment for type 2 diabetes mellitus. Metabolic syndrome, dyslipidaemia, gout, non-alcoholic steatohepatitis (NASH), shortness of breath, gastro-oesophageal reflux, excessive daytime sleepiness, snoring, sub-fertility, menstrual irregularities, stress, depression, and social isolation were also encountered.

Table II. Number of LAGBs inserted annually since the conception of the programme.

2001	14
2002	12
2003	35
2004	100
2005	95
TOTAL	**256**

Table III. Demographics of patients who underwent LAGB.

Age	median	36 years
	range	18-63 years
Sex	female	163 (63.7%)
	male	93 (36.3%)
Race	Chinese	110 (43%)
	Malay	72 (28.1%)
	Indian	60 (23.4%)
	Others	13 (5.5%)
Weight	median	112.7 kg
	range	71.5-204 kg
Height	median	1.64 m
	range	1.42-1.87 m
BMI	median	41.9
	range	32-73

Median operating time was 95 minutes (range 43-335 minutes), which decreased with the experience of the operator. All procedures were completed laparoscopically, except three (1.2%) which were converted to open laparotomy because of bleeding. The three patients with a history of previous open bariatric surgery underwent planned open laparotomy for adjustable gastric banding making a total of six patients (2.3%) who had their bands inserted at open surgery. Four patients, of whom two had gastro-oesophageal reflux symptoms, underwent repair of a small or moderate sliding hiatus hernia performed laparoscopically during LAGB insertion. One patient with an unusual parahiatal diaphragmatic hernia also had this repaired during LAGB insertion[21]. 10-cm bands are now routinely used in patients with BMI below 42. In heavier patients, we now use an 11-cm band. We had inserted 43 of the larger 12.5-cm bands, but no longer use these as the weight loss achieved in our Asian patients has been poor (14% failed to lose at least 25% of excess body weight by one year and only 12% lost more than 50% of excess body weight).

Table IV. Hospital morbidity and late revisional surgery following LAGB.

Hospital morbidity	**No.**
Major	
Aspiration pneumonia (fatal)	1
Wound infection/collection	1
Minor	
Transient dysphasia	1
Atypical chest pain	4
Total	7 (2.7%)
Late revisional surgery	**No.**
Major	
Band slippage	5*
Band erosion	3**
Gastric pouch dilatation	1**
Band infection	1**
Minor	
Port leakage	3
Tubing leakage	3
Port infection	3
Port displacement	1
Total	20 (7.8%)

* Band revised ** Band removed

91% of the patients were allowed home the day after surgery. Seven complications were encountered during the initial hospital admission (2.7%) (Table IV). One super-obese patient (178 kg and BMI of 59) required multiple and prolonged attempts at endotracheal intubation. The patient aspirated gastric contents during these attempts. LAGB insertion was completed uneventfully once the patient was eventually intubated, but the patient remained on a ventilator postoperatively and developed severe respiratory failure. Despite full support in the intensive care unit, he died on the fifth day. The mortality was classified as anaesthetic-related and changes in anaesthetic protocol have since been instituted. One planned open banding following a previous failed vertical banded gastroplasty was complicated by a wound infection and a sterile intraperitoneal collection of fluid. These settled with antibiotic therapy and there were no port-site sequelae. One patient stayed in hospital for four days after LAGB because of initial dysphagia. This settled spontaneously. The remaining four patients experienced early postoperative atypical chest pain. This pain subsided quickly and no specific cause was found but one of the four patients was kept in hospital for an extra day as a precaution.

Median follow-up was 15 months (range 1-56 months). 20 patients (7.5%) had required late re-operation (Table IV). Ten were minor port or tubing revisional surgery. These patients required surgery for port or tubing leakage with loss of early satiety (6), port infection (3) or port displacement (1). The other ten patients required major open or laparoscopic band revisions or removals. Five of these were revisions for slippage of stomach up through the band (one posterior, four anterior). Four were performed laparoscopically and the other patient (who had the initial band inserted following conversion to open surgery) underwent an open revision of the band. Two patients had an acute gastrointestinal bleed, one followed erosion of the band into the stomach and the other followed acute dilatation of the gastric pouch. There were two other band erosions and one band infection. This infection was associated with upper abdominal peritonitis from a small perforation of the transverse colon. These five bands were removed at open surgery and the patients recovered uneventfully. The bands have not been replaced to date.

161 patients (62.9%) had a postoperative follow-up of at least 12 months. One patient died 53 weeks after surgery following massive acute myocardial infarction. Her weight had dropped from 94.5 kg to 82.4 kg, and her BMI had dropped from 42 to 36.6. She was still on treatment for hypertension and diabetes. She was on regular vitamins and was noted to be well at the support group meeting just a week earlier. She was suddenly admitted to our coronary care unit with a large myocardial infarction and died of fatal cardiac arrhythmias within 24 hours of admission. We have classified this as a late mortality unrelated to band placement.

At one-year follow-up, all our patients had lost weight. The median weight loss was 27.6 kg (range 5.6-71.2 kg). No significant difference in weight loss was seen in the five patients whose bands were inserted at open surgery when compared to the purely laparoscopic group. Using a baseline BMI of 23 (as US metropolitan life insurance tables were felt to be inappropriate for our Asian populations and the upper limit of normal BMI in Singapore is now 23), our patients lost a median of 51.7% of excess body weight (range 9-117.5%). The median number of band adjustments made in the outpatient department during the first year was six (range 1-9). The frequency of band adjustments fell markedly from the second year onwards as patients generally reach a stable weight by 1-2 years after

band insertion. "Failure" as defined by loss of less than 25% of excess weight at one year occurred in 15 patients (9.3%). This was associated with band complications (3), the use of the 12.5 cm band (6) or non-compliance by the patient (6). Comorbidity was markedly improved. Although much of the comorbidity was difficult to quantify, at one-year follow-up, medication for hypertension was reduced or stopped in 86.4% of patients and medication for diabetes mellitus was reduced or stopped in 83.3% of patients compared to the preoperative treatment.

DISCUSSION

Although the epidemic of obesity worldwide[1,2] has had less impact in Asia than in many western countries, there is nevertheless a rapid increase in obesity in most Asian countries. Singapore has not been spared[3-5]. Using the previous World Health Organisation criteria for severe obesity, there were an estimated 48,000 people in Singapore with BMI above 35[22]. Now that the criteria for severe obesity have been modified for Asians[10], we estimate that there are 156,000 severely obese people on our island. Some people regard severe obesity as a food and lifestyle addiction. Although many obese patients can achieve temporary weight reduction by means of dieting, exercise programmes, anti-obesity medication or one of the many more dubious techniques offered in the newspapers and glossy magazines, only 5% of severely obese patients will achieve sustained weight reduction[11]. The same percentage of alcoholics will achieve permanent sobriety (Alcoholics Anonymous – personal communication). Obesity is associated with multiple comorbidities, reduced quality of life and reduced life expectancy. The health cost implication of obesity is considerable. Bariatric surgery in the severely obese has belatedly been recognised as a medical and not a cosmetic procedure[3]. This has allowed our patients to use their Medisave and other insurance policies to offset the cost of the procedure.

Surgical treatment has an established role in the treatment of severe obesity[14,23]. Bariatric surgery provides a physical and functional change to the digestive tract that makes it difficult to overeat (restrictive procedures) and/or reduces absorption of nutrients from food ingested (malabsorptive procedures)[16]. These operations provide sustained weight loss in 90-95% of patients[16,24]. Purely malabsorptive procedures such as the jejuno-ileal bypass have been abandoned because of severe and life-threatening late complications related to macro- and micronutrient deficiencies, blind loop and hepatic fibrosis. The most popular bariatric procedures worldwide were the Roux-en-Y gastric bypass (restrictive and malabsorptive) and gastroplasty (restrictive). Both these procedures have been adapted for laparoscopic surgery but they are complex procedures and involve stapled anastomoses, which are the major source of hospital mortality and morbidity[17].

The gastric banding technique has evolved from non-adjustable gastric bands inserted at laparotomy, to LAGB, which was first developed by Belachew et al[25] and first reported by Marino et al and Cadiere et al in 1994[26,27]. The widespread use of LAGB since 1996 has provided a bariatric surgical option that is laparoscopy-friendly, easier to learn, safer, has an adjustable stoma to allow gradual controlled weight loss and is easily reversible. Hospital morbidity is less than 25% of that associated with other bariatric surgical procedures and hospital mortality is reduced tenfold[13,17]. Although initial weight loss may be slower, the eventual weight loss achievable with close supervision is very similar to that reported with gastric bypass and gastroplasty[13,17]. LAGB is the most frequently-performed bariatric surgical procedure in Singapore, Europe and Australia[13,17,26]. Even in the huge USA market, where the other surgical procedures are well-established and where LAGB was not approved by the Food and Drug Administration until June 2001, the use of LAGB is increasing rapidly[27].

The main disadvantage of LAGB is that follow-up needs to be more intense for band adjustments and monitoring for complications[28]. The undoubted short-term reduction in morbidity has to be offset against longer-term complications such as band slippage, band erosion and port site or tubing complications. In other series, 6-26% of patients have required some form of revision surgery during follow-up[15,29-39]. Revision rates decrease with experience[29]. Band slippage is less common since the introduction of the Pars Flacida approach to replace the perigastric approach[40]. We have only had to perform revision surgery in 7.8% of our patients, but this figure is likely to increase with longer follow-up. Half of the revisions are minor port and tubing procedures but band slippage and band erosion can lead to serious outcome if they are not recognised and treated early. Recognition and management of complications are best done in an experienced centre. Our patients are all encouraged to come back early to our own hospital if problems arise. The carrying of an information card by the patient is important in case they have to be seen elsewhere.

We have used 10-, 11- and 12.5-cm bands on our patients. Meaningful comparison between results of band sizes and types is unrealistic as they were not matched groups and the sample size is too small to pick up significant differences in complications. We did notice that the initial weight loss was faster with the 10-cm band. In larger patients, we still use an 11-cm band but we have abandoned the use of the 12.5-cm band as it has not given adequate weight reduction in our Asian population of patients. The 12.5-cm bands were inserted in our largest patients, but it appears that inside even the heaviest Asian patients, the cardio-oesophageal junction is probably not big enough for this band to be reliably effective. The original low volume, high pressure 10-cm band has been associated with migration or erosion into the stomach in up to 6% of patients and a significant re-operation rate for gastric slippage[41,42]. There is a theoretical advantage of the high volume low pressure 11-cm band in reducing the risk of band erosion[29]. While current literature suggests that the results of the two bands are probably comparible[30,40], a large randomised controlled trial will be required to answer this question definitively.

The Asian experience of bariatric surgery in general and LAGB in particular is limited. At the February 2005 Asia-Pacific Bariatric Surgical Conference in Taiwan, it was apparent that our experience in LAGB is the largest in Asia outside that of the Middle East. Although in overall numbers, more bariatric operations had been performed in Taiwan at the time of the conference, they had performed far fewer LAGB as most of their operations were gastric bypass or gastroplasty. Many centres in Asia are now embarking on bariatric surgical programmes in response to the obesity dilemma.

Genetic and cultural differences should be taken into account when contemplating bariatric surgery and looking at the results of bariatric surgery in Asia. Most Asians are rice eaters. Many of our patients find it difficult or impossible to eat rice after LAGB, but generally adapt well to a rice-free diet. Gastric cancer is so common in some parts of Asia that gastroscopic screening is advisable. LAGB still allows access to the entire stomach for screening examinations, while most of the stomach is inaccessible after gastric bypass. The increased prevalence of obesity in Malay and Indian Singaporeans compared to Chinese Singaporeans[4,5] accounts for the relatively high proportion of these ethnic groups in our study, compared to the entire Singaporean population which comprises 77% Chinese. The relative shortness of Asians compared to Caucasians accounts for the lower median weight of patients in this series while the BMI of our patients is similar to that in western series. The recent reduction of BMI threshold for severe obesity in Asian patients is already having an impact on our practice with more patients in the BMI range 32-40 now undergoing surgery.

The routine use of overnight polysomnography is controversial. Obesity is a risk factor for OSA, and OSA is associated with an increased overall morbidity and mortality during anaesthesia. This risk can be reduced by perioperative CPAP which decreases hypoxic episodes[43-45]. Polysomnography is expensive and time consuming but remains the gold standard for the assessment of OSA. Other bariatric surgical centres select patients at high risk of OSA by using criteria such as older age, male sex, weight, BMI, excessive snoring or OSA reported by the patient's partner/family, daytime sleepiness scores, neck circumference, abdominal girth, waist-hip ratio, modified Mallampati grade, tonsil size or combined scoring systems[45]. None of these methods is totally reliable, and we and others[46] have preferred to subject all patients to polysomnography. We are currently analysing our data to see if we can relax our criteria for polysomnography and/or the threshold for CPAP in our Asian patients.

The use of a VLCD to obtain weight loss prior to bariatric surgery is popular in some centres[47]. A weight loss of as little as 10 kg can facilitate surgery by reducing intra-abdominal fat and the volume of the fatty liver. It also reduces neck fat and improves OSA. In a small preliminary controlled trial, we confirmed that surgery is technically easier after VLCD[48]. James Toouli's group in Australia has measured significant reduction in liver volume after the diet (personal communication).

The importance of a dedicated weight management team cannot be overemphasised. Bariatric surgeons should not work in isolation. Experienced weight management physicians, endocrinologists, respiratory physicians, anaesthetists, radiologists, nurses, dieticians, physiotherapists and support staff are vital to the success and safety of a programme. Easy patient access to help and advise, and a patient support group such as our "Singapore Lapbandits", should be in place.

There is current enthusiasm in Singapore for the use of an intragastric balloon (BIB®, BioEnterics, Carpinteria, CA, USA) for the treatment of obesity. This balloon is inserted

endoscopically but has to be removed after six months. We inserted the first of these balloons in Singapore and have found them to be ineffective for most of our Asian patients. Despite close supervision within our established weight-management programme, the balloon had to be removed early in 20% of our patients because they were unable to tolerate the side effects. Another 10% failed to lose any weight. The remaining 70% lose only 5-15 kg and our early follow-up indicates that most patients will regain this weight after balloon removal. We only advocate the use of the intragastric balloon in patients with BMI below 32 who accept the low long-term success associated with this device. Patients with severe obesity are advised to opt for LAGB.

In conclusion, LAGB is an effective method for achieving significant weight loss in severely obese Singaporeans. Our early and late morbidity rates compare favourably with other LAGB series[15,29-39]. The results at one year are gratifying. A mean loss of 51.7% of excess body weight compares favourably with other bariatric series[16,29,30,40,42], especially as we have adjusted our baseline BMI down from 25 to 23 in line with the new upper limit of the healthy range for Asian patients. Long-term follow-up is required to confirm the durability of our results, but further significant weight loss is unlikely after two years for most patients[29]. The improvement in comorbidity is dramatic and often occurs within a few weeks of surgery. Measurable comorbidity such as the need for anti-hypertensive and diabetic medication has been reduced or eliminated in 85.4% of patients by one year. Equally rewarding are the improvements in some of the less easily measured morbidities including orthopaedic problems, depression and general quality of life. We are currently running studies to try and quantify some of these other benefits in our Asian patients. Seeing the transformation in the lives of many of our patients as they lose weight justifies the intense effort put into this programme.

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