ORIGINAL ARTICLE

Laparoscopic bariatric surgery: a five-year review

Simon KH Wong 黃健鴻
Alice PS Kong 江碧珊
Wilfred LM Mui 梅力文
WY So 蘇詠儀
Bonnie YS Tsung 曾玉珊
Phyllis YP Yau 邱燕萍
Francis CC Chow 周振中
Enders KW Ng 吳國偉

Objective To review our results of laparoscopic adjustable gastric banding, laparoscopic sleeve gastrectomy, and laparoscopic gastric bypass for the treatment of morbid obesity.

Design Prospective cohort study.

Setting Bariatric Surgery Centre, Prince of Wales Hospital, The Chinese University of Hong Kong, Hong Kong.

Patients All patients consisted of those referred to our Combined Obesity Clinic (to provide multidisciplinary weight management for severely obese patients) during the period July 2002 to December 2007. For patients who received bariatric surgeries as treatment of morbid obesity, peri-operative data, postoperative weight change, and co-morbidity improvements were collected and prospectively reviewed.

Results During the study period, 531 patients attended our Clinic for treatment of obesity. Their mean (standard deviation) body weight was 96 (22) kg, mean body mass index was 36 (6) kg/m^2, mean age was 40 (10) years, and 64% were female. Of these patients, 94 (18%) underwent bariatric surgery, which included: laparoscopic adjustable gastric banding (n=57), laparoscopic sleeve gastrectomy (n=30), and laparoscopic gastric bypass (n=7). Adverse events occurred in 11 (12%) of these 94 patients, but there was no operative mortality. At 2 years, the mean percentage weight loss for patients having laparoscopic adjustable gastric banding, laparoscopic sleeve gastrectomy, and laparoscopic gastric bypass were 34%, 51% and 61%, respectively. After operative treatment, obesity-related co-morbidities including metabolic syndrome, type 2 diabetes, hypertension, and sleep apnoea had also improved significantly.

Conclusion Through a multidisciplinary weight management programme and various bariatric procedures, favourable results can be achieved in Chinese patients with severe obesity.

Key words
Bariatric surgery; Gastrectomy; Gastric bypass; Laparoscopy; Obesity, morbid

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Prince of Wales Hospital, The Chinese University of Hong Kong, Shatin, Hong Kong:
Division of Upper Gastrointestinal Surgery, Department of Surgery
SKH Wong, FRCS (Edin), FHKAM (Surgery)
WLM Mui, FRCS (Edin), FHKAM (Surgery)
BYS Tsung, PhD, MPhil
EKW Ng, MD, FHKAM (Surgery)
Division of Endocrinology, Department of Medicine and Therapeutics
APS Kong, FRCP, FHKAM (Medicine)
WY So, FRCP, FHKAM (Medicine)
FCC Chow, FRCP, FHKAM (Medicine)
Dietetic Department
PYP Yau, BSc, SRD

Correspondence to: Prof EKW Ng
E-mail: endersng@surgery.cuhk.edu.hk

Introduction

With the rapid growth and development in the economy of Hong Kong and China, obesity and its associated co-morbidities are increasingly a regional health and societal burden. In a territory-wide survey of Chinese adults, the age-standardised prevalence of metabolic syndrome was 13.9%, according to International Diabetes Federation (IDF) criteria.[1] The prevalence of overweight was even more alarming; 29.1% of men and 21.3% of women had a body mass index (BMI) of over 25 kg/m^2.[2] A recent multi-centre Asia-Pacific study revealed that nearly 3% of the Chinese in Hong Kong are medically obese (BMI >30 kg/m^2).[3] Moreover, South-East Asians have a higher risk of developing diabetes and cardiovascular disease than Caucasians having the same BMI values, for which reason in Asian populations the World Health Organization recommends lower cut-offs for defining overweight (BMI >23 kg/m^2) and obesity (BMI >25 kg/m^2).[4]

These figures are alarming, as many obese patients inevitably suffer from co-morbidities that lead to premature mortality. While lifestyle modification, exercise, dietary training, and medical therapy may be effective for the slightly overweight, those who are morbidly obese (BMI >35 kg/m^2) are often refractory to these simple measures. According to the National Institutes of Health (NIH) consensus in 1991, bariatric surgery is the only way to guarantee substantial weight loss with reasonable weight maintenance. Moreover, it has been shown to reduce the cardiometabolic risk factors associated with obesity,[5] reverse glucose intolerance, hypertension and pulmonary dysfunction,[6] and improve

overall survival.[7]

The development of bariatric surgery in Hong Kong is in its infancy, when compared to western countries. In 2002, we established the first Combined Obesity Clinic (COC) in Hong Kong, with input from surgeons, endocrinologists, dietitians, and specialty nurses. The clinic provided a platform for both clinical services and research on the management of obese Chinese patients. A variety of bariatric surgical procedures including laparoscopic adjustable gastric banding (LAGB),[8] laparoscopic gastric bypass (LGB), and laparoscopic sleeve gastrectomy (LSG)[9] were introduced over the years. This report serves as an audit of the outcomes of all bariatric surgery performed in that period. Our standard criterion for referral to the COC was a BMI of 30 kg/m^2 or more. For those suffering from obesity-related co-morbidities (including type 2 diabetes, hypertension, hyperlipidaemia, obstructive sleep apnoea, degenerative arthropathy), the criterion for referral was 27 kg/m^2. The COC provides preoperative counselling, endocrine and metabolic disease screening for secondary causes of obesity and obesity-associated co-morbidities, dietary assessment and counselling. For each patient, a tailor-made weight management programme is formulated according to the severity of obesity, potential risk-benefit considerations, and after discussing realistic goals in relation to available treatment strategies (Fig 1).

腹腔鏡減肥術：五年經驗回顧

目的 回顧本院使用腹腔鏡可調節胃束帶術、腹腔鏡胃袖套狀切除術，以及腹腔鏡胃繞道手術來治療病態肥胖症的結果。

設計 前瞻性隊列研究。

安排 香港中文大學威爾斯親王醫院的減肥手術中心。

患者 2002年7月至2007年12月期間轉介至綜合體重控制門診的病人；診所專為嚴重肥胖人士提供跨部門體重控制治療。在病態肥胖症病人接受減肥術後，收集並前瞻性回顧病人的圍術期數據、術後體重的改變，以及其他病患改善的情況。

結果 研究期間，共531位病人於本診所治療肥胖症。病人平均體重96 kg（標準差：22 kg），平均體重指數36 kg/m^2（6 kg/m^2），平均年齡40歲（10歲）；64%為女性。共94位病人（18%）接受減肥術，分別為：腹腔鏡可調節胃束帶術57位、腹腔鏡胃袖套狀切除術30位，以及腹腔鏡胃繞道手術7位。其中11位病人（12%）出現併發症，但未有因手術而死亡的案例。術後兩年，病人平均體重下降率為：腹腔鏡可調節胃束帶術34%、腹腔鏡胃袖套狀切除術51%，以及腹腔鏡胃繞道手術61%。與肥胖有關的病患，包括代謝綜合徵、2型糖尿病、高血壓，以及睡眠窒息症均有明顯改善。

結論 透過跨部門體重控制治療及不同種類的減肥術，嚴重肥胖的華籍病人可以有良好的效果。

Methods

Before contemplating any bariatric procedure, all morbidly obese patients were offered psychiatric assessment for potential eating/depressive disorders. Before a final decision on the suitability of surgical treatment, each patient was assessed several times regarding their medical history, co-morbidities, previous attempts and motivation to achieve weight reduction.

Candidates for bariatric surgery

From 2002 to 2005, we recruited patients for surgery (LAGB, LSG, LGB) in keeping with the United States NIH consensus guidelines. Such patients were those whose BMI exceeded 40 kg/m^2, or were less obese (BMI, 35-40 kg/m^2) but suffered from high-risk co-morbidities.[9,10] However, subsequent studies in Hong Kong showed that the Chinese had a higher body fat percentage than Caucasians with comparable BMIs.[11,12] These observations were in agreement with higher morbidity risks at a lower BMI in the Hong Kong Chinese population.[13] In 2005, the Asia-Pacific Bariatric Surgery Group consensus meeting therefore recommended bariatric surgery in Asian patients with BMIs of more than 37 kg/m^2, or more than 32 kg/m^2 if they had diabetes or two other obesity-related co-morbidities.[14] Since then, we modified our criteria and started recruiting patients with even lower BMIs for surgery.

Bariatric surgery

Laparoscopic adjustable gastric banding

In 2002 we adopted LAGB, our first bariatric procedure. It is purely gastrorestrictive, and involves the laparoscopic insertion of an adjustable silicone band around the gastric cardia[8] to create a small (15 mL) gastric pouch with a narrow outlet. The bands were adjusted postoperatively until the desired weight loss was achieved. This involved percutaneous injection or withdrawal of saline from a reservoir via a subcutaneous port, deep within the abdominal wall. Patients were followed up monthly for the first 6 months, then 3-monthly for 2 years and then half-yearly.

Laparoscopic sleeve gastrectomy

'Sleeve gastrectomy' or 'vertical gastrectomy' involves laparoscopic removal of more than 75% of the stomach and leaving a small gastric tube[9] that decreased the stomach size, inhibiting its distention and increasing the sensation of fullness while decreasing appetite. In

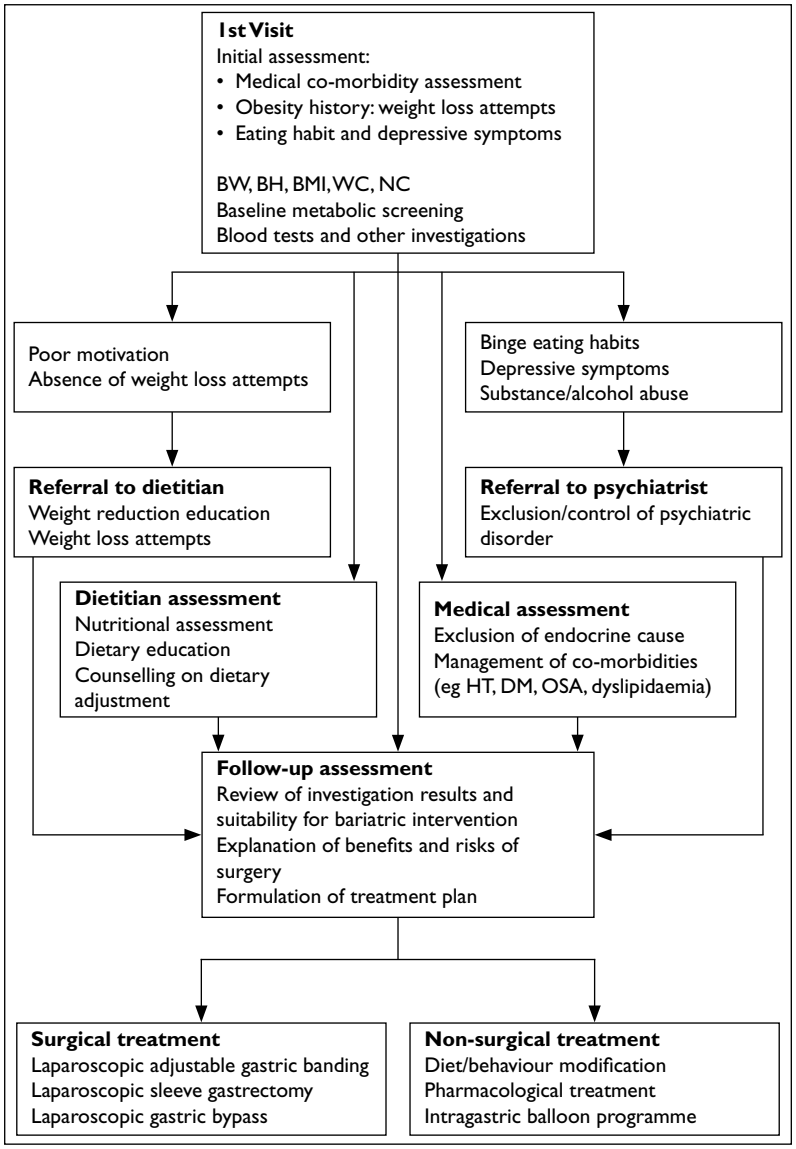

FIG 1. Flowchart for assessment in the Combined Obesity Clinic

BH denotes body height, BMI body mass index, BW body weight, DM diabetes mellitus, HT hypertension, NC neck circumference, OSA obstructive sleep apnoea, and WC waist circumference

contrast to LAGB, LSG was an irreversible procedure, which could induce substantial weight loss and did not require postoperative adjustment. As part of our prospective cohort study protocol, we adopted this procedure from 2005, and it serves as an alternative restrictive procedure to attain weight reduction in morbidly obese patients.

Laparoscopic gastric bypass

Although LAGB and LSG were effective for most of our patients with morbid obesity, they still had limitations. Restrictive procedures cannot limit fluid calories, and patients with poor dietary compliance are at risk of inadequate weight loss due to pouch dilatation secondary to binge eating behaviour. Gastric bypass, on the other hand, is a hybrid procedure combining gastric partition (restriction) and foregut bypass (malabsorption). First, we divide the stomach into a small upper pouch and a much larger, lower 'remnant'. Then we re-arrange the small intestine to allow food to enter the distal small bowel without passage through the remnant stomach, duodenum, and proximal jejunum. There are two forms of reconstruction techniques. In Roux-en-Y gastric bypass (RYGB), the proximal stomach is transected and converted into a small pouch (15-30 cc) around 2 cm below the cardia. The small bowel is then divided about 50 cm below the ligament of Treitz, and re-arranged into a Y-configuration. This enables outflow of food from the small upper stomach pouch, via a 'Roux limb' to the distal small bowel. The Roux limb is constructed to have a length of 80 to 150 cm and forms the gastrojejunal anastomosis. The duodeno-jejunal (biliary) limb is then joined to the Roux limb to preserve distal small bowel's absorptive capacity for nutrients. The mini-gastric bypass involves creation of a long gastric tube by transecting the proximal stomach at the level of angular incisura and along the lesser curve. A loop gastrojejunostomy is then performed at about 200 cm beyond the ligament of Treitz. This bypass that uses the loop reconstruction has been suggested as an alternative to the Roux-en-Y procedure, due to its simplicity to construct and shorter operating time. Lee et al[15] from Taiwan have conducted a randomised controlled trial which confirmed these advantages over the RYGB, and outcomes were comparable in terms of postoperative complications, amount of weight loss, and co-morbidity improvement.

Although gastric bypass is more effective for weight reduction and induces remissions of type 2 diabetes,[16] it confers higher peri-operative morbidity and mortality, and requires lifelong nutritional supplementation. Macro-nutrient (protein) deficiency is much less common than following other malabsorptive procedures like bilio-pancreatic diversion (BPD). However, deficiencies of micro-nutrients such as iron (6-52%), vitamin B12 (8-64%), folate (0-38%), calcium (10%), and vitamin D (50%) have been reported after RYGB surgery,[17] which may lead to anaemia and reduced bone mass (especially in females). Because these deficiencies are quite common after RYGB, aggressive supplementation with iron, vitamin B12, folate, calcium, and vitamin D and regular monitoring of nutritional status is necessary.

Data collection

All patients who received bariatric surgery were included in our bariatric surgery database and data on preoperative characteristics (sex, age, BMI,

TABLE 1. Baseline characteristics of patients having surgery*

	Patients attending the Clinic (n=531)		Type of surgery†		
			LAGB (n=57)	LSG (n=30)	LGB (n=7)
Sex (M:F)	191:340		24:33	9:21	2:5
Age (years)	40±10		41±9	33±7	39±9
Body weight (kg)	96±22		106±24	118±22	117±11
Body mass index (kg/m²)	36±6		40±7	45±8	43±2
Co-morbidities	Before screening	After screening			
Metabolic syndrome	-	324 (61%)	23 (40%)	18 (60%)	5 (71%)
Type 2 diabetes	52 (10%)	65 (12%)	14 (25%)	9 (30%)	1 (14%)
Hypertension	103 (19%)	174 (33%)	43 (75%)	29 (97%)	5 (71%)
Obstructive sleep apnoea	88 (17%)	88 (17%)	25 (44%)	4 (13%)	3 (43%)
Hyperlipidaemia	65 (12%)	287 (54%)	20 (35%)	7 (24%)	3 (43%)

* Data shown as numbers or mean±standard deviation

† LAGB denotes laparoscopic adjustable gastric banding, LSG laparoscopic sleeve gastrectomy, and LGB laparoscopic gastric bypass

baseline blood tests, co-morbidities, medication list), treatment options (LAGB, LSG, LGB), operative progress (operating time, complications, mortality, hospital stay), and follow-up details (co-morbidity status, weight change, side-effects) were collected and analysed.

Results

From July 2002 to December 2007, 531 patients attended our COC for assessment of their obesity problems, with a mean age of 40 (standard deviation [SD], 10) years, and 340 (64%) were women. Their mean baseline body weight and BMI was 96 (SD, 22) kg and 36 (SD, 6) kg/m², respectively, and their mean waist circumference was 112 (SD, 17) cm. Before attending our clinic, 345 (65%) of the patients suffered from obesity-related co-morbidities, including: hypertension (30%), diabetes (15%), obstructive sleep apnoea (25%), hyperlipidaemia (12%), degenerative arthropathy (29%), and psychiatric disorder (7%). After screening investigations, hypertension, diabetes, and hyperlipidaemia were diagnosed in a further 71, 13, and 222 patients, respectively (Table 1). According to the IDF definitions, 95% of our patients had central obesity (waist circumference >90 cm in males and >80 cm in females) and 61% had the metabolic syndrome.

Bariatric surgery

Among our COC patients, 313 (59%) fulfilled weight criteria for bariatric surgery. After explanation and discussion of the pros and cons of the surgery, 94 (30%) patients agreed to have it as part of their weight management programme. Among the latter, LAGB, LSG and LGB were performed on 57 (61%), 30 (32%) and 7 (7%) patients, respectively. By contrast, 82 patients decided to receive alternative weight reduction treatment (intragastric balloon or pharmacological therapy), while the rest declined any endoscopic or medical therapy.

Laparoscopic adjustable gastric banding

Since 2002, 57 patients underwent LAGB as primary treatment of morbid obesity; their mean age was 41 (SD, 9) years and 33 (58%) were women. Their mean body weight was 106 (SD, 24) kg and mean BMI was 40 (7) kg/m². Among them, 42 (74%) of the patients received a LapBand (Bioenterics; Inamed Corp, Allergan, Inc, Irvine, US) and 15 (26%) a Swedish Adjustable Gastric Band (Ethicon Endo-Surgery in cooperation with OBTECH, Johnson & Johnson, Inc, New Brunswick, US). The mean operating time was 99 (SD, 43) minutes. There was no peri-operative morbidity or mortality and the mean hospital stay was 2 (SD, 1) days. The mean duration of follow-up for these patients was 24 (SD, 16) months. Five (9%) developed postoperative complications (Table 2) for which three (5%) were re-operated. One patient had a connection tubing leakage and had a laparoscopic gastric band replacement. Another patient had blockage of the connecting tube due to kinking at the injection port site, for which local wound exploration with readjustment was performed. The third patient developed an infected port with persistent wound discharge. Despite wound debridement and dressing, the infection persisted and the gastric band was removed 4 months after the initial operation. Moreover, one patient had inadequate weight loss and poor diabetes control, despite LAGB, for whom the band was removed and an open RYGB was carried out 14 months after the initial operation. In all, two (3%) of the patients had their gastric bands removed in the ensuing 5 years. Values for mean weight loss at 6, 12, and 24 months were 11, 12, and 15 kg, respectively. The mean percentage excessive body weight loss (EBW

TABLE 2. Operative outcome of patients having bariatric surgeries*†

	LAGB (n=57)	LSG (n=30)	LGB (n=7)
Operating time (min)	99±43	108±52	200±59
Hospital stay (days)	2±1	6±3	15±13
Complications	5 (9%)	3 (10%)	4 (57%)
Types of complications			
Connection tube problems	2	-	-
Wound infection	1 (band infection)	1	-
Diet intolerance	2 (pouch dilation)	2	-
Stomal stenosis	-	1	1
Anastomosis leakage	-	-	1
Anastomosis ulcer	-	-	1
Intestinal obstruction	-	-	1
Operation/intervention for complications	3 (5.3%)	1 (3.3%)	3 (43%)
Revision surgery for poor weight loss	1 (1.8%)	-	-
Follow-up duration (months)	24±16	12±13	24±5
Weight loss (kg)			
6 Months	11±8	27±8	26±3
12 Months	12±9	33±11	34±7
24 Months	15±13	27±7	30±9
% Excessive weight loss			
6 Months	27±26	63±33	54±11
12 Months	31±24	65±32	70±16
24 Months	34±37	51±38	61±16

* LAGB denotes laparoscopic adjustable gastric banding, LSG laparoscopic sleeve gastrectomy, and LGB laparoscopic gastric bypass
† Data shown as numbers or mean±standard deviation

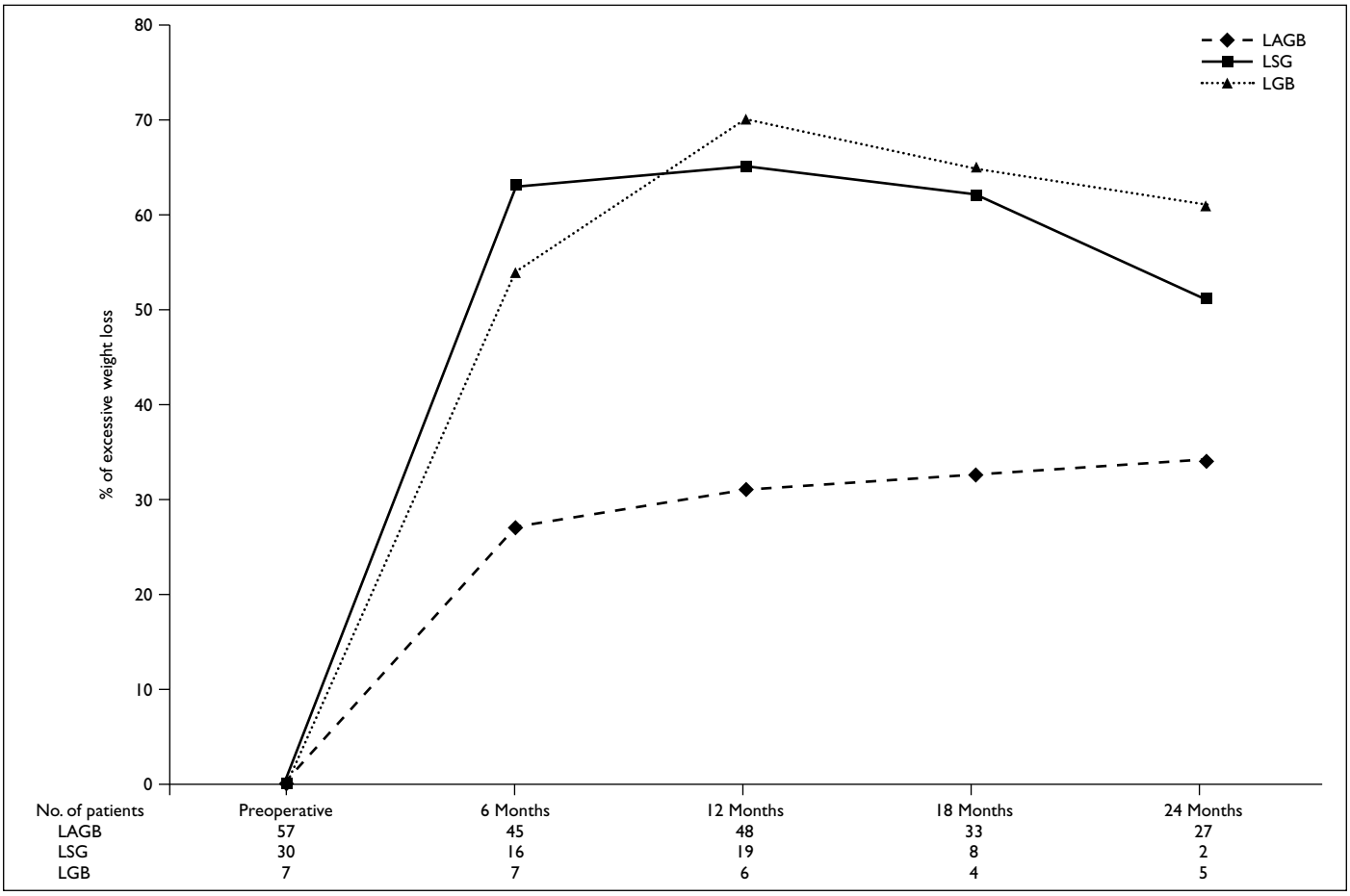

FIG 2. Patient numbers followed up and mean percentage of excessive weight loss associated with different bariatric procedures
* LAGB denotes laparoscopic adjustable gastric banding, LSG laparoscopic sleeve gastrectomy, and LGB laparoscopic gastric bypass

loss = weight loss/[initial body weight - ideal body weight at BMI 25 kg/m^2] x 100%) at 6, 12, and 24 months were 27%, 31%, and 34%, respectively (Fig 2, Table 2). Six patients continue to live with their LAGB for more than 5 years (mean, 63 months), and their mean weight loss and EBW loss values were 14.8 kg (range, 4.1-25.2 kg) and 26% (range, 6-54%), respectively.

TABLE 3. Patient numbers with major co-morbidities

Co-morbidities	Before surgery	After surgery	Resolution
Metabolic syndrome	46	28	18 (39%)
Hypertension	77	71	6 (8%)
Type 2 diabetes	24	14	10 (42%)
Hyperlipidaemia	31	18	13 (42%)

Laparoscopic sleeve gastrectomy

Since 2005, 30 patients received LSG as the primary procedure for morbid obesity. Their mean age was 33 (SD, 7) years, and 21 (70%) were women. Their baseline mean body weight was 118 (SD, 22) kg and mean BMI was 45 (SD, 8) kg/m^2. The mean duration of their surgery was 108 (SD, 52) minutes. The mean duration of their hospitalisations was 6 (SD, 3) days and they endured no operative morbidity or mortality during their hospital stay. The duration of follow-up was short for the LSG procedure (mean, 12; SD, 13 months); only two patients were followed up for more than 2 years. Complications occurred in three (10%) patients. One developed a wound infection and two suffered dietary intolerance for which they were hospitalised. One of the latter improved without intervention and was discharged after rehydration. The other had stomal stenosis at the distal gastric tube and had endoscopic dilatation to relieve her symptoms. The mean values for weight loss at 6, 12, and 24 months were 27, 33, and 27 kg, respectively, and for mean EBW loss at 6, 12, and 24 months they were 63%, 65%, and 51%, respectively (Fig 2, Table 2).

Laparoscopic gastric bypass

In all, five men and two women (mean age, 39; SD, 9 years) had laparoscopic mini-gastric bypass; six as the primary procedure and one as an open gastric bypass for failed LAGB surgery. Their mean baseline body weight was 117 (SD, 11) kg and their mean BMI was 43 (SD, 2) kg/m^2. Their mean operating time was 200 (SD, 59) minutes. There was no operative mortality but one of the seven patients developed an anastomotic leakage, and underwent re-laparotomy with repair and drainage performed 3 days later. Their mean hospital stay was 15 (SD, 13) days, and the mean follow-up duration was 24 (SD, 5) months. Apart from the patient who suffered the anastomotic leak, three others developed postoperative problems. One developed a small bowel volvulous after 4 weeks and underwent operative repair, one was hospitalised for a hypoglycaemic attack, and one suffered epigastric pain and was diagnosed to have a stomal ulcer. The latter was treated with a proton pump inhibitor but subsequently developed an anastomotic stricture for which endoscopic dilatation was carried out. Upon latest follow-up, no patient was suffering from anaemia, hypocalcaemia or hypo-proteinaemia. Their respective mean values for weight loss at 6, 12, and 24 months were 26, 34 and 30 kg, and corresponding mean EBW loss values were 54%, 70%, and 61%, respectively (Fig 2, Table 2).

Improvement of co-morbidities

Obesity-related co-morbidities were present in 91 (97%) of the patients at initial preoperative assessment, which included the metabolic syndrome (n=46), hypertension (n=77), diabetes (n=24), obstructive sleep apnoea (n=32) and hyperlipidaemia (n=31) [Table 3]. The mean duration of follow-up after surgery was 20 (SD, 14) months, and at latest follow-up there were significant improvements in co-morbidities.

Metabolic syndrome

Before their operation, 46 (49%) of the 94 patients had the metabolic syndrome according to the IDF definition.[18] There were postoperative improvements in the degree of dysglycaemia (mean fasting glucose, 6.2 vs 5.4 mmol/L; P<0.001), dyslipidaemia (mean triglyceride level, 1.7 vs 1.3 mmol/L; P=0.008 and mean high-density lipoprotein level, 1.3 vs 1.5 mmol/L; P<0.001) and the metabolic syndrome resolved in 18 (39%) of them.

Hypertension

Thirty-three patients were known to have hypertension upon attending our COC and thereafter 44 more were noted to have high blood pressure (systolic >140 mm Hg or diastolic >90 mm Hg). After their operations, there was significant improvement in their mean systolic blood pressure from 149 (SD, 17) to 141 (SD, 20) mm Hg (P=0.021) and mean pulse pressure from 65 (SD, 13) to 60 (SD, 12) mm Hg (P=0.033). At their last follow-up, six (8%) of the patients did not need to continue their antihypertensive mediations due to normal blood pressures.

Diabetes mellitus

Twenty-two patients had known type 2 diabetes mellitus before attending the COC and two more were diagnosed after baseline blood screening. After surgery, there were significant improvements in mean values for fasting blood glucose (mean, 9.2 mmol/L

vs 6.5 mmol/L; P=0.005), HbA_{1c} (mean, 7.4% vs 6.5%; P=0.011), and reductions in the number of medications used for glycaemic control (mean, 1.3 vs 0.8; P=0.005). Of the 24 patients, 13 (54%) showed improvement of glycaemic control, and 10 (42%) achieved remission of their diabetes (fasting blood glucose <7 mmol/L and HbA_{1c} <6.2% without medication).

Obstructive sleep apnoea

Before their operation, 32 patients were diagnosed to have obstructive sleep apnoea, 18 of whom were using continuous positive airway pressure (CPAP) devices at night. Among these patients, 10 (56%) noted a significant improvement after their operation; the mean settings for their CPAP devices being reduced from 11.8 to 8.4 cm H_2O (P=0.011).

Discussion

Since 2002, various laparoscopic bariatric surgeries have been performed in our hospital, with a view to control morbid obesity and improve patient health and quality of life. Numerous studies have reported the effectiveness of such surgery and its ability to alleviate obesity-related diseases such as metabolic syndrome, diabetes, sleep apnoea, and hypertension. In two recent prospective cohorts,[7,19] it was clearly demonstrated that bariatric surgery improved survival of severely obese patients compared to those who did not receive such surgery. In Hong Kong however, the majority of patients are unwilling to undertake such aggressive surgery to treat obesity; only one third agreed to have such a procedure, among those in whom it was deemed indicated after thorough assessment and counselling in our COC. Obesity prevention is very important for society. Weight control management for those with morbid obesity is also crucial and difficult to achieve without a multidisciplinary team. This approach should start with education from primary health care providers and professional advice on the needs for interventional therapy when conservative methods fail. In Hong Kong, we adopted the Asia-Pacific Bariatric Surgery Group consensus guideline[14] on patients with BMIs of more than 37 kg/m^2 (or a BMI >32 kg/m^2 in patients with diabetes mellitus or two co-morbidities) as criteria for considering weight reduction surgery.

In 2002, we introduced LAGB (a comparatively safe operation with a lower morbidity and mortality than LGB) as our first bariatric procedure. In a series of 1120 patients, O'Brien and Dixon[20] reported an early peri-operative complication rate of 1.5% and late complication rate of 14%.[20] Complication rates reported by others ranged from 3.9 to 11.3%,[21,22] and were comparable to our results (9%). Re-operation and band failure are still the most challenging problems of this surgery. A recent meta-analysis has shown that around 7.7% of patients require re-operation for band removal, usually due to intolerance, infection, band slippage, and band erosion. In our series, four (7%) patients underwent re-operation; two (3%) had bands removed due to infection and inadequate weight loss, which reflects the potential limitations of LAGB in severe obesity. Moreover, the degree of weight reduction attained was relatively minimal compared to other bariatric procedures (sleeve gastrectomy and gastric bypass). The procedure is less effective for patients with poor dietary compliance and those with high BMIs.[23] In contrast to patients with lower BMIs (<60 kg/m^2), super-obese patients require a longer period of follow-up to accomplish a similar percentage of EBW loss. However, LAGB is still an attractive operation for both patients and surgeon due to its reversibility and safety; associated mortality being about one tenth of that after gastric bypass.[24]

No single operative procedure is suitable for all patients and different strategies are therefore needed. We introduced LGB and LSG in 2005 as alternative procedures for patients not suitable for LAGB. Over the last 5 years, we performed LGB on only seven patients. Although RYGB is the more commonly performed reconstructive technique used around the world, we choose mini-gastric bypass as our preferred technique, because it is more easily performed by laparoscopy, and entails a shorter operating time than RYGB.[15] Our initial results show that LGB is the most effective for inducing weight loss. However, it is difficult to perform laparoscopically and has a steep learning curve.[25] Early complications (anastomotic leakages) are life-threatening; reported mortality ranges from 0.5 to 2%.[24] Late complications such as stomal stenosis, internal herniation, and bleeding are also quite common, especially at the beginning of the learning curve. We experienced a significant morbidity from LGB; three of seven patients underwent re-operation for leakage problems and bowel volvulus. Therefore we currently reserve LGB as a salvage procedure for patients with failed LAGB or LSG; only patients not regarded as at high risk and having extreme BMIs (>60 kg/m^2) would be offered this operation as a primary weight reduction procedure.

Laparoscopic sleeve gastrectomy is a relatively new procedure. It may be viewed as a modification of the widely accepted vertical banded gastroplasty with a gastric component of the more established malabsorptive BPD procedure with duodenal switch.[26] The mechanism of weight loss and resulting improved co-morbidity may be related to gastric restriction or to neurohumoral changes. Ghrelin is an appetite hormone produced from the gastric corpus and reduction in fasting and postprandial ghrelin levels have been observed after LSG and LGB. In a recent randomised trial, LSG was shown

to be superior in reducing body weight and fasting ghrelin levels than LGB.[27] This type of surgery has been performed in patients with preoperative BMIs ranging from 35 to 69 kg/m^2 and results in EBW losses ranging from 33 to 83%.[28-32] Most of these reports, however, describe short-term outcomes and no follow-up beyond 3 years. Similar to other forms of gastroplasty, the perioperative risk for sleeve gastrectomy appears relatively low, even in high-risk patients. Published complication rates ranged from 0 to 24% with an overall reported mortality of 0.39%. We have conducted a prospective cohort study on the use of LSG in morbidly obese patients. In our early experience, 30 patients received LSG without mortality and only 10% developed complications. The mean weight loss after 1 year was 33 kg and after 2 years it was 27 kg, and the corresponding EBW loss values were 65% and 51%. Compared to LAGB, it appears superior in terms of weight loss and does not require frequent follow-up (as for band adjustment). After LSG, weight loss however seems to plateau at 1 year and there is a potential for weight regain. The American Society of Bariatric and Metabolic Surgery issued its own position statement on LSG in 2007.[33] This suggests that surgeons who perform sleeve gastrectomies should inform patients regarding the lack of published evidence for sustained weight loss beyond 3 years. Surgeons are advised to prospectively collect and report outcome data for this procedure in the scientific literature. We believe that LSG is safer than LGB, though we need to review our long-term results, especially with regard to the durability of weight control following this new procedure.

Whatever the procedure, the primary aim of bariatric surgery should always be to improve health and reduce the risk of future life-threatening co-morbidity. A series of reports from the Swedish Obesity Subjects study support the superiority of surgery in comparison to medical therapy in ameliorating or preventing obesity-related comorbidity.[34,35] In 2007, two large population-based prospective cohorts demonstrated that for severely obese patients, surgery is associated with longer survival than non-operative treatment.[7,19] Although we have operated on less than a hundred patients in the last 5 years, most have enjoyed significant improvement of their health and alleviation of co-existing diseases. Arguably, improvement of co-morbidities may be related to more intense medical therapy and dietetic care, which could be related to the bariatric surgery service and its team approach. We believe that management of morbid obesity requires multidisciplinary teamwork and that surgery is only part of it. Although we cannot separate the improvement after treatment due to surgery or better medical therapy, without this multidisciplinary approach, satisfactory results are difficult to achieve. Among patients who received surgery, prevalence of metabolic syndrome was reduced from 49 to 30%, diabetes mellitus from 26 to 14%, and there was also a significant improvement with respect to obstructive sleep apnoea and hypertension. Maggard et al[24] reviewed over 140 reports on the effects of bariatric surgery and found that improvement or resolution of diabetes ranged from 64 to 100%, whilst 25 to 100% (median, 89%) showed improvement or resolution of hypertension, and 60 to 100% (median, 88%) had improvement or resolution of dyslipidaemia. Contrarily, as more and more bariatric procedures are performed, more re-operations for revision and other complications are likely to be encountered. In five of our patients, re-entry of the abdominal cavity was deemed necessary for emergency surgery or revision for failed primary procedures. The latter procedures entailed: small bowel decompression for volvulus; open drainage and repair for anastomotic leakage; laparoscopic removal of a band due to infection; laparoscopic removal and replacement of a leaking gastric band; and open gastric bypass after failed LAGB. Notably, only two of these procedures were performed laparoscopically, as revision for bariatric procedures is difficult and technically demanding. However, in high-volume bariatric centres, laparoscopic re-operation for revision is possible with low conversion to open (4.3%) and complication (14.3%) rates.[36] As we gain more experience, we too can expect to manage more of these patients with minimally invasive surgery.

Bariatric surgery is evolving in Hong Kong and around the world. Procedures such as gastric bypass and BPD are now proven to be able to manipulate gut hormones (including incretin production) and ameliorate diabetes. The term 'metabolic surgery' has recently been adopted by most bariatric surgical societies. If associated mortality and morbidity from the operations can be minimised, such surgery appears to be an irresistible option for patients with severe obesity. Careful preoperative assessment and counselling by multidisciplinary specialties, appropriate surgical training, and patient mentoring should also be considered essential steps in starting up a bariatric surgical practice. For many surgeons, operating on morbidly obese patients can be a disaster and special precautions are needed, with respect to anaesthesia, positioning, peritoneal access, organ retraction and manipulation, as well as for wound closure and patient's recovery. Without proper training and understanding of the pathophysiology and psychology of patients with morbid obesity, the risks of operation are substantial.

In conclusion, from our experience, bariatric surgery is a feasible and reliable modality for treating severely obese Chinese subjects. Sustainable weight loss and improvement of co-morbidities was achieved and our results were comparable to those from western countries. Through a multidisciplinary weight management programme and careful selection

of patients, favourable results can be attained in the severely obese patients. With continuous follow-up and maintenance of our prospective database, further long-term results associated with different procedures may help to enlighten us on the most appropriate procedures for our Chinese population.

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