Review

Recent advances in the surgical management of morbid obesity.

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INTRODUCTION - OBESITY EPIDEMIC

Over 30,000 deaths per year are caused by obesity in England alone. Obesity rates have nearly quadrupled in the last 25 years. Currently, 22% of Britons are obese and 75% are overweight (NAO). In the United States, obesity characterises over 60 million people with more than ten million being considered morbidly obese (American Obesity Association, AOA).

Obesity is defined as body mass index (BMI) > 30 kg/m2. People are considered to have morbid obesity if they have a BMI > 40 kg/m2 or a BMI between 35 – 39.9 kg/m2 with other significant medical co-morbidities (e.g. diabetes, high blood pressure, obstructive sleep apnoea, and fatty liver disease).

WHY UNDERGO BARIATRIC SURGERY (WEIGHT LOSS SURGERY)?

While obesity in itself is a risk factor, the majority of mortality and morbidity is caused by associated medical co-morbidities such as diabetes, hyperlipidaemia, hypertension, obstructive sleep apnoea as well as psychosocial disorders, many of them reversible with potential weight loss.

Studies have demonstrated that non-operative methods alone (supervised diets and exercise programs) fail to produce a permanent and sustained, long-term weight loss in severely obese patients. The surgical treatment of obesity is the only proven method of achieving long term weight control, resolving life-threatening medical co-morbidities, preventing secondary medical complications and improving the lifestyle of morbidly obese patients. On average, after successful weight loss surgery, the life expectancy of the patient can be extended by as much as twelve years.

WHO IS A CANDIDATE FOR BARIATRIC SURGERY?

While weight loss surgery is not the first option for patients with morbid obesity, it is an option and should be offered. The patients should be well informed of the operative risks and the life-changing aspects of such major operations. Pre-operative teaching regarding the dietary, vitamin, and protein supplementation requirements, as well as education regarding exercise and lifestyle modifications necessary after weight reductive surgery is crucial for a successful long term outcome. When performed by an experienced and trained surgeon at a high volume facility that incorporates a multi-disciplinary program, weight reductive surgery can be safe and effective with a mortality < 0.14% (NICE).

NICE recommends that surgery is offered to patients that have been unsuccessful with non-surgical conservative treatments for obesity, and have been obese for over five years. Patients also need to be aware of the need of long-term follow-up by the bariatric surgeon, other medical professionals as well as further corrective-cosmetic surgery. Similar indications exist in the US, recommended by the National Institutes of Health Consensus Development Panel in 1991[1].

THE EVOLUTION OF BARIATRIC SURGERY.

Bariatric surgery can be divided into restrictive and malabsorptive procedures, some operations being a combination of both. Chronologically the first published bariatric procedure was reported by Kremen et al in 1954[2]. This was a malabsorptive method that

consisted of a jejunoileal intestinal bypass. Although the weight loss produced was satisfactory, the many life threatening complications, including hepatic failure, led to the abandonment of this operation.

The procedure having the biggest impact in bariatric surgery was developed by Mason in the 1960's[3]. The gastric bypass (GB) procedure entailed partial gastrectomy (restrictive) with loop gastroenterostomy (malabsorptive). Over time, the procedure was developed to its current form, the Roux- en- Y gastric bypass (RYGB).

With the introduction of stapling devices and restrictive bands in bariatric surgery purely restrictive procedures were sought. Mason et al developed the vertical banded gastroplasty (VBG) in the 1980s[4]. To permit changes in the diameter of the band, Kuzmak (1986) added an adjustable inflatable portion (adjustable gastric banding, AGB)[5].

The initial jejunoileal procedure was also modified through time to its modern version, the biliopancreatic diversion (BPD). This operation was initially performed by Scopinaro in 1976[6]. It involves limited gastrectomy in combination with a long loop anastomosis leaving just a short distal ileal common channel, producing significant malabsorption. Hess in 1988 produced a hybrid of this technique by performing a duodenal switch (DS)[7].

Since the introduction of minimally invasive surgery in the bariatric field[8] the rate at which these procedures are performed has exponentially risen[9]. Surgeons are still devising new procedures. On the horizon is the implantable gastric stimulation (IGS) as well as the intragastric balloon.

Staged procedures are applied in specialized centres for high risk patients with extreme obesity (BMI > 65 kg/m2). These involve a primary restrictive procedure to lower the BMI, thus decreasing the operative risk when returning to the operating room months later to complete the procedure by adding a malabsorptive component.

We will review the procedures currently performed with greater emphasis in RYGB and AGB. Complications and outcomes of the procedures will be presented as well as comparative studies and recent developments in the surgical techniques used.

ROUX-EN-Y GASTRIC BYPASS (RYGB)

Surgical Technique – Complications

The RYGB is a combination procedure. A small gastric pouch of 15-30 ml. (restrictive) is combined with a bypass of the duodenum and 50-200cm of proximal jejunum (malabsorptive component).

Different variants of the initial gastric bypass have been performed since 1967[3]. Initially the operation was performed by performing a loop gastrojejunostomy to the small stomach pouch. Leaks at the gastrojejunal junction were common, leading to catastrophic complications. Over time the procedure has been refined to its current form, completing the intestinal bypass in a "roux-en-y" (in the form of) fashion which eliminates the risk of bile reflux gastritis and decreases the rate of marginal ulceration as well as anastomotic disruptions. Currently the RYGB is the most commonly performed operation in the US, and considered by many to be the gold standard of weight reductive procedures (FIGURE 1).

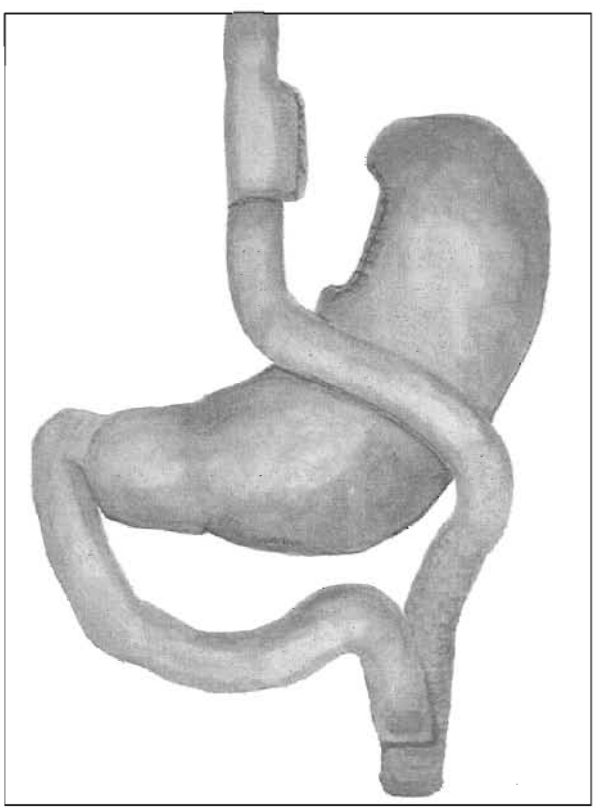

Fig. 1: Diagramatic representation of the gastric bypass with roux-en-y reconstruction.

Since 1994, advances in laparoscopic surgery have been introduced to bariatric procedures[8]. Many groups throughout the world have been performing these operations with outstanding results in weight loss, control of obesity-related co-morbidities and marked improvement in the quality of life of patients[10-13].

Studies have demonstrated that the laparoscopic approach is safe and cost effective in comparison to the open approach with a significant decrease in hospital length of stay. Since 2001, surgeons have been performing the Laparoscopic Roux – en – Y Gastric Bypass (LRYGB) with tremendous frequency. It produces an initial weight loss similar to the open approach while benefiting from the advantages of minimally invasive approaches such as a decrease in mean operating time, operative haemorrhage and mean intensive care and hospital stay[14,15].

The mortality rate is higher in the open gastric bypass (ORYGB) than in the laparoscopic procedure[16]. Compared to the open procedure, LRYGB is associated with decreases in frequency of iatrogenic splenectomy, wound infection, incisional hernia and mortality. The frequency of gastrointestinal haemorrhage, early and late bowel obstruction and stomal stenosis may be higher for the laparoscopic approach. There is no difference in the frequency of pulmonary embolism, anastomotic leak or pneumonia which are the most frequent cause of mortality[16]. While some of the complications observed in the ORYGB route can be attributed to the large access incision, the complications observed in the laparoscopic technique can be accredited to the steep learning curve and the inadequate training of surgeons performing these procedures[17].

Since many of the complications observed in the LRYGB are considered technically preventable, a great deal of research has been put into the refinement of this procedure. Two critical stages are the construction of the gastrojejunostomy and the jejunojejunostomy. Common complications at these sites include leak, narrowing or obstruction of the anastomoses as well as gastrointestinal haemorrhage[12]. Recently there has been a tendency for surgeons to use intracorporeal stapling devices instead of suturing because of the convenience of this technique[18].

Gastrojejunostomy may be fashioned by many different techniques. Stapled anastomoses include a circular stapled technique (trans-oral or trans-gastric introduction of the anvil of the stapler) or the linear stapled technique. Furthermore, a handsewn laparoscopic anastomosis may be completed[19]. A recent advance in robotic technology facilitates surgeons in decreasing operative time by utilizing robotic assistance for handsewn anastomosis. One study proposed that a gastrojejunostomy constructed with an endo-cutter cartridge and an endo-TA stapler reduced operating time and complications[20]. Another group suggested that the handsewn gastrojejunostomy was more time/cost effective while seemingly producing lower rates of postoperative anastomotic strictures and wound infections[21] - these differences might reflect the learning curve for stapling techniques. Anastomotic strictures are a frequent complication[15] but can be successfully and safely treated with endoscopic balloon dilation[22].

The most common cause of small bowel obstruction after GB is secondary to stenosis of the jejunojejunostomy[23]. This anastomosis can be technically very challenging and it is of paramount importance that a large patent anastomosis is constructed using a time/cost effective technique. The jejunojejunostomy can be performed in various ways, side-to-side semi-stapled or entirely stapled, or end-to-side and side-to-side handsewn.

Nguyen et al[15] investigated the technical feasibility of a side-to-side (functional end-to-side) double-stapling jejunojejunostomy (occasionally using suturing if haemorrhage was identified). The study confirmed that the anastomosis was safe and technically practicable although still noted postoperative complications such as bowel obstruction due to afferent limb stricture. Similar complications were observed in a study by Schauer et al[12] who used the same stapling technique for the construction of the anastomosis. A simple, preventative, anti-obstruction suture is frequently used and shown to decrease the incidence of anastomotic obstruction[24].

Recently, doctors Frantzides and Madan developed a new, modified stapling technique (triple stapling technique) which has produced promising results[18]. Used in 256 patients for the construction of the jejunojejunostomy, there was no incidence of leakage or stricture after a median follow-up of 6 months. A retrospective review of 435 consecutive patients that underwent the triple-stapling technique for the creation of the jejunojejunostomy, showed only one plausible

obstruction[25]. These results provide surgeons with an additional technical tool which can be expeditiously and safely used to create entero-enteric anastomoses.

Another frequent complication of GB, is the post-operative nutritional deficiencies including iron, calcium, thiamine, vitamin D, vitamin B12 and protein. Patient non-compliance with post-operative supplementation requirements is most often the cause. Protein deficiency correlates with the length of the roux (alimentary) limb. Weight loss in super obese patients is greater after long limb RYGB compared to the construction a roux limb < 150 cm., though two years after surgery 13% of the patients suffered from hypoalbuminaemia - two patients requiring total parenteral nutrition due to severe protein malnutrition[26].

Low levels of iron, contributing to iron deficiency anaemia is a relatively common complication after bypass of the duodenum and proximal jejunum[27]. With distal-RYGB, iron deficiency anaemia was again more prevalent[26]. Vitamin B12, folate, calcium, vitamin D, thiamine, as well as other fat-soluble and micronutrient deficiencies have been described by numerous studies[27]. Bariatric surgeons are expected to provide the necessary supplementations, even prophylactically, and maintain a long-term follow-up of patients to avoid the incidence of deficiencies.

Obesity is a well known risk for gallstone formation. In addition, it has been shown that rapid weight loss following bariatric surgery is a risk factor for cholesterol cholelithiasis[28] leading to more serious complications such as cholecystitis, cholangitis, gallstone pancreatitis, and formation of cholecystenteric fistulae. The incidence of symptomatic gallstones after RYGB has been shown to decrease with a prophylactic daily dose of ursodiol[29]. Routine pre-operative ultrasound can identify gallstones which can be concurrently removed during the GB surgery[30]. The use of pre-operative gastroesophagoduodenoscopy can also detect diseases

Table 1: EWL after RYGB

Study	Procedure	N of patients	Follow-up	EWL
Reinhold et al (1994)[32]	RYGB	129 86	1y 5y	66.4% 50.9%
Pories et al (1995)33	RYGP	591	1y 5y 10y 14y	pre-op mean 138.1kg to 87.2kg to 93.7kg to 93.7kg to 92.9kg
MacLean et al (2000)34	RYGP	243	5.5 ± 1.5y	60-70%
Wittgrove et al (2000)11	LRYGB	500 with>80% follow-up	6m 1y 2y 4y 5y	>60% 77% >80% 75% >80%
Schauer et al (2000)12	LRYGB	275	24m 30m	83% 77%
Nguyen et al (2001)15	RYGP open or laparoscopic	76 79	1y	62% 68%
DeMaria et al (2002)35	LRYGB	69	1y	70±5%
Buchwald et al (2004)36	RYGB	metanalysis of 22094 patients	1990-2003	68.2%
White et al (2005)37	RYGB	1y 342 with variable follow-up	89% 2y 5y 10y	 87% 70% 75%

such as tumours, ulcers and hernias. The pre-operative identification of gastric abnormalities may alter the surgical and medical management of patients[31]. This tool may be very important in preventing the incidence of post-operative complications associated with the pre-existent conditions.

OUTCOMES

The most common criterion used in the evaluation of weight reduction after bariatric surgery is 'excess weight loss' (EWL). This is the difference between the actual weight of the patient and the ideal body weight calculated and adjusted for their height. EWL of less than 50% or lack of maintenance of the EWL at more than 50% may be considered as weight loss failure. Many studies have solidified excellent results in weight loss after open or LRYGB (Table 1).

There is a rapid and substantial EWL at 1year which ranges from 62-89% (for the studies under consideration). Long term follow-up studies[33,37] have determined a relative weight gain of about 15% after 10 years which then seems to stabilize. Furthermore, many studies report that obesity-related co-morbidities such as NIDDM, hyperlipidaemia, hypertension, obstructive sleep apnoea and depression improve, or resolve after substantial weight loss. Weight loss after bariatric surgery can be attributed to a combination of anatomic, behavioural and hormonal changes. It is interesting that aversion to sweets secondary to the 'dumping syndrome' is another mechanism contributing to weight loss in GB.

LAPAROSCOPIC ADJUSTABLE GASTRIC BANDING (LAGB)

Surgical Technique – Complications

LAGB is the most recent procedure to be added to the bariatric surgeons' repertoire. It is a purely restrictive procedure in which an adjustable silicone band is inserted around the proximal stomach thus creating a small pouch. The adjustable band is connected to a subcutaneous reservoir which can be inflated thus tightening the band around the stomach and decreasing the volume of food outlet (FIGURE 2). Since the advent of laparoscopic banding by Belachew et al in the 1990s this procedure has become very popular, especially in Europe and Australia.

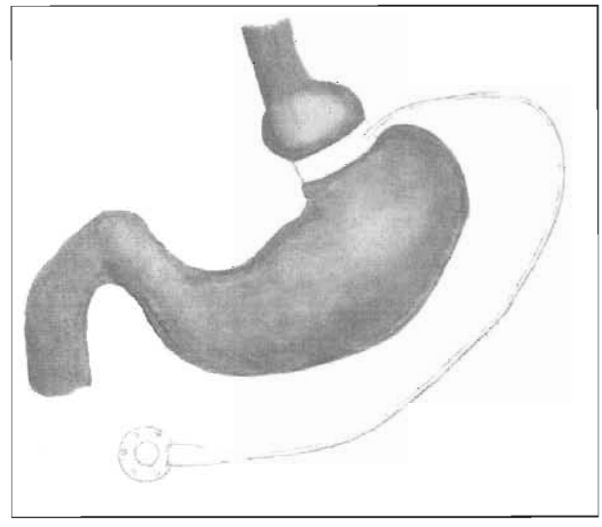

Fig. 2: Gastric adjustable banding.

The two main types of bands available are the Swedish AGB (SAGB) and the Lap-Band. Only the latter has been approved for use in the US since 2001. A study by Suter et al showed that there was no significant difference in EWL, correction of co-morbidities or complications after LAGB using either the SAGB or the lap-band[38].

The position of the band is measured approximately 1 cm – 2 cm from the gastroesophageal junction by using either a graduated rod or a calibration tube with an inflatable balloon. The dissection technique used for the insertion of the band varies. The peri-gastric approach is well described by Belachew et al[39]. Another alternative is the pars-flaccida approach at the base of the right crus which is now most commonly performed due to better posterior fixation of the band40 and decreased band slippage.

The patients stay on a liquid diet until the fourth postoperative day. Some groups recommend a Gastrografin radiographic study to assess the pouch integrity and the band position. The balloon is left deflated to avoid food intolerance related to gastric oedema until a fibrotic capsule has enveloped the band (4-6 weeks).At subsequent outpatients' visits the stomal size may need to be re-adjusted in order to provide optimal weight loss and reasonably good food tolerance[39].

A large systematic review found that LAGB was related with a mean short-term mortality rate of approximately 0.05% and median overall morbidity of about 11.3%[41].The most common postoperative complication associated with LAGB is gastric prolapse which consists of herniation of the stomach through the band. Pouch dilation in some patients is responsible for band dislocation but it can also occur vice versa. A long term retrospective analysis reports an incidence up to 21% with a mean follow-up of 55 months[42]. Should symptoms of dysphagia and vomiting persist in the post-operative period, the surgeon should evaluate the patient further for the presence of band slippage/ gastric prolapse. Some investigators have shown that the pars-flaccida approach is associated with a lower incidence of posterior band slippage than the peri-gastric technique[43,44]. Positioning of the band is the most critical aspect of the procedure. O'Brien et al[45] recommend that anterior wall sutured fixation of the band, as well as posterior fixation if the dissection path is above the apex of the lesser sac, avoids gastric prolapse (they report a drop in incidence form 9% to 2.5%). Many of these patients require re-operation for band repositioning, replacement of removal. Suter et al[43] report disappointing results in the majority of patients undergoing revision and recommend that conversion to gastric bypass might be a better option.

A recent study by Moser et al[46] has pointed to the importance of identifying whether the presenting symptoms are due to pouch dilatation or band slippage. The former was found to be a chronic complication that can be managed conservatively (band deflation, followed by radiologic oesophagogastric study, and parenteral nutrition[47]) whereas the latter requires acute surgical treatment.

Dargent et al[48] suggest that oesophageal dilatation should be considered as a separate entity from pouch dilatation and in severe cases be treated with band removal and conversion to GB. This is essential to prevent potentially irreversible oesophageal dysmotility to which some obese patients are already predisposed. Regular contrast studies as part of patient follow-up can detect these changes and prevent complications.

Band erosion into the stomach has also been distinguished as a late complication, only occurring in a minority of patients. It was noted in 1.1% in a large study by Angrisani et al[49]. It can be treated conventionally by deflation of the band or more drastically with band removal by laparoscopy or laparotomy. Occurrence of this complication appears to be related to the surgical technique or perhaps an unrecognised sero-muscular trauma initiating the transmural migration process[49].

Port and tubing problems include port rupture/ leakage, dislodgment and infection. Angrisani et al reported port complications in 4.1% of the patients; these require surgical repair under local or general anaesthesia. Careful surgical technique significantly reduces these complications[49].

As with any surgical procedure LAGB is associated with a risk of intra-operative and early complications. Intra-operative gastric perforation during creation of the retro-gastric tunnel can be diagnosed and fixed laparoscopically but in some cases conversion to laparotomy is necessary. A contrast study may be used to confirm the diagnosis in post-operative presentation[44]. Haemorrhage, damage to the spleen, liver and oesophagus, as well as pulmonary emboli and ARDS are other recognised minor complications[41]. Development of vomiting and food intolerance is also documented by many investigators[41].

OUTCOMES

Weight loss after LAGB is gradual and there has been great controversy as to whether there is adequate EWL after long-term follow-up (Table2).

EWL 1 year after the operation ranges between 30 and 59.3% for the studies presented, demonstrating a relatively slow weight loss in comparison to RYGB. Medium term follow-up at 3-5 years shows a slow increase in EWL. Longer follow-up studies are just beginning to become available but there is still some controversy surrounding the results reported. The general trend shows an EWL of less than 32% at 6-9 years follow-up with the exception of one study reporting an EWL of 59.3 at 9 years (table 2). EWL of less than 50% at >5 years postoperatively is considered insufficient and the majority of studies seem to point in this direction. Further results of long-term follow-ups will shed light on to this point of contention.

Some studies have cited ethnicity[50] and the compliance of patients as important factors influencing EWL.

Resolution or improvement of co-morbidities has been well documented and depends on the reduction

Table 2: EWL after LAGB

STUDY	PROCEDURE	N OF PATIENTS	FOLLOW-UP	EWL
O'Brien et al (1999) [45]	LAGB		1y 2y 3y 4y	51% 58% 61.6% 68.2%
DeMaria et al (2001) [50]	LAGB	28 Caucasians 8 African Americans	36m 36m	44±26% 11.5±18%
Doherty et al (2002) [51]	LAGB	58 46 36 31 28 23 18	1y 2y 3y 4y 5y 6y 7y 8y	34% 41% 30% 22% 26% 26% 33% 32%
Szold et al (2002) [52]	LAGB	715 (66.8% follow-up)	mean 30 months	BMI from 43.3 to 32.1
Chevallier et al (2002) [40]	LAGB	99	1y 2y	42.1% 52.7%
Weiner et al (2003) [53]	LAGB	984 (follow-up 95-100%)	8y	59.3%
Steffen et al (2003) [54]	LAGB	824 (97% follow-up)	1y 2y 3y 4y 5y	30%. 41% 49% 55% 57%
Angrisani et al (2003) [49]	LAGB	1893	0m 6m 1y 2y 3y 4y 5y 6y	BMI 37.8 37.9 33.7 34.8 34.1 32.7 34.8 32
Ren et al (2004) [55]	LAGB	99	1y	44.3%
Martikainen et al (2004) [42]	open or LAGB	73	1y 9y	36±24% 21±5%
Zehetner et al (2004) [56]	LAGB	190 (pre op) 140 at 139 102 42 31 6	6m 12m 24m 36m 48m 60m	35.4 ±14.2% 42.8± 20.1% 51.3±23.2% 51.7±23.2% 56.8±30% 44.7±14.7%
Fielding et al (2005) [57]	LAGB	NA	1y 2y 3y 4y 5y	44.7%. 54.9% 57.5% 53% 57%

of BMI rather than the procedure used. However, the complete resolution of insulin dependant diabetes has been shown to be less after LAGB vs. LRYGB.

VERTICAL BANDED GASTROPLASTY

Gastroplasty was designed by Mason et al in the 1970s as a safer alternative to the malabsorptive procedures. The VBG involves stapling a small partition of the stomach on the lesser curvature and a mesh band or silastic ring around the outlet of the pouch to control the outflow. Although this procedure was initially very successful, long-term studies showed a considerable amount of weight regain58 as well as band-related complications and exacerbation of GORD. Superior weight loss with other bariatric procedures has rendered VBG a much less frequently performed procedure.

BPD WITH OR WITHOUT DUODENAL SWITCH

This is a purely malabsoptive procedure in which 70%-90% of the stomach is removed and an anastomosis is created into the small intestine. The principle is very similar to RYGB except that the common channel – the intestine from the stomach to the colon – is much shorter (50-100cm). The biliopancreatic fluids connect with the alimentary channel carrying food, mix in the common channel, and a small amount is reabsorbed. Various formulas can be used to determine the appropriate length of the channels, controlling the degree of malabsorption. The BPD has been reported to provide the greatest EWL (>70% at one year) of all bariatric procedures, persisting in long-term follow-up[59].

In its DS form, a sleeve gastrectomy is combined with a duodenoenterostomy. The main anatomic difference between the two techniques is the shape of the stomach, whereby in the DS, the stomach is fashioned into an elongated tube rather than a horizontal gastrectomy (pure BPD). Instead of performing an anastomosis between the stomach and intestine, in the DS, the duodenum is attached to the intestine. Both of these techniques can be performed laparoscopically, however due to the requirement of the highest surgical expertise, life-long follow-up in specialized centres and potential serious malabsorptive side-effects they are not as popular as the RYGB and the AGB techniques

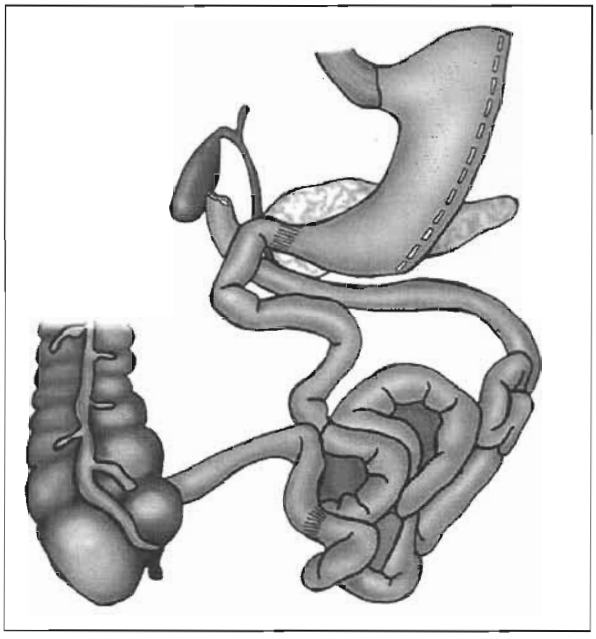

Fig. 3: Biliopancreatic diversion with duodenal switch.

SLEEVE GASTRECTOMY

For patients with morbid obesity and BMI > 65 kg/m2 many centres are now performing a staged procedure to facilitate substantial weight loss, also involving a decreased risk. Sleeve gastrectomy has been safely performed in patients that are very high-risk, and for some centres is the procedure of choice for super-morbidly obese patients. The initial procedure is a laparoscopic sleeve gastrectomy performed by tubularizing the stomach over a 32 French bougie. Most surgeons begin sleeve gastrectomy approximately 5 cm proximal to the pylorus, and while using the bougie as a guide, divide the stomach towards the Angle of His. Lastly, by dividing the short gastric vessels, the stomach may be removed, completing a primary restrictive procedure, frequently in less than an hour (FIGURE 4).

As the patients continue to lose weight, the patient may be brought back to the operating room several months later to laparoscopically complete a malabsorptive procedure (LRYGB or BPD/DS). Many patients will need nothing further beyond the initial restrictive procedure, however, adding a malabsorptive component to the initial operation allows for further weight loss and better resolution of co-morbidities.

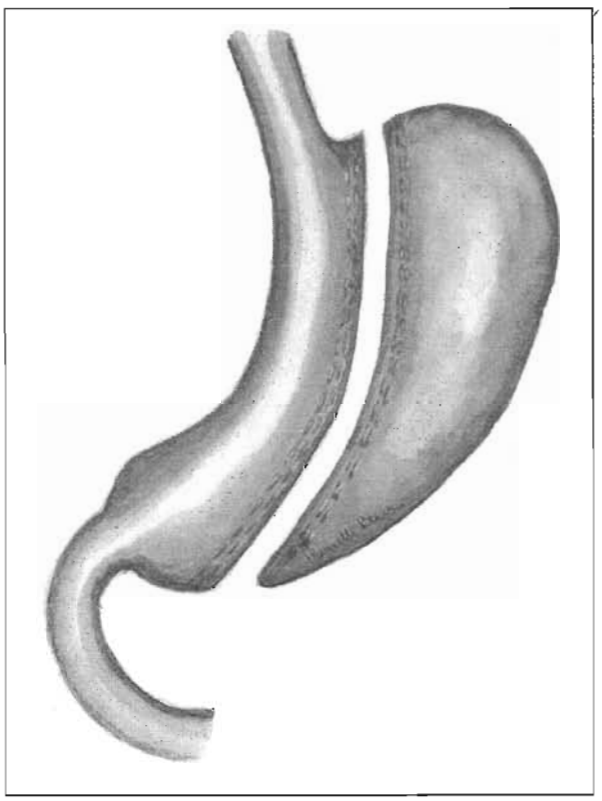

Fig. 4: Vertical sleeve gastrectomy.

IMPLANTABLE GASTRIC STIMULATOR (IGS)

The IGS is a new technique developed by Cigaina in the 1990s. The device consists of a stimulation lead implanted on the lesser curvature by laparoscopy, connected to a subcutaneous electric pulse generator. This is a simple procedure which induces satiety while avoiding the complications of malabsorptive and restrictive procedures.

A multicentre European survey recorded a mean EWL of 21% at 15 months post-implantation[60]. They also recorded increased satiety and reduced appetite in most of the patients, effects which can be attributed to the inhibitory effects of myoelectric stimulation on gastric motility and direct effects on central hormones related to satiety and appetite (see review by Chen[61]). Cigaina followed up 5 patients implanted with the IGS and showed an EWL of 70% at 8 years of follow-up[62]. The mean EWL at 2 years post-implant was 25% for most of the patients followed. In addition co-morbidities such as GORD, glucose intolerance and HTN showed considerable improvement[62]. EWL initially does not reach high values but since complications are basically non-existent it would be interesting to see the results of larger studies with long follow-up periods.

COMPARATIVE STUDIES – CONVERSION OF A FAILED BARIATRIC PROCEDURE TO ANOTHER

The amount of randomized controlled studies (RCS) comparing the different bariatric procedures are relatively few. For the two most common bariatric procedures (RYGB and LAGB) there are no RCS available and it is unlikely they will be carried out due to the highly different character of the techniques. Furthermore there are no RCS to date comparing BPD with any other procedure. There is, however, extensive literature on case series and retrospective comparative studies.

The majority of studies comparing RYGB with VBG have shown superiority of the former in terms of EWL. Lee et al performed a prospective RCS comparing RYGB and VBG. Although RYGB was associated with a higher early complication rate and long-term trace element deficiency it was significantly better in reducing EWL (62.9% vs. 55.4% at 1 year, 71.4% vs. 53.1% at 2 years), as well as providing a better quality of life postoperatively[63]. Unsatisfactory weight loss is frequently observed after a VBG. Conversion to RYGB (performed laparoscopically at many centres) is a safe and feasible procedure leading to improved weight loss and reversal of comorbidities[64].

One RCS comparing VBG to LAGB showed that EWL was significantly less for the VBG group compared to LAGB (54.9% vs. 70.1%) at 2 years of follow-up. Furthermore the patients of the VBG group had a higher complication rate and longer stay in hospital[65].

Since RCS are not available for comparison of LAGB and RYGB we have to rely on retrospective analyses. However comprehensive these studies may be, they encompass unavoidable bias and cannot provide firm conclusions.

A retrospective, comparative analysis of 1200 cases from two institutions was carried out. The early post-operative complication rate was higher in the RYGB group (4.2% vs. 1.7%) as was the mortality (0.4% vs. 0%). EWL at 18 months was 74.6% vs. 40.4% for RYGB

and LAGB respectively. EWL in 3-4 years of follow-up was only available for the LAGB group and was about 57%. This study showed that the criterion of EWL of >50% is met faster by the RYGB approach although associated with a higher rate of complications[66]. Certain authors suggest that the LAGB procedure should be the initial choice of treatment for morbid obesity based on the incidence of fewer complications and the acceptable weight loss[67]. Although this might be true for intermediate length follow-up, most of the literature shows long-term failure of maintaining EWL with the LAGB approach (see AGB-outcomes).

Major re-operation after LAGB is >10% either due to insufficient EWL or device-related complications68. Inadequate weight loss can be reversed by conversion to GB. Kothari et al showed that although the conversion requires high bariatric surgical skills, it is feasible and results in superior weight loss[69]. Conversion to RYGB after the occurrence of band-related complications such as erosion is fairly safe and prevents weight regain[70].

If procedures like VBG and RYGB fail to produce adequate EWL, BPD with DS can be performed safely as a more radical revisional operation[71]. BPD with DS is a very effective operation when performed by experienced bariatric surgeons and it might be wise to reserve it for super-obese patients or patients with previously failed bariatric procedures.

CONCLUSION

Obesity is a serious medical condition, its incidence increasing exponentially. At present bariatric surgery is the only effective means of curing obesity and its associated comorbidities. The choice of procedure is multifactorial including the extent of obesity, co-morbidities, as well as the patient's and surgeon's choice. There is little consensus among surgical centres regarding choice of bariatric procedure. RYGB is considered the gold standard in most American centres while most surgeons in Europe and Australia favour AGB, implying a geographical and surgical skill distribution in procedure choice[9]. Malabsorptive techniques should probably be reserved for super-obese patients with numerous co-morbidities due to the high levels of EWL. On the horizon is IGS. A minimally invasive procedure with minimal morbidity which may have a more significant role in the future when it is better evaluated.

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