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Brief Overview

Laparoscopic Adjustable Gastric Banding for Severe Obesity

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Background: Morbid obesity is an increasingly common condition with serious associated morbidity and decreased life expectancy. The only treatment with long-term efficacy for this condition is surgical intervention. Laparoscopic adjustable gastric banding (LAGB) is a procedure increasingly performed in European centres and recently approved by the FDA in USA. This article reviews its effectiveness and complications.

Methods: A literature search identified relevant articles.

Results: LAGB results in approximately 60% (43-78%) excess weight loss at 3 years with improvement in co-morbidities , with perioperative mortality <0.5%. Potential complications include prolapse or pouch dilatation, and port-related complications. Less common complications are intra-operative gastric perforation and band erosion. Reoperation-rate varies greatly between series, and is usually needed for band repositioning or port-related procedures, many of the latter being performed under local anesthesia.

Conclusion: The available data demonstrate that LAGB is a safe bariatric procedure, and effective in the short- and medium-term. Results of long-term follow-up are awaited.

Key words: Morbid obesity, bariatric surgery, laparoscopic adjustable gastric banding, Lap-Band®, Swedish adjustable gastric band.

Introduction

About 1.9% of women and 0.6% of men in the UK are morbidly obese (body mass index (BMI) >40 kg/m^2). Obesity-related morbidity costs the NHS an estimated £2 billion annually, and the small subgroup of morbidly obese individuals accounts for >40% of the total obesity-related expenditure. Bariatric surgery is the only intervention that has been proven effective in achieving and maintaining long-term weight loss in the morbidly obese, thereby resulting in improvement in co-morbid conditions.

The most significant development in bariatric surgery in the last few years has been the trend towards laparoscopic procedures. Potential benefits from the laparoscopic approach are expected to be even greater in morbidly obese patients and include: decreased perioperative morbidity, e.g. ileus, wound complications, cardiopulmonary adverse events; decreased perioperative mortality; shorter recovery time; and fewer long-term complications from incisional hernias.

Gastric banding was described by Molina (Houston) and Kolle (Norway) in the 1980s, and modified to allow the use of an adjustable band by Kuzmak to control size. Laparoscopic adjustable gastric banding (LAGB) has become increasingly popular, particularly in Europe and Australia. This article attempts to determine whether LAGB is a viable alternative bariatric procedure.

Methods

Medline, PreMedline, and Cochrane Library were searched using the keywords “obesity, weight loss, bariatric surgery, gastric restriction procedures, laparoscopic adjustable gastric banding, Lap-Band®, Swedish adjustable gastric band”, to identify articles on LAGB. Identified articles were criti-

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cally appraised. Further articles missed by the initial search were identified from references. Series of over 100 patients were selected to identify such factors as operation times, conversion rates, morbidity, mortality, reoperation rates, and weight loss. Important observations from smaller series were included.

Technique of Laparoscopic Adjustable Gastric Banding

Gastric banding is designed to create a tiny pouch with an adjustable outlet (stoma) just distal to the esophagogastric junction, thereby restricting food intake and resulting in early satiety. The band has an inflatable inner wall and is connected by a length of silicone tubing to a reservoir with a self-sealing port placed in the abdominal wall. A syringe with a noncoring (Huber) needle can be used to pierce the diaphragm of the reservoir to adjust the inner diameter of the band, and thereby alter the diameter of the pouch outlet. Two main types of band are commercially available; the Swedish Adjustable Gastric Band (SAGB) (Obtech, associated with Ethicon EndoSurgery) and the Lap-Band® (INAMED, Santa Barbara, CA, USA). The latter has been the more popular and was granted FDA approval in the USA in June 2001.

The procedure is well described.[1] A retrogastric tunnel is created above the lesser sac by dissection under direct vision, avoiding injury to the posterior gastric wall. Dissection on the greater curvature starts at the angle of His. On the lesser curvature, dissection begins either approximately 2 cm from the gastro-esophageal junction, opening the hepatogastric ligament, or, in the pars flaccida approach,[2] at the base of the right crus. The band is buckled around the stomach and connected by the silicone tubing to the reservoir, which is implanted in the abdominal wall. The band is held in place by gastrogastric sutures anteriorly and by the dense connective tissue normally present above the lesser sac posteriorly.

Patients are allowed liquids and pureed solids within a few hours after surgery. Solids are reintroduced gradually after 4 weeks. Some groups recommend the use of a water-soluble contrast study on the first postoperative day to assess pouch integrity and band position, but it is not a universal recommendation.

The band is left uninflated for 4 to 6 weeks until postoperative gastric edema has subsided and a fibrotic capsule has enveloped the band. This decreases the incidence of postoperative food intolerance. At subsequent visits, the stomal size may need to be adjusted. With the Lap-Band®, 3-4 ml of saline may be needed for an adequate stoma,[3] while 6-8 ml with the SAGB.[4]

Operation time decreases with increasing experience and is around 1 hour in most large series.[3,5-8] Conversion to laparotomy has been necessary in up to 9.3% (Table 1). In many series, conversion was more likely in the first 50 patients[3,8,11,13,18,19] and was rare thereafter. Indications for conversion have included an inadequate view (eg. a huge left lobe of the liver), difficult retrogastric dissection, bleeding, and visceral trauma.

Potential advantages of LAGB include those of laparoscopic bariatric surgery, as well as relative ease of placement, adjustability, and complete reversibility to normal anatomy if desired or required. To date, the procedure also has the lowest perioperative mortality of all bariatric procedures[20,21] (Table 2).

Published Results

Weight Loss

Reports of weight loss should be evaluated with caution, and may not be strictly comparable if patient groups are different in terms of: ethnicity (Afro-Caribbean patients may lose less weight); initial BMI; patient compliance; weight loss measures (percent excess weight loss, total weight lost or BMI achieved).[6,8,10]

Percentage of excess weight loss (%EWL) reported for LAGB varies from 38% to 71% at 1 year, but is around 50% in most series (Table 1). In the studies quoting %EWL at 3 years,[1,11,13,14,18] this varied from 43% to 78%, with most studies quoting around 60% EWL. Unfortunately, many studies do not specify the number of patients followed-up to 3 years. In Busetto et al's[14] 260 patients followed-up for at least 3 years, %EWL 3 years after LAGB was 43%. In O'Brien et al's[13] series, only 25 patients had been followed for 3 years, with 62% EWL. The lim-

Table 1. Results of LAGB

Authors	No. of patients	Preop BMI mean (range)	Percentage of excess weight loss (mean)					Conversion	Reoperation-rate				Complications					Band used
			1yr	2yrs	3yrs	4yrs	5yrs		Revision	Explantation	Port	Overall	Prolapse	Perforation	Erosion	Mechanical	Deaths	
Ital collab[9]	1265	44.1 (27-78.1)	BMI 35.1	BMI 30.2	BMI 32.1	BMI 31.5	-	1.7%	1.7%	0.7%	2.7%	6.6%	5.2%	0.0%	2.2%	4.3%	7pts	LapBand
Szold[10]	715	43.7 (35-66)	BMI 33	BMI 33	BMI 32	BMI -	-	0.8%	5.0%	4.5%	2.5%	12%	7.4%	0.1%	0.4%	2.5%	0%	LapBand
Cadière[3]	652	45 (35-65)	38%	62%	-	-	-	3.8%	2.4%	2%	2.7%	7.6%	4%	0.5%	0.3%	2.7%	1	LapBand
Dargent[11]	500	43 (36-60)	56%	65%	64%	-	-	1.9%	4%	1%	1%	6%	5%	0.2%	0.6%	1%	0	LapBand
Chevallier[2]	400	43.8 (35-66)	42.1%	52.7%	-	-	-	3%	2.3%	5.8%	7.5%	10%	7.8%	1%	0%	7.5%	0%	LapBand
Abu-Abeid[12]	391	43.1 (33-66)	BMI 31.9	BMI 29.8 at 18m	-	-	-	1.1%	4.6%	1.3%	0.7%	6.6%	5.4%	0.3%	0.5%	3.0%	0	LapBand
Belachew[1]	350	43 (36-65)	51%	59%	78%	65% at 41m	-	1.4%	10.6%	2.6%	0%	13.5%	13%	-	0.0%	0%	0	LapBand
Fielding[5]	335	46.7 (34-86)	52%	62% at 18m	-	-	-	0.9%	4.2%	0.9%	1.5%	7.2%	4.2%	0.3%	0.0%	1.5%	0	LapBand
O'Brien[13]	302	44.5 (s.d.6)	51%	58%	61.6%	68.2%	-	1.8%	7.6%	2%	4%	13.6%	9%	0.7%	0	4%	0	LapBand
Busetto[14]	260	46.6 (35-70)	39.7%	-	43%	-	-	4.2%	2.3%	1.9%	23.9%	28.1%	12.3%	0.8%	0.8%	29.3%	0%	LapBand
Nehoda[6]	250	46.7	71%	-	-	-	-	0.8%	2.9%	1.7%	5.4%	10%	1.2%	0	1.7%	6.2%	-	SAGB
Mortele[15]	218	-	-	-	-	-	-	-	8.3%	-	1.9%	-	7.8%	-	-	1.9%	-	SAGB
Hauri[16]	207	42.5 (31.8-64.2)	44.5%	-	-	-	-	-	4.3%	0.5%	2.9%	7.7%	0.5%	0.5%	1%	2.9%	0	SAGB
Chelala[17]	185	43 (34-67)	-	-	-	-	-	4.3%	2.7%	2.2%	1.6%	6.5%	4.9%	1.1%	0	2.7%	1 (0.5%)	LapBand
Weiner[7]	184	47.8 (36-79)	58%	87%	-	-	-	0	2.2%	1.6%	1.6%	5.9%	2.2%	0	1.1%	3.2%	0	LapBand
Doldi[18]	172	46.3 (35-70)	-	-	62.5%	-	-	9.3%	2.3%	3.5%	-	5.8%	11.5%	2.3%	1.2%	2.3%	0%	LapBand
Miller[4]	158	44 (37-71)	BMI 34 (24-48)	BMI 30 (21-39)	BMI 28 (20-35)	-	-	2%	2%	1.3%	2.5%	7%	1.3%	0.6%	0.6%	2.6%	0	LapBand 102 SAGB 54
Paganelli[19]	154	43.6 (35-66)	42.5%	-	-	-	-	2.6%	2.6%	0.6%	1.3%	4.5%	2.6%	2.6%	0	1.3%	0	LapBand
Suter[8]	150	44.6 (35-64)	55%	56%	-	-	-	5.3%	7.3%	4%	4.0%	18%	10.6%	2%	2%	3.9%	1 (0.7%)	LapBand 101 SAGB 47

ited data available therefore support the notion that LAGB sustained weight loss in the medium-term. Longer follow-up of large numbers of patients is presently under way.

Improvement in Co-morbidity

Weight loss is associated with improvement of co-morbidities[13,19,22] such as hypertension, diabetes, lipid abnormalities, asthma, sleep apnea and arthritis. Patients report a significant improvement in quality of life.[23]

Dixon and O'Brien[22] found that 90% of patients with gastro-esophageal reflux experienced an improvement in their symptoms after LAGB, with 76% reporting complete resolution. Only a small minority (4%) experienced exacerbation of their reflux symptoms. More recently, the same authors reported an improvement in diabetic control in 90% of 50 type II diabetics.[23]

Potential Complications Specific to LAGB

Band Erosion

The potential for gastric erosion by the band, is a concern with adjustable gastric banding. The reported incidence is less than 2.2% in large series (Table 1), over a maximum 4-year follow-up. Factors thought to predispose to band erosion are an unrecognized intra-operative gastric trauma,[9] infection, rapid inflation of the band, or band over-inflation.[6]

Patients may present with weight regain,[6] port-site infection[14] or, infrequently, with severe back pain or hematemesis. Contrast studies may reveal an intragastric portion of the band, but the diagnosis is often made at gastroscopy. Treatment involves removal of the band, and may require closure of the gastric defect, which may be performed endoscopically[6] or laparoscopically, although laparotomy may be required.[8] Most surgeons advocate delaying a further bariatric procedure for several months.

Gastric Perforation

Intra-operative gastric perforation, during the creation of the retrogastric tunnel, occurred in up to 2.6% of patients (Table 1). Perforation can be diagnosed intra-operatively, in which case laparoscopic repair is often feasible,[18] although conversion to laparotomy may be necessary.[3,8,12,19] Some surgeons have then proceeded with synchronous placement of the band.[18] If gastric perforation is not recognized perioperatively, the patient presents later with abdominal or left shoulder pain, unexplained tachy-

Table 2. Comparison of LAGB, open and laparoscopic gastric bypass

	LAGB	Gastric bypass	Lap gastric bypass
% Excess weight loss at 36 months	43%-78%[1,14]	66%[20]	77%[21]
Mortality	10 out of >5700 patients[1-19]	0.5%[20]	0.4%[21]
Operative time (minutes)	52-116[1,2,3,5,6,12,13,14]	120	260 [21]
Conversion rate	0-9.3%[7,18]	-	1%[21]
Reoperation rate	4.5%-28%[14,19]	1%-6%[20]**	9.8%[21]
Complications			
Anastomotic leak/fistula		0.5%[20]	4.4%[21]
Marginal ulcer		0.5%-13%[20]	1%
Stomal stenosis		1%[20]	5%
Partial staple-line disruption		1%[20]	0[21]
Intestinal obstruction		5%[20]	1.5%[21]
Incisional hernia	2 out of >5700 patients[12]	17%[20]	0.7%[21]
Splenectomy		0.5%[20]	
Gastric perforation	0-2.6%[6,7,9,19]		
Band erosion	0-2.2%[2,8,9]		
Gastric prolapse	<7.8%*[1,2,3,5,6,7,8,11,13]		
Port/catheter-related complications	0-29.3%[3,6,7,12,14]		
Bands explanted	0-5.8%[2,9,10,19]		

*with 15 ml pouch
**excludes operations for incisional hernia

cardia, tachypnea, and/or pyrexia. In these cases, a Gastrografin® study helps to confirm or exclude the diagnosis.

Prolapse

Prolapse of the stomach upwards through the band has been the most common complication, occurring in up to 13% of patients (Table 1). Anterior gastric wall prolapse is thought to be due to insufficient fixation of the band,[11] and is usually easily amenable to laparoscopic adjustment of the band position, and placement of further gastro-gastric securing sutures. Posterior prolapse is generally due to the band being placed within the lesser sac. Some surgeons advocate posterior, as well as anterior, fixation of the band to further decrease the risk of prolapse.[13] Other factors thought to predispose to prolapse are vomiting,[13] over-indulgence, band over-inflation, and the preoperative presence of a hiatus hernia or esophageal dysmotility.[24] Greenstein et al[24] suggest preoperative manometry in all patients being considered for LAGB, in the hope of identifying patients at high risk for gastric prolapse, as these patients may benefit from an alternative bariatric procedure.

Prolapse increases the size of the proximal gastric pouch, leading to failure to lose weight or weight regain. If torsion of the dilated pouch occurs, the patient presents with acute obstruction.[15] The diagnosis is confirmed radiologically. Many patients require band repositioning (laparoscopic or open), although simple band deflation may be sufficient.[7,14,15]

Most authors altered their technique during the study period, reducing pouch volume from 25 ml to 15 ml, and siting the band above the lesser sac to reduce its mobility. When cases of prolapse occurring before this change in technique are excluded, the incidence of prolapse decreases markedly (Table 3). Cadiere et al,[3] Fielding et al,[5] and Nehoda et al[6] have not needed to reposition any bands in a total of 868 patients since altering their technique.

Esophageal Dilatation

Esophageal dilatation has been noted when comparing pre- and postoperative contrast studies in a small series of patients.[25] The degree of esophageal dilatation did not appear to be related to the gastric stomal diameter. It may be asymptomatic or result in dysphagia, vomiting and reflux. At present, the significance of dilatation in terms of long-term consequences on esophageal function is unknown. DeMaria[25] suggested regular contrast studies as part of patient follow-up, with band deflation or removal if esophageal dilatation is progressive, to prevent potentially irreversible esophageal dysmotility.

Port-Related Complications

The incidence of port-related complications in most series is <7.5%.[2,3,6,7,10,12,15,17] However, Busetto et al[14] reported a 29% incidence of port-related complications, which were almost exclusively port leakages, due to disconnection or tube rupture at the junction between port and tubing. Patients present with weight regain. Most required minor corrective procedures.

Other port-related complications include port dislodgement, infection and chronic pain. Removal and re-siting of a new port may be necessary. Early band failure due to a leak in the system, caused by puncturing the band during suturing (incidence up to 2.8%),[6,15,16] becomes uncommon with experience.

Reoperation Rates

The reported reoperation-rate varies greatly, from 4.5% to 28% (Table 1). Reoperation may be necessary for band repositioning, band removal or port/tubing-related procedures. Less than 5.8% of

Table 3. Incidence of prolapse with 25 ml pouch and with 15 ml pouch

Author	No. of patients	Incidence of Prolapse				
		Overall	25 ml		15 ml	
		%	No.	%	No.	%
Belachew[1]	350	13.1%	36	40%	10	4.2%
Cadiere[3]	652	4%	26/34	76%	0/618	0%
Dargent[11]	500	-	-	-	25/500	5%
Chevallier[2]	394	7.8%	-	-	31/394	7.8%
Fielding[5]	335	4.2%	14/235	6%	0/100	0%
O'Brien[13]	302	9%	15/50	30%	12/250	4.8%
Busetto[14]	260	12.3%	32/260	12.3%	-	-
Nehoda[6]	250	1.2%	3/100	3%	0/150	0%
Weiner[7]	184	2.2%	4/65	6.2%	0/119	0%
Suter[8]	150	10.6%	14/30	46.7%	2/120	1.6%

bands were removed in most large series. Indications for band explantation include band erosion, gastric prolapse and, less commonly, inadequate weight loss[25] or psychological intolerance.[5] Excluding port-related procedures, which are usually minor procedures that may be performed under local anaesthesia,[4,6] the reoperation-rate was 4% to 14%.

Discussion

Many bariatric surgeons consider gastric bypass to be the best bariatric operation. Unfortunately, inconsistent reporting of outcome measures, as well as potential differences between patient groups, including different initial BMI, make direct comparison difficult (Table 2). Furthermore, 10-year follow-up for LAGB is not yet available. A randomized controlled trial would be necessary to directly compare these procedures.

Obesity is a major public health problem. Its increasing prevalence in young people underlines the urgent need for effective prevention programs that radically change people's attitudes to diet and exercise. On the other hand, the medical profession is faced with ever increasing demands for treatment from severely obese individuals and should be prepared to meet the challenge. The trend towards laparoscopic bariatric surgery is justified and likely to be sustained. The steep learning curve and technical difficulty of laparoscopic gastric bypass make it unlikely to be widely adopted as the laparoscopic procedure of first choice by many bariatric surgeons. Published data regarding LAGB are encouraging, and, if confirmed at long-term follow-up, this procedure deserves its place in the bariatric surgeon's armamentarium.

Candidates for LAGB should be counselled regarding results of this procedure, unanswered questions, and alternatives. Close patient follow-up is essential, and patients should be encouraged to be part of well-designed trials to help answer pending questions. Randomized clinical trials are urgently required to provide an evidence base to assist patients and surgeons in the selection of the appropriate bariatric procedure.

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