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ORIGINAL CONTRIBUTIONS

Short- and Mid-term Outcomes of 527 One Anastomosis Gastric Bypass/Mini-Gastric Bypass (OAGB/MGB) Operations: Retrospective Study

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Abstract

Background One anastomosis gastric bypass/mini-gastric bypass (OAGB/MGB) is considered an alternative option in metabolic and bariatric surgery. The aim of this study was to evaluate the safety, efficacy and postoperative challenges of OAGB/MGB as a new procedure.

Methods We performed 519 primary MGBs and 8 additional second-stage MGBs during 2014–2018. The data were collected from patients' notes as well as the surgeons' prospective data sheets. Two senior surgeons performed the operations. The ultimate primary measures were assessment of the safety and management of the complications. The secondary outcomes were excess weight loss and resolution of the comorbidities.

Results The type 2 diabetes mellitus (T2DM) remission rate was 83% and 70% over 1 and 3 years, respectively (HBA1C < 6.5%). Weight loss was 28–152 kg (SD 23.11). Excess weight loss ranged from 41 to 125%. Hypertension resolution was 61%, 58% and 58% in the first, second and third years, respectively. Ninety-nine per cent of sleep apnoea patients improved symptomatically and went off the continuous positive airway pressure (CPAP) machine. Two (0.37%) patients developed diarrhoea, cured by shortening the afferent biliopancreatic limb (BPL). Eight (1.5%) stomal ulcers were reported. Two patients (0.37%) developed deranged liver function, revised by shortening the BPL in one patient and a reversal in the second patient. The mean follow-up was 2.5 years. Mortality was zero.

Conclusions This is the largest UK OAGB/MGB study to date showing safety and acceptable results for metabolic syndrome and obesity problems. OAGB/MGB revisional options are rectifying the morbidity and no mortality.

Keywords One anastomosis gastric bypass/mini-gastric bypass · Metabolic syndrome · Bariatric surgery · Roux-en-Y gastric bypass · Body mass index · Excess weight loss

Introduction

The aim of introducing one anastomosis gastric bypass/mini-gastric bypass (OAGB/MGB) was to address the shortcomings of the current bariatric operations, such as long learning curve and drastic complications, and to provide maximum clinical benefits for the patients. The operation continued to produce comparable or superior results to the current gold standard bariatric interventions, both for metabolic syndrome and weight reduction [1–3]. Lee et al. [4] and Victorzon [5] reviewed the available literature of more than 7000 OAGB/MGB operations and found that randomised controlled trials and long-term data demonstrated the procedure to be a simpler and safer alternative to Roux-en-Y gastric bypass (RYGB). There is also good evidence of efficacy for metabolic syndrome [6, 7]. Ten years' experience of OAGB/MGB showed superior weight loss, lower body mass index (BMI) and lower revision rate compared to RYGB [8]. The operation was found to be more effective for type 2 diabetes mellitus (T2DM) compared to laparoscopic sleeve gastrectomy (LSG) at 1-year follow-up [9]. A recent long-term study of OAGB/MGB with 10-year follow-ups

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showed superior outcomes to RYGB and LSG [10]. The Carbajo group [11] reported the safety and efficacy of OAGB/MGB after a 12-year follow-up, which showed 70% excess weight loss (EWL), while 15 years' experience with MGB showed higher EWL and lower revision rate compared to RYGB and LSG [12].

One hundred per cent of the bariatric experts felt that OAGB/MGB was an 'acceptable mainstream surgical option', and 96.0% felt that it could no longer be regarded as a new or experimental procedure [13]. In the UK, OAGB/MGB is a new procedure that was introduced in 2010, almost 13 years after Rutledge's first report [1]. The largest published UK series included 125 patients [14]. The British Obesity and Metabolic Surgery Society (BOMSS) recommended introduction of OAGB/MGB into routine bariatric surgical practice [15]. IFSO agreed on one anastomosis gastric bypass as the correct name for the procedure. One anastomosis gastric bypass/mini-gastric bypass can also be used. The aim of this paper is to report our initial experience with OAGB/MGB, focusing on the safety, efficacy and challenges of the procedure. Additionally, the paper reports the causes and management of revisions, which are potentially difficult clinical scenarios that can be faced by any bariatric surgeon.

Materials and Methods

The work has been reported in line with the STROCSS criteria [16]. Two senior bariatric surgeons performed 519 consecutive primary OAGB/MGBs and 8 additional second-stage OAGB/MGB procedures after an initial LSG during 2014–2018 at King's College Hospitals, Chelsfield Park Hospital and Doncaster and Bassetlaw Teaching Hospitals. Patients' characteristics are shown in Table 1.

Table 1 Patients' characteristics (*BMI* body mass index, *T2DM* type 2 diabetes mellitus, *OSA* obstructive sleep apnoea)

	Number (%)	Mean/standard deviation
Primary	519 (98.5%)	
Revisional	8 (1.5%)	
Age	18–68	44 + 11.08
Women	358 (68.13%)	
Men	169 (31.86%)	
BMI	33–79	48 + 8.01
Weight	96–235	123.4 + 22.45
T2DM	124 (23.51%)	
OSA	42 (7.9%)	
Hypertension	100 (19%)	
Arthritis	134 (26.15%)	

We offered OAGB/MGB to patients who had exhausted their efforts with non-surgical methods and had a BMI above 40 or a BMI above 35 with weight-related comorbidities, as well as to patients who failed to lose weight after LSG or adjustable gastric band (AGB). Diabetic patients of Asian origin with a BMI less than 35 kg/m^2 may be offered the procedure according to the UK's National Institute of Clinical Excellence (NICE) guidelines (www.nice.org.uk). The outcome measures of morbidities, complications and mortality were accurately recorded to avoid any bias.

An upper gastrointestinal (UGI) endoscopy was performed for patients who had upper gastrointestinal symptoms, gastro-oesophageal reflux disease (GORD), dyspepsia, pain, nausea and vomiting, family history of UGI cancer, history of Barrett's oesophagus, peptic ulcer disease or who were more than 50 years old.

The ultimate primary measures were assessment of the safety and management of the complications. The secondary outcomes were excess weight loss and resolution of the co-morbidities. The operative setting for the procedure is exactly the same as for RYGB. We used the LIoyed-Davies position and Nathanson liver retractor. The small bowel was run to 150 cm from the duodenojejunal junction (DJJ) for patients with a BMI of less than 50 kg/m^2 and 200 cm for those with a BMI of more than 50 kg/m^2 and marked with a vicryl suture after making sure the jejunum reached the stomach and the proposed anastomosis was free of tension. The dissection started at the crow's foot to access the lesser sac. The first staple was applied at the crow's foot of the lesser curve using a 45-mm purple cartridge (Medtronic, Minneapolis, USA). The gastric pouch was created over a 36-FR bougie using purple and tan cartridges. Usually, six to seven fires of a 45- to 60-mm cartridge are needed to create a gastric pouch more than 15 cm in length. The end-side gastro-jejutonal anastomosis was performed using a hand-sewn technique in 364 (69%) patients and stapler anastomosis in 163 (31%) patients after creation of a 150- to 200-cm biliopancreatic limb (BPL), depending on the BMI (see Videos 1 and 2). The enterotomy closure was completed using two layers of continuous 2/0 vicryl sutures with two needles from each side (preoperatively assembled from two vicryl sutures of 20 cm in length; see the videos). The patients were usually discharged after 2 days. The loss to the follow-up was assessed. The first follow-up of the patients was arranged at 2 weeks, then at 1, 3 and 6 months and yearly for 3 years. They received iron, multivitamins, calcium and trace elements supplements. Lansoprazole 30 mg once a day was prescribed for 6 months. We adopted the American Diabetic Association (ADA) definition of resolution or remission of diabetes. Patients' informed consents were confirmed, and the department of surgery approved the study. Ethical approval was not needed, as OAGB/MGB is a routine bariatric procedure.

Results

There were 519 (98.5%) primary and 8 (1.5%) revisional procedures. Patients were 18–68 years old, with a mean of 44 years. There were 358 (68%) women and 169 (32%) men. The BMI range was 33–79, with a mean of 48 kg/m^2. Patients' preoperative weight was 96–235 kg, with a mean of 123.4 kg. Of the patients, 211 (40%) had a BMI above 50 kg/m^2. Type 2 diabetes mellitus was reported in 124(23.51%) patients, with HBA1c more than 6.5%. Sleep apnoea incidence was 42 (7.9%), 100 (19%) patients were hypertensive and 134 (25.4%) had arthritis.

EWL was 89% at the first year and 81% and 77% at the second and third years of the follow-up. T2DM remission (ADA definition) was achieved in 83% of the patients for the first year and 70% of them for the second and third years. The hypertension was controlled in 61% in the first year and remained normal in 58% for the second and third years. The sleep apnoea patients were off their CPAP machine at the end of the first year and maintained high success rate at 99% for the second and third years. The joint pain and osteoarthritis symptoms were resolved in 70% in the first year and remained so in 75% and 78% for the second and third years. Lastly, the dyslipidaemia was normalised in 60% of patients for the first year and 55% for the second and third year, respectively (see Tables 2 and 3). All of these figures are consistent with previous OAGB/MGB results [2].

Twenty-one (3.98%) complications were reported and majority were managed by revisional surgery (see Table 3). The most common one was stomal ulceration in 8 (1.52%) patients, followed by afferent loop obstruction in 4 (0.75%) patients. Two (0.37%) patients developed postoperative bleeding, two (0.37%) patients diagnosed with deranged liver function/failure and another two (0.37%) patients reported diarrhoea. The management of all these complications was reported in Table 3.

One hundred and fifty six (29.6%) of our patients had completed a 3-year follow-up. The mean follow-up was 2.5 years. Loss to follow-up was 3 (0.5%). No single case of leak or mortality was reported over the follow-up period.

Discussion

The most important findings of this study are the safety and the high efficacy, which were translated into no mortality and high EWL and remission/improvement of diabetes, as well as other comorbidities (see Table 2). This largest UK study to date replicates the superior outcomes that were previously reported by Rutledge, Carbajo Musella, Kular and Chevalier [1, 3, 7, 8, 17].

There are some attractive benefits of OAGB/MGB to provide good service for patients, but there are also concerns and doubts by many bariatric surgeons regarding reflux in short-term and UGI cancer in long-term follow-up [4, 18, 19]. OAGB/MGB's effect is induced through non-obstructive restriction, metabolic changes and malabsorption. The main effector of OAGB/MGB is the length of the BPL and the post-operative effect on the UGI neuro-endocrine signals and incretin/anti-incretin mechanisms [20]. Mid-term follow-up showed safety low complications and high patient satisfaction and compared favourably with other mainstream procedures of RYGB and LSG [17, 21, 22].

The OAGB/MGB component of a long and narrow gastric pouch makes it an easy salvage surgical option for challenging high BMI patients when it is not possible to join the small bowel to a high and short RYGB pouch because of excess abdominal fat, thick omentum, difficult access or short small bowel mesentery. These patients would otherwise be managed using less effective or low metabolic effect alternative operation, such as LSG. About 7% of our previous patients who were scheduled for RYGB (a total of 2500 patients) ended up with LSG and had to come for RYGB as a second revisional surgery with all known risks and costs. We used to do LSG as a first-stage procedure followed by RYGB in 6–12 months in high BMI patients (usually male patients with a BMI of more than 60 kg/m^2 due to excess abdominal fat/thick omentum), where RYGB was not possible for the technical reasons.

Due to the long pouch and one anastomosis, less complex OAGB/MGB has a superior success rate to provide one definitive surgery option.

OAGB/MGB could provide satiety in the short and long term due to the slow emptying of the pouch. This possibly ameliorates the problem of dumping syndrome, although it still exists with OAGB/MGB [23].

The internal herniation that can be catastrophic and was reported as a cause of mortality [24] is negligible after OAGB/MGB [3, 25, 26]. None of our 527 patients developed internal hernia during the follow-up period of 6–36 months.

The chronic left upper abdominal pain problem after bariatric surgery is usually related to events around the jejuno-jejunal anastomosis of RYGB with upper left quadrant adhesions, bacterial overgrowth, intussusception and internal herniation, which warrants extensive investigations and frequent hospitalisation, resulting in increased cost [27]. This was not the case in any of our patients. None of the OAGB/MGB large series has reported such problems [4].

OAGB/MGB patients may need revisions for a variety of reasons, including bile reflux, obstruction, afferent loop syndrome and leak. Revision or corrective surgery after OAGB/MGB can easily be done in most cases; however, it may be very challenging, especially in emergency situations [28, 29].

The major criticism of OAGB/MGB is the theoretical risk of bile reflux. A recent study showed that the intragastric pressure (IGP) and gastroesophageal pressure gradient

Table 2 Percentage resolution in type 2 diabetes and other morbidities and excess weight loss (*EWL* excess weight loss, *T2DM* type 2 diabetes mellitus)

Resolution of	At 1 year (%)	At 2 years (%)	At 3 years (%)
EWL	89	81	77
T2DM	83	70	70
Hypertension	61	58	58
Sleep Apnoea	100	99	99
Osteoarthritis, joint pain	70	75	78
Dyslipidaemia	60	55	55

(GEPG) statistically diminished after OAGB/MGB, and no evidence of esophagitis or bile reflux was seen on gastroscopy [30]. This supports the clinical experience of OAGB/MGB in many studies of thousands of patients [4, 5]. One (0.18%) of the included patients needed revisions for bile reflux. Several other patients already on lansoprazole after surgery developed reflux symptoms and were settled without need for revision. The EWL and diabetes remissions in our study were comparable to the OAGB/MGB large series [4]. T2DM remission depends on various factors of age, BMI, peptide C, HBA1c level, medications and insulin use, as well as duration of diabetes. It is difficult to adjust these factors to compare our results to Lee's meta-analysis study outcomes [4]. The EWL in our study was 77%, compared to 74.9% in Lee et al.'s report, while T2DM remission was 70%, compared to 90% in Lee et al.'s study. The variations in the outcomes could be explained by the diabetes-related factors mentioned above, as well as the differences in technique and the length of the BPL and the common channel in each patient. The longer the BPL, the more aggressive metabolic effect and superior the outcomes are, but the higher the risk of severe complications of liver failure, malnutrition and severe EWL. The challenge for all of us is to find a solution to apply specific OAGB/MGB power (BPL length) to a specific patient and a specific clinical scenario.

Stomal ulceration was reported in 8 (1.5%) patients. A systematic review of 16,987 patients' RYGB showed an average incidence of 4.3% [21], compared to 4% quoted in Rutledge's largest study to date, involving 2410 patients [31]. There is no definite single reason for stomal ulceration, and it is a multifactor aetiology. Ischemia is suspected to be the only credible explanation of a stomal ulcer. Other factors such as smoking, steroids, non-steroidal anti-inflammatory medications, foreign body reaction, stagnation, obstruction and stoma size may play a role [32]. Previous studies have shown that the use of proton pump inhibitors resulted in significant reduction of stomal ulceration [33]. We prescribed our patients lansoprazole 30 mg twice a day and sucralfate 1 g 6-hourly for 8 weeks. All patients had repeat gastroscopy after 8–12 weeks, which has shown complete healing in all patients.

Intractable diarrhoea was reported in two patients who had a BMI above 50 kg/m^2 with T2DM; both had a BPL length of 300 cm, and both had lost all of their excess body weight with diabetes remission. Surprisingly, neither had any symptoms of diarrhoea in the first 6 months. Examination of the colon and small bowel with endoscopy and biopsies revealed no cause. Both had revision by shortening the BPL. As a result, their diarrhoea resolved completely and they remained off medication for T2DM. The cause of the diarrhoea was not clear because they had enough common limb length, which was > 300 cm. There are theories of bacteria colonisation and/or denaturalisation of the digestive enzymes in the afferent loop. Both OAGB/MGB and RYGB have a common limb with different lengths. A randomised controlled trial showed no significant differences in terms of gastrointestinal symptoms and bowel habit [34].

A hand-sewn technique in 364 (69%) patients and stapler anastomosis in 163 (31%) patients were applied. None of our patients developed leaks with either technique; however, the incidence of stomal ulceration was higher in the stapled anastomosis group compared to the hand-sewn anastomosis group.

Table 3 Complications and management (*BPL* biliopancreatic limb, *PPI* proton pump inhibitors, *RYGB* Roux-en-Y gastric bypass)

Complications	Number (%)	Management
Stomal ulcerations	8 (1.52)	PPI and sucralfate
Afferent loop obstructions	4 (0.75)	Jejuno-jejunostomy /RYGB
Bleeding	2 (0.37)	Exploration and controlling the bleeders
Deranged liver function	2 (0.37)	Reversal, shortening of BPL
Diarrhoea	2 (0.37)	Shortening of the BPL limb
Gastro-jejunal stenosis	1 (0.18)	Revision of anastomosis
Excessive weight loss	1 (0.18)	Shortening of BPL
Bile reflux	1 (0.18)	RYGB

One patient in the hand-sewn group needed revision for gastro-jejunostomy stenosis. All four (0.75%) afferent loop syndrome cases were hand-sewn anastomosis.

Results of the first 209 patients of the Carbajo study in 2005 confirmed 4 (0.2%) leaks [35], while Rutledge's first study reported a leak rate of 1.6% [1], which was the most serious complication.

Liver dysfunction was the most important complication in our series; one patient had a reversal of the procedure after 6 months, and another one had revision and shortening of BPL to 150 cm. Both had a preoperative BMI of > 50. The initial BPL was 300 cm. The liver function rectified back to normal, and both recovered completely. They had no pre-existing alcohol liver disease or cirrhosis at the time of the operation.

Liver failure was also reported after RYGB with high mortality that could reach 60% [36]. None of the large OAGB/MGB series reported liver failure [4].

Our experience with liver dysfunction/failure and diarrhoea taught us to 'never do BPL more than 200 cm'.

Limitations

This was a consecutive series of OAGB/MGB procedures; hence, the selection bias was eliminated. The assessment of the outcomes was conducted by the operating surgical team, and efforts to reduce the bias of outcome assessment were undertaken. Initial experience with this type of procedure was reported, and the resolution of diabetes and EWL and morbidity data were all on a short-/mid-term scale; thus, further studies to confirm the long-term benefits and durability of the OAGB/MGB results are necessary.

Conclusions

OAGB/MGB is a safe and effective procedure for metabolic syndrome and obesity-related problems. Postoperative morbidity challenges were easily managed by revisions.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Informed Consent Informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.

A Statement of Human and Animal Rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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