Review Article

Single anastomosis (mini-) gastric bypass for the treatment of Asian type 2 diabetes mellitus

Nawaf Alkhalifah[1,2], Wei-Jei Lee[2]

[1]Department of Surgery, Al-Adan General Hospital, Mahboula, Kuwait; [2]Department of Surgery, Min-Sheng General Hospital, Taoyuan, Taiwan

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Correspondence to: Wei-Jei Lee, MD, PhD. Min-Sheng General Hospital, No. 168, Chin Kuo Road, Taoyuan, Taiwan.
Email: wjlee_obessurg_tw@yahoo.com.tw.

Abstract: Bariatric surgery is the most efficacious therapy for morbid obesity today, and now moving from bariatric surgery to metabolic surgery for the treatment of type 2 diabetes mellitus (T2DM). Advancement in laparoscopic technique contributed to a rapid surge of the volume of bariatric surgery. However, the type of bariatric/metabolic procedures evolved over the past 60 years and is still evolving. Single anastomosis (mini-) gastric bypass (SAGB) was first proposed by Dr. Robert Rutledge in 2001. Many surgeons across the world have strong concerns to this procedure but do not perform it. Although controversy existed, tens of thousands of this procedure have been reported throughout the world with universally good results. The advantages of this procedures included technique simplicity, shorter learning curve, easy to convert and better weight loss and co-morbidities resolution. However, data about the result of SAGB specifically for the treatment of T2DM in Asian is less known. The review examines the current status, long-term result of SAGB on weight reduction and the efficacy on T2DM treatment in Asian.

Keywords: Single anastomosis (mini-) gastric bypass (SAGB); type 2 diabetes mellitus remission (T2DM remission); bariatric surgery; metabolic surgery

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Introduction

Obesity is closely associated with type 2 diabetes mellitus (T2DM) (1). Both diseases are very difficult to control and became a major growing health problem in both developing and developed countries (2). Bariatric surgery proved to be the most effective therapy for maintaining a successful weight loss and improving obesity related co-morbidities (3). The success of bariatric surgery in the treatment of T2DM in morbidly obese patients made it a valid option in the treatment of not-well controlled T2DM in mildly obese patients (4). However, bariatric/metabolic operations have been evolving over the past 60 years and have witnessed a significant increase of the volume since the advent of laparoscopic surgery (5). Rutledge performed the first mini-gastric bypass (MGB) in 1997 and published his initial experience of 1,274 patients in 2001 (6). However, criticisms and controversies about this procedure were raised immediately from many surgeons who do not perform it (7,8). Their main concern was focused on the incidence of bile reflux associated with symptomatic gastritis and esophagitis as was mentioned in Mason's original experience on loop gastric bypass. However, MGB gained worldwide acceptance after demonstrating its safety and efficacy which was proven by a randomized trial done by Lee *et al.* comparing it to the conventional Roux-en-Y gastric bypass (RYGB) (9). Tens of thousands of this procedure have reported throughout the world and the procedure was re-named to a laparoscopic single anastomosis (mini-) gastric

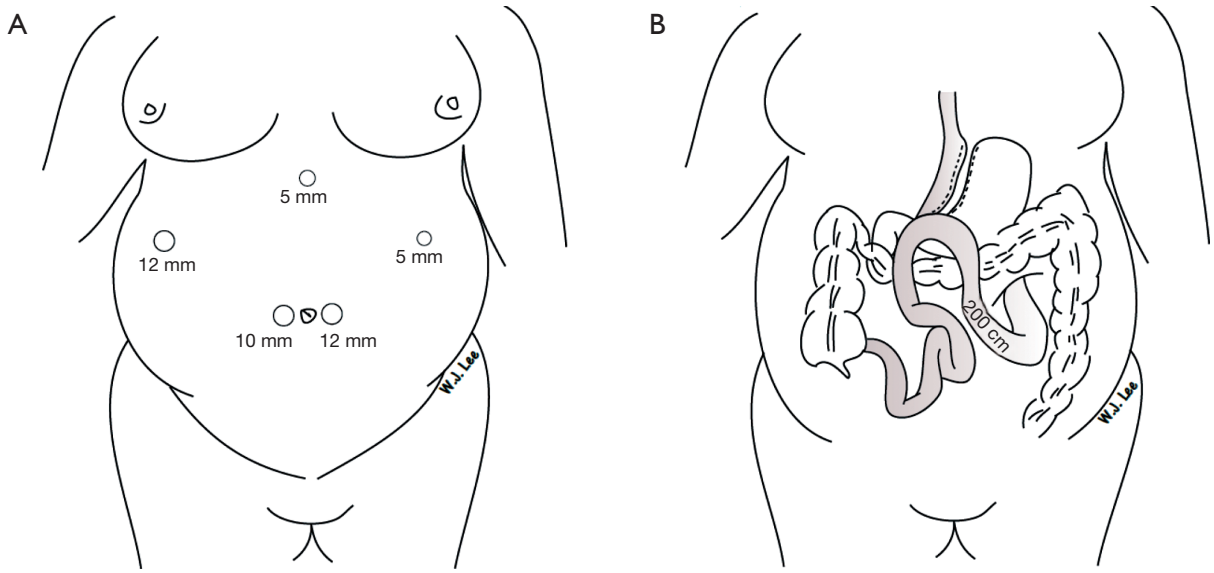

Figure 1 Laparoscopic mini-gastric bypass or single-anastomosis gastric bypass. (A) Port sites on abdomen; (B) schema: a long, narrowed gastric tube is created by stapling and transecting the lesser curvature side of stomach. The tube is anastomosed to the jejunum, approximately 200 cm below the ligament of Treitz.

bypass (LSAGB) in order to avoid the controversy (10). In addition to a sustained weight loss and remission of the obesity relation co-morbidities, this procedure provides other advantages such as technique simplicity, shorter learning curve and easy to conversion (10-12). Accordingly, this procedure was proposed as a metabolic operation for treating T2DM (13-15). In this article, we examine the current status, weight loss sustainability on the long-term and T2DM remission after this procedure.

Technical aspects

The operation consists of two components, the first component is performing a long-sleeved gastric tube along the lesser curvature of the stomach and the second component is a Billroth II loop gastrojejunostomy with a 200 cm afferent limb. The operation, LSAGB is routinely performed with a standard 5-port laparoscopic technique (*Figure 1*). Patients were placed in a gentle reverse Trendelenburg position. A total of five incisions placed at four sites of the abdomen including: (I) two incisions along the nature fold of the umbilicus (10 mm camera port and 12 mm port as a working channel); (II) a 5 mm port incision at the left lateral abdominal wall (working channel); (III) a 12 mm port incision at the right lateral abdominal wall (first assistant); (IV) a stab incision at subxyphoid level to provide retraction of the left lobe of the liver. Exposure of the E-G junction is achieved by dissecting the gastric fat pad. Starting from the antrum distal to the crow's foot we begin the creation of a long sleeved gastric tube heading all the way to the E-G junction. Following this, we identify the jejunum at the ligament of Treitz and measure 150 to 250 cm distally according to the patient's BMI. A whole length of the intestine is measured to make sure that the common channel is more than four meters. Antecolic Billroth type 2 side-side gastrojejunostomy was performed using a stapling technique. The gastro-enteric defect is then closed by hand-sewn technique over 18F nasogastric tube placed into the efferent loop to ensure the patency of the anastomosis. Anchoring the afferent limb with continuous suture to prevent bile reflux was performed. The efferent limb is then fixed to the antrum to avoid torsion of the loop (9,10).

Operative risk

SAGB has a lower operative risk in comparison to the standard RYGB. In comparing 40 patients with SAGB to 40 patients with RYGB, a randomized clinical trial showed that the SAGB arm had a shorter operative time, less post-operative analgesia use, shorter hospital stay and fewer post-operative complications (9), therefore reflecting the relative simplicity of the procedure as only one anastomosis

Table 1 Operation risk and long-term weight loss results of SAGB

Author	n	Starting year	Report year	Major C (%)	Mortality (%)	Initial BMI (kg/m^2)	Final BMI (kg/m^2)	%TWL	%EWL	DM Rem
Rutledge (18)	2,410	1997	2005	5.9	0.08	46.0	NA	NA	80	–
Lee (19)	1,163	2001	2012	1.8	0.17	41.4	27.7	NA	72.9*	93
Carbajo (20)	1,200	2002	2017	2.7	0.16	46.0	29.9	41	70.0*	94
Noun (21)	1,000	2005	2012	3.4	0	42.5	28.4	NA	68.6	–
Musella (22)	974	2006	2014	2.0	0.2	48.0	28.0	NA	77.0	87
Chevallier (23)	1,000	2006	2015	5.5	0.2	46.7	31.5	NA	71.6	85.7
Kular (24)	1,054	2007	2014	1.3	0.18	43.2	25.9	NA	87.0	93.2
Jammu (25)	473	2007	2016	0.9	0	56.5	NA	NA	92.2	95.1
Genser (26)	2,321	2007	2016	1.5#	0	48	NA	NA	NA	–
Overall	11,595	–	–	2.8	0.11	44.7	27.6	41	74.9	–

*, data of 10 years, others are data of 5 years; #, leakage only. NA, not available; BMI, body mass index; %TWL, percentage of total weight loss; %EWL, percentage excess weight loss; C, complication; Rem, remission.

is required leading to a better risk profile compared to RYGB. RYGB is technically more difficult as it requires two anastomoses, one higher in the abdomen to the gastric pouch and one jejuno-jejunal anastomosis in the lower abdomen. A RYGB requires a bivalve of the greater omentum in order to reduce the tension on the gastro-jejunostomy, in addition to closing the mesenteric defects which is not the case in SAGB, and this adds more time and complexity to the procedure. A bivalve of the greater omentum is not required in SAGB because the posterior aspect of the loop becomes adherent to the omentum. The learning curve of SAGB is estimated to be approximately 30 cases (11), much less than the 100 to 500 cases in RYGB (16,17). Currently this procedure represents around 1.5% of bariatric surgeries worldwide, which is a similar figure to biliopancreatic division (BPD)/duodenal switch (DS) (5). In the English literature, more than 11,000 cases of SAGB have been reported to date (18-26). A major complication rate of less than 3%, and a leak rate of approximately 1% is illustrated by the current published observational studies (*Table 1*). Average 30-day mortality rate was 0.11% (ranged from 0–0.9%).

Weight loss

The weight loss after SAGB was universally good and durable (*Table 1*). The reported mean %EWL at 5-year after SAGB was 76% (varied from 68.6% to 92.2%). The reported mean excess weight loss at 10 years in SAGB was 72.9%, slightly higher than the 60% plus in RYGB, as reported in a randomized clinical trial comparing both procedures (19). Two studies investigated the quality of life change after SAGB both showed a significantly increasing quality of life after surgery and non-inferior to RYGB (19,27). Using SAGB as a revision surgery for failed bariatric procedure also resulted a similar weight loss as primary SAGB with acceptable morbidities (11,28-31).

T2DM remission after SAGB

It is expected that a 90% remission rate of diabetes can be achieved after SAGB as reported by some large series (*Table 1*). However, these data are not adequate because those were for bariatric surgery not specific for T2DM treatment and using different criteria for T2DM resolution. *Table 2* listed the outcome of T2DM treatment using SAGB as metabolic surgery for the treatment of T2DM from reports with adequate data (13,15,22,24,32-41). Lee was the first one to report the result of using SAGB for T2DM treatment (13). In this report, SAGB is an effective and durable treatment for T2DM patients but the remission rate was lower in low BMI patients. Several studies then from Asia and other parts of the world also confirmed the good results using SAGB for the treatment of Asian T2DM patients. A higher diabetes remission rate in SAGB might be a result of a

Table 2 T2DM remission rate after surgery of each report at different definitions

Report	Patient No.	Mean pre-op BMI (kg/m^2)	Mean pre-op A1c%	Complete remission (A1c <6.0%) (%)	Partial remission (A1c <6.5%) (%)	Improved or remission (A1c <7%) (%)
Lee (13)*	201	40.1	–	–	–	87.1 (1 y)
Dixon (32)*	88	39.0	9.1	85.5 (1 y)	–	98 (1 y)
Lee (33,34)*	30	30.3	10	–	93 (1 y)	–
				70.5 (5 y)		85 (5 y)
Dixon (35)*	103	26.0	9.1	30.1 (1 y)	–	67
Kim (36)*	107	25.3	9.0	–	–	53 (1 y)
García-Caballero (15)	13	27	8.3	–	73 (1 y)	–
Kular (24)*	674	43.2	–	–	93 (1 y)	98 (1 y)
Kular (37)*	128	33.4	10.7	64 (1 y)	82 (1 y)	100 (1 y)
				53 (5 y)	70 (5 y)	87 (5 y)
Musella (38)	229	48	–	–	87 (1 y)	98 (1 y)
Musella (22)	224	48.0	–	–	–	84.8 (5 y)
Milone (39)	16	45.8	–		87.5(1 y)	–
Lee (40)*	33	31.0	9.1	46.9 (5 y)	68.8% (5 y)	–
Lee (41)*	249	39.9	8.6	85.7 (1 y)	–	98.5 (1 y)
Overall (1 y)	2,095	34.7	8.0	78.4 (1 y)	87.3% (1 y)	96.5 (1 y)
Overall (5 y)	287	31.6	9.9	56.8 (5 y)	69.4 (5 y)	85.6 (5 y)

*, Asian patients. pre-op, pre-operative; BMI, body mass index.

better weight loss and a longer BP limb (10,12). In Asian, SAGB can provided a high T2DM complete remission rate up to 78.4% at 1-year and 56.8% at 5-year. However, the complete remission rate varied with BMI, 86% at BMI >35, 65–70% at BMI between 30 and 35 and dropped to 30% at BMI <30 kg/m^2. Therefore, using SAGB to treat low BMI T2DM patients should be very carefully and the BP limb should be tailored short in low BMI patients to avoid the malnutrition problem after SAGB (42). A diabetes surgery scoring system ABCD score can also be applied for patient selection and choice of procedure (43,44).

Comparison of SAGB and other procedures

Accumulating data is strongly indicating that SAGB is an effective and durable bariatric procedure. Long-term available database and randomized clinical trials indicate that SAGB can be considered as a simpler and safer alternative to the standard RYGB with a better weight loss and glycemic control (9,19). Two randomized controlled trial also demonstrated a better weight loss of SAGB than sleeve gastrectomy (SG) or gastric plication (34,45). Many comparative studies and meta-analysis also demonstrated a better weight loss of SAGB than RYGB or SG (29,46-49). In T2DM patients, SAGB had a higher and more durable T2DM remission rate than SG (29,34,38,40,41). However, SAGB had a higher incidence of micronutrient deficiencies than RYGB or SG because of a greater mal-absorptive component of longer BP limb (10,12). Revision surgery is rarely needed in SAGB but some patients may need a conversion surgery because of malnutrition (50-52).

Conclusions

After a journey of more than 15 years, SAGB is strongly becoming an accepted bariatric operation with a favorable risk profile and metabolic results. In term of weight loss, SAGB could achieve good %EWL of 80% at 5-year and 70% at 10-year follow-up. In obese Asian T2DM patients, SAGB can achieve a 5-year durable complete remission

of more than 50% with a low complication rate but the remission rate varied according to the patient's BMI. SAGB can be a valid treatment option for Asian obese T2DM patients.

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Footnote

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