Chapter 7

Novel Metabolic/Bariatric Surgery — Loop Duodenojejunal Bypass with Sleeve Gastrectomy (LDJB-SG)

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Additional information is available at the end of the chapter

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1. Introduction

Metabolic surgery is now a well-established concept which originated from diabetic remission of bariatric surgery. Roux-en-Y gastric bypass (RYGB), biliopancreatic diversion with duodenal switch (BPD-DS), mini-gastric bypass (MGB) and even the new entrant, sleeve gastrectomy (SG), have been shown to achieve good results in diabetic control and glycaemia result of type II Diabetes Mellitus. [1, 2, 3, 4] But all these procedures come with their own set of limitations and long-term complications. Marginal ulcer, intractable dumping syndrome, internal herniation, bile reflux, malnutrition are to name a few and some patients require reoperation in the future because of these complications.

Laparoscopic RYGB (LRYGB) has been taken as the gold standard procedure now in the world in treating morbid obese patients with type II Diabetes Mellitus. LRYGB can be accomplished using either an antecolic or retrocolic approach which creates 3 or 2 potential mesenteric defects respectively. Otherwise, internal hernia has been the most common causes of small bowel obstruction following LRYGB, with an incidence ranging from 1% to 9%. [5, 6, 7] It has become ever more frequent following laparoscopic RYGB than it was during open surgery era. [8]

Marginal ulceration has been also reported in 1%–16% of patients. [9] Stricture of the gastrojejunal anastomosis happens in 2.9% to 23.0% of patients. [10, 11] Gastrogastric fistula has been reported in 1.5% and 6.0% of cases. [12]

Another rare but potentially devastating complication of RYGB involves the inadvertent anastomosis of the proximal biliopancreatic limb of the jejunum to the gastric pouch in conjunction with a misplaced jejunojejunostomy. [13]

Compared with gastric bypass, duodenal switch could not get rid of all these complications mentioned above and even is associated with a greater risk of vitamin deficiencies. [14] Kevin et al reported that 18% of patients were hypoalbuminemic, 32% anemic, 25% hypocalcemic, and almost half had low vitamin A, D, and K levels, despite more than 80% taking vitamin supplementation. [15]

Though LSG is a simpler procedure and owns satisfactory weight loss, a recent meta-analysis and some randomized controlled trials have demonstrated inferiority of LSG over LRYGB in the treatment of diabetes and control of metabolic syndrome. [16, 17, 18, 19] Evidence suggests that MGB has real risk of bile reflux due to the loop configuration that may have long-term damaging effects to the gastric pouch and possibly cancer of the distalesophagus. [20, 21, 22] McCarthy et al performed endoscopy in 28 patients who had undergone loop gastroenterostomy, loop gastroenterostomy plus diverting enteroenterostomy between the afferent and efferent loops or Roux-en-Y anastomosis. [23] Total bile acid levels in the gastric pouch were 2080. 1 μg/mL in patients who had undergone loop gastroenterostomy alone compared with 165.0 μg/mL in patients who had undergone Roux-en-Y anastomosis. Gastritis by endoscopy was only 13% in Roux-en-Y group compared to 71% in loop gastroenterostomy group. In 2007 Johnson WH et al concluded that MGB does require revision in some patients (because of leak, bile reflux, intractable marginal ulcer, mal-absorption/malnutrition, weight gain etc.) and that conversion to RYGB is a common form of revision. [24]

The never-ending search of a more physiological and less complex surgery has led surgeons to develop novel procedures. “Laparoscopic Loop Duodenojejunal Bypass with Sleeve Gastrectomy (LDJB-SG)” [25] was first invented and described by Chih-Kun Huang since October 2011, which was reported in 2013. The pyloric preserving mechanism could decrease the incidence of dumping syndrome. Also, the mixture of alkaline bile and pancreatic enzyme with gastric acid around anastomosis also decrease the incidence of marginal ulcer. The acid and intrinsic factor secretion would be maintained. Thus, iron, vitamin and protein deficiency should be less because some part of antrumis preserved. Moreover, one anastomosis and only Petersen’s defect may help in decreasing the chances of anastomotic leakage and internal hernia as compared to RYGB and BPD-DS. It also eliminates the chances of gastro-gastric fistula with sometimes complicates LRYGB. And less bypassed bowel (200-300 cm) would improve the malnutrition part as compared to BPD-DS.

2. Mechanism of action

LDJB-SG works by combining restriction of food (Sleeve Gastrectomy) with bypassing duodenum and proximal jejunum. This procedure predominantly owned the part of duodenojejunal bypass for glycemic control based on the foregut hypothesis. And sleeve gastrectomy is incorporated into this to eliminate the ghrelin effect to make sufficient weight loss and

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reversal of insulin resistance. The rapid gastric emptying ensures swifter nutrient delivery to the hindgut with secretion of incretins like GLP-1 which are responsible for augmenting satiety and improving pancreatic function.

Restriction: It is achieved by performing sleeve gastrectomy along a 38 Fr orogastric tube.

Bypass: 200-300 cm of duodenum and proximal jejunum is bypassed.

Special features:

- Single loop duodenojejunal anastomosis other than Roux-en-Y anastomosis could prevent more possibility of anastomotic stricture or leakage.
- Only Peterson defect to decrease the chances of internal hernia.
- Pyloric preservation to avoid dumping syndrome.
- Mixture of alkaline bile and pancreatic enzyme with gastric acid around anastomosis to decrease the incidence of marginal ulcer.
- Less chances of hypo-proteinemia, vitamins deficiency and diarrhoea as compared to BPD-DS which has only 75-100 cm of common limb.
- Easy post-operative endoscopic surveillance of remnant stomach.

2.1. Indications of the procedure

- Body mass index (BMI) ≧ 35 with co-morbidities or BMI ≧ 40
- BMI ≧ 27. 5with poorly controlled Type 2 Diabetes Mellitus (HbA1c >7)

2.2. Contraindications of this procedure

- Chronic alcoholism
- Drug/substance abuse
- Psychiatric disorder
- Severe gastro-esophageal reflux disease
- Chronic duodenal ulcer

2.3. The procedure

a. Preoperative Considerations

The preoperative examination does not differ from other bariatric procedures. The patients are admitted one day before surgery to maintain stable glucose level less than 200mg/dL by insulin infusion if necessary, and keep patients on clear liquid diet one day before surgery. One dose antibiotics (cephalosporin) and 40 mg pantoprazole is given half an hour before surgery. Antithrombotic devise and low molecular weight heparin are prescribed to avoid deep vein thrombosis and thrombo-embolic events.

b. Technique:

- *Positioning:* Patient is laid supine on the table (Figure 1). Surgeon stands on the right side of the patient. Cameraman and first assistant stand on the left of the patient.

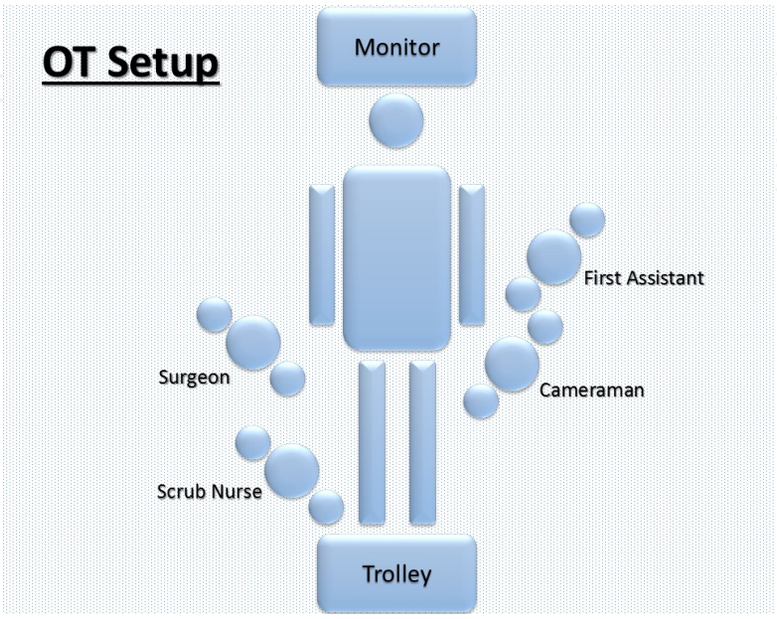

Figure 1. OT Setup

- *Port-positions:* 5 ports technique to access the abdominal cavity as shown in figure 2.

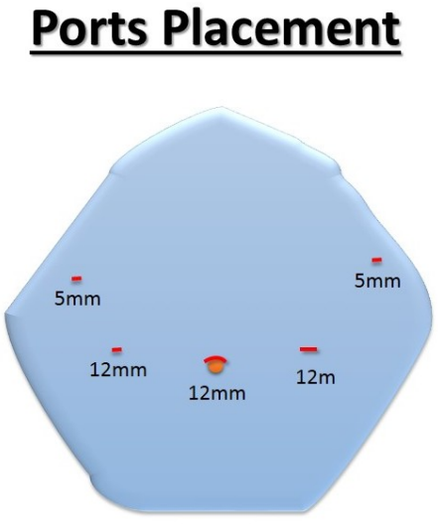

Figure 2. Port Placement

- *Liver retraction:* The liver could be retracted by Nathanson liver retractor or T-shape liver suspension tapes in order to achieve good exposure of both stomach and duodenal area.

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- *Sleeve Gastrectomy:* The first step involves devascularisation of greater curvature of stomach, 4 cm from the pylorus till the left crus of diaphragm, using an energy source like LigaSure vessel sealing (Covidien, USA), sealing the gastric branches of gastroepiploic vessels and short gastric vessels. Sleeve gastrectomyis then performed using 38 Fr orogastric tube as a stent with sequential firing of Endo GIA™ 60 mm articulating medium/thick Reload with Tri-Staple™ (Covidien, USA) (Figure 3). Black reloads are used for the first two firings while purple reloads are used for the subsequent firings toward the gastric fundus.

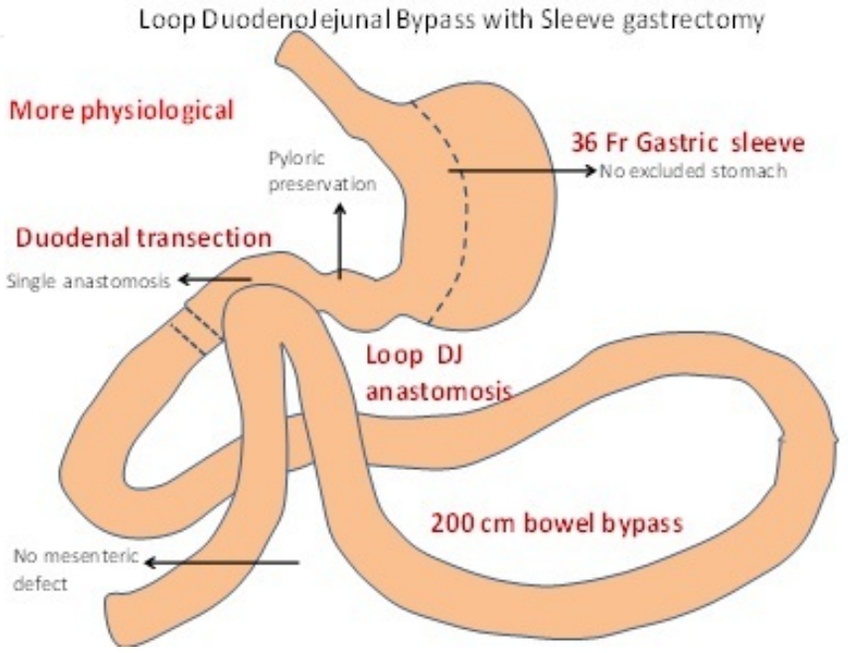

Figure 3. Loop Duodenojejunal Bypass with sleeve gastrectomy

- *Duodenal transaction:* After ensuring haemostasis, a stay suture is placed at the distal end of stomach tube for counter-traction and better visualization of the first part of the duodenum. A tunnel is created posterior to the first part of duodenum 2 cm distal to pylorus using Goldfinger (Ethicon Endo Surgery USA). A tape is passed and lifted cranially and laterally for traction so as to aid in insertion of the stapler. The first part of the duodenumis transected2cm distal to the pylorus with Endo GIA™ 45 mm Curved Tip Articulating Vascular/ Medium Reload with Tri-Staple™ (Covidien, USA) and take care not to injure common bile duct, pancreas and major vessels in the area. Routine over-sewing of the distal duodenal stump is not necessary.

- *Duodeno-jejunostomy:* Jejunum is measured for 200-300 cm from the ligament of Treitz. A 1. 5 cm enterotomy is created in jejunum and the first part of duodenum. Iso-peristaltic totally hand-sewn side to side anastomosis is then performed using 3/0 absorbable suture. The air leak test is performed to check the anastomosis. After the anastomosis, we place an antitorsion suture between the antrum and upper jejunum, 4 cm proximal to the duodenojejunostomy.

- *Mesenteric defect closure and drainage:* Peterson's defect is repaired with a continuous non-absorbable suture. Jackson-Pratt drain is placed behind the duodeno-jejunal anastomosis reaching up to the sleeve to complete the procedure.

2.4. Post-operative care

A postoperative antibiotic (Cephalosporin) is given for one day. Deep-breathing exercises, early mobilization and adequate pain control administration are given in order to avoid postoperative pulmonary complications. A clear-liquid diet is started once the patient is fully conscious. The patients are discharged once they can tolerate oral fluid well, which is usually by postoperative day 2-3. Pantoprazole 40 mg is given for 30 days daily after discharge. Patients are scheduled for follow-up in the outpatient clinic 1 week after the discharge. They are advanced to take soft diet by the third week and solid diet intake after 1 month. Subsequent routine follow-ups are done at 1, 3, 6, 9 and 12 months after surgery. Thereafter, patients are advised to visit hospital every 6 months.

3. Complications

Bleeding: This usually happens from the long staple line of sleeve gastrectomy or divided mesentery, but mostly could be managed conservatively. Re-laparoscopy is indicated if the patient presents as persistent drop in hematocrit despite blood transfusion or shock.

Leak: Leakage of sleeve gastrectomy mostly occurs near the upper end of staple line which could be treated initially by stent placement endoscopically and drainage of abscess. And if leakage occurs in anastomosis of duodeno-jejunosotomy, conversion to Roux-en-Y gastric bypass with removal of distal stomach and first part of duodenum would be a rescue procedure.

Stricture: Stricture of sleeve gastrectomy could be managed by endoscopic stent or balloon dilatation, laparoscopic stricturoplasty or conversion to Roux-en-Y gastric bypass.

Internal Hernia: Even we routinely repair Peterson defect during the procedure, but internal hernia is still a possibility to happen. Suspicion should be made when patient presented as intermittent cramping upper abdominal pain or acute/chronic intestinal obstruction. Abdominal CT Scan is mandatory in diagnosis and laparoscopic exploration would be necessary when definite diagnosis is obscure.

4. Micronutrient supplementation after this procedure

We recommended taking two multivitamin tablets each containing B1, B12, folate, iron and vitamin D in a dose of 1.1 mg, 2.4 microgram, 400 microgram, 10-15 mg and 10 microgram respectively and 2000 mg of calcium citrate in two divided doses.

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4.1. Surgical results

To compare the safety and diabetic remission and metabolic results after LDJB-SG and RYGB in patients with BMI < 35 kg/m2, we did a prospective non-randomized study starting from July 2006 to March 2012 in Bariatric & Metabolic International Surgery Centre, E-Da Hospital, Taiwan (Table 1). A total of 109 patients were involved with a follow-up period of at least one year. 89 patients underwent Laparoscopic RYGB and 20 underwent Laparoscopic LDJB-SG. Mean age (50.0 ± 8.6 years in LDJB-SG group vs. 50.0 ± 10.6 in RYGB group), BMI (27.9 ± 3.0 vs. 28.9 ± 3.8 kg/m2), FPG (126.0 ± 37.8 vs. 168.0 ± 68.9 mg/dl), HbA1c (7.5 ± 1.8 vs. 9.0 ± 1.9), c-peptide (2.1 ± 1.0 vs. 2.2 ± 1.6ng/ml), and duration of diabetes (78.0 ± 65.5 vs. 84.0 ± 70.1 months) were similar in two groups. Fasting plasma glucose (FPG=126.0 ± 37.8 vs 168.0 ± 68.9 mg/dl) and HbA1c (7.5 ± 1.8 vs. 9.0 ± 1.9 %) were significantly higher in LRYGB group though. Operative time (119.0 ± 46.9 vs. 73.0 ± 51.3 minutes) and length of stay in the hospital (3.0 ± 1.3 vs. 2.0 ± 2.4 days) were significantly higher in LDJB-SG group.

Parameters	**LDJB-SG group**	**LRYGB group**	***P value***
Gender (M/F)	13/7	54/35	0.719
Age (y)	50.0 ± 8.6	50.0 ± 10.6	0.745
BMI (kg/m2)	27.9 ± 3.0	28.9 ± 3.8	0.121
FPG (mg/dl)	126.0 ± 37.8	168.0 ± 68.9	0.002
HbA1c (%)	7.5 ± 1.8	9.0 ± 1.9	0.004
C-peptide (ng/ml)	2.1 ± 1.0	2.2 ± 1.6	0.270
TG (mg/dl)	158.0 ± 182.1	166.0 ± 115.6	0.585
CHO (mg/dl)	182.5 ± 35.6	202.0 ± 193.0	0.039
HDL (mg/dl)	46.0 ± 12.8	45.0 ± 9.8	0.993
LDL (mg/dl)	106.5 ± 245.2	110.0 ± 35.7	0.267
AST (U/L)	35.0 ± 15.5	30.0 ± 38.5	0.666
ALT (U/L)	33.0 ± 29.5	34.0 ± 64.8	0.663
Family history DM (N;%)	12;60%	65;73%	0.247
Duration of DM (month)	78.0 ± 65.5	84.0 ± 70.1	0.064
Operation time (min)	119.0 ± 46.9	73.0 ± 51.3	0.000
LOS (day)	3.0 ± 1.3	2.0 ± 2.4	0.000

BMI: Body Mass Index; FPG: Fasting Plasma Glucose; CHO: Cholesterol; TG: Triglyceride; LOS: Length of Stay

Table 1. Comparison of clinical and biochemical characteristics at baseline between the patients underwent LDJB-SG and RYGB

At one year after surgery, there was no significant difference in BMI (22.5 ± 2.4 in LDJB-SG vs. 21.0 ± 2.7 LRYGB group), HbA1c (6.0 ± 0.9 vs. 6.3 ± 1.2) or c-peptide (1.4 ± 0.5 vs. 1.3 ± 1.5 ng/ml) but FPG was significantly lower (98.0 ± 18.0 vs. 106.0 ± 31.7 mg/dl) in LDJB-SG group (Table 2). There were 17 late complications seen in LRYGB group vs nil in LDJB-SG group during first one year after surgery (Table 3). LDJB-SG had higher remission rate (60% vs. 40%) of diabetes and also better glycemic control (90% vs. 71%) as compared to RYGB (Figure 4).

Parameters	**LDJB-SG group**	**RYGB group**	***P value***
BMI (kg/m2)	22.5 ± 2.4	21.0 ± 2.7	0.234
FPG (mg/dl)	98.0 ± 18.0	106.0 ± 31.7	0.048
HbA1c (%)	6.0 ± 0.9	6.3 ± 1.2	0.442
C-peptide (ng/ml)	1.4 ± 0.5	1.3 ± 1.5	0.881
TG (mg/dl)	119.0 ± 81.4	84.0 ± 46.3	0.257
CHO (mg/dl)	180.5 ± 33.7	173.0 ± 39.4	0.339
HDL (mg/dl)	49.5 ± 12.2	52.0 ± 13.7	0.540
LDL (mg/dl)	99.0 ± 20.3	85.0 ± 27.8	0.503
AST (U/L)	24.0 ± 12.1	30.0 ± 38.5	0.157
ALT (U/L)	26.5 ± 21.6	34.0 ± 64.8	0.062

BMI: Body Mass Index; FPG: Fasting Plasma Glucose; CHO: Cholesterol; TG:Triglyceride

Table 2. Comparison of clinical and biochemical characteristics at 1 year between the patients underwent LDJB-SG and RYGB.

	LDJB-SG group (20)	**RYGB group (89)**
Resolution of co morbidities (%)		
T2DM	60	49
Hypertension	85.7	88.2
Dyslipidemia	70	76.6
Operative complications (N)		
Major	1	1
Late	0	17
Mortality	0	1

T2DM: Type II Diabetes Mellitus

Table 3. Operative outcomes of LDJB-SG and RYGB.

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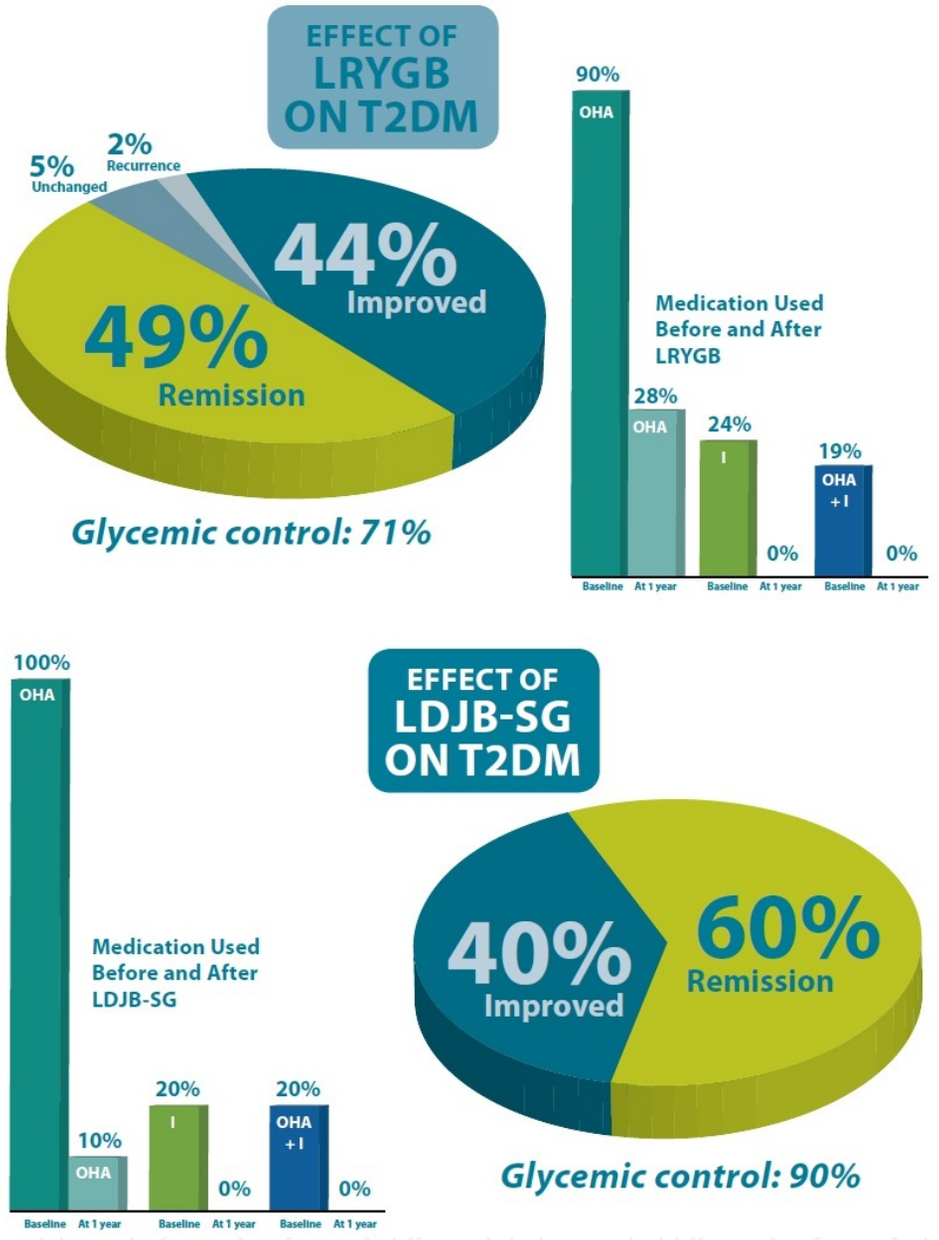

Figure 4. Effect of LRYGB on T2DM

This study concluded that LDJB-SG has higher remission rate and better glycemic control as compared to RYGB in patient with BMI < 35kg/m2.

5. Conclusion

LDJB-SG is a novel metabolic surgery, with single anastomosis and mesenteric defect aimed at achieving less mal-absorption, decreased gastrointestinal complications, adequate weight loss and good remission of T2DM. From the preliminary results of weight loss and glycemic

controls, this novel procedure will not only become an important surgical procedure of treating type II D.M in the near future, but also in treating morbid obesity.

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