

Short-Term Outcomes of Laparoscopic Sleeve Gastrectomy with Duodenojejunal Bypass for Morbid Obesity

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Purpose: This study aimed to evaluate the safety and feasibility of laparoscopic sleeve gastrectomy with duodenojejunal bypass (SDJB) surgery in Korean patients. **Materials and Methods:** This was a retrospective study analyzing SDJB surgery with a 200-cm biliopancreatic limb; the surgery was performed between January 2019 and August 2020 in 56 Koreans with morbid obesity. All demographic, clinical, operative, and follow-up data were documented and analyzed for weight loss and diabetes remission efficacy. Safety and feasibility were analyzed in terms of perioperative and postoperative complications. A decrease in the HbA1c value and discontinuation or reduction of anti-diabetics were considered as indicators of improvement in diabetes. **Results:** The median operation time was 180.0 min (105–210 min), and the median postoperative hospital stay was 5.0 days (3–35 days). Postoperative complications occurred in two patients who were managed by conversion to Roux-en-Y gastric bypass surgery. Meaningful weight loss was 3.5%, 27.7%, and 54.9% at the 1-month, 3-month, and 6-month follow-ups, respectively. Of the 56 patients, 46 had type 2 diabetes. Among those patients, at the 1-month follow-up, 4/31 patients (12%), at the 3-month follow-up, 22/41 patients (53.6%), and at the 6-month follow-up, 31/42 patients (73.8%) were found to show improvement. Of the patients who received anti-diabetics or insulin therapy, only three (9%) patients continued to receive reduced treatment of diabetes, and the other thirty (91%) discontinued the anti-diabetics. **Conclusion:** SDJB surgery with a 200-cm biliopancreatic limb was a safe and effective procedure to treat morbid obesity and diabetes.

Key Words: Bariatric surgery, Metabolic surgery, Obesity, Diabetes, Laparoscopic sleeve gastrectomy with duodenojejunal bypass

INTRODUCTION

Obesity, one of the most common lifestyle diseases, has grown into a pandemic in the present world [1]. It is one of the most common causes of type 2 diabetes. The attempts to manage obesity using basic methods such as

diet and exercise are unsuccessful [2]. However, surgery is an effective method for managing both, obesity and associated comorbidities. There are several bariatric surgeries available; however, no single procedure is suitable to address all patients with obesity [3].

Since westernized eating habits have become widespread

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in Korea, patterns of westernized diseases are also increasing, and obesity is a problem that has gradually emerged over time, along with metabolic syndrome. Consequently, the Korean National Insurance System has covered those who have morbid obesity with a body mass index (BMI) $>30 \text{ kg/m}^2$ with comorbidities or $>35 \text{ kg/m}^2$ since 2019.

Most common laparoscopic surgical options include sleeve gastrectomy (SG), Roux-en-Y gastric bypass (RYGB), and Laparoscopic sleeve gastrectomy with duodenojejunal bypass (SDJB). The gold standard surgery, RYGB, has several short-term and long-term complications such as loss of access to the gastric remnant, dumping syndrome, marginal ulcers, internal hernias, and vitamin deficiencies [4]. The postoperative complication rates of the standard bariatric surgeries RYGB and SG are approximately 3.0% and 2.1%, respectively. The mortality rate was found to be 0–1.5% in patients with obesity, while it was higher in patients with obesity and comorbidities [5]. Long-term complications are related to nutritional deficiencies requiring long-term vitamin and mineral supplementation [2]. ‘Laparoscopic sleeve gastrectomy with duodenojejunal bypass (SDJB)’ surgery is a combination of SG and one anastomosis gastric bypass (OAGB). This surgery aimed at addressing the limitations of standard bariatric surgeries to some extent. It is similar to laparoscopic single anastomosis duodenoileal bypass with a sleeve (SADI-S), but with a more proximal anastomosis. In SDJB surgery, the jejunum 200 cm distal to the duodenojejunal flexure, instead of the ileum, is anastomosed to the divided first part of the duodenum in a loop fashion. Pyloric preservation in SDJB surgeries reduces the risk of marginal ulcers, prevents bile reflux, and dumping syndrome [4]. The reduction of marginal ulcer risk from 3% in RYGB to 0.3% in SDJB and the absence of dumping syndrome in the latter is attributed to pylorus preservation [6]. The reduced number of anastomoses and mesenteric defects in SDJB surgery reduces the incidence of anastomotic leaks and internal hernias [4]. The literature available on SDJB surgeries is extremely limited, and no literature is available from Korea on these surgeries. In this context, this study was conducted to evaluate the safety and feasibility of SDJB

surgery with a 200 cm biliopancreatic limb in Korean patients.

MATERIALS AND METHODS

This was a retrospective study conducted between January 2019 and August 2020, and included 56 Koreans with obesity. Patients who underwent SDJB surgery with a 200-cm biliopancreatic limb for obesity were included in the study. The study protocol was reviewed and approved by Institutional Review Board of Kyung Hee University Hospital at Gangdong (IRB File No. KHNMC 2020-10-038).

All patients were checked for the presence of metabolic syndromes such as diabetes, sleep apnea, hypertension, and the presence of diseases that were undiagnosed. Exercise therapy was performed in conjunction with rehabilitation medicine to manage obesity continuously, and in conjunction with psychiatry, diagnoses related to eating disorders and exercise therapy were made possible.

We consider a lot of things related to patient condition. In this article, we commonly performed sleeve DJB in patient who suffer from diabetics with gastric cancer risk (family history of gastric cancer, mucosal dysplasia and *H. pylori* infection).

In this study, a total of Six ports with three-dimensional (3D) and two-dimensional (2D) laparoscopic equipment were used. Electrocautery and energy device such as Thunderbeat type S (Olympus, Japan), harmonic scalpel (Ethicon, USA) were used for dissection and powered linear stapler such as Ethilon surgical stapler (Ethicon, USA), SIGNIA™ stapling system (Medtronic, USA) in order to resection and anastomosis during the surgery. Liver was retracted using flexible retractor (gold finger) via epigastric trocar. The greater curvature of the stomach was resected 4 cm proximal to the pylorus to the gastroesophageal junction. The fundus was completely mobilized. A 36-Fr calibration tube was advanced transorally along the lesser curvature, and the stomach was divided using a linear stapler. The staple line was imbricated while keeping the calibration tube in place. Then, the posterior wall of the duodenum was dissected and divided using a linear stapler 1–2 cm distal to the

pylorus. The omentum was divided to avoid tension at the anastomosis during an antecolic reconstruction. The biliopancreatic limb length was 200 cm, and a duodenojejunal side-to-side anastomosis was created by single layers of hand sewing. The Peterson space was closed with non-absorbable sutures.

Patients were ambulated on the first postoperative day. Leak check was done by a contrast X-ray of the stomach, and complete blood test a week and a month after surgery.

Table 1. Patient data

Parameter	Mean (min-max)
Age (years)	44.8 (21-61)
Weight (kg)	99.3 (68-157.9)
Height (cm)	165.3 (150-181)
BMI (kg/m ²)	36.2 (27.8-53.1)
Operation time (min)	150 (105-210)
Postoperative hospital stay (days)	5 (3-35)
Sex (Male no. (%):female no. (%))	22 (39.2):34 (60.8)
DM (DM no. (%):non-DM no. (%))	46 (82.1):10 (17.9)

Patients were analyzed based on their weight, BMI, percentage total weight loss (%TWL), percentage excess weight loss (%EWL) with a BMI reference point of 25 kg/m², and investigations including HbA1c and DM medications at the 1-month, 3-month, and 6-month follow-ups. Meaningful weight loss was defined as %TWL ≥ 25% [7].

RESULTS

The mean operation time was 180.4 min (105-210 min), and the mean postoperative hospital stay was 5.6 days (3-35 days), and patient data of their age, height, weight, BMI, sex is depicted (Table 1). Postoperative complications occurred in two patients. The clinical manifestation of one patient was recurrent vomiting. Laparoscopic exploration was performed because there was no significant improvement with conservative management, and severe adhesion and stricture at the site of anastomosis

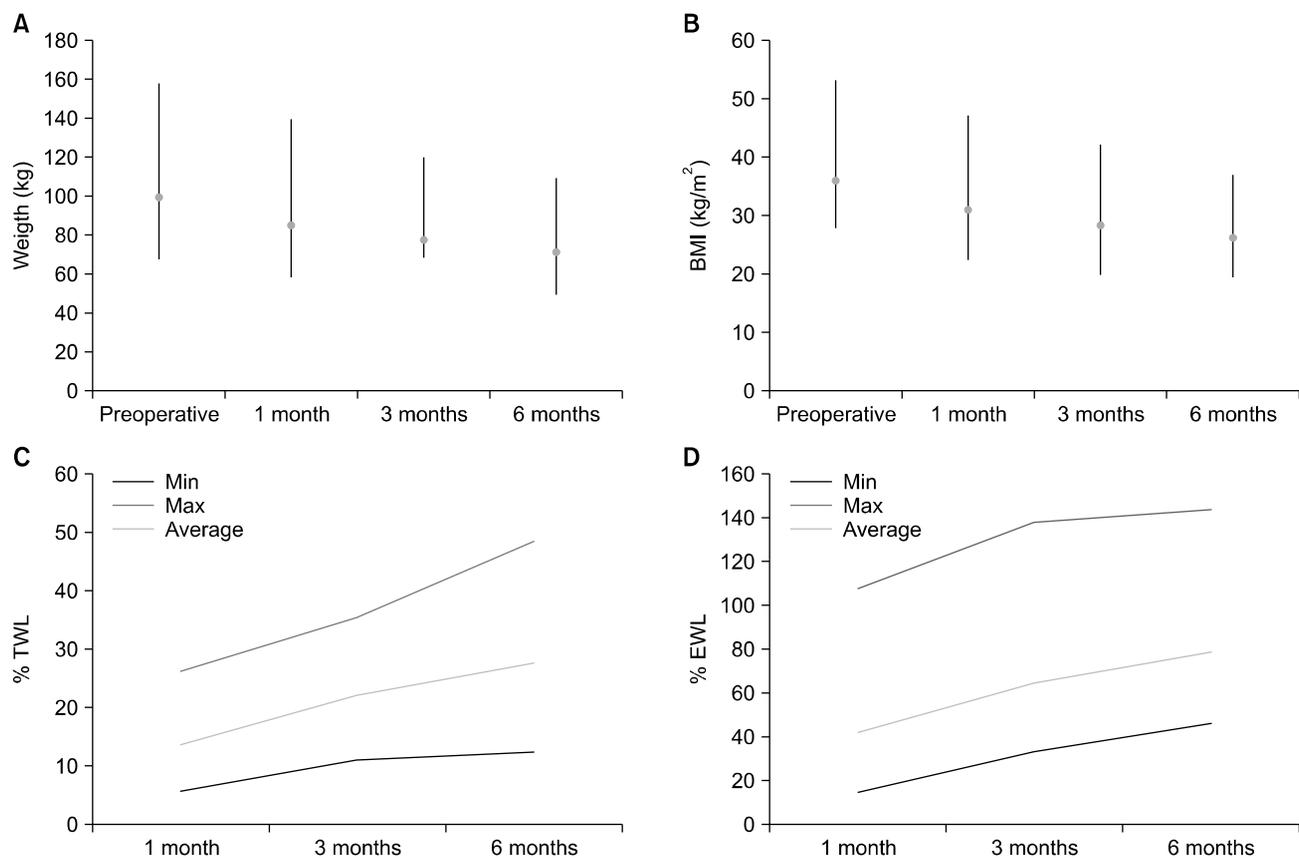


Fig. 1. (A) Weight change. (B) BMI change. (C) %TWL change. (D) %EWL change.

were found. Resectional RY bypass conversion was performed. The patient was discharged without any discomfort after surgery, including oral intake after the second surgery. The other postoperative complication was anastomotic leakage. The patient underwent RY bypass conversion and was discharged with no further complications. The 6-month mortality rate was 0%, and no malnutrition was observed. There were no major intraoperative or postoperative bleeding complications.

None of the patients had gastroesophageal reflux disease before surgery. No patient developed clinical manifestations suggestive of dumping syndrome or internal hernias.

Table 2. Weight parameters

Parameter	Time	Number	Mean
Weight (kg)	Preoperative	56	99.5 (68.0–157.9)
	1 month	56	85.6 (58.7–140)
	3 months	54	78.0 (69.0–120.0)
	6 months	51	71.7 (49.7–109.4)
Body mass index (kg/m ²)	Preoperative	56	36.0 (27.8–53.1)
	1 month	56	30.9 (22.5–46.9)
	3 months	54	28.3 (19.8–42.1)
	6 months	51	26.1 (19.5–36.8)
Total weight loss (%TWL)	1 month	56	13.7 (5.8–26.2)
	3 months	54	22.1 (11.1–35.4)
	6 months	51	27.5 (12.3–48.5)
Excess weight loss (%EWL)	1 month	56	41.9 (15.0–107.6)
	3 months	54	64.5 (33.2–137.9)
	6 months	51	78.6 (46.1–143.3)
%TWL ≥25%	1 month	56	3.5% (2/56)
	3 months	54	27.7% (15/54)
	6 months	51	54.9% (28/51)

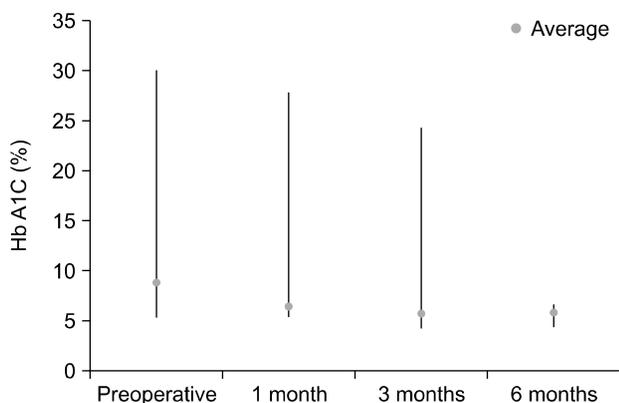


Fig. 2. HbA1C change.

The mean weight and BMI at different time intervals are depicted in Fig. 1A, B, %TWL and %EWL with a BMI reference point of 25 kg/m², calculated at the 1-month, 3-month, and 6-month follow-ups, are depicted in Fig. 1C, D, and Table 2. When the value of meaningful weight loss was set to more than 25% of TWL, the proportion of patients with meaningful weight loss over time was investigated, and the pattern of an increase was confirmed. Its ratio was 3.5%, 27.7%, and 54.9% at the 1-month, 3-month, and 6-month follow-ups, respectively.

Of the 56 patients, 46 had type 2 diabetes. An HbA1c cut-off value <6 was considered to be an improvement in diabetes. At the 1-month follow-up, only 4/31 patients (12%), at the 3-month follow-up, 22/41 patients (53.6%), and at the 6-month follow-up, 31/42 patients (73.8%), were found to show improvement (Fig. 2, Table 3).

The improvement of diabetes was also investigated in terms of maintenance, reduction, and discontinuation of insulin injection and administration of anti-diabetics. After excluding nine patients without diabetes, among forty-seven patients with diabetes, the remaining thirty-three patients were surveyed, excluding seven patients with insufficient information on the treatment of diabetes and seven without the treatment of diabetes. Of the patients who received anti-diabetics or insulin therapy, only three (9%) continued to receive reduced regimen treatment and the other thirty (91%) discontinued the

Table 3. HbA1c at the follow-up

Parameter	Time	N	Mean or Remission (%)
HbA1c	Preoperative	49	8.9 (5.4–30.0)
	1 month	31	6.5 (5.5–27.8)
	3 months	41	5.8 (4.3–24.3)
	6 months	42	5.9 (4.5–6.6)
Response with HbA1c cut-off <6	1 month	4	12.0% (4/31)
	3 months	22	53.7% (22/41)
	6 months	31	73.8% (31/42)

Table 4. Medication for diabetes mellitus

Anti-diabetics after 6 months	N (33)	%
Non-responder	0	0
Switch medication (reduction)	3	9
Discontinuation	30	91

anti-diabetics (Table 4).

DISCUSSION

Bariatric surgery is a highly effective method to treat morbid obesity and diabetes. SG is simple and easy to perform; however, weight regain and recurrence of comorbid conditions are high in the long run [8]. RYGB surgery is the gold standard to treat morbid obesity [9]. However, it has limitations such as a prolonged learning curve, endoscopic inaccessibility to monitor the remnant stomach (at risk gastric remnant), increased risk of calcium and iron deficiencies despite oral supplements due to the exclusion of the proximal bowel, increased risk of dumping syndrome due to the exclusion of the pylorus and internal hernias [10–13]. OAGB has become very popular in recent times because of its technical simplicity and increased effectiveness. It addresses the problem of internal hernia associated with RYGB; however, other challenges mentioned above continue to persist [14]. BPD–DS is the most effective operation, both in terms of weight loss and diabetes remission, since hormonal changes are maximum as food empties directly into the distal ileum. However, malabsorption is increased because most of the bowel is bypassed [15]. Huang et al. [16] proposed a loop duodenojejunal bypass with sleeve gastrectomy (LDJBSG) to address the limitations associated with standard surgeries. Various loop duodenal switch surgeries have been described in the literature with different biliopancreatic limb and common channel lengths [17]. SDJB surgery is a combination of SG and OAGB with a fixed biliopancreatic limb length to address the malabsorption associated with BPD–DS. In SDJB surgery, the right gastric artery (RGA) is divided at its origin, and the lesser omentum is teased anterior to the caudate lobe before transecting the duodenal bulb, which helps in the complete mobilization of the pyloric antrum and duodenal bulb. As a result, the gastric sleeve and divided duodenal bulb are supplied only by the left gastric pedicle and anchored by the esophagus and lesser omental vascular arcade. This allows free movement of the pyloric antrum and duodenal bulb, facilitating tension-free anastomosis with the jejunum. The resultant gap behind

the loop duodenojejunal anastomosis is enormous, which probably obviates the possibility of intestinal obstruction or strangulation even if small intestinal loops enter the gap behind the anastomosis. In SDJB surgery, the loop duodenojejunal anastomosis is an end-to-side anastomosis. Dallegrave Marchesini [18] proposed the division of the RGA while performing loop duodenal switch surgeries.

The anastomosis of the jejunum to the divided duodenal bulb in a Roux-en-Y fashion was described by Seki et al. (SDJB) [19]. Loop anastomosis is simpler, with a reduced number of anastomoses and mesenteric gaps. Loop rather than Roux-en-Y anastomosis, antecolic rather than retrocolic anastomosis, and division of the RGA with a free-lying duodenal bulb may translate into a reduced risk of internal hernias as the number of mesenteric gaps is reduced. Endoscopic surveillance of the gastric sleeve is possible after SDJB surgery. This means that there is no ‘at risk’ gastric remnant. The pylorus was preserved in our surgery, which may reduce dumping syndrome to some extent; however, it cannot be entirely avoided [4].

This study showed that patients could achieve significant weight loss after SDJB surgery. At the 6-month follow-up, 54.90% of the patients maintained %TWL $\geq 25\%$. Meaningful weight loss was not high enough; however, this was due to the short follow-up period, and it was expected that the meaningful weight loss would increase further in the long-term follow-up. Maciejewski et al. [20] showed that weight regain after RYGB was 3.4% at the 10-year follow-up. Nor Hanipah et al. [21] showed a significant drop in the BMI from $30.2 (\pm 5.1) \text{ kg/m}^2$ to $22.9 (\pm 5.6) \text{ kg/m}^2$ at the 2-year follow-up in 163 patients who underwent LDJBSG surgery.

Digestion and absorption of nutrients primarily occur in the duodenum and proximal jejunum [22]. The duodenum plays an important role in the absorption of minerals in deficiency states [23,24]. In SDJB surgery, the risk of calcium and iron deficiency was theoretically less since the duodenal bulb was preserved. Although some patients had asymptomatic iron and calcium deficiencies, they responded well to oral supplements. This response, to some extent, may be related to the preservation of the duodenal bulb. The major complication rate in this study was 0.88%, which was low. Nor Hanipah et al. [21]

showed a complication rate of 3.6% requiring reoperation. None of the patients in this study developed symptoms suggestive of dumping syndrome or internal hernias. Internal hernia is one of the most common complications of RYGB. According to the statistics of a meta-analysis, the incidence of internal hernia was found to be 1% in patients who underwent RYGB with the antecolic Roux limb and closure of the mesenteric and Petersen defects [4].

Morbid obesity and diabetes increase the risk of cancers [25,26], and bariatric surgery can reduce this risk [27]. SDJB surgery was not performed in patients with gastroesophageal reflux disease. There was no incidence of postoperative gastroesophageal reflux in this study. The modification of dividing the RGA and keeping the sleeve and duodenal bulb in the vertical position could reduce reflux to some extent.

The limitations of SDJB surgery are that it is a technically complex procedure and requires a steep learning curve. Access to the biliary tract was lost in SDJB surgery as the second part of the duodenum was excluded. The results indicated that SDJB surgery appeared to be safe to treat patients suffering from morbid obesity and diabetes. Long-term data from multiple centers is desirable to standardize and evaluate the exact efficacy of this novel surgery.

In severely obese patients with type 2 diabetes, bariatric surgery resulted in better glucose control than did medical therapy. Preoperative BMI and weight loss did not predict the improvement in hyperglycemia after these procedures [28].

Naitoh et al. [29] found that at the 1-year postoperative follow-up, remission of type 2 diabetes mellitus (HbA1c < 6.5%, off medications) after surgery was 80.8% for LSG and 86.0% for LSG/DJB, which is pretty much similar result with our data.

Insufficient cases and retrospective data collection could be a limitation and weak point if this study. However, SDJB surgery with a 200-cm biliopancreatic limb was a safe and effective procedure to treat weight loss of morbid obesity and improvement of diabetes control in short term. Also we believe this paper will help in deciding the surgical method, as a reference for bariatric surgery in

the future.

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