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ORIGINAL ARTICLE

Diabetes Remission Rate after Sleeve Gastrectomy or Roux-en-Y Gastric Bypass; Utilizing Individualized Metabolic Surgery Score for Korean Patients

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Purpose: The purpose of this study is to evaluate the usefulness of individualized metabolic surgery score for Korean patients in determining bariatric surgical procedures. **Materials and Methods:** A total of 135 patients with type 2 diabetes mellitus who underwent sleeve gastrectomy (n=19) or Roux-en-Y gastric bypass (n=116) at our institute with a 1-year follow up were analyzed for the predictive power of diabetes remission using the individualized metabolic surgery scoring system. **Results:** At the postoperative follow-up of 1 year, the remission of type 2 diabetes mellitus (HbA_{1C} < 6.5%, off medications) was achieved in 88 (65.2%) patients. The remission rates showed no significant differences between patients who underwent sleeve gastrectomy and Roux-en-Y gastric bypass (63.2% versus 65.5%; P=0.84), regardless of the severity of type 2 diabetes mellitus. Although there was no statistically significant difference in the remission rate according to the bariatric surgery procedures (P > 0.99 in mild, P=0.11 in moderate, P > 0.99 in severe IMS score), remission rates were higher in moderate severity patients who underwent Roux-en-Y gastric bypass than in those who underwent sleeve gastrectomy (69.7% versus 37.5%). **Conclusion:** The remission rates after bariatric surgery procedures were similar to that of the previously reported study. Despite the limitations of our data, the individualized metabolic surgery score can be used as a complement to other scoring systems in Korean patients.

Key Words: Diabetes mellitus, Remission, Gastrectomy, Gastric bypass

INTRODUCTION

Diabetes has been rapidly increasing health problems worldwide in the last several decades, especially in East Asia [1]. It is also a chronic disease with numerous complications and socioeconomic effects [2,3]. Derived from bariatric surgery, metabolic surgery has been proved superior to medical therapy for the type 2 diabetes mellitus (T2DM) patients [4-7]. There are two mainstreams of bariatric surgery, one is sleeve gastrectomy (SG) and the other is Roux-en-Y gastric bypass (RYGB) [8,9]. Regardless of operative risk, the conclusion as to which surgical procedure produces better outcomes is debatable [10,11]. Some studies have reported the recurrence of T2DM even after surgery [12]. Because of the reasons mentioned above, we need to select the appropriate patients and exclude conditions predicted to have poor outcomes in improving T2DM after surgery. Consequently, a scoring

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system for patient selection is necessary.

Several scoring systems have been proposed previously. Recently, Aminian et al. [13] proposed the Individualized Metabolic Surgery (IMS) Score based on a large retrospective study with long-term glycemic follow-up after bariatric surgery and a validation cohort. The IMS score can be used not only for patient selection, but also for surgical procedure selection according to the severity of T2DM. The objective of our study was to evaluate the usefulness of IMS for estimating the metabolic result after bariatric surgery and determining the optimal procedure in each IMS score in a Korean population.

MATERIALS AND METHODS

This retrospective study was approved by the Institutional Review Board (2018-11-023). We identified all patients who underwent primary SG or RYGB at Soonchunhyang University Seoul Hospital, Seoul, Korea, between 2009 and 2016. During this period, 248 patients with T2DM underwent primary SG or RYGB. Only patients with a complete and documented baseline and postoperative glycemic follow-up of at least 1 year were included. Patients who received revision surgery or those who were lost to follow-up were excluded. Finally, a total of 135 patients were enrolled in this study.

Because the aim of this study was to check the applicability of the IMS scoring system, we applied similar inclusion and exclusion criteria. According to the American diabetes association (ADA) consensus statement, diabetes remission was defined as glycated hemoglobin (HbA_{1C}) < 6.5%, fasting glucose < 126 mg/dl, and at least 1 year duration in the absence of active pharmacologic therapy or ongoing procedures [14].

1. The choice of procedure

At our institute, the patient's preference is taken into account for selection of the procedure if there are no contraindications for a certain procedure. For instance, patients with gastroesophageal reflux disease (GERD) are not recommended for LSG and patients who are currently smokers or on non-steroidal anti-inflammatory drugs (NSAIDs) are not recommended for LRYGB. We usually explain all of the contraindications and risk factors for each procedure and decide on a procedure with the patient. Table 1 shows preoperative patient characteristics according to surgical procedure.

2. Surgical procedures

All operations were done using the laparoscopic technique. SG was performed by using five trocar incisions. Gastric resection was performed with laparoscopic linear staplers under 36-Fr bougie guidance for creating a staple line parallel to the lesser curvature of the stomach. The staple line was selectively reinforced with either the interrupted method or the continuous oversewing method, especially where bleeding persisted or staples overlapped. RYGB was performed via three 5-mm and two 12-mm ports. A small gastric pouch of approximately 30 ml volume was created along the lesser curvature by using laparoscopic linear staplers. A 40-cm biliopancreatic limb and a 100-cm alimentary limb were constructed. The surgical procedures are described in detail other articles [15,16].

3. Statistical analysis

All statistical analyses were performed using SPSS, version 18.0 (SPSS Inc., Chicago, IL). Baseline comparison was made using paired *t* tests or Wilcoxon signed rank tests. The comparison of remission rates between SG and RYGB was established using the χ^2 tests. Within each T2DM severity, numeric performance measures were compared with independent-sample *t* tests or Mann-Whitney

Table 1. Preoperative patient's characteristics according to procedure[a]

	SG	RYGB
Number of patients	19	116
Age, yrs	39±8	39±12
Female (%)	11 (58%)	88 (76%)
BMI, kg/m^2	40.4±8.2	38.8±6.0
Duration of T2DM, yrs	1 (0-3)	1 (0-5)
Number of medications	1.1±1.1	1.4±1.0
Insulin usage	5 (26%)	29 (25%)
HbA_{1c}, %	7.0 (6.6-8.9)	7.6 (6.8-8.9)
Glycemic control (HbA_{1c}<7%)	9 (47%)	36 (31%)

[a]Descriptive statistics reported as mean±standard deviation, median (Q1-Q3), or count (%).

tests, whereas categorical performance measures were compared with Fisher exact tests. Within each T2DM severity and surgical procedures, numeric performance measures were compared preoperatively with 1 year follow-up with paired *t* tests or Wilcoxon signed rank tests, whereas categorical performance measures were compared with McNemar tests to accommodate the paired nature of the data. We calculated the remission rates according to the IMS score to assess the ability of the scoring system to predict the outcome of treatment. A 2-sided P value of .05 was considered as statistically significant.

RESULTS

1. Characteristics of patients

Our dataset consisted of 135 patients who underwent either SG or RYGB with a complete postoperative glycemic follow-up of at least 1 year. Baseline characteristics of the study cohorts are summarized in Table 2 [13]. Patients had a mean body mass index (BMI) of 39.0±6.3 kg/m^2 (range 28.9-58.3), a mean duration of T2DM of 3.3±0.4 years (range 0-22), and HbA_{1C} of 8.0±0.1% (range 6.1-11.7). The average number of diabetes medications at preoperative state was 1.4±1.0, and 32 (24%) patients were taking insulin treatment before surgery. There were no mortality cases in our study.

Table 2. Preoperative patient's characteristics[a]

	Original study[b]	Our study
Number of patients	659	135
Age, yrs	51±10	40±11
Female (%)	451 (68%)	103 (76%)
BMI, kg/m^2	46.4±9.0	39.0±6.3
Duration of T2DM, yrs	6 (3-11)	1 (0-5)
Number of medications	1.9±1.0	1.4±1.0
Insulin usage	241 (37%)	32 (24%)
HbA_{1c}, %	7.4 (6.4-8.6)	7.5 (6.8-8.9)
Glycemic control (HbA_{1c}<7%)	257 (39%)	42 (31%)
Operative procedure		
SG	148 (22%)	19 (14%)
RYGB	511 (78%)	116 (86%)

[a]Descriptive statistics reported as mean±standard deviation, median (Q1-Q3), or count (%).
[b]Data from original article [13].

2. Postoperative changes

After the 1-year follow-up, the mean percent of total weight loss, mean BMI and mean HbA_{1C} were significantly improved (Table 3). The mean percent total weight loss was 26.4±7.7%, and the mean BMI decreased from 39.0±6.3 kg/m^2 to 28.6±4.6 kg/m^2. The mean HbA_{1C} decreased to 6.0±1.1%. Also, the number of medications and insulin usage were significantly reduced.

The remission of T2DM was observed in 88 (65.2%) patients at the 1-year follow-up. The remission rates showed no significant differences between patients who underwent SG and RYGB (63.2% versus 65.5%; P=0.84), in overall patients.

There were 4 patients who took insulin therapy at 1 year after the surgery. There were no patients with mild T2DM before surgery (2 moderate and 2 severe T2DM according to IMS score). Despite continuing insulin therapy, one patient who had moderate T2DM preoperatively achieved glycemic control (HbA_{1C}<7.0) 1 year after the bariatric surgery.

3. Utilization of IMS score

According to IMS score system, our patients were classified as the following: 32% mild, 55% moderate, and 13% severe (Table 4) [13]. The remission rates of T2DM, 1 year after surgery, were 88.4% for the mild, 66.2% for the moderate, 5.6% for the severe group.

Table 5 shows changes since 1 year after surgery in glycemic and medication status according to severity of T2DM. In patients with mild T2DM (IMS score ≤25), SG showed 90% remission rate and RYGB showed 88%

Table 3. Comparison of patient's data before and after surgery

	Preoperative	Postoperative	P value*
Number of medications	1.36±0.1	0.30±0.7	<0.001
Insulin usage, n	32 (24%)	4 (3%)	<0.001
Weight, kg	106.6±22.5	78.0±16.4	<0.001
BMI, kg/m^2	39.0±6.3	28.6±4.6	<0.001
%Total weight loss		26.4±7.7	
FPG, mg/dl	167.9±68.7	112.7±35.4	<0.001
HbA_{1c}, %	8.0±1.5	6.0±1.1	<0.001

FPG = fasting plasma glucose.
*P<0.05.

Table 4. Comparison of IMS score

Severity	Original study[a]			Our study		
	Frequency	Remission after RYGB	Remission after SG	Frequency (n)	Remission after RYGB (n)	Remission after SG (n)
Mild	15%	92%	74%	32% (43)	88% (29)	90% (9)
Moderate	51%	60%	25%	55% (74)	70% (46)	38% (3)
Severe	34%	12%	12%	13% (18)	6% (1)	0% (0)

[a]Data from original article [13].

Table 5. Performance measures over time by diabetes severity level and metabolic surgical technique

	Mild			Moderate			Severe		
	SG	RYGB	P	SG	RYGB	P	SG	RYGB	P
Number of patients	10	33		8	66		1	17	
Remission	90%	88%	0.99	38%	70%	0.11	0%	6%	0.99
HbA_{1c}<7%			0.99			0.45			0.39
Preop	90%	79%		0%	11%		0%	0%	
1 yr F/U	100%	100%		88%	94%		100%	35%	
P (compared with preop)	0.99	0.016		0.016	<0.0001		–[a]	0.03	
HbA_{1c}, %			0.70			0.99			0.96
Preop	6.7±0.3	7.0±1.0		9.4±1.8	8.3±1.4		8.3	8.7±1.2	
Change from preop	−1.3±0.6	−1.5±1.0		−2.5±2.5	−2.5±1.6		−1.5	−1.4±1.5	
P (compared with preop)	<0.0001	<0.0001		0.03	<0.0001		–[a]	0.01	
Number of medications			0.97			0.52			0.99
Preop	0.2±0.4	0.2±0.4		2.1±0.8	1.8±0.7		1	2.4±0.8	
Change from preop	−0.2±0.4	−0.2±0.5		−1.5±1.7	−1.6±0.7		−1	−1.0±0.9	
P (compared with preop)	0.16	0.03		0.04	<0.0001		–[a]	0.01	
Not taking medications			0.99			0.61			0.22
Preop	80%	79%		0%	0%		0%	0%	
1 yr F/U	100%	97%		75%	85%		100%	18%	
P (compared with preop)	0.50	0.07		0.03	<0.0001		–[a]	0.25	

[a]Incapable of calculation due to extremely small number of case (n=1, SG in severe T2DM).

remission rate after 1 year. In patients with moderate severity (25<IMS score≤95), even if there were no statistically significant changes, RYGB showed greater remission rates than SG (70% versus 38%, P=0.11). Both SG and RYGB were less effective in patients with severe T2DM (IMS score>95). There were no significant differences in remission, glycemic control, medication status between the two surgical procedures.

DISCUSSION

Our study is the first to utilize the IMS score using a Korean cohort. In this report, we utilized the IMS score in predicting the probability of T2DM remission after bariatric surgery. The probability of T2DM remission was 88%, 66%, and 6% for patients with an IMS score of mild, moderate, and severe, respectively. So, patients of T2DM may be selected for bariatric surgery according to their IMS score. However, unlike the original study, this study showed a limited differentiating power between SG and RYGB. There were no significant differences in T2DM remission rates between patients who underwent SG and RYGB (63.2% versus 65.5%; P=0.84), regardless of T2DM severity. Also in each severity, there were no statistical differences in remission rates between two surgical procedures. These findings are compatible with other clinical trials [10,11]. But the shortness of the follow-up period is a limitation of our study and further data should be collected.

The overall remission rate was 65.2% in our study,

which is higher than that reported in the original report (44.4%) [13]. This difference is judged to be due to the different characteristics of enrolled patients in the two studies. In this study, patients had a lower BMI (39.0 versus 46.4 kg/m^2), younger age (40 versus 51 year), and more mild severity (32% versus 15%) compared to that of the original report.

According to the nomogram of the original report, patients with IMS score ≤25 are considered to have mild T2DM. In these patients, both SG and RYGB were highly effective in the treatment of T2DM (90% and 88%, respectively). As mentioned in the original report, mild severity means less advanced T2DM, so functional β-cell reserve is higher than in the other severity groups. Also there were no statistically significant differences in glycemic control and medication reduction between the two procedures. Thus, both bariatric surgeries are good options for treatment of patients with mild T2DM.

If the IMS score is between 25 and 95 points, T2DM is considered moderate. In this group, even though there was no statistical significance, a slightly higher T2DM remission rate was shown in patients who underwent RYGB. This result showed a similar tendency with the original cohort in the moderate severity group. Hence, RYGB is considered as the better procedure for patients with moderate T2DM.

T2DM is considered severe if the IMS score is above 95 points. In this group, extremely low remission rates were shown in both surgical modalities, which is similar with the original report. There was only one patient who underwent SG in the severe group in our study. This is a limitation of our study in determining the surgical procedures for patients of severe T2DM. The patient had been diagnosed with T2DM 12 years before the surgery. The preoperative HbA_{1C} of the patient was 8.3, and he had been receiving single insulin therapy (Lantus 40IU before breakfast) without oral antihyperglycemic agents. At 1 year after surgery, HbA_{1C} was decreased to 6.8% without medications. More studies about surgical outcomes of patients with severe T2DM are in need.

There are other various conditions that may favor one procedure over another for determining which surgical procedure is suitable. SG may be a better choice in these conditions; if the patient is a current smoker, uses corticosteroids and NSAIDs, has Crohn's disease, or is a transplant recipient [17-21]. On the other hand, RYGB is the proper choice for patients with severe GERD [22,23]. Therefore, we considered not only the severity of T2DM but also the general health of the patient when deciding on the choice of bariatric surgery that is most optimal for the patient.

As mentioned in the original report, the lack of a C-peptide value is a limitation of the IMS scoring system. Because the fasting C-peptide level may reflect the pancreatic reserve for insulin, many studies have indicated C-peptide as considered the most important predicting factor in T2DM patients [15,24-29]. Unfortunately, we also did not have complete data on the C-peptide, so further investigations and research should be done about this issue.

Our study has some limitations in data. First, the number of patients who underwent sleeve gastrectomy is low, especially in severe T2DM according to the IMS score (n=1), which may impact the outcomes. Second, the duration of follow-up period is only 1 year, so our study cannot represent long-term outcomes. Finally, our data was from a single institute and a single ethnic group. In order to find out an ideal scoring system for predicting the remission of T2DM, a multicenter prospective study with a large population that covers various ethnic groups should be done.

Although there were two major limitations, including a low number of patients who underwent sleeve gastrectomy and a short duration of follow-up period, this is the first study that utilized the IMS scoring system using a Korean cohort. There is a similar tendency in the T2DM remission rates with the original cohort in the moderate severity group. The usage of IMS score in Korean patients is thought to be available with a combination of other scoring systems.

CONFLICT OF INTEREST

The authors have no commercial associations that might be a conflict of interest in relation to this article.

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