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Original article

Validation of the individualized metabolic surgery score for bariatric procedure selection in the merged data of two randomized clinical trials (SLEEVEPASS and SM-BOSS)

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Abstract

Background: LSG and LRYGB are globally the most common bariatric procedures. IMS score categorizes T2D severity (mild, moderate, and severe) based on 4 independent preoperative predictors of long-term remission as follows: T2D duration, number of diabetes medications, insulin use, and glycemic control. IMS score has not been validated in a randomized patient cohort.
Objectives: To assess the feasibility of individualized metabolic surgery (IMS) score in facilitating procedure selection between laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (LRYGB) for patients with severe obesity and type 2 diabetes (T2D).
Setting: Merged individual patient-level 5-year data of 2 large randomized clinical trials (SLEEVEPASS and SM-BOSS [Swiss Multicenter Bypass or Sleeve Study]).
Methods: IMS score was calculated for study patients and its performance was analyzed.
Results: One hundred thirty-nine out of 155 patients with T2D had available preoperative data to calculate IMS score as follows: mild stage (n = 41/139), moderate stage (n = 77/139), severe stage (n = 21/139). At 5 years, 135 (87.1%, 67 LSG/68 LRYGB) were available for follow-up and 121 patients had both pre- and postoperative data. Diabetes remission rates according to preoperative IMS score were as follows: mild stage 87.5% (n = 14/16) after LSG and 85.7% (n = 18/21) after LRYGB (P = .999), moderate stage 42.9% (n = 15/35) and 45.2% (n = 14/31) (P = .999), and severe stage

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18.2% (n = 2/11) and 0% (n = 0/7) (P = .497), respectively. The T2D remission rate varied significantly between the stages as follows: mild versus moderate odds ratio (OR) 8.3 (95% CI, 2.8–24.0; $P < .001$), mild versus severe OR 52.2 (95% CI 9.0–302.3; $P < .001$), and moderate versus severe OR 6.3 (95% CI, 1.3–29.8; P = .020).

Conclusions: In our study, remission rates of T2D were not statistically different after LSG and LRYGB among all patients and among patients with mild, moderate, and severe diabetes stratified by the IMS score. However, the study may be underpowered to detect differences due to small number of patients in each subgroup. IMS score seemed to be useful in predicting long-term T2D remission after bariatric surgery. (Surg Obes Relat Dis 2022;■:1–8.)

Keywords: Bariatric surgery; Sleeve gastrectomy; Roux-en-y gastric bypass; Type 2 diabetes; IMS score

The global obesity epidemic is ever increasing, resulting in concurrent increase of obesity associated diseases with type 2 diabetes (T2D) as one of the most important comorbidities driving towards an increased rate of cardiovascular morbidity and mortality [1–3]. To date, bariatric surgery is the most effective treatment of severe obesity with good and sustainable weight loss and remission or alleviation of associated diseases at long-term follow-up [4–9]. Currently, the annual number of bariatric procedures worldwide is around 750,000 and since 2014, laparoscopic sleeve gastrectomy (LSG) has been the most frequently performed bariatric procedure, while laparoscopic Roux-en-Y gastric bypass (LRYGB) represents the second most common procedure [10].

Tailoring the surgical treatment of severe obesity for all bariatric surgery patients aiming to optimize outcomes is under active research and the optimal treatment choice is naturally a multifactorial issue. The severity of T2D and its predicted remission play an important role in this decision. Recent meta-analyses have shown no difference in either weight loss or T2D remission between LSG and LRYGB [11,12], but as stated by Lee et al. [12], long-term data from randomized controlled trials (RCTs) are lacking and firm conclusions cannot be drawn. In addition, even the most recent meta-analysis [12] still includes the RCT by Ruiz-Tovar et al., which was retracted in March 2021 for scientific inconsistencies further reducing the number of available RCT patients. In a large retrospective cohort study, LRYGB was associated with greater weight loss, a slightly higher T2D remission rate, less T2D relapses, and better long-term glycemic control compared to LSG [13].

In order to increase statistical precision, the 5-year individual patient data of 2 large RCTs (SLEEVEPASS and SM-BOSS) were merged and additional patient-level data for T2D were retrieved. In this merged data, although LRYGB induced greater weight loss and better amelioration of hypertension than LSG, there was no difference in T2D remission and there were more complications after LRYGB [14].

While the probability of T2D relapse increases with follow-up, it should not be considered a failure as the trajectory of the disease and the associated cardiometabolic risk factors change favorably after bariatric surgery [7,15]. Longer preoperative duration of T2D, patient age, preoperative insulin use, poor glycemic control, and the number of T2D medications at baseline are all associated with greater likelihood of T2D relapse [14,16–19].

Several scoring systems have been assessed as tools to facilitate optimal metabolic procedure choice for patients with severe obesity and T2D, and many of these scores have been validated and compared within a variety of patient cohorts [20–27]. The individualized metabolic surgery (IMS) score [23] categorizes patients into 3 stages of T2D severity (mild, moderate, and severe) based on the following 4 independent preoperative predictors of long-term remission: T2D duration, number of diabetes medications, insulin use, and glycemic control. The IMS score suggested LSG as the procedure of choice for patients with severe T2D based on the better risk-benefit ratio and LRYGB for patients with moderate stage T2D [23]. To our knowledge, the IMS score has only been validated in retrospective cohorts and at short- or mid-term follow-up [28,29].

Using the unique merged individual patient data of the so far 2 largest RCTs (SLEEVEPASS [30] and SM-BOSS [31]) comparing LSG and LRYGB with 5-year follow-up data [14], the aim of this study is to validate the IMS score in a large prospective cohort assessing the feasibility of the IMS score in both tailoring the metabolic surgery procedure choice for patients with T2D and predicting the sustainability of T2D remission.

Methods

The study design, rationale, and methods of both RCTs have been previously reported [30,31]. The study protocols were approved by the local ethics committees of each participating hospital, the trials were conducted in accordance with the principles of the Declaration of Helsinki and registered at the clinical trials registry of the National Institutes of Health (ClinicalTrials.gov NCT00356213, NCT00793143). All patients gave written informed consent.

The methods and analyses of the merged individual patient data have been previously described in detail [14]. Briefly, both trials were randomized, controlled, multicenter, and multisurgeon trials comparing LSG and LRYGB involving a total of 240 patients with severe obesity from Finland and 225 patients from Switzerland, and similar inclusion and exclusion criteria and similar operative techniques [30,31]. For LSG, a 33-Fr to 35-Fr calibration bougie was used, and the resection was initiated from 3–6 cm proximal to the pylorus. For LRYGB, in both trials the standardized surgical technique for LRYGB entailed creating a small gastric pouch and constructing an antecolic end-to-side gastrojejunostomy, as either a circular or a linear anastomosis according to the preference of the surgeon. The alimentary limb was measured to 150 cm and the biliopancreatic limb was 50–80 cm in the SLEEVEPASS trial and 50 cm in the SM-BOSS trial.

Raw patient level data from the 2 original RCTs were combined, and outcomes were standardized. Additional 5-year data were retrieved on T2D (preoperative T2D duration and number of T2D medications). Out of the 398 patients (398/465, 85.6%) available for follow-up in this merged data, 155 patients had T2D at baseline and were included in this study.

The IMS score [23] was calculated based on 4 different independent preoperative variables predicting long-term remission of T2D as follows: duration of T2D in years, the number of diabetes medications, insulin use, and glycemic control (glycated hemoglobin level, A1c $<$7%). Based on the calculated scores, patients were categorized into the following 3 different groups according to IMS score T2D severity stage: mild (IMS score $\leq$25), moderate (IMS score $>$25 to $\leq$95), and severe (IMS score $>$95), and the T2D remission rates were assessed according to these groups. Long-term T2D remission was defined according to ADA consensus statement as A1c$<$6.5%, fasting blood glucose 126 mg/dl, and off T2D medications at 5 years or more after surgery [32]. Furthermore, the changes in BMI were calculated according to T2D severity. Weight loss was defined as percentage total weight loss (%TWL [preoperative weight – postoperative weight/preoperative weight $\times$ 100]), as it is the recommended metric of choice when reporting weight loss.

Statistical analyses

Continuous variables were described using as means with standard deviations (SD) or, if the data were skewed, as medians with 25th (Q_1) and 75th (Q_3) percentiles. Nonparametric Kruskal-Wallis test was used to test differences in continuous baseline variables between the IMS T2D severity stages. Categorical variables were characterized using frequencies and percentages and tested using Pearson's Chi Squared test or Fisher's exact test when appropriate. In order to be able to compare the results to the original publication, Pearson's Chi Squared test was used to compare the remission rates of T2D between the operations separately in 3 severity stages, and one-way analysis of variance (ANOVA) was used to evaluate the differences in body mass index (BMI) between the severity stages separately in 2 operations. In addition, logistic regression analysis was used to evaluate the effect of T2D severity stage, operation, and percentage total weight loss (%TWL) on T2D remission. In contrast to the original article, we used %TWL in the model to represent the weight loss instead of change in BMI used in the original article. In the severe T2D stage, there was no remission after LRYGB operation and thus, we combined the severe stage with the moderate stage and this modified variable was used in the first reported model. First model included T2D severity stage (severe and moderate stages combined), operation, %TWL, and interaction of severity stage and operation. The final model included only the main effects of T2D severity stage (original variable with 3 categories) and operation because using this simple model enabled the use of severity stage with original categories. The results of logistic regression models were quantified using odds ratios (OR) with 95% confidence intervals (95% CIs).

Two-sided tests were used and P values $<$.05 were considered statistically significant. Missing observations were excluded from the analyses. Statistical analyses were performed using SAS System for Windows (Version 9.4, SAS Institute Inc., Cary, NC, USA).

Results

The patient flow is presented in Figure 1 and the patient baseline characteristics are displayed in Table 1. Out of the 155 patients with T2D at baseline, 139 (89.7%) had the preoperative data for IMS calculations, and 135 (87.1%) were available for follow-up at 5 years. The T2D remission rate 5 years after LSG was 49.3% (n = 33/67) and 55.8% (n = 38/68) after LRYGB (P = .418). Baseline characteristics of the patients according to T2D severity stage and operation are shown in Table 2.

There were altogether 121 patients with available data for both IMS score calculation and T2D remission analysis at 5 years. In total, 52.6% (n = 63/121) of these patients had complete remission of T2D at 5 years. Within the severity stages, the rates in achieving long-term remission at 5-year follow-up were 86.5% (n = 32/37) in the mild stage, 43.9% (n = 29/66) in the moderate stage, and 11.1% (n = 2/18) in the severe stage (P $<$ .001). The remission rates after LSG and LRYGB according to T2D severity are presented in Table 3. The remission rates did not differ statistically and significantly between the operations in any of the severity stages.

The change in BMI at 5 years after LSG or LRYGB according to T2D severity is shown in Table 4. The change in BMI differed significantly (P = .043) between the

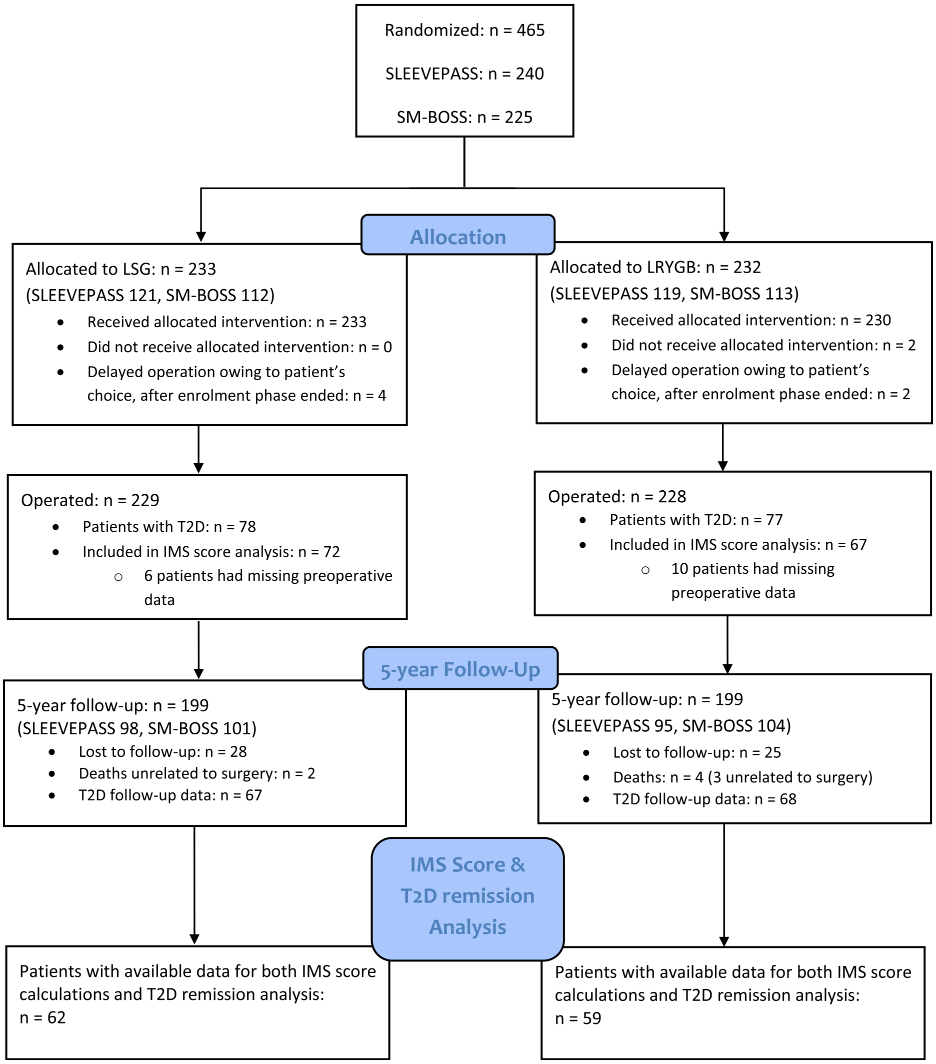

Figure 1. Flow diagram. LSG = laparoscopic sleeve gastrectomy; LRYGB = laparoscopic Roux-en-Y gastric bypass; T2D = type 2 diabetes; IMS = individualized metabolic surgery.

severity stages in patients who underwent LRYGB with the highest BMI loss associated with T2D mild stage. In patients who underwent LSG, there were no significant differences ($P = .454$) in BMI change between the T2D severity stages.

In the logistic regression analyses for T2D remission, interaction of IMS severity (severe and moderate stages combined) and operation was not statistically significant ($P = .524$) and thus no further analyses were needed to test the difference between the operations separately in IMS severity stages. The effect of %TWL on T2D remission was statistically significant ($P = .001$) and the odds for remission increased with greater %TWL (OR, 1.1; 95% CI, 1.0–1.2). In the final model there was no statistically significant difference in T2D remission between LSG and LRYGB (OR, 1.1; 95% CI, 0.5–2.6; $P = .812$). Difference in T2D remission between the IMS score T2D severity stages was statistically significant ($P < .001$). The odds for T2D remission were the highest in the mild stage (mild versus moderate OR, 8.3; 95% CI, 2.8–24.0; $P < .001$ and mild versus severe OR, 52.2; 95% CI, 9.0–302.3; $P < .001$). There was also a statistically significant difference between the moderate and the severe stages in the odds for T2D remission (OR, 6.3, 95% CI, 1.3–29.8; $P = .020$).

Discussion

In this large merged randomized patient cohort, T2D remission rates between LSG and LRYGB were similar in all 3 IMS score T2D severity groups. However, the T2D severity stage was strongly associated with T2D remission with patients in the mild stage group being more likely to

Table 1
Baseline patient characteristics

	SM-BOSS (N = 54)	SLEEVEPASS (N = 101)	LSG (N = 78)	LRYGB (N = 77)
Age (yr), mean (SD)	47.9 (10.3)	51.6 (8.1)	50.4 (8.9)	50.2 (9.2)
Sex: female/male, frequency (%)	30/24 (55.6%)	62/39 (61.4%)	43/35 (55.1%)	49/28 (63.6%)
Body Mass Index, BMI (kg/m^2), mean (SD)	44.7 (10.3)	46.9 (6.2)	46.1 (6.2)	46.1 (6.0)
Preoperative duration of T2D (yr), median (Q_1–Q_3)	1.0 (0.5–7.0)	5.0 (2.0–8.0)	5.0 (1.1–7.5)	4.0 (1.0–7.0)
No T2D medication, frequency (%)	17/44 (38.6%)	0/100 (0.0%)	9/75 (12.0%)	8/69 (11.6%)
1 T2D medication, frequency (%)	22/44 (50.0%)	51/100 (51.0%)	32/75 (42.7%)	41/69 (59.4%)
2 T2D medications, frequency (%)	5/44 (11.1%)	40/100 (40.0%)	31/75 (41.3%)	14/69 (20.3%)
3 T2D medications, frequency (%)	0/44 (0.0%)	8/100 (8.0%)	3/75 (4.0%)	5/69 (6.8%)
4 T2D medications, frequency (%)	0/44 (0.0%)	1/100 (1.0%)	0/75 (0.0%)	1/69 (1.5%)
Insulin use, frequency (%)	10/54 (18.5%)	32/101 (31.7%)	24/78 (30.7%)	18/77 (23.4%)
Glycated hemoglobin, A1c (%), median (Q_1–Q_3)	6.8 (6.1–7.9)	6.6 (6.3–7.2)	6.7 (6.3–7.5)	6.6 (6.1–7.7)
Glycemic control, frequency (%)*	31/51 (60.8%)	67/101 (66.3%)	51/77 (66.2%)	47/75 (62.7%)

LSG = Laparoscopic sleeve gastrectomy; LRYGB = Laparoscopic Roux-en-Y gastric bypass; T2D = Type 2 Diabetes mellitus; A1c = Glycated hemoglobin level; SD = Standard deviation.

* Glycated hemoglobin level (A1c) < 7%.

achieve remission compared to patients in the moderate or severe stage groups. Our results, therefore, suggest that IMS score does not facilitate the procedure selection between LSG and LRYGB, but IMS could be used as a general predictive model for T2D remission in patients with severe obesity.

Our findings are in contrast to the original IMS score article [23] by Aminian et al., who suggested LRYGB for patients with moderate stage T2D due to their retrospective results of LRYGB resulting in superior T2D remission rates in this group, but are in line with Chen et al., [28] who also found no difference in 5-year remission rates between LSG and LRYGB in the moderate stage. However, the latter study may have been influenced by the Asian ethnicity and lower preoperative BMI of the study population, while in our merged data set, both these factors are likely more similar to the dataset of the original IMS score article.

A recent study by Ohta et al. [29] found LSG superior to LRYGB regarding T2D remission in patients with moderate T2D, although patients undergoing LSG had higher BMI compared to LRYGB in their study population. Their results showed sleeve gastrectomy with duodenojejunal bypass to be the most effective procedure in treatment of T2D in the moderate stage [29] in line with results showing that biliopancreatic diversion with duodenal switch is superior for T2D remission [9].

To our knowledge, this is the first validation of the IMS score using randomized data comparing LSG and LRYGB

Table 2
Baseline patient characteristics by type 2 diabetes severity according to calculated individualized metabolic surgery score

	Mild stage (N = 41)		Moderate stage (N = 77)		Severe stage (N = 21)	
	LSG (N = 19)	LRYGB (N = 22)	LSG (N = 41)	LRYGB (N = 36)	LSG (N = 12)	LRYGB (N = 9)
Age (yr), mean (SD)	46.4 (9.2)	50.6 (11.0)	52.2 (8.0)	49.2 (8.0)	51.8 (8.0)	52.5 (9.7)
Sex: female/male, frequency (%)	12/7 (63.2%)	15/7 (68.2%)	24/17 (58.5%)	22/14 (61.1%)	5/7 (41.7%)	7/2 (77.8%)
Body Mass Index, BMI (kg/m^2), mean (SD)	47.6 (6.4)	47.8 (5.7)	46.1 (6.4)	46.8 (6.4)	42.9 (6.0)	43.8 (6.2)
Glycated hemoglobin, A1c (%), median (Q_1-Q_3)	6.2 (5.8–6.7)	6.1 (5.7–6.5)	6.7 (6.4–7.0)	6.8 (6.2–7.7)	8.6 (7.4–9.7)	8.7 (8.2–9.7)
Preoperative duration of T2D (yr), median (Q_1-Q_3)	1.0 (0.5–1.5)	1.0 (0.5–1.0)	5.0 (4.0–7.0)	5.0 (4.0–7.0)	11.0 (8.0–20.5)	15.0 (13.0–26.0)
No T2D medication, frequency (%)	7/19 (36.8%)	8/22 (36.4%)	1/41 (2.4%)	0/36 (0.0%)	0/12 (0.0%)	0/9 (0.0%)
1 T2D medication, frequency (%)	12/19 (63.2%)	14/22 (63.6%)	19/41 (46.3%)	22/36 (61.1%)	0/12 (0.0%)	4/9 (44.4%)
2 T2D medications, frequency (%)	0/19 (0.0%)	0/22 (0.0%)	20/41 (48.8%)	10/36 (27.8%)	10/12 (83.3%)	3/9 (33.3%)
3 T2D medications, frequency (%)	0/19 (0.0%)	0/22 (0.0%)	1/41 (2.4%)	4/36 (11.1%)	2/12 (16.67%)	1/9 (11.1%)
4 T2D medications, frequency (%)	0/19 (0.0%)	0/22 (0.0%)	0/41 (0.0%)	0/36 (0.0%)	0/12 (0.0%)	1/9 (11.1%)
Insulin use, frequency (%)	0/19 (0.0%)	0/22 (0.0%)	10/41 (24.4%)	7/36 (19.4%)	12/12 (100.0%)	9/9 (100.0%)
Glycemic control, frequency (%)*	18/19 (94.7%)	22/22 (100.0%)	28/41 (68.3%)	19/36 (52.8%)	1/12 (8.3%)	1/9 (11.1%)

LSG, Laparoscopic sleeve gastrectomy; LRYGB, Laparoscopic Roux-en-Y gastric bypass; T2D, Type 2 Diabetes mellitus; A1c = Glycated hemoglobin level; SD = Standard deviation.

* Glycated hemoglobin level (A1c) < 7%.

Table 3
T2D remission rates by severity stage and operation

Severity stage	Remission after surgery	Remission after LSG	Remission after LRYGB	*P* value
		Merged data		
Mild [frequency (%)]	32/37 (86.5%)	14/16 (87.5%)	18/21 (85.7%)	.999*
Moderate [frequency (%)]	29/66 (43.9%)	15/35 (42.9%)	14/31 (45.2%)	.999*
Severe [frequency (%)]	2/18 (11.1%)	2/11 (18.2%)	0/7 (0.0%)	.497*
		SLEEVEPASS		
Mild [frequency (%)]	15/18 (83.3%)	5/7 (71.4%)	10/11 (90.9%)	.528*
Moderate [frequency (%)]	18/48 (37.5%)	10/26 (38.5%)	8/22 (36.4%)	.999*
Severe [frequency (%)]	0/13 (0.0%)	0/7 (0.0%)	0/6 (0.0%)	NA
		SM-BOSS		
Mild [frequency (%)]	17/19 (89.5%)	9/9 (100.0%)	8/10 (80.0%)	.474*
Moderate [frequency (%)]	11/18 (61.1%)	5/9 (55.6%)	6/9 (66.7%)	.999*
Severe [frequency (%)]	2/5 (40.0%)	2/4 (50.0%)	0/1 (0.0%)	.999*

LSG = Laparoscopic sleeve gastrectomy; LRYGB = Laparoscopic Roux-en-Y gastric bypass.
* Fisher's exact test.

with the randomization mitigating the selection bias. The IMS score is based on a large retrospective patient cohort (n = 900) with severe obesity and T2D with long-term glycemic follow-up after metabolic surgery (LSG or LRYGB). In the original IMS score training cohort only a quarter of the patients underwent LSG, which could potentially have led to a false-positive effect of LSG in the severe stage group [23].

The present study showed no significant difference in T2D remission rates between LSG and LRYGB. This result is in line with a recent meta-analysis by Lee et al. [12], which included 33 RCTs and 2475 patients comparing these 2 procedures. The Oseberg trial [33] comparing LRYGB and LSG in the treatment of patients with T2D, and severe obesity with 2 endpoints of 1-year T2D remission and β-cell function was not included to this meta-analysis showing superior T2D remission after LRYGB with no difference in β-cell function. However, to detect a 10-percentage point difference in T2D remission rate between the operations, about 700 patients with T2D would need to be enrolled underlining the need for international scientific collaboration for an individual patient data meta-analysis.

Previous studies have reported the ability of the IMS score in predicting overall T2D remission [34,35]. Plaeke et al. [34] compared the performance of 11 different predictive scores and found the IMS score to be the most accurate. In patients undergoing LSG, IMS score was able to discriminate T2D remissions [35]. Many scoring systems have been developed to predict T2D remission after bariatric surgery such as DiaRem [22], advanced-DiaRem (ad-DiaRem) [24], DiaBetter [25] and ABCD scores [20]. Chen et al. [28] reported that the ABCD scores have better discriminative ability between the procedures compared with the IMS score. This was suggested to derive from the lack of C-peptide value in the IMS score as it has been shown to predict T2D remissions [36–38]. However, there are contradicting results of the role of C-peptide in predicting T2D remissions showing comparable prediction results of the IMS score to the ABCD score in an Asian population [29].

DiaRem, ad-DiaRem, DiaBetter, and IMS score all include similar parameters; preoperative A1c along with the use of diabetes medications and insulin use all associated with T2D remission prediction [22,24,25,38–40]. Ad-Diarem, DiaBetter, and IMS score all include preoperative duration of T2D, which is strongly associated with remission rate [7,24,36,39], and these 3 scores performed best in the comparison of the 11 predictive scores by Plaeke et al. [34]. With the progressing nature of T2D

Table 4
Change of body mass index by severity stage and operation

Body Mass Index, BMI (kg/m^2), mean (SD)	LRYGB				LSG			
	Mild	Moderate	Severe	*P* value*	Mild	Moderate	Severe	*P* value*
Baseline	47.8 (5.7)	46.8 (6.4)	43.8 (6.2)	.275	47.6 (6.4)	46.1 (6.4)	42.9 (6.0)	.137
5 yr	33.25 (5.5)	34.8 (6.1)	35.1 (5.0)	.586	36.6 (6.4)	37.6 (5.9)	33.3 (6.7)	.172
Change from baseline	−14.6 (6.1)	−11.6 (4.2)	−10.0 (3.5)	.043	−11.0 (5.6)	−9.3 (4.1)	−10.4 (4.5)	.454

LSG = Laparoscopic sleeve gastrectomy; LRYGB = Laparoscopic Roux-en-Y gastric bypass.
* One-way analysis of variance.

pathophysiology, worse A1c, number of diabetes medications, and insulin use are basically by-products of T2D duration and signs of progression of disease severity [41,42].

In our study, we used both change in BMI and %TWL as weight loss variables, and change in BMI was used to facilitate the comparison with the original IMS score [23]. Currently %TWL is considered to be the variable of choice in reporting weight loss outcomes after bariatric surgery [43], and therefore, we used %TWL in our advanced model. The effect of preoperative BMI on T2D remission remains somewhat controversial [24,36,39]. A meta-analysis of 4944 patients showed preoperative BMI not to be a significant predictor of T2D remission [44].

This study has limitations. First, the present study is limited by the number of patients and underpowered to detect differences in T2D remission between LSG and LRYGB. However, to our knowledge, this is so far the largest randomized cohort with the longest follow-up and high follow-up rate comparing LSG and LRYGB of patients with severe obesity and T2D. Second, the patients in our study population had somewhat better glycemic control (hemoglobin [Hb] A1C$<$7%) and shorter T2D duration (5 years in SLEEVEPASS but 1 year in SM-BOSS) at baseline compared to the training and validating cohort of the original IMS score study (HbA1C, 7.3%–7.4% and T2D duration, 5–6 years), which may partly contribute to the differences in our results. Third, the LRYGB surgical technique used in the original IMS training and validating cohorts was not reported limiting the assessment on the potential differences of the procedure details (e.g., limb lengths). Fourth, the study population consisted mostly of patients with Caucasian ethnic background limiting the generalizability of the results in patients of other ethnicities.

Conclusions

In our study, remission rates of T2D were not statistically different after LSG, and LRYGB among all patients and among patients with mild, moderate, and severe diabetes were stratified by the IMS score. However, the study may be underpowered to detect differences due to small number of patients in each subgroup. IMS score seemed to be useful in predicting long-term T2D remission after bariatric surgery.

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Disclosures

All authors have completed and submitted the ICMJE (International Committee of Medical Journal Editors) form for disclosure of potential conflicts of interest. No other authors reported disclosures.

Author Contributions

Drs Saarinen, Grönroos and Salminen had full access to all the data in the study and take full responsibility for the integrity of the data and the accuracy of the data analyses. Dr. Salminen had the final responsibility for the decision to submit the manuscript for publication. Concept and design: Saarinen, Grönroos, Hurme, Strandberg, Peterli, Bueter, Wölnerhanssen, and Salminen. Acquisition, analysis, or interpretation of data: Saarinen, Grönroos, Hurme, Helmiö, Peterli, Bueter, Strandberg, Wölnerhanssen, and Salminen. Drafting of the manuscript: Saarinen, Grönroos, Hurme, Strandberg, and Salminen. Critical revision of the manuscript: Helmiö, Peterli, Wölnerhanssen, Bueter, Saarinen, Grönroos, Hurme, Strandberg, and Salminen. Statistical analyses: Saarinen, Grönroos, Hurme, and Salminen. Administrative, technical, or material support: Saarinen, Grönroos, Hurme, Helmiö, Peterli, Bueter, Strandberg, Wölnerhanssen and Salminen. Supervision: Salminen.

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