Applicability of individualized metabolic surgery score for prediction of diabetes remission after endoscopic sleeve gastroplasty

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Abstract

Background: Endoscopic sleeve gastroplasty (ESG) is a safe and effective obesity treatment. The individualized metabolic score (IMS) is a validated score that uses preoperative variables predicting T2D remission (DR) in bariatric surgery.

Objectives: We evaluated the applicability of using the IMS score to predict DR in patients after ESG.

Design/Methods: We performed a retrospective review of patients with obesity and T2D who underwent ESG. We calculated DR, IMS score, and severity, and divided patients based on IMS category.

Results: The cohort comprised 20 patients: 25% (5) mild, 55% (11) moderate, and 20% (4) severe IMS stages. DR was achieved in 60%, 45.5%, and 0% of patients with mild, moderate, and severe IMS scores ($p=0.08$), respectively. IMS score was significantly associated with DR ($p=0.03$), with the area under the curve of the receiver operating characteristic for predicting DR 0.85.

Conclusion: These pilot data demonstrate that the IMS score appears to be useful in predicting DR after ESG.

Plain language summary

Use of individualized metabolic surgery score in endoscopic sleeve gastroplasty

Why was the study done? Endoscopic sleeve gastroplasty (ESG) is effective and safe as a treatment for obesity and has also shown improvement in diabetes in previous studies. However, there is no data showing the rates of diabetes remission after this procedure and no measures to predict this outcome. This study uses the individualized metabolic score (IMS) to predict diabetes remission after ESG. What did the researchers do? They analyzed a sample of patients who had undergone ESG, and evaluated the change in their diabetes parameters at 1 year compared to baseline, and then correlated this with their calculated baseline IMS score. What did the researchers find? Patients with a higher IMS score, representing more severe disease, were less likely to have an improvement in their diabetes after ESG. What do the findings mean? ESG can be an effective treatment option for patients with obesity and early-stage diabetes.

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Introduction

Obesity and related comorbidities of insulin resistance and type 2 diabetes mellitus (T2D) continue to increase globally. Early treatment of T2D can decrease the burden of the disease significantly and lead to improved cardiovascular outcomes.[1] Endoscopic sleeve gastroplasty (ESG) is a safe and effective therapeutic modality for obesity.[2,3] Many studies have shown an improvement in metabolic comorbidities after ESG; however, there are no models or parameters for predicting diabetes remission (DR) following ESG.[2,4] The individualized metabolic surgery (IMS) score is one of the most widely used, validated scoring systems used for the prediction of DR after bariatric surgery.[5,6] We explored the applicability of this score in patients undergoing ESG.

Methods

We performed a retrospective cohort study of adults who underwent ESG from 2013 to 2022 in our health system. ESG was performed using a standard technique with full-thickness endoscopic suturing with Apollo OverStitch, with some procedures using ablation with Argon Plasma Coagulation (APC) prior to suturing for marking and ablation.[2] These patients had been referred for the procedure from clinical avenues (clinical trials, weight loss clinic, endocrinology clinic, primary care clinics, self-referred). As such, they all received standard post-ESG instructions but did not all have a standardized follow-up program. Our initial cohort was screened for patients with a diagnosis code of T2D, which were then manually reviewed, and patients with prediabetes and erroneous diagnosis codes were excluded. Demographic, weight, medical, and surgical data were gathered from the electronic record. The IMS score was calculated based on four independent preoperative variables: duration of T2D in years, the number of diabetes medications, insulin use, and glycated hemoglobin level (A1c) < 7%) using an online calculator (https://riskcalc.org/Metabolic_Surgery_Score/). IMS groups proposed by Aminian *et al.*[5] were as follows: mild (IMS score ≤ 25), moderate (IMS score > 25 to ≤ 95), and severe (IMS score > 95). DR was defined according to the 2021 American Diabetes Association consensus statement as A1c < 6.5% off T2D medications and calculated at an interval of 12 ± 3 months.[7] Statistical analyses were performed using JMP, version 17 (SAS Institute Inc). Baseline characteristics are summarized as mean ± standard deviation. Categorical data are presented as frequencies and percentages. Categorical data were analyzed using Fisher's exact *t*-test, and continuous data using a two-sample independent *t*-test and analysis of variance (ANOVA) test. We performed logistic regression models to analyze the relationship between the IMS score and DR. A significant two-sided *p* value was set at 0.05 or less. We used JMP, version 17 (SAS Institute Inc) to conduct the statistical analysis.

Results

A total of 164 patients underwent ESG, of which we included 20 patients based on eligibility criteria (Supplemental Figure 1S), with 25% (5) mild, 55% (11) moderate, and 20% (4) severe IMS stages. Details of ESG are included in Supplemental Table 1S. There were no significant differences between groups (Table 1). Baseline HbA1c for the cohort was $6.9 \pm 1.1\%$. Baseline IMS scores for groups were 17.6 ± 5.0, 56.6 ± 24.9, and 115.8 ± 9.2 ($p < 0.01$), respectively, with mean IMS score for cohort 58.7 ± 38.5.

After ESG, the cohort lost a significant amount of weight with a mean % total body weight loss (TBWL) of 13.2 ± 8.6 at 12 months. There was a significant decrease in HbA1c and number of medications from baseline and DR was achieved in 40% of the cohort. IMS score was significantly associated with DR ($p = 0.03$), with patients with higher scores more likely to have a lower DR (Supplemental Figure 2Sa). The area under the curve (AUC) of the receiver operating characteristic (ROC) for predicting DR was 0.85 (Supplemental Figure 2Sb). After controlling for baseline age, sex, and BMI, the IMS score continued to be significantly associated with DR ($p < 0.01$). DR was achieved in 60%, 45.5%, and 0% of patients with mild, moderate, and severe IMS scores ($p = 0.16$) [Table 1, (c)]. The mean number of medications at follow-up decreased from baseline and was significantly different between groups. When evaluating baseline independent variables of the IMS score, higher A1c, higher number of medications, higher number of years of having a diagnosis of T2D, and insulin use all were negatively correlated with DR ($p = 0.02$, 0.04, 0.02, and 0.06, respectively).

DR was not associated with %TBWL at 12 months ($p = 0.71$). IMS score was not associated with %TBWL at 12 months ($p = 0.70$). Weight loss was not significantly different between IMS groups.

Table 1. Baseline and follow-up characteristics, by IMS category.

Variable	Mild	Moderate	Severe	Total	*p* Value
1a: Baseline characteristics					
n	5	11	4	20	
Age, years	54.2 ± 5.3	54.6 ± 8.4	55.5 ± 7.9	54.7 ± 7.3	0.97
Female, % (*n*)	40 (2)	72.7 (8)	100 (4)	70 (14)	0.14
White, % (*n*)	100 (5)	81.8 (9)	75 (3)	85 (17)	0.44
Height, m	1.8 ± 0.1	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1	0.19
Weight, kg	120.1 ± 25.7	100.7 ± 16.2	105.3 ± 14.2	106.3 ± 14.2	0.18
BMI, kg/m^2	38.4 ± 5.1	35.2 ± 2.5	38.5 ± 3.5	36.6 ± 3.7	0.14
1b: Baseline T2D variables					
Baseline A1c	6.5 ± 0.5	6.7 ± 1.2	7.8 ± 1.2	6.9 ± 1.1	0.09
Baseline number of medications	0.8 ± 0.4	1.2 ± 1.0	2.8 ± 0.5	1.4 ± 1.0	**<0.01**
Baseline insulin use, % (*n*)	0 (0)	9.1 (1)	75 (3)	4 (20)	**<0.01**
Baseline duration of diagnosis, years	1.0 ± 0.7	6.3 ± 2.1	11.8 ± 3.5	6.1 ± 4.2	**<0.01**
IMS score	17.6 ± 5.0	56.6 ± 24.9	115.8 ± 9.2	58.7 ± 38.5	**<0.01**
1c: Follow-up T2D variables					
Remission of T2D, % (*n*)	60.0 (3)	45.5 (5)	0.0 (0)	40 (8)	0.16
Follow-up A1c	5.9 ± 0.4	6.3 ± 1.5	7.8 ± 1.2	6.6 ± 1.4	0.10
Change in A1c	−0.8 ± 0.1	−0.4 ± 1.0	−0.1 ± 0.6	−0.4 ± 0.9	0.59
Follow-up number of medications	0.4 ± 0.5	0.8 ± 0.9	2.3 ± 0.5	1 ± 1.0	**<0.01**
Change in the number of medications	−0.4 ± 0.5	−0.4 ± 0.7	−0.5 ± 0.6	−0.4 ± 0.6	0.66

A1c, glycated hemoglobin; IMS, individualized metabolic score.
Statistically significant values are indicated in bold.

Discussion

To our knowledge, this is the first study that has described and used a scoring system to predict DR after ESG. Our data show that the IMS score significantly correlates with DR at 1 year after ESG. Furthermore, a higher IMS score category was associated with lower rates of DR, such that in our cohort, no patient in the severe IMS score group achieved DR. However, DR was achieved in 60% and 45.5% of patients in the mild and moderate groups. Although we did not find any correlation of DR or IMS score with weight loss, critical weight loss required for improvement of insulin resistance was likely reached, leading to DR.[8] We may hypothesize that for early disease, weight-centric approaches are effective for DR; for later-stage disease, we may require intestinal bypass pathways ('foregut' hypothesis).[9]

Risk factors for relapse of T2D after bariatric surgery include older age, longer duration of disease, worse preoperative glycemia, higher number of T2D medications, and use of insulin at baseline.[10,11] Presumable, these characteristics may also predict the relapse of T2D after endoscopic bariatric therapies. Of note, these are some of the variables incorporated into the IMS score, which is one of the most popular risk

prediction models of DR after metabolic surgery. Patients with lower IMS scores have early, less advanced disease that is likely reflective of higher functional pancreatic ß-cell reserve, and hence more likely to have better response to therapy. Our study supports this hypothesis by demonstrating an inverse relationship between baseline DR and IMS scores. Moreover, it signals the rate of DR among patients with different severity of T2D disease after ESG. Rates of DR are found to be 74%, 25%, and 12% after laparoscopic sleeve gastroplasty (LSG) in patients with mild, moderate, and severe IMS scores, respectively.[5] Although we have a very limited cohort, rates of DR may be similar after ESG and LSG in the mild and moderate IMS score groups, and either procedure may be considered in these patients. ESG poses certain advantages over bariatric surgery in that it is not anatomy-altering and has a potentially better safety profile and hence may be carefully considered in patients with less severe disease (lower IMS score).[12] In patients with more severe disease, bariatric surgery should remain the treatment of choice. Our study provides pilot data on the use of a score that may help guide the appropriate selection of procedures for optimal and individualized treatment of patients with obesity and T2D; future studies with larger, comparative cohorts are required to establish these standards.

Our study is limited by its retrospective nature, 1-year follow-up, and small cohort. ESG is not a common treatment modality for patients with T2D; even so, our cohort comprised >12% of the patients who had undergone ESG at our center, compared to other cohorts, where less than 5% of patients who undergo ESG have T2D.[4] A small fraction of procedures had APC performed prior to suturing, which may influence outcomes.

Our data demonstrate that ESG produces an acceptable rate of DR, and outcomes may be predicted by the use of metabolic scoring systems. As it continues to mature as a procedure and larger long-term data become available, we will be able to answer key questions about long-term DR that are vital in positioning ESG as a treatment option for patients with T2D and obesity. Individualizing patient care by evidence-based prediction of outcomes is the next step in further establishing endoscopic interventions in managing obesity and metabolic syndrome.

General Mills, Amgen, Bausch Health, RareStone; has contracts with Vivus Inc, Satiogen Pharmaceutical, and Rhythm pharmaceutical. Other authors do not have a conflict of interest or disclosure.

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Supplemental material
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