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Article

Pre-Procedural Predictors of Successful Endoscopic Sleeve Gastroplasty: A Retrospective Study

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Abstract: Objective: Obesity is a major risk factor for the morbidity and mortality of cardiovascular disease and predicts the development of hypertension, diabetes mellitus and other various diseases. Methods: A retrospective study evaluated predictors for higher total body weight loss following endoscopic sleeve gastroplasty (ESG). Adults (>18 years old) with BMI > 30 kg/m^2 who underwent ESG from January 2019 to July 2022 were included. Patients under the age of 18 were excluded from the study. Results: This retrospective cohort included 76 patients, of whom 62 women (81.6%) and 14 were men (18.4%) with a mean age of 46.3 ± 10.4. The mean BMI baseline was 36.6 ± 4.21. Out of the included patients, 10% were lost to follow-up at 1 month, 33% at 3 months, 50% after 6 months, and only 30% met 12 months follow-up. During the follow-up period, no mortality was documented. Three major adverse events (3.9%) were documented (one mediastinal abscess, one lower gastrointestinal bleeding and one pulmonary embolism), all of them in female patients. Among the demographic clinical and laboratory data examined, smoking (N = 6, $p < 0.001$) was associated with successful ESG, which was determined as total body weight loss (TBWL) above 15%. The rest of the variables examined were not shown to be statistically significant to sleeve success. Overall, 65 of the 76 patients which were studied in this research had more than 5% TBWL, 42 patients had more than 10% TBWL, 21 patients had more than 15% TBWL and 7 patients lost more than 20% of their weight during 1 year of follow-up. Maximal TBWL was achieved 3 months following the procedure. During the first month following ESG, the average weight lost was 8.6% (N = 69); at 3 months, it was 12.3% (N = 48); at 6 months, it was 11.3% (N = 33); and at 12 months, it was 9.8% (N = 13). Smoking was associated with higher weight loss. Conclusions: The current study showed a positive correlation between ESG weight loss above 15% and smoking. Older patients (>50) gained weight earlier, within 3 months, and by 1 year of follow-up almost returned back to their original weight. Females sustained weight loss over 1 year of follow-up compared to males. Patients with lower BMI continued losing weight during the follow-up period (12 months). This study tries to summarize pre-procedural prediction of ESG success.

Keywords: obesity; endoscopic sleeve gastroplasty

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1. Introduction

Obesity has become a global public health concern due to increased risk of illness, impaired quality of life and increased health care costs. Prevalence of obesity has doubled in the last 40 years, and approximately one third of the world population is suffering from overweight or obesity. The World Health Organization (WHO) defines overweight and obesity as abnormal or excessive fat accumulation that presents risk to health. Body mass index (BMI) is calculated by dividing the body weight in kilograms by the square of height in meters. BMI is considered as a screening measurement, and waist circumference measurement is an additional value used in order to complement BMI. Overweight is considered BMI $\geq$ 25 kg/m^2, obesity is considered when BMI $\geq$ 30 kg/m^2 and severe obesity is considered BMI $\geq$ 40 kg/m^2. Obesity results from increased calorie intake that exceeds the energy expenditure. The excess calorie is converted to triglyceride that stores in adipose tissue and leads to an increase in body fat and thus to weight gain. Major reasons for obesity are an excess consumption of sweetened beverages and nutrient-poor foods prevalent after the globalization of food system, which produced more processed and affordable food. Moreover, a decrease in physical activity is also an important factor in the development of obesity. Obesity in low-income countries is more prevalent in middle-aged women from urban and wealthy areas, while in high-income countries, it affects men and women of all ages with prevalence that is higher among the disadvantaged population. Kelly et al. estimate that approximately 57% of the global population will suffer from overweight or obesity by the end of this decade if the current trends continue [1].

Obesity is a multifactorial disease which progressed throughout history due to changes in the environmental, behavioral, genetic, epigenetic and physiological factors [2–5]. The gut microbiome can affect both weight and metabolism. Thus, dysbiosis, which is an imbalance of the microbial population in the gut, is associated with obesity due to its effect on the host immune system, which can lead to the downregulation of signaling pathways which influence insulin and glucose. Family history increases the risk of obesity due to genetic reasons. A child with an obese parent has up to a three-fold risk for obesity as an adult, and if both parents are obese, the risk can increase up to 10 times. Single gene mutations, syndromic obesity and polygenic mutations play a role in obesity. Single gene mutations, mainly located in the leptin–melanocortin pathway, are recognized to disrupt the appetite system and hormonal signals. Syndromic obesity is associated with an alteration in a single gene or several genes and results from a neurodevelopmental abnormalities. Polygenic obesity results from mutations in multiple genes which leads to increased caloric intake, increased hunger levels and a reduction in satiety. Epigenetic changes including the DNA methylation of leptin, adiponectin, insulin-like growth factor 2, tumor necrosis factor and other genes have shown to play a role in obesity. Histone modification is also associated with obesity through the regulation of enzymes which play a role in adipogenesis such as CCAAT-enhancer binding protein, pre-adipocyte-1 and PPARγ. MicroRNAs (miRNAs) also play a role in adipocyte proliferation and differentiation and have been shown to have an effect on insulin resistance, and an increase in several specific miRNAs subtypes can indicate a high risk of obesity [6].

Obesity, in recent years, has become a fifth major risk factor of cardiovascular disease. Other complications of obesity include chronic kidney disease, non-alcoholic fatty liver disease, obstructive sleep apnea, osteoarthritis, depression, cancer and a tendency for thrombotic events. Thus, weight loss has become a valuable goal in the prevention of sequela, using lifestyle modifications, pharmacotherapy, endoscopy and surgery [2,6–12].

The classification of obesity is based on an obesity staging system [13], BMI [14] and metabolically abnormal obesity [15]. These current classifications do not address the underlying etiological and pathophysiological heterogeneity of obesity. For instance, BMI is a well-known anthropometric classification and is frequently used as a surrogate on a daily basis in the calculation of obesity; however, the sensitivity and specificity of BMI is low when applied to individuals. BMI may be the same while the total body fat is different, or the BMI may be different while the total body fat is the same. Moreover, the current anthropometric classification does not include concomitant comorbidities, thus making BMI an insufficient tool in guiding clinical decisions [13].

Four related phenotypes have been proposed in regard to obesity and are based on homeostatic and hedonic drives, which are important determinants of eating behavior. While hedonic behavior is associated with positive and negative emotions that leads to increased eating, the homeostatic drive is controlled by the brain–gut axis and involves satiety, hunger and satiation. The first phenotype is “hungry brain”, which is characterized by increased calorie consumption in order to terminate a meal, “hungry gut” is characterized by a decreased duration of fullness, and "emotional hunger" is characterized by emotional eating, craving, and negative mood while having normal homeostatic behavior. The last phenotype is "slow burn", which is characterized by reduced physical activity, low muscle mass and reduced energy expenditure [8].

Acosta et al. examined the effect of anti-obesity medication according to phenotypes. The hungry brain phenotype was treated with phentermine-topiramate extended release, emotional hunger was treated with bupropion–naltrexone sustained release, hungry gut was treated with liraglutide, and slow burn was treated with a low dose of phentermine plus resistance training. The results show that pharmacotherapy guided by phenotype more than doubled the response rate and increased the total weight loss by 75% in comparison to standard care [8].

ESG is associated with a TBWL of approximately 15% one year following the procedure. The highest rate of weight loss is seen in the first month and continues up to one year. One year following ESG, the rate of weight loss either slows down, halts, or weight recidivism is seen [16–18].

Studies on patients who had laparoscopic sleeve gastrectomy (LSG) found several predictors of weight loss: among them, baseline BMI, age, early post-operative weight loss, and in some studies, there are some evidences that tie between specific eating habits and post-operative weight loss [19–21].

Among patients who had ESG, nutritional and psychological meetings are associated with a decrease in total body weight loss [22], but pre-procedural predictors were not studied so far. The aim of this study is to evaluate variables that can predict successful ESG.

2. Methods

2.1. Study Design

We performed a retrospective study which evaluated predictors for higher total body weight loss following endoscopic sleeve gastroplasty.

2.2. Setting

The study was conducted at Beilinson campus, Rabin Medical Center, which is a 900-bed academic tertiary-care hospital. It included patients who had endoscopic sleeve gastroplasty in the gastroenterology division. Laboratory data were extracted from the electronic charts within the 18 months prior to the procedure.

2.3. Procedure

The procedure is performed with patients under general anesthesia using CO_2 insufflation. Patients should be placed on a partial left lateral position or supine position to move abdominal organs away from the gastric cavity (liver, spleen, abdominal wall). An esophagogastroduodenoscopy was performed with a standard upper endoscope. The distance from the gastroesophgeal junction (GEJ) to the pylorus should be measured with the endoscope. This will be compared with the GEJ to pylorus distance post-suturing. A double-channel therapeutic upper endoscope was outfitted with a cap-based flexible endoscopic suturing system (OverStitch; Boston Scientific, Boston, MA, USA) or a single-channel gastroscope is fitted with the Sx Apollo Overstitch device to perform the procedure. The suturing device consists of a needle driver, a catheter-based suture anchor, and an actuating handle. Sutures were reloaded without endoscope removal. ESG is then created by using an interrupted suturing pattern to invaginate the greater curvature of the stomach for formation of the sleeve. The helix device was used to capture the muscularis propria by turning the catheter three times clockwise to enable grasping of the tissue to imbricate and allow for full thickness stitches. After the needle driver is closed and the needle is exchanged to the needle grasper; the helix is turned three times in the counter-clockwise direction to release the tissue, which is followed by opening the suture handle and completing the stitch process. This process is repeated in a series of 6–9 stitches per suture in either a Z, O or U type patterns. At the last stitch site, the needle is released into the gastric lumen, pushing the blue button on the suture anchor, and it will serve as one T-tag to tighten the suture. A running stitch was used to oppose the anterior and posterior placement sites. The stitch was then tightened to approximate the opposing gastric walls, creating a full thickness volume reduction plication. The suture was cut by using a cinch, which will serve as the second T-tag with the plicated tissue between the cinch and the needle. A second layer of sutures was then placed over the length of the central sleeve in an interrupted stitch pattern to further reduce gastric volume and reinforce the sleeve. The end result of the procedure was a tubular reconfiguration of the gastric lumen. Figure 1 shows ESG during the procedure and the end result.

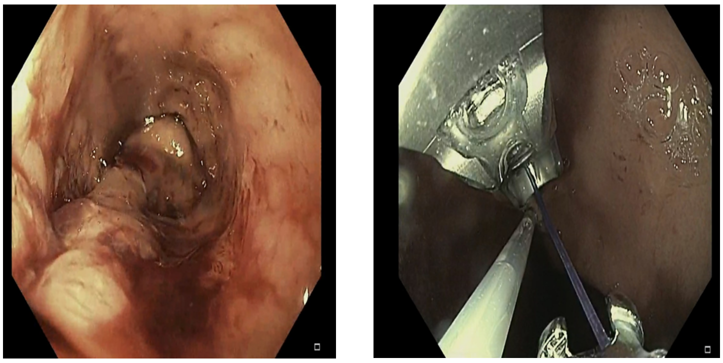

Figure 1. ESG suturing on the **right** side and end result on the **left** side.

2.4. Participants

2.4.1. Inclusion Criteria

Adult (>18 years of age) subjects with BMI $\geq$ 30 kg/m^2 with or without adiposity related comorbidity who underwent endoscopic sleeve gastroplasty from January 2019 to July 2022. They were identified through the electronic medical records.

2.4.2. Exclusion Criteria

Patients under the age of 18, BMI $\leq$ 30 kg/m^2, previous gastrointestinal malignancy, previous gastrointestinal surgery, breastfeeding, pregnancy, active drug or alcohol abuse, uncontrolled psychiatric disorders.

2.5. End Points and Assessments

2.5.1. Primary End Point

Identifying favorable variables for successful ESG (total body weight loss over 15%) following endoscopic sleeve gastroplasty.

2.5.2. Secondary End Points

Proportion of patients who had a reduction from baseline body weight of >5, >10, >15 and more than 20%.

Total body weight loss at 1, 3, 6 and 12 months following endoscopic sleeve gastroplasty.

2.6. Ethics Approval

The study was approved by the Ethics Committee of Rabin Medical Center (RMC-0619-21).

2.7. Statistical Analysis

Statistical analysis was performed using SPSS version 25 (SPSS Inc., Chicago, IL, USA). Categorical and continuous variables will be examined using Student's *t*-test, Mann–Whitney U test, chi-square, or Fisher exact tests, as appropriate. A 2-sided *p*-value of less than 0.05 was considered statistically significant. The primary outcome of mean weight loss reduction differences between groups was analyzed using ANOVA or Student's *t*-test as appropriate, whereas differences in proportions of patients who had a reduction from baseline body weight of >5, >10, >15 and more than 20% were analyzed using chi-square test. A multivariate analysis was performed in order to identify variables associated with successful ESG.

3. Results

A total of 77 study participants were admitted to the Division of Gastroenterology, of which 76 patients met the inclusion criteria, while 1 patient with BMI < 30 kg/m^2 was excluded. The patients underwent the ESG procedure between January 2019 and July 2022. Table 1 describes the demographic, clinical and relevant laboratory data. Overall, 76 patients, of whom 62 women (81.6%) and 14 men (18.4%) at a mean age of 46.1 ± 10.6 were studied in this retrospective cohort. The mean BMI baseline was 36.6 ± 4, 21% of the patients had a BMI over 40 (16/76). Of the 76 patients, 10% were lost to follow-up at 1 month (8/75), 33% (24//72) at 3 months, 50% after 6 months (33/66) and only 30% met 12 months follow-up (13/43).

Table 1. Baseline characteristics.

Parameter	Number of Patients (N = 76)	Successful ESG Mean (SD)	ESG Failure Mean (SD)	*p*-Value *
Age		46.6 (10.1)	45.9 (10.9)	0.802
Gender (female)	62	19	43	0.216
Gender (male)	14	2	12	
Hypertension	9	3	6	0.684
Diabetes mellitus	8	3	5	0.509
Smoking	7	6	1	<0.001
Ischemic heart disease	1	0	1	0.534
Non-alcoholic fatty liver disease	26	7	19	0.921
HDL	76	48.8 (13.7)	49.7 (12.1)	0.784
Triglycerides	76	121.5 (38.6)	133 (70.8)	0.483
Creatinine	76	0.7 (0.1)	0.9 (1.6)	0.566
AST	76	26.8 (13.8)	23.1 (10.4)	0.949
ALT	76	23.3 (12.5)	23.5 (13.8)	0.949
ALK-P	72	90.5 (28.6)	84.6 (27.1)	0.414
GGT	57	27.4 (18.6)	23.5 (14.8)	0.411
A1C	65	5.8 (0.8)	5.6 (0.6)	0.234
TSH	68	2.3 (1.5)	2.3 (1.4)	0.837
Cholesterol	75	182.2 (40.5)	177.9 (35.6)	0.651
LDL	73	108 (34.4)	96.8 (30.6)	0.184
Folic acid	58	19.9 (11.2)	17.5 (10.0)	0.439
Vitamin B12	69	380.7 (274.9)	324.8 (156.7)	0.285

* *p* value compares successful ESG vs. ESG failure.

During the follow-up period, no mortality was documented. Three major adverse events (3.9%) were documented (one mediastinal abscess, one lower gastrointestinal bleeding and one pulmonary embolism). Two out of the three patients with major adverse events were above the age of 50, and all were females. Possible prognostic predictors of successful outcome were studied. Among these factors, demographic, clinical and laboratory data were examined and are shown in Table 1. Smoking was observed in 9% of the patients (N = 7); of them, six patients had a successful ESG procedure ($p < 0.001$). Smokers had more than ten cigarettes per day. Smoking was the only factor associated with successful ESG, which was determined as total body weight loss (TBWL) above 15%. The remaining 65 patients which were studied in this research had more than 5% TBWL, while 42 patients had more than 10% TBWL, 21 patients had more than 15% TBWL and 7 patients lost more than 20% of their weight during 1 year of follow-up. Table 2 shows TBWL during 1, 3, 6 and 12 months following ESG; maximal TBWL was achieved 3 months following the procedure. During the first month following ESG, the average weight lost was 8.6% (N = 69), at 3 months 12.3%% (N = 48), at 6 months 11.3% (N = 33) and at 12 months 9.8%

(N = 13). Figure 2 demonstrates the change in BMI over 1 year and shows that maximal BMI was achieved 3 months following the procedure ($p < 0.001$), and thereafter, weight recidivism was observed. Table 3 shows multivariable logistic regression for sleeve success (TBWL > 15%). Figure 3 presents the maximal weight loss percentage among the patients who were adherent to follow up; in this cohort, it was observed after 3 months ($p < 0.001$) and was relatively steady up to 6 months with a tendency for slight weight gain thereafter. Older patients (age above 50) gained weight starting 3 months following the procedure, while younger patients (age less than 50) show gradual weight loss during 1 year of follow-up ($p = 0.07$), as seen in Figure 4. Females had consistent weight loss over 12 months ($p < 0.004$), while males started to mildly gain weight after 3 months, as seen in Figure 5. Figure 6 shows TBWL classified by BMI and shows that BMI ≤ 35 was associated with continuous weight loss during 1 year ($p = 0.02$) and those with BMI ≥ 35 regained weight 6 months following ESG.

Table 2. Total body weight, total body weight loss (%) and BMI change at 1, 3, 6 and 12 months following the procedure.

	Total Body Weight	Total Body Weight Loss (%)	BMI	BMI Change (%)
Baseline (n = 76)	100		36.6	
1 months (n = 69)	91.4	8.6%	33.3	9.0%
3 months (n = 48)	87.7	12.3%	32.1	12.1%
6 months (n = 33)	88.7	11.3%	32.5	11.0%
12 months (n = 13)	90.2	9.8%	32.6	10.7%

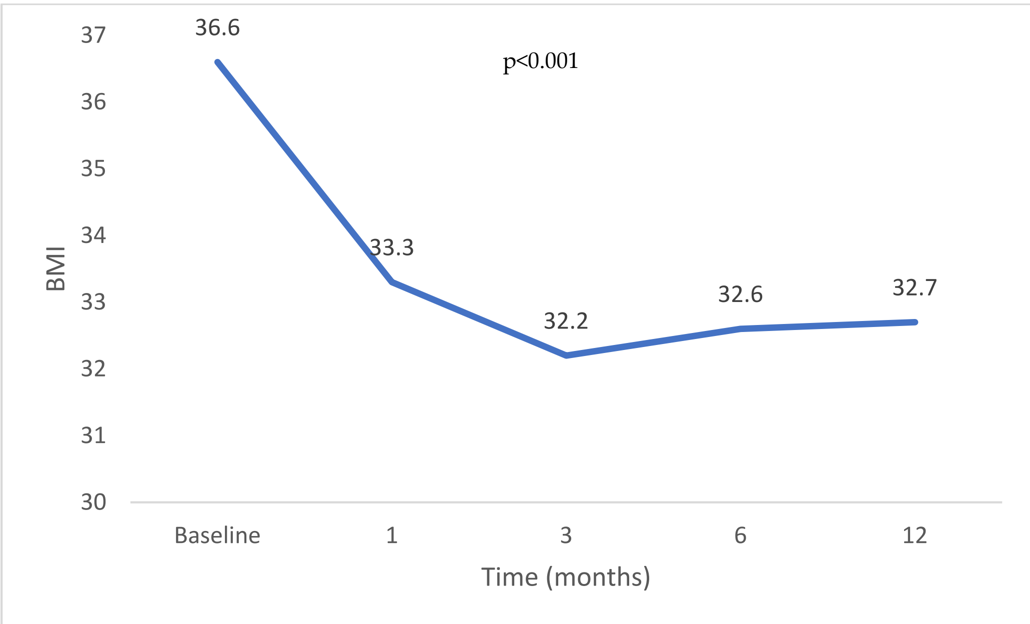

Figure 2. BMI change over 1 year.

Table 3. Multivariable logistic regression for sleeve success (TBWL > 15%).

Variable	Odds Ratio (95% CI)
NAFLD	0.69 (0.14–3.38)
smoking	41.48 (2.17–794.19)
DM	20.89 (0.89–492.37)
HTN	0.52 (0.03–8.5)
Arab (vs. Jewish)	0.18 (0.02–1.76)
Female	15.12 (0.55–419.13)
Age	1.03 (0.96–1.1)
BMI before procedure	1.18 (0.97–1.43)
Triglycerides	1 (0.98–1.02)
cholesterol	0.97 (0.89–1.06)
HDL	0.99 (0.89–1.1)
LDL	1.03 (0.95–1.12)

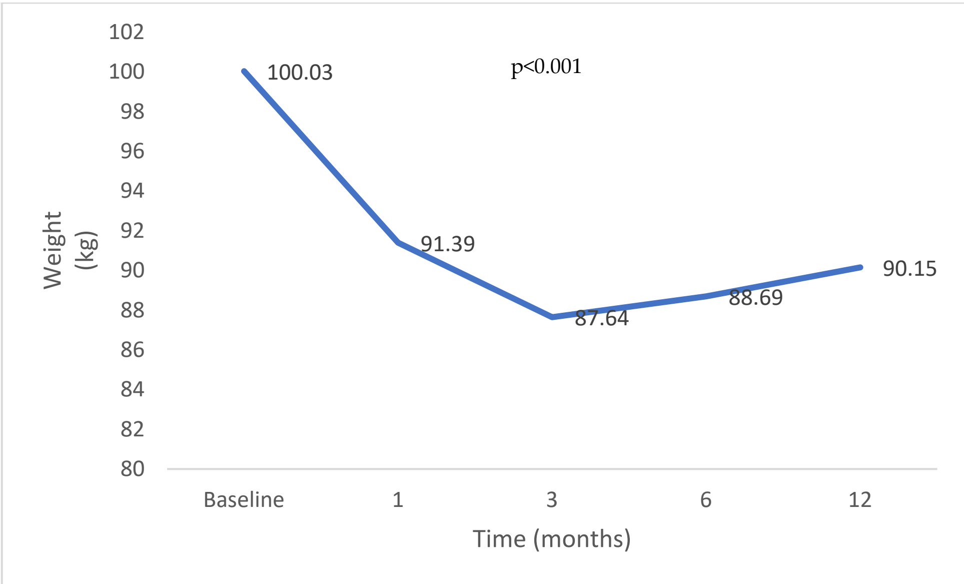

Figure 3. Total body weight loss over 1 year.

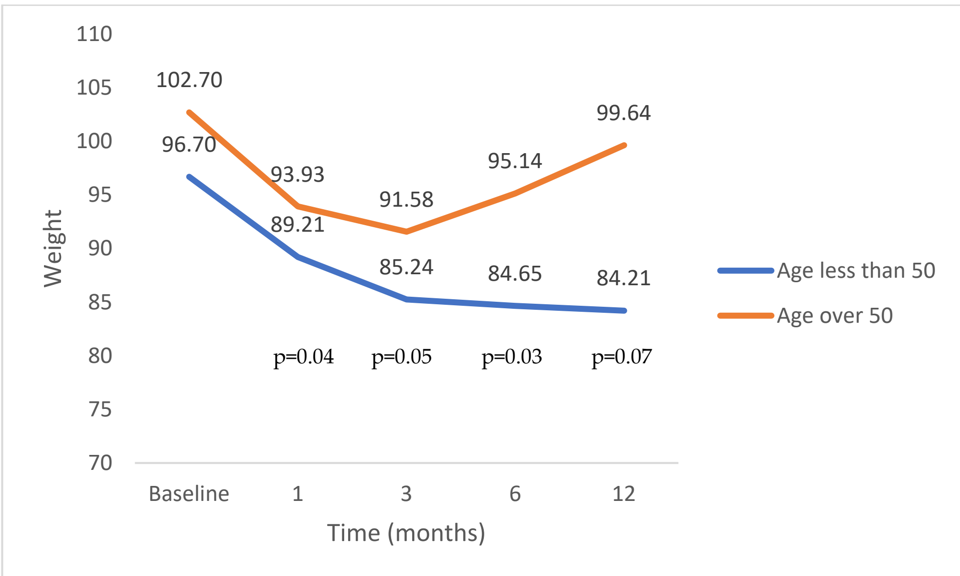

Figure 4. Total body weight loss among different ages according to periods of 1, 3, 6 and 12 months.

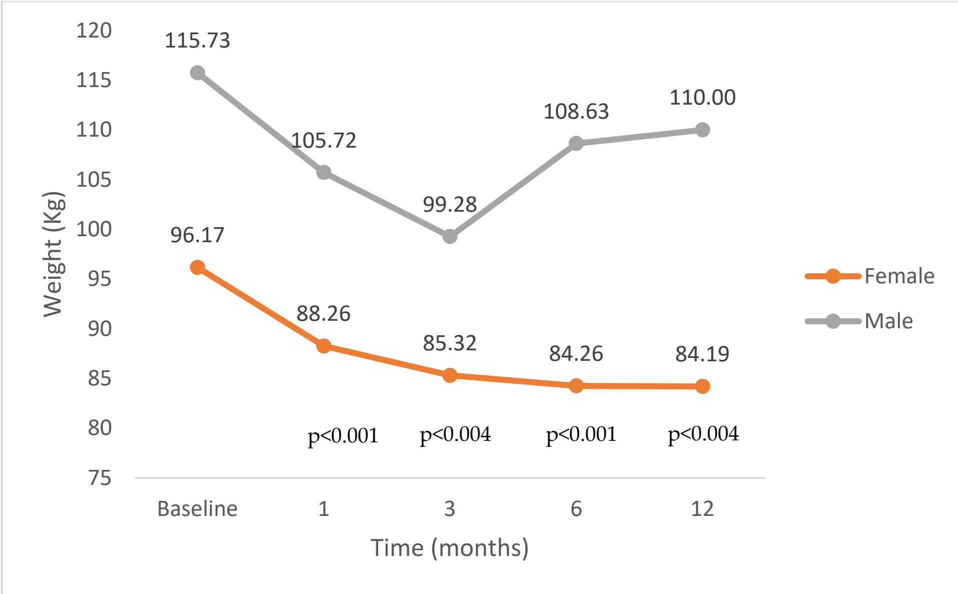

Figure 5. Total body weight loss based on gender according to periods of 1, 3, 6 and 12 months.

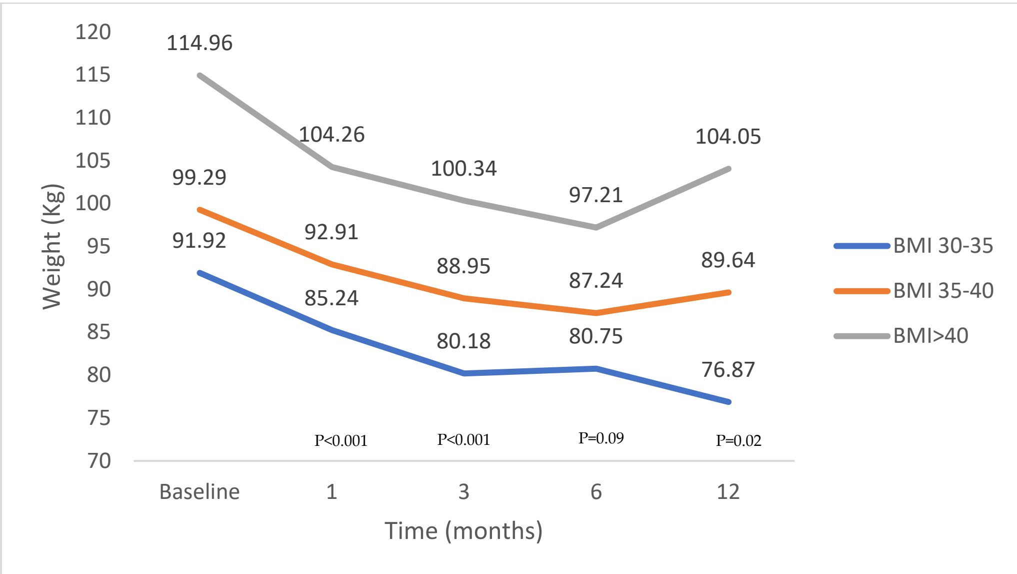

Figure 6. Total body weight loss among different obesity class groups according to periods of 1, 3, 6 and 12 months.

4. Discussion

The current study examined prognosticators of success before ESG during one year of follow-up.

Obesity has become a major risk factor for morbidity and mortality and is considered as a chronic disease, and thus, weight loss has become a major objective in primary therapy to improve longevity and prevent comorbidities [2–6]. TBWL of more than 10% is associated with improvement in obesity-related comorbidities. Treatments such as lifestyle modifications and pharmacotherapy might show a decrease in this percentage, but even if it is initially effective, weight recidivism is common and may even increase above the original baseline [16,17,23].

Among the pharmacological treatments, orlistat showed a TWBL of approximately 2.4% after 4 years. The phentermine/topiramate mean weight reduction was 10.9% after 1 year in the EQUIP study, while TWBL in the CONQUER trial was 7.8% and 9.8% with 7.5/46 mg and 15/92 mg, respectively. The SEQUEL study established that weight loss was maintained over 2 years of follow-up using phentermine/topiramate. Four trials assessed the clinical efficacy of naltrexone/bupropion, and weight loss ranged between 5 and 9% compared to placebo. The SCALE study evaluated liraglutide 3 mg once daily, and the STEP 1 study assessed semaglutide 2.4 mg weekly. The results show that liraglutide led to 5% weight reduction during 56 weeks of follow-up while semaglutide induced approximately 12% weight reduction during 68 weeks of follow-up. Future treatment for obesity include combinations of glucagons like peptide-1 and glucose-dependent insulinotropic polypeptide (GIP) receptor dual agonist, GLP-1/GIP/glucagon receptor agnonists, combinations of semaglutide with amylin analogues and cagrilintide and combinations of semaglutide together with Y2R agonist [24–26]. Haseeb et al. demonstrated that ESG was cost effective compared to semaglutide in the treatment of class III obesity over five time horizons [27].

Behavioral therapy such as lifestyle modification, including dietary therapy and physical activity, play an important role in weight reduction. Cheskin et al. compared ESG to lifestyle modification and showed that ESG was superior to high-intensity diet and lifestyle therapy with TBWL of 20.6% versus 14.3% during 12 months of follow-up [9].

Bariatric interventions include endoscopic and surgical interventions. Endoscopic interventions include endoscopic sleeve gastroplasty (ESG) and intragastric ballon (IGB); surgical procedures include laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y (LRYGB). ESG is used in mild to moderately obese patients with BMI usually between 30 and 40 kg/m^2, and it can bridge between pharmacotherapy and surgical intervention. It can also be used in patients who are not suitable for surgery or patients who are afraid of surgical intervention [28,29].

Intragastric ballon (IGB) has been a well-known procedure for the last 30 years. Fayad et al. compared ESG versus IGB and showed that ESG is superior to IGB in TWBL during follow-up time of 1 year after the procedure. Adverse events were also lower in the ESG group (5.2% vs. 17%), although ESG-associated adverse events were more likely to require medical treatment [30].

Hedjoudje et al. performed a meta-analysis on nine ESG research studies, four of which were retrospective and the remaining were prospective. Five cohorts showed results at 1 month, 4 cohorts at 3 months, 8 cohorts at 6 months, 3 cohorts at 9 months, 5 cohorts at 12 months and 4 cohorts at 18–24 months. The results demonstrated that the pooled mean TBWL was 8.8% at 1 month following the procedure, 11.2% at 3 months, 15.1% at 6 months, 16.1% at 9 months, 16.5% at 1 year and 17.1% at 18–24 months following the procedure. These results are partly in concordance with our results, which show relatively similar weight loss at 1 and 6 months, 8.6% and 11.3%, respectively, but lower rates thereafter. The meta-analysis did not show a correlation between baseline BMI, number of sutures used, cohort size, duration of the procedure or duration of follow up [18].

Our literature review reveals an ESG complication rate between 2% and 2.7% compared to LSG, which has an approximately four-fold rate of complications (9–17% with current literature reported as 8.7%). Complications seen in ESG include intra-abdominal collections/leak, gastrointestinal bleeding, pneumothorax and pneumoperitoneum. The aforementioned complications are seen also in LSG, and in addition, wound infection, acute pancreatitis and wound dehiscence were also documented [31]. Our study shows the relatively same complication rate and asserts the safety profile of ESG. In this cohort, there were three patients with major adverse events (one GI bleeding, one mediastinal abscess and one PE). Two out of the three patients were older than 50, and all were women.

A meta-analysis by Mohan et al. compared LSG and ESG. Eight studies analyzed ESG, and the TBWL rates at 1 month, 6 months and 12 months were 8.7%, 15.3% and 17.1%, respectively. Seven studies analyzed LSG with TWL of 30.5% at 1 year; however, effective weight loss and change in BMI were comparable between the ESG and LSG groups, 63% vs. 69% and 30% vs. 29%, respectively [31]. Thus, the better safety profile and the relatively similar effect on weight loss and BMI makes ESG an acceptable approach compared to restrictive surgery.

This study did not manage to show pre-procedural predictors which are associated with successful ESG (defined as TBWL > 15%), except for smoking, which showed statistical significance and is known to be associated with weight loss [32].

Assessment of age and gender in our study showed that older patients showed weight recidivism starting 3 months following the procedure compared to younger patients, who were able to maintain weight loss during 1 year of follow-up. Females maintained weight loss compared to males, who started to gain weight 3 months following ESG. Males showed higher TBWL compared to females. A possible explanation for the better maintenance of weight loss among younger patients can be due to their ability to change behavioral habits and maintain diet [33]. If excluding behavioral elements between the genders, a possible reason for this difference can be attributed to the difference between body fat and muscle mass between the genders. Females are known to have higher fat mass, and males have higher muscle mass, which burns more calories at rest than fat; thus, males require more calories to sustain their weight [34]. When stratifying total body weight loss per obesity classification, it is seen that obesity class 1 had a durability of weight loss over 1 year, but patients with obesity class 2 and 3 showed weight gain starting 6 months following the procedure. This can be partially explained due to different obesity phenotypes, including hungry brain, hungry gut, emotional hunger and slow burn [35,36].

Limitations

This study's limitations include being retrospective and having a relatively small sample size, no control group, limited long-term follow-up and a significant number of patients who were lost to follow-up, which can be explained partly due to the COVID-19 pandemic.

5. Conclusions

The current study showed maximal weight loss rate a month following the procedure and a correlation between successful ESG (total body weight loss above 15%) and smoking. Older patients (>50) gained weight early following ESG (within 3 months) and by 1 year of follow-up almost returned back to their original weight. Females showed the ability to sustain weight loss over 1 year of follow-up compared to males. Patients with lower BMI managed to keep losing weight during the follow-up period (12 months). ESG was once again shown to be a relatively safe procedure with a low rate of complications, and in this study, only females had complications. Further investigation and larger prospective trials are needed, which will determine whether there are reliable predictors for successful ESG, including the effect of the microbiome, hormonal profile and combination with new anti-obesity medications. Moreover, an investigation of the effect of different obesity phenotypes on successful ESG should also be a subject of future research.

Author Contributions: Conceptualization, L.C. and S.S.; methodology, S.S.; software, L.C.; validation, L.C. and N.P.; formal analysis, R.A. and N.P.; investigation, L.C.; resources, S.S.; data curation, L.C.; writing—original draft preparation, L.C.; writing—review and editing, L.C., S.S. and N.P.; visualization, L.C.; supervision, S.S.; project administration, S.S and L.C. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Rabin Medical Center (RMC-0619-21).

Informed Consent Statement: Patient consent was waived due to the study being retrospective.

Data Availability Statement: Available data can be made public in accordance with the journal's policy.

Conflicts of Interest: The authors declare no conflicts of interest.

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