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ORIGINAL CONTRIBUTIONS

Weight Loss and Eating Pattern 7 Years After Sleeve Gastrectomy: Experience of a Bariatric Center of Excellence

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Abstract

Purpose Report the analysis from a single center series of consecutive primary sleeve gastrectomy (SG) on the factors affecting weight loss at long term.

Materials and Methods Patients submitted to primary SG with a follow-up of 7 years were screened. Weight loss was evaluated with %excess weight loss (%EWL) and %excess BMI loss (%BMIL). Weight regain (WR) was defined as in increase of 25% of the obtained %EWL and insufficient weight loss (IWL) as loss < 50% EWL. Eating behaviors were evaluated with 7 days record (7dR). All the variables potentially affecting the weight loss were cross-matched for correlation. The study population was divided in three groups: group A (WR), group B (IWL), and group C (sustained weight loss) for comparative analysis.

Results A total of 86 patients (21 M/65 F) with a preoperative BMI of 47.08 ± 6.15 kg/m^2 were evaluated. Cumulative 7 years weight loss was as follows: 61.66 ± 22.69% EWL and 32 ± 9% EBMIL. A total of 4.6% had an IWL while 27.9% a WR. The analysis showed a significant difference among the daily calories and fats consuming, number of meals, physical activity, grazing/sweet eating habits, and adherence to follow-up ($p < 0.05$) between groups A and C. Cox hazard demonstrated a significant risk ($p < 0.05$) to WR in case of adherence to follow-up shorter than 48 months, high daily calories, and fats intake (hazard ratio (HR) range 5–9). Eight patients (9.3%) had a surgical revision.

Conclusion Our data demonstrated that long-term results (7 years) of SG are strongly related to eating habits and patient's behaviors.

Keywords Weight regain · Sleeve gastrectomy · Insufficient weight loss · Bariatric surgery failure · Long-term results

Introduction

Obesity represents a progressive chronic disease that affects up to 40% of adult population in Western countries [1]. Medical therapies do not achieve sustained weight loss and co-morbidities control [2–4]. On the contrary, bariatric/metabolic surgery can help achieve adequate weight loss and its sustained maintenance over time. In addition, it is associated with almost complete control of obesity-related comorbidities. Since 2015, laparoscopic sleeve gastrectomy (SG) is being considered the most performed bariatric procedure [5]. The main weight loss mechanisms advocated under this procedure include gastric volume restriction and changes in appetite-regulating hormones, producing a "food limiting" effect. Due to the absence of a hypo/malabsorptive component, weight loss and weight maintenance depend predominantly on the type of food intake, compliance with the postoperative regimen, and "appetite" downregulation [6]. However, weight regain (WR) and insufficient weight loss (IWL) represent the "dark side" of SG. IWL at 1 year after primary SG has been reported in 51.4% cases [7]. Patient selection, initial BMI, improper technique, and non-adherence to follow-ups may be strongly related to IWL/WR at 1 year [8, 9]. A systematic review published by Lauti et al. reported 5.7% to 75.6% WR at 2 and 6 years after surgery [10]. They have also reported several causes of WR such as sleeve size, increased levels of ghrelin, inadequate follow-up, and improper lifestyles. However, there is a lack of evidence-based criteria for predicting the eventual long-term "failure" of the procedure. The simple question "what's the eating pattern of IWL, WR and sustained weight loss population at long term?" has no consistent answer from the literature.

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Thus, the aim of the present retrospective monocentric study was to report the percentage of patients with IWL and WR after primary SG and their correlation with eating habits and lifestyle at 7 years.

Materials and Methods

All the patients submitted to primary SG in our Department were screened from a prospectively maintained database in order to include those with 7 years follow-up. All patients had a multidisciplinary preoperative evaluation according to the national guidelines (www.sicob.org). Age and preoperative BMI were not considered as exclusion criteria. For this study, adolescents, patients submitted to concomitant procedures, those who converted to open surgery, or cases complicated by leak requiring reoperation were excluded. Weight loss was evaluated using %excess weight loss (%EWL) (weight loss/excess weight × 100, where excess weight = total weight before prebariatric surgery − ideal weight) and %excess BMI loss (%BMIL) (baseline BMI-follow-up BMI/baseline BMI × 100). WR was defined as an increase of 25% of the obtained %EWL from the nadir in absence of surgical complications [10]. IWL was defined as the inability to achieve 50% EWL in first year [10]. Eventual revisional procedures were evaluated in terms of type and timing from the primary procedure.

Eating behaviors, evaluated with seven days food record (7dR), were used to report daily intake in kilocalorie, grams of proteins, carbohydrates and fats, number of meals, and sweets consumption (drinks and foods). Sweet eating (SE) was defined as daily consumption of at least 50% of simple carbohydrates [11]. Grazing (GR) was defined as the repetitive, unplanned, eating of small amounts of food (> 5 meal/day) [12]. Factors potentially affecting weight loss such as sex, adherence to follow-up, and eating behaviors were cross-matched for correlation. The study population, after an initial overall analysis, was divided into three groups of group A (WR), group B (IWL), and group C (sustained weight loss) for a comparative analysis.

Statistical Analysis

All data were described in terms of mean ± standard deviation, and range, or frequencies and percentages as appropriate. Numerical variables were compared between different groups using Student's *t* test for independent samples. Various variables were correlated using Pearson product moment correlation equation or Spearman rank correlation based on variable distribution. To evaluate the effect of a single variable on long-term %EWL, a multivariate linear regression and a Cox hazard analysis were performed considering the factors that can potentially affect weight-loss failure. A p value < 0.05 was considered statistically significant. Statistical analyses were performed with STATISTICA 10 (StatSoft, Inc., Tulsa, OK 74104, USA).

Results

A total of 118 patients (operated by the same bariatric team - one senior and two staff surgeons) were eligible for the study. Of them, 32 patients were excluded: death ($n = 2$), moved to other countries/regions ($n = 15$), refused follow-up ($n = 12$), and unavailable personal contact ($n = 3$). The remaining 86 (73%) patients with a minimum follow-up of 7 years were evaluated. The study population included 21 males and 65 females with a mean age of 45 ± 10 years. The mean preoperative BMI and weight of the included patients were 47.08 ± 6.15 kg/m^2 and 131.6 ± 23 kg, respectively (Fig. 1). All the patients were submitted to SG calibrated on 42 Fr bougie with a post-operative complications rate of 3% (minor 2.2%, major 0.8%).

Regarding the preoperative comorbidities, 10 patients (11.6%) affected by type II diabetes (T2DM) or hyperinsulinism, 22 cases of hypertension (HTN) (25.6%), and 16 patients with obstructive sleep apnea syndrome (OSAS) (18.6%) were registered.

Analysis of weight loss at 7 years showed mean weight, mean BMI, mean %EWL, and mean %EBMIL of 88.81 ± 18.38 kg, 31.96 ± 5.95 kg/m^2, 61.66 ± 22.69%, and 32 ± 9%, respectively. Weight loss nadir was achieved between 12 and 18 months (Fig. 2).

Eating behaviors demonstrated a mean daily calorie intake of 1718.02 ± 212 including 68.68 ± 15.00 g of protein, 203.77 ± 77.33 g of carbohydrates, and 73.04 ± 24.38 g of fats. Significant ($p < 0.05$) negative correlations were found for last %EWL vs. daily intake of lipids ($r = -0.35$), %EWL vs. number of meals ($r = -0.25$), and %EWL vs. kcal/day ($r = 0.54$). On the other hand, no significant correlations were observed among the other variables. At 7 years, we noted the following observations: IWL in 4 patients (4.6%) and WR in 24 patients (27.9%). Subanalysis among the patients in three groups is mentioned below:

Group A (WR) Twenty-four patients (27.9%) (5 M/19 F) with a mean weight, BMI, %EWL, and %EBMIL of 101.19 ± 14.5 kg, 35.83 ± 4.9 kg/m^2, 47.48 ± 18.9%, and 23 ± 10%, respectively, presented progressive WR from the second postoperative year. Eating analysis showed daily caloric intake of 1833 ± 558 kcal with a mean per day of 74.38 ± 13.3 g proteins, 221.48 ± 5.16 g carbohydrate, and 76.73 ± 7.97 g fats. The mean number of meals/day recorded was six, with only three patients (12.5%) doing regular physical activities. Only five had a follow-up longer than 48 months (21%). Of the 24 patients, 8 patients (33%) were SE, and three (12.5%) were GR.

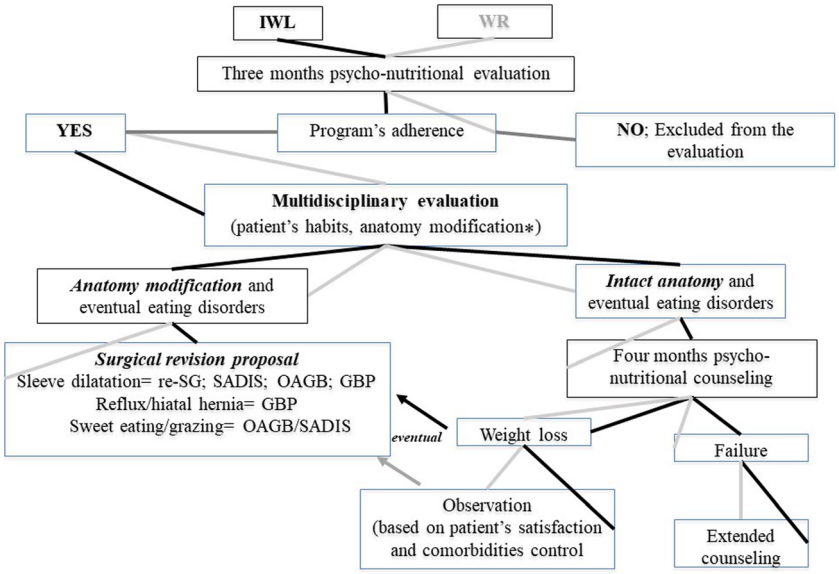

Fig. 1 Personal decisional flowchart in case of IWL/WR. Black line = IWL patients; gray line = WR patients. *Anatomy modifications were assessed with upper-GI endoscopy and CT scan with oral contrast and 3D pouch reconstruction. Study group population. SG sleeve gastrectomy

None of the patients with WR reported a comorbidities relapse, eight patients (35%) still required treatment to ameliorate HTN, and five (21%) showed improvement of OSAS.

Group B (IWL) This group included four patients (4.6%) (1 M/3 F) with a mean weight, BMI, %EWL, and %EBMIL of 109 ± 22.5 kg, 41,39 ± 4.2 kg/m^2, 28.68 ± 9.83%, and 13 ± 5%, respectively. Their eating evaluation showed daily caloric intake of 2129.3 ± 857 kcal with a mean per day of 77.49 ± 14.4 g proteins, 253.4 ± 9.14 g carbohydrate, and 96.69 ± 5.06 g fats. The mean number of meal/day recorded was six. All the patients were GR, and 2 of them (50%) were SE. None of the patients with IWL maintains regular physical activities and a follow-up adherence longer than 48 months.

Group C (Sustained Weight Loss) Fifty-eight patients (67%) (13 M/45 F) with a mean weight, BMI, %EWL, and %EBMIL of 78.6 ± 12.7 kg, 28.37 ± 3.39 kg/m^2, 74.6 ± 15.5%, and 40.4 ± 6%, respectively, experienced the long-term positive effect on weight loss. Their eating evaluation showed daily caloric intake of 1594.73 ± 355.5 kcal with a mean per day of 74.38 ± 15.5 g proteins, 186.5 ± 8.5 g carbohydrate, and 67.78 ± 6.26 g fats. The mean number of meal/day recorded were five with a prevalence of daily assumption of protein (animal/vegetables). Of the 58 patients, three patients (5.17%) were SE and two (3.44%) were GR. Twenty-three (39.6%) patients reported regular physical activity, while 43 patients (74.1%) observed follow-up for more than 48 months.

The subgroup cross-analysis showed a significant difference among the daily calories, number of meals, percentage in fats consumption, physical activity, grazing/sweet eating habits, and adherence to follow-up ($p < 0.05$) between groups A and C (Fig. 3). The cross-analysis of group B demonstrated a difference that was not statistically significant for each variable compared with group C and group A.

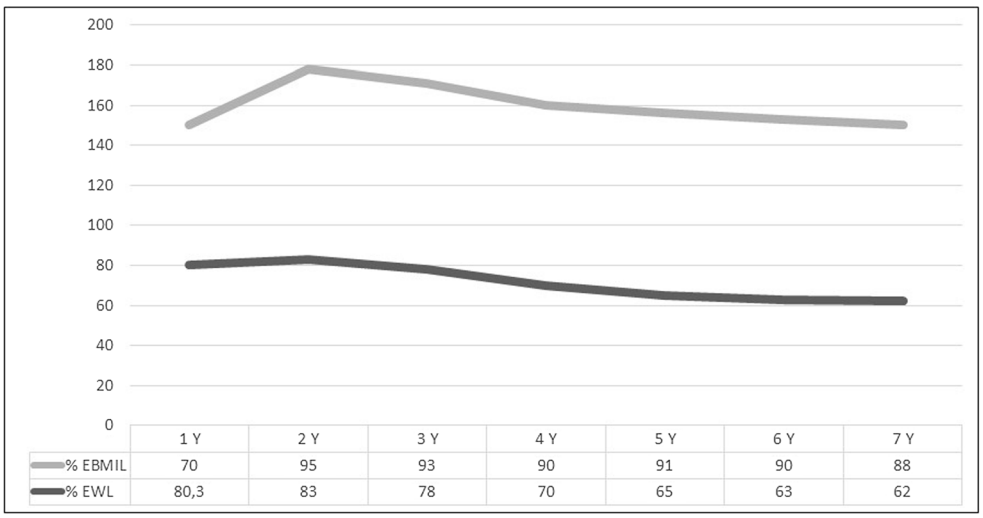

Fig. 2 Cumulative weight loss modification; %EWL %excess weight loss, %EBMIL %excess BMI loss (values are reported as mean)

Table 1 Cox hazard analysis evaluating the factors affecting weight regain after SG

Variable	HR	CI	*p* value
G fats/day	*4.2*	*6–11*	*< 0.05*
Calories/day	*8.1*	*5–16*	*< 0.05*
Adherence to follow-up <48 months	*5.3*	*4–8*	*< 0.05*
Preoperative BMI	1.1	0.78–1.4	0.78
Sex	1.3	0.65–1.2	0.92
Age	0.5	0.3–0.9	0.56

In Italics the significant (p>0.05) outcomes

Cox hazard analysis demonstrated a significant risk ($p < 0.05$) to WR in case of adherence to follow-up shorter than 48 months, high fat consumption, and daily calorie intake > 1300 kcal (HR range 5–9) (Table 1). No significant factors affecting the IWL were demonstrated.

At 7 years post-surgery, a total of 8 patients (9.3%) were submitted to surgical revision. Specifically, in group A (WR), six patients (25%) were scheduled for conversion to anastomosis gastric bypass (OAGB; $n = 5$) and standard gastric bypass (RYGB; $n = 1$) after a median post-operative time of 3–5 years. In comparison, in group B (IWL), two patients (50%) were scheduled for conversion to SADI-S ($n = 1$) and OAGB ($n = 1$) after a median post-operative time of 2–4 years. The indication to each procedure was made based on multidisciplinary evaluation and patient's characteristics and desire. The remnant 20 patients (18 patients in group A and 2 patients in group B) were referred to multidisciplinary team support and denied revisional surgery.

Discussion

SG represents a valid and durable option to treat morbid obesity and its related co-morbidities. The results of the present retrospective study confirm that SG patients maintain a very satisfying weight loss (mean cumulative %EWL and %EBMIL of 61.66 ± 22.69% and 32 ± 9%) at 7 years. These data are similar to those reported by Diamantis et al. with an average %EWL at 5 years of 62.3% [13], Casella et al. [14] reporting % EWL of 67.3% at 6 years, Nasta Am et al. reporting 5 years %EWL of 69.1 ± 27.8% [15], and Jìmenez A. et al. showing %EWL of 53.2 ± 25.1% at 10 years [16]. In our study group, the success rate is also amplified by the absence of comorbidities relapse; data probably balanced by the small number of patients affected by T2DM ($n = 10$; 11.6%) and mid-term history of the disease (≈ 32 months) (Fig. 1). Despite those evidence, as for all the bariatric procedures, the question about SG durability represents a literature hot topic, and the analysis of the mechanism responsible for "weight loss failure" at long term remains to be completely understood. Several published studies have focused on three main categories of predictors: surgical/anatomic factors, hormonal imbalance, and behavioral factors [6]. Surely, behavioral factors (e.g., eating habits, calorie intake, food selection, and physical activity) represent the main scientific focus [17–21]. In 2016, Alvarez et al. reported that weight regainers after SG tended to have a higher fat and energy intake compared with weight maintainers [18]. Similarly, Essayli et al. in 2018 showed that regainers were more likely to abandon healthy eating styles and consume a higher number of

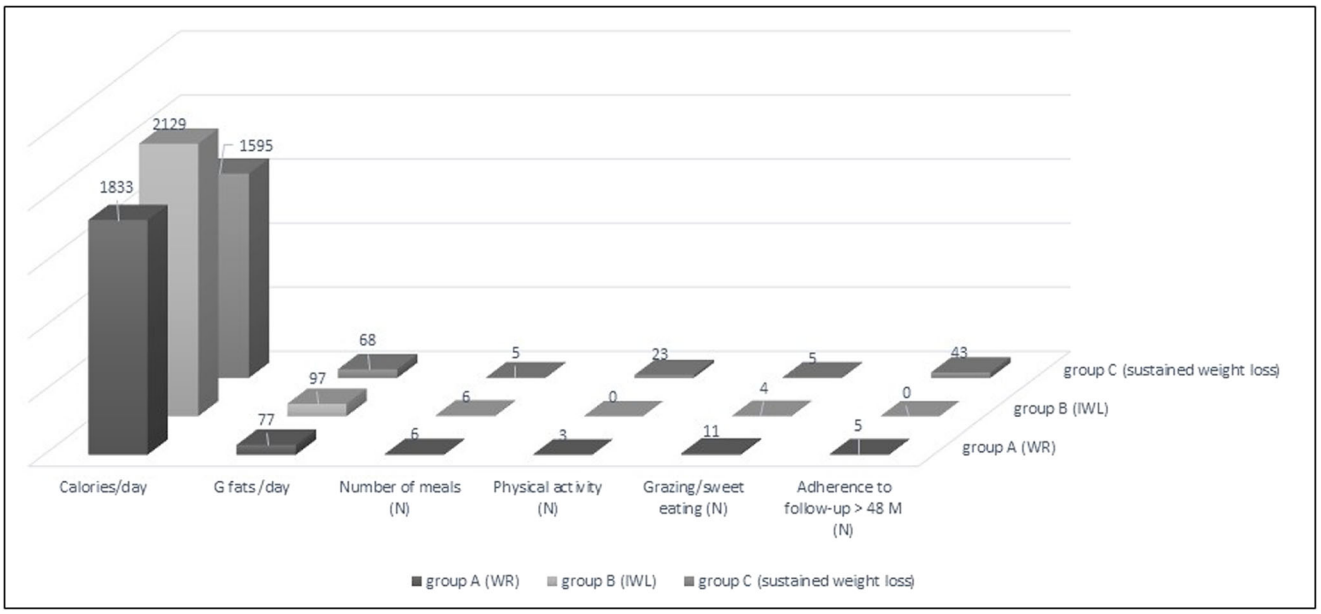

Fig. 3 Cross-matched analysis between the three groups: the difference between each variable for group A vs. group C is statistically significant ($p < 0.05$). (Values of calories/day, grams of fats/day, and number of meals are reported as mean; physical activity, grazing/sweet eating, and adherence to follow-up > 48 months as number.)

calories. [19]. The authors also noted that weight regainers were more likely to discontinue daily recording of their food intake.

The present study reported a WR percentage of 27.9 at 7 years and demonstrated that these patients consumed a higher percentage of fats daily (76.73 ± 7.97 vs. 67.78 ± 6.26 g), number of meals (6 vs. 5), and calories/day (1833 ± 558 vs. 1594.73 ± 355.5 kcal) compared with patients who maintained weight loss ($p < 0.05$) from the second post-operative year. Furthermore, our study demonstrated a significant difference between the patient's attitude towards regular physical activities: 3 patients (12.5%) of WR group vs. 23 (39.6%) of sustained weight loss group. Keren et al. [20] examined the reasons for WR by comparing the regain and non-regain groups. Their results revealed that poor exercise habits contributed to WR ($p < 0.05$). GR and SE habits represent a well-recognized mechanism of WR. Nicolau et al. [21] revealed that 41.7% of patients submitted to bariatric procedures (SG and GBP) had grazing behaviors and that participants were more likely to have WR ($p < 0.0001$). In our study, 33% and 12.5% of WR group patients were SE and GR compared with 5.17% and 3.44% of sustained weight loss group, respectively. These differences were statistically significant, underlying that the change in food choice (volume and timing) affects calorie intake and weight maintenance. The IWL group involving only a small number of patients (4.6%; $n = 4$) showed interesting results in terms of calorie intake (2129.3 ± 857 kcal/day), physical activity (0%), and fats/day (96.69 ± 5.06 g). Although these results were not statistically different (small number for comparative analysis) from the other groups, the results offer a trend of this specific category.

Adherence to follow-up is advocated as mandatory to reach durable results. Himpens et al. [22] reported that an interruption of continued follow-up visits may be associated with post-operative WR. This finding is similar to the results by Lauti et al. [23]. In our long-term evaluation, the Cox hazard analysis demonstrated a significant risk ($p < 0.05$) to WR in case of adherence to follow-up shorter than 48 months (HR 5.3). Regarding the needing for surgical revision, we report an incidence of 9.3%, which is similar to those reported by Noel et al. [24] and Kowalewski et al. [25] (10–20%). A large number of patients ($N = 20$; 23%) refused further surgical treatments.

The present study includes some limitations. First, it was conducted on a single-center, and second, it is a retrospective study of a small cohort of patients ($n = 86$).

The significance of this study is related to the follow-up period of 7 years, the strict dietologic assessment (monthly and quarterly nutritional evaluation for IWL/WR and for sustained weight loss patients respectively), and the statistically significant correlations between habits and weight results.

Conclusions

In a consecutive series ($N = 86$) with long-term follow-up (7 years), our data showed the relationship between the durable results of SG and the eating habits and behaviors of patients. It should be noted here that WR should not be considered as procedure failure but as a possibility of long-life chronic disease as morbid obesity.

The patients should be informed about the factors affecting long-term weight loss, and great efforts should be addressed to educate patients on the need for lifelong follow-up and support.

Compliance with Ethical Standards

This article does not contain any studies with human participants or animals performed by any of the authors. For this type of study formal consent is not required. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of Interest The authors declare that they have no conflict of interest.

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