Excess Weight Loss after Roux-en-Y Gastric Bypass: The Trend and Associated Factors for weight loss

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Abstract

Background Historically Roux-en-Y gastric bypass (RYGB) has been considered the gold standard of bariatric surgery. This procedure acts as a mixed restrictive and malabsorptive operation.

Methods This retrospective cohort study included 410 morbidly obese patients (BMI>40kg/m² or BMI>35kg/m² along with at least one major comorbidity) who underwent primary laparoscopic RYGB surgery from 2009 to 2015 by a single surgery team. The patients were aged 18 years and older with at least 12 months follow-up with alimentary and biliopancreatic limb length of 150 and 50cm respectively. Percent excess weight loss (%EWL), Percent excess BMI loss (%EBMIL) and comorbidity resolution were compared in short-term (12 months) and mid-term (12-60 months) follow-up.

Results The mean±SD age, weight, and BMI at surgery were 40.1±10.58 years, 123.32±19.88 kg, and 45.78±5.54 kg/m2, respectively, and 329 (80%) were female and 62 (15%) had T2DM. Mean±SD %EWL and %EBMIL was significantly higher in T2DM patients 9 months postoperatively and thereafter. Age at surgery, lower educational level, being single, and female patients had no significant effect on %EWL and %EBMIL during long-term follow-up. Patients with lower BMI at surgery (<50kg/m²) and non-diabetic patients had a significantly lower %EWL and %EBMIL over a short- and long-term follow-up (P<0.001).

Conclusions Bariatric surgery remains the most efficacious and durable weight loss treatment. However, a proportion of patients will experience unfavorable weight loss following bariatric surgery.

Key Points

- A proportion of patients will experience unfavorable weight loss following bariatric surgery.
- It was observed a rapid weight loss during the first 12 months and a gradual decrease in slope of weight loss afterwards, to a little degree of weight regain.
- Diabetic and higher BMI patients experienced a significantly lower %EWL.

Introduction

Roux-en-Y Gastric Bypass (RYGB) has been considered the gold standard of bariatric surgery for the past two decades. It represents the second most performed procedure [1]. This popularity is due to consistently satisfying and long-lasting weight loss and comorbidity resolution with acceptable complications and mortality rates [2]. Most patients can expect to lose more than 70% of their excess weight in the first 12 months after the surgery. Mean weight loss is 32% at 1-2 years and then it decreases slightly to 25% at 10 years and maintaining this up to 20 years post-op [3]. Many clinical trials compared different limb lengths of gastric bypass have not shown any significant differences in weight loss [4]. Despite excellent weight loss, there is still a percentage of patients who fail to lose 50% excess weight loss or reach a BMI of less than 35 kg/m². The prevalence of weight loss failure following RYGB is reported between 5 and 40% [2, 5, 6]. For the super-obese patients, acceptable weight loss may be achieved with a final BMI remaining over 35 kg/m^2.

The etiology of weight regain and weight loss failure tends to be multifactorial, including pre-operative BMI, nutritional habits, mental health and anatomical changes such as dilation of gastro-jejunal anastomosis and presence of gastro-gastric fistula [7-9].

There is a gradual tendency to weight regain over time, according to the severity of obesity. Individuals with a BMI < 50 kg/m^2 are more likely to lose a higher percentage of their excess weight initially but tend to regain weight similar to the super-obese patients[10].

Recent studies also suggest that the success of weight loss after obesity surgery are dependent on some characteristics of patients before the surgery, including age, gender, weight, BMI, fat percentage and fat distribution. So that the younger, lower BMI, lower body fat percentage and android fat distribution phenotype of bariatric surgery candidates, probably have more successful weight loss [11-14].

This study is aimed to determine the associated factors impressing weight changes after RYGB during 5 years follow-up.

Methods

Studied sample

This retrospective cohort study included 410 morbidly obese patients (BMI>40kg/m^2 or BMI>35kg/m^2 along with at least one obesity-related comorbidity) who underwent primary laparoscopic RYGB surgery with an alimentary limb length of 150cm and biliopancreatic limb length of 50cm from May 2009 to January 2015 by a single surgery team. The patients were aged 18 years and older with at least 12 months follow-up. The data from converted, reversed, and revision patients due to weight loss failure was included in the analysis until the time of the failure and afterwards was excluded. The cases of pregnancy after the surgery were excluded. Data were provided from the National Obesity Surgery Database, Iran. Written informed consent was obtained from all patients. Ethics committee approval code for this study is IR.IUMS.REC 1396.32051.

Studied factors

Age, sex, preoperative BMI (categorized as 35-50, ≥50), patients who reported major comorbidities at the first visit including hypertension, type 2 diabetes mellitus (T2DM), dyslipidemia, and hypothyroidism were included. Percent excess weight loss (%EWL) = [(initial weight) – (post-op weight) / (initial weight– ideal weight)] × 100 and percent excess BMI loss (%EBMIL)= [(Initial BMI) – (Post-op BMI) /(Initial BMI – 25)] × 100 at 1, 3, 6, 9, 12, 18, 24, 36, 48, and 60 months were the main outcomes of the study (in which ideal weight is defined by the weight corresponding to a BMI of 25 kg/m². Short-term (12-36 months), and mid-term (36-60 months) follow-up were the studied phases.

Surgical technique

The patient was placed in a supine position with split legs, and the surgeon stood between the patient's legs (French position) while inserting 5 trocars, and the assistant stayed on the left side. The operating table was placed in a reverse Trendelenburg position. The angle of His was initially dissected, and the left crus of the diaphragm was exposed. A 36 French orogastric tube was inserted by the anesthesiologist to calibrate the gastric pouch. The dissection of vascular arcades began 6cm below the gastroesophageal junction on the lesser curvature.

Once the gastric pouch had been created by using staplers, the omentum and transverse mesocolon were lifted upwards until Treitz' ligament was being identified. If the omentum was very thick, it would be divided longitudinally up to the transverse colon. The biliary limb was measured 50cm distal to the Treitz ligament. Then a side-to-side gastrojejunostomy was performed using a linear 30-mm stapler. Starting at this level, the alimentary limb was measured up to 150cm and jejunojejunostomy was carried out between alimentary and biliary limbs. The remaining anastomotic defects were closed using absorbable 2-0 PDS sutures. Finally, the biliary loop and alimentary loop were separated using a linear cutter stapler. Jejunojejunal mesentery and Petersen's space defects were closed at the end of the procedure. The mesenteric defects were closed using 2-0 non-absorbable polypropylene sutures.

Statistical analysis

Variables are summarized using mean±standard deviation (SD) and frequency (%) for quantitative and qualitative variables, respectively. Patients with at least two weight measurements before the 12th month were recruited for short-term analysis. In addition, if a patient had at least two weight measures until 36 months, was included in the mid-term analysis. Univariate linear mixed effect model was used to assess the effect of variables on weight loss outcomes considering random intercept and random slope [15]. Factors with $P<0.2$ in univariate analysis were included in the multiple linear mixed model. The results were reported using estimate (95%CI: confidence interval). All the regression models are fitted to each phase weight loss short and mid-term. The data were analyzed using R3.5.1. P-values less than 0.05 were considered significant.

Results

Four hundred and ten patients were analyzed with alimentary and biliopancreatic limb length of 150cm and 50cm, respectively. The mean age, weight, and initial BMI were 40.1±10.58 years, 123.32±19.88 kg, and 45.78±5.54 kg/m2, respectively. Totally, 329 (80%) were female and 62 (15%) had T2DM. The median (IQR) follow-up time was 22.11 (16.8, 29.84) months. The mean number of weight measures was

8.8 (min: 3, max: 17). Follow-up rates were 97% (400 cases), 95% (392 cases), 92% (378 cases), 89% (365 cases), and 77% (318 cases) at 12, 24, 36, 48, and 60 months, respectively. Dyslipidemia, hypertension, and sleep apnea prevalence was significantly different between groups (Table 1, P<0.05).

Table 1

The comparison of the patient's baseline characteristics between T2DM- and T2DM+

Characteristics	N (%)		
	T2DM-	T2DM+	P
Age<50yr	55 (89)	274 (81)	.12
BMI>50kg/m2	10 (16)	74 (21)	.35
Male	12 (19.5)	69 (20)	.93
High school and lower	22 (35.5)	118 (34)	.81
Married	45 (72.5)	253 (72.5)	.98
Hypertension	31 (50)	50 (14.5)	.01
Dyslipidemia	43 (70)	154 (45)	.001
Hypothyroidism	11 (17.5)	58 (16.5)	.83
Sleep apnea	17 (27.5)	56 (16)	.03

Mean BMI of the patients was not significantly different between diabetic (45.09±5.42) and non-diabetic (45.9±5.56) patients (P=.28). Table 2 shows the mean %EWL and %EBMIL was significantly lower in diabetic patients, 12 months postoperatively and thereafter.

Table 2
Mean±SD %EBMIL and %EWL of the patients postoperativelyT2DM+ and T2DM-

Follow-up		%EBMIL			%EWL		
Short term	Month	T2DM+	T2DM-	P	T2DM+	T2DM-	P
	1	27.29±9.08	25.43±8.99	.03	26.20±9.29	24.83±8.77	**0.26**
	3	46.72±13.23	46.31±12.93	.74	42.83±12.1	43.58±12.5	**0.66**
	6	60.61±15.93	62.99±16.27	.11	55.40±15.1	58.31±15.4	**0.17**
	9	67.53±15.80	72.25±17.42	.007	62.81±15.8	67.74±15.9	**0.02**
	12	72.19±18.43	77.26±18.93	.01	69.26±19.2	73.90±17.8	**0.06**
	18	73.13±20.59	79.24±19.69	.009	69.36±20.2	75.95±19.3	**0.01**
	24	70.48±18.84	78.60±20.46	.001	67.12±17.8	75.41±20.6	**0.003**
Mid term	36	64.87±20.79	75.06±20.67	<.001	61.82±19.9	72.22±20.7	**<0.001**
	48	62.53±19.99	70.82±21.77	.004	59.01±19.0	68.71±21.6	**0.002**
	60	57.14±20.36	67.01±23.3	.002	53.92±18.1	64.70±23.1	**0.002**

The trajectory of the mean %EWL over time in both diabetic and non-diabetic patients illustrates a rapid weight loss through the first 12 months, a gradual weight loss in 12-36 months, and a relatively modest weight regain was observed afterwards (Figure 1). The superiority of the mean %EWL curve in non-diabetic patients to the diabetic patients was maintained in 60 months follow-up.

Table 3 and 4 show that age (<50 years) was not associated with short-term and long-term weight loss. Female patients, single-status and the ones with lower educational level had a lower mean %EWL and %EBMIL; however, none of them was statistically significant. Patients with lower preoperative BMI (<50kg/m²) and non-diabetic patients had a significantly higher %EWL and %EBMIL over a short and long-term follow-up (P<0.001). Patients with lower initial BMI (<50kg/m²) experienced a higher %EWL of %11.28 (%6.7, %15.8) over long-term follow-up compared with the patients with BMI>50 adjusted for other factors (Table 4, P<0.001). Moreover, table 3 shows that the mean %EBMIL was %10.98 (%5.85, %16.1) higher for the non-diabetic patients than the diabetics controlling for the other factors (P<0.001). All the results were adjusted for follow-up time and random effects.

Table 3
The effect of demographic and clinical factors on EBMIL% in each weight loss phase

	Short-term (<36 months)		Mid-term (36–60 months)	
Factor	Effect size* (95%CI)	P	Effect size* (95%CI)	P
Age<50 yr	1.22 (-1.73, 4.2)	0.41	-0.57 (-5.6, 4.46)	0.82
BMI<50 kg/m2	12.09 (9.7, 14.4)	<0.001	12.17 (7.57, 16.78)	<0.001
Female	-1.14 (-4.34, 2.05)	0.48	-0.47 (-6.7, 5.76)	0.88
LowerUndergraduate	-2.55 (-5.1, 0.00)	0.05	-4.7 (-9.5, 0.08)	0.05
Single	-1.7 (-4.3, 0.9)	0.2	-1.92 (-7.34, 3.5)	0.48
Non-T2DM	4,05 (1.02, 7.08)	0.009	10.98 (5.85, 16.1)	<0.001

*Adjusted for time (month) which was highly significant (P<0.001)

Table 4

The effect of demographic and clinical factors on EWL% in each weight loss phase

	Short-term (<36 months)		Mid-term (36–60 months)	
Factor	Effect size* (95%CI)	P	Effect size* (95%CI)	P
Age<50 yr	1.23 (-1.94, 4.42)	0.44	-0.66 (-5.57, 4.24)	0.79
BMI<50 kg/m2	12.35 (9.47, 14.9)	<0.001	11.28 (6.7, 15.8)	<0.001
Female	-1.11 (-4.6, 2.4)	0.53	-.5 (-6.5, 5.51)	0.87
Lower than Undergraduate	-2.7 (5.4, 0.05)	0.05	-4.6 (-9.26, 0.46)	0.05
Single	-1.9 (-4.7, 0.93)	0.18	-1.8 (-7.08, 3.45)	0.5
T2DM-	4.67 (1.34, 8)	0.006	10.66 (5.6, 15.7)	<0.001

*Adjusted for time (month) which was highly significant (P<0.001)

Discussion

Nowadays bariatric surgery has become the best treatment option for morbid obesity. RYGB is an effective and long-lasting treatment for weight loss and comorbidity improvement. Long-term data regarding gastric bypass have been lacking due to the complexity of issues regarding follow-up [4, 16-18]. There is no consensus in the literature indicating which factors can actually predict success after bariatric surgery, despite a similarity in the characteristics of the samples in terms of age, sex, preoperative BMI, T2DM, high blood pressure, and dyslipidemia [19]. Therefore, more studies with long-term follow-up should be carried out to investigate the effect of these factors on weight loss.

In our study, a 5-years follow-up analysis was performed. Our data demonstrated that the mean age of all patients were 40.1 years with BMI of 45.78 kg/m² that 80% were female. There was no significant difference among age, BMI and sex between diabetic and non-diabetic patients at the surgery which shows the homogeneity of these variables. Also, marriage and educational level were not significantly different between diabetic and non-diabetic groups. The present study has strengths and limitations. The relatively high number of the patients enrolled in this study is strength, as well as a prolonged and excellent follow-up rate of 93% for 5 years.

The patients' %EWL was 59% and 74% in 6 months and 12 months follow-up, respectively. Our findings regarding %EWL are similar to those of Sjöström L, who reported that most patients can expect to lose more than 50 % of their excess weight and an average excess weight loss of more than 70% can be expected in the first 12 months after the surgery [3].

In the study of Junior et al., a progressive loss of excess weight following RYGB was observed along the follow-up periods up to the second year (45%, 64%, 70%, and 73% excess weight loss at 6, 12, 18, and 24 months, respectively) [20]. Our results demonstrated suitable weight loss in short and mid-term follow-up which has been achieved in many other studies. It can be concluded that RYGB induces excellent weight loss in morbidly obese patients.

The %EWL and %EBMIL changes showed that there was no significant difference between diabetic and non-diabetic groups until 9months follow-up, but after that %EWL and %EBMIL was significantly higher in non-diabetic group. In both groups, weight loss trajectory stopped after 18 months.

Sjöström L. also reported that weight loss with RYGB was maximal at 24 months [3]. In our study T2DM lead to a lower weight loss in comparison to non-diabetic patients, which is in agreement with the literature. In a 4-year follow-up study, Junior et al. found that patients with T2DM had a lower weight loss at 18 months after RYGB versus non-diabetic ones [20]. It may be related to insulin metabolism and patient compliance. Diabetic patients, due to hypoglycemia following drug consumption, eat more sweaty food which may lead to weight gain. On the other hand, interactive relation among glucose metabolism, appetite and body basal metabolism can affect weight changes.

The evaluations demonstrated a higher rate of %EBMIL in male patients in short-term follow-up, which was not different in long term. It may be related to psychological and physical characteristics of men. In contrast to our data analysis, Junior et al. in a 4-year follow-up revealed that male sex was associated with limited success after RYGB [20]. This controversy has been concluded by other reports, as determining an effect of sex is complicated due to the fact that the majority of studies include samples that are made up mostly of women [21-23].

On the other hand, in short-term and long-term follow-up, super-obese patients (BMI>50 kg/m²) had a significantly lower %EWL in comparison with patients with BMI<50 kg/m². This association between higher baseline BMI and lower %EWL has been reported in the literature [12]. This finding may be induced by the lower activity level of super-obese patients due to their higher weight and probable musculoskeletal problems. Also, it can be caused by inappropriate eating habits in comparison with patients with BMI<50.

The main objectives of bariatric surgery are to promote a significant and sustainable weight loss, to improve or resolve comorbidities, and to promote a better quality of life, with low rates of preoperative and long-term complications. However, weight loss is not homogeneous in this population, even with technical standardization of the surgery [19, 24].

Limitation:

The weakness point of this study is that it is retrospective and based on database information. Furthermore, all included patients had 150cm alimentary and 50cm biliary limb length; on the other hand, since weight changes are multifactorial, some variables such as calorie consumption, physical activity and eating habits were not evaluated. We recommend that these results should be investigated in long term follow-up.

Conclusion

RYGB is a standard bariatric surgery resulting in efficient long-term weight loss and comorbidity improvement; however, these effects are dependent on many factors. Based on our results BMI>50 kg/m² is related to lower EWL in short and mid-term follow-up, but male sex can induce higher weight loss in short term. On the other hand, T2DM is associated with poor response in long-term follow-up.

Declarations

Ethics approval and consent to participate

All procedures performed in the study were in accordance with the ethical standards of the Iran university of medical science (IUMS) institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standard. IUMS institutional ethics committee approval code is: IR.IUMS.REC 1396.32051.

Consent for publication

Written informed consent was obtained from all patients.

Availability of data and materials

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Competing interests

The authors declare that they have no competing interests.

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Contributions

FE, BH and AT contributed in the conception of the work, revising the draft, approval of the final version of the manuscript, approval of the final version of the manuscript and agreed for all aspects of the work; RK: contributed in the conception of the work, drafting and data and Statistical analysis and agreed for all aspects of the work; AH: Guarantor; AP: Data acquisition, Literature search; and all authors agreed for all aspects of the work.

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Figures

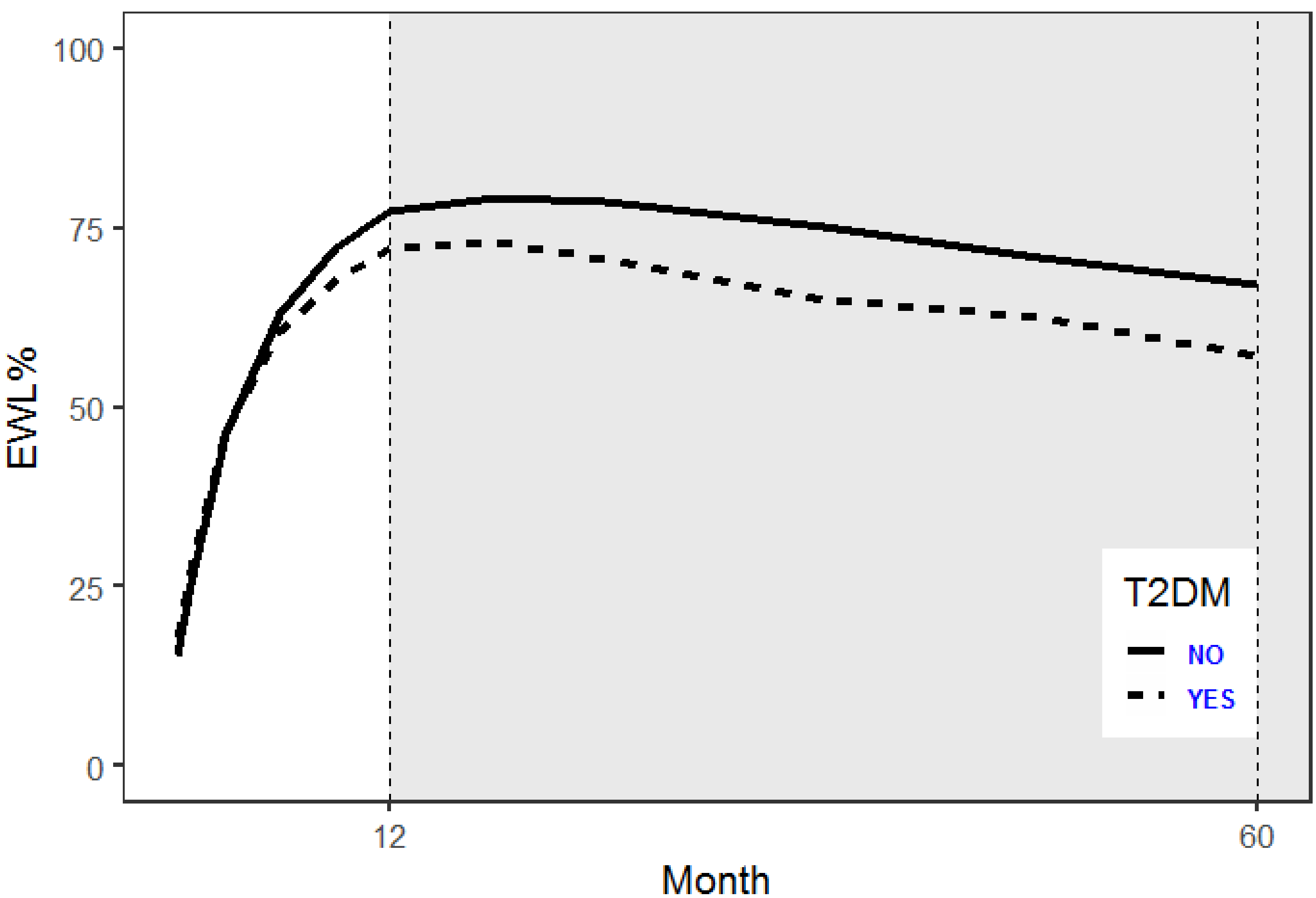

Figure 1

The trajectory of the mean %EWL postoperatively after RYGB in T2DM+ and T2DM- groups