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ORIGINAL CONTRIBUTIONS

The Effect of Age, Gender, and Baseline BMI on Weight Loss Outcomes in Obese Patients Undergoing Intragastric Balloon Therapy

Abdul-rahman F. Diab[1] · Emad M. Abdurasul[2] · Fadi H. Diab[3,4]

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Abstract

Background The effect of age, gender, and baseline BMI as predictors of weight loss outcome in patients undergoing bariatric surgery is controversial with conflicting results in the surgical literature. Few studies evaluated the effect of age, gender, and baseline BMI on weight loss in patients undergoing the intragastric balloon (IGB). This study aimed to evaluate age and gender and baseline BMI as predictors of weight loss in a group of obese patients who were treated with the IGB.

Methods We prospectively followed 229 patients who underwent the Orbera IGB in the period between June 2014 and December 2017, performed at one institution. Data were collected for age, gender, baseline weight, and baseline BMI. At 6 months of IGB insertion, the following parameters were documented: % excess weight loss (%EWL), total body weight loss (TBWL), and % total body weight loss (%TBWL). Patients were categorized according to gender and age groups: age less than 40 years and age equal to or more than 50 years (45 patients who were 40–49 years old were excluded). Baseline BMI was grouped into 2 groups: BMI < 35 and BMI > 40. Patients in the BMI range of 35–40 were excluded.

Linear regression analysis was used to evaluate the effect of age, gender, and baseline BMI on weight loss. *T* test was used to compare the means of TBWL, %EWL, and %TBWL between the groups studied.

Results One hundred eighty-four patients (80% female) were enrolled in the study; 135 (106 females and 29 males) younger than 40 years, and 49 (42 females and 7 males) with age equal or more than 50 years. There was a significant effect of age on weight loss in females at 6 months, with more weight loss (as measured by % excess weight loss) in the younger age group compared with patients aged 50 years or more (% excess weight loss was 47.34% and 38%, respectively, p value = 0.04). There was no difference in % excess weight loss in the younger or older male patients (% excess weight loss was 50.21% and 47.05%, respectively, p value = 0.836). Patients of both sexes with lower baseline BMI had a significantly more % excess weight loss compared with the group with the higher baseline BMI (%EWL females/males 53.7%/50.1% and 32.5%/32.2%, respectively, p value <0.01).

Conclusions Female patients younger than 40 years lost greater amount of excess weight than older patients at 6 months after IGB insertion. On the other hand, age did not alter the outcome in male patients. Lower baseline BMI was significantly correlated with greater excess weight loss in both sexes. Age and baseline BMI can be used as predictors of weight loss outcome in patients treated with IGB.

Keywords Intragastric balloon · Obesity · Predictors of weight loss · Age · Baseline BMI · Gender · Bariatric endoscopy · Orbera · Gastric balloon · Weight loss · Endoscopy · Gastroenterology

✉ Fadi H. Diab

Abdul-rahman F. Diab
a.diab94@hotmail.com

Emad M. Abdurasul
abduraem@jmu.edu

[1] School of Medicine, University of Jordan, Amman, Jordan

[2] Mathematics and Statistics Department, James Madison University, Harrisonburg, VA, USA

[3] Khaldi Medical Center, Amman, Jordan

[4] Sentara RMH Medical Center, Rockingham, VA, USA

Introduction

Obesity is a growing problem worldwide, affecting close to 700 million people [1, 2], and resulting in several co-morbidities, like hyperlipidemia, hypertension, diabetes, obstructive sleep apnea, non-alcoholic fatty liver disease [3, 4], and cirrhosis [5]. The outcomes of lifestyle interventions and pharmacological therapies for obesity are mild and are commonly challenged by strong counter-regulatory physiologic responses leading to frequent relapses [6]. Bariatric and metabolic surgeries, such as Roux-en-Y gastric bypass (RYGBP), biliopancreatic diversion with duodenal switch, and sleeve gastrectomy, continue to be the most successful long-term interventions, enabling patients to lose a significant amount of excess body weight [7, 8]. The problem is that only a minority of obese patients eventually undergo these surgical procedures, leaving a huge number of obese patients untreated, resulting in enormous healthcare costs and increased mortality [9]. In order to bridge this gap in obesity management, several less-invasive endoscopic procedures have evolved, such as the IGB and endoscopic suturing devices. These modalities are suitable for the treatment of moderate obesity (BMI between 30 and 40) and for those who are not surgical candidates, or those who desire an alternative treatment modality with possibly fewer complications and reduced cost [10].

Several studies in the surgical literature have looked at clinical factors that serve as predictors of weight loss outcome after bariatric surgery, including age, sex, and baseline BMI, with conflicting results [11–16].

There is a paucity of studies that looked at such clinical factors as predictors of weight loss outcome in patients undergoing IGB. Defining such predictors is expected to improve weight loss outcomes by intelligently selecting those patients who are most likely to respond to such an intervention, hence the need for studies that address these issues [17, 18].

The aim of our study was to study the effect of age, gender, and baseline BMI on weight loss outcome after IGB therapy.

Materials and Methods

Data were collected prospectively on 229 consecutive patients who underwent the Orbera IGB (Apollo Endosurgery Inc., Austin, TX) at Khaldi Medical Center in Amman Jordan. Approval for the study was obtained from the institution review board. Informed consent was obtained from all individual participants included in the study. Data were recorded over a period of 42 months (June 2014–December 2017) and included demographics, baseline BMI, and % excess weight (%EW). At the time of Balloon removal at 6 months, the following data were recorded: % excess weight loss (%EWL), total body weight loss (TBWL), and % total body weight loss (%TBWL). %EWL at 6 months was calculated as = 100 × (weight lost)/(preoperative weight−ideal body weight). Ideal body weight was calculated as that equivalent to BMI 25 kg/m^2. We examined the effects of the following variables at the time of balloon removal on weight loss: age, gender, and baseline BMI. Patients were categorized according to two age groups: age less than 40 years and age ≥ 50 years. The patients were also studied in two baseline BMI groups: BMI < 35 and BMI > 40. After excluding patients in the age group 40–49 years and patients in the BMI range of 35–40, 184 patients were enrolled in the study.

Inclusion criteria were patients who have not received weight loss therapy for at least 8 months before placement of the IGB and those who completed the 6 months period of IGB placement with successful balloon removal.

Exclusion criteria were previous esophageal or gastric surgery, more than 2-cm hiatal hernia, active gastric ulcers, coagulopathy, early balloon removal, or spontaneous deflation.

Endoscopic procedure: After obtaining informed consent, the patients were sedated with propofol under the supervision of the anesthesiologist. Esophagogastroduodenoscopy was first performed and then the Orbera IGB was introduced through the mouth into the stomach. The position of the balloon was confirmed by direct endoscopic visualization and was then inflated with 600–650 ml of normal saline mixed with 10 ml of methylene blue. The volume used was decided upon by visually evaluating the filling of gastric fundus.

Table 1 Outcome after 6 months of intragastric balloon therapy based on age

	Female patients (148)			Male patients (36)		
	< 40 year	≥ 50 year	*p* value	< 40 year	≥ 50 year	*p* value
Number	106	42		29	7	
*TBWL (kg)	12.5 ± 5.4	14 ± 6.7	N.S.	17.2 ± 6.3	16.4 ± 4.9	N.S.
%TBWL	12.9% ± 5.2	11.9% ± 6.9	N.S.	14.2% ± 4.7	13.9% ± 2.7	N.S.
%EWL	47.3% ± 28%	38% ± 22.5%	0.04	50.2% ± 39%	47% ± 10%	0.84

*When comparing male and female groups, TBWL was significantly higher in males (*p* value = 0.000)

Table 2 Outcome after 6 months of intragastric balloon therapy based on baseline BMI

		Baseline BMI < 35	Baseline BMI > 40	*p* value
%EWL	Females	53.72% ± 22.3%	32.5% ± 16.7%	< 0.01
	Males	50.1% ± 12.3%	32.1% ± 17.1%	< 0.02
%TBWL	Females	12.63% ± 5.5%	13.2% ± 6.4%	N.S.
	Males	11.8% ± 2.8%	12.9% ± 7.2%	N.S.
*TBWL	Females	10.3 ± 4.7	14.9 ± 6.5	N.S.
	Males	11.7 ± 3.4	18.9 ± 8.6	N.S.

*When both sexes were combined, higher baseline BMI group had significantly more TBWL compared with the BMI < 35 group (*p* value = 0.000)

Following the procedure, the patients were placed on a 1000-calorie diet and were followed monthly by a multidisciplinary team until balloon removal.

Statistical analysis: Multiple linear regression techniques were used to analyze the influence of age, BMI, and gender on the weight loss outcome. Tests of the residual plots showed the adequacy of the models in all cases. All reported *p* values were obtained by the 2-sided exact method, at the conventional 5% significance level. All analyses were performed with the use of SPSS software. Data were reported as mean ± standard deviation. *T* test was used to compare the means of TBWL, %EWL, and %TBWL between the groups studied.

Results

One hundred eighty-four patients who underwent IGB placement for 6 months were included in the study: 148 females (80%) and 37 males (20%). One hundred thirty-five patients (73%) were younger than 40 years and 49 (27%) were ≥ 50 years. Among the 148 female patients studied, 106 patients (71.6%) were younger than 40 years, with a mean age of 30 years and age range of 20–40 years. Forty-two patients (28.4%) were ≥ 50 years with a mean age of 53 and age range of 50–57 years. Among the 37 male patients: 29 (81%) were younger than 40 years, with a mean age of 30 years and age range of 20–40 years. Seven patients (19%) ≥ 50 years with a mean age of 55 years and age range of 50–58 years.

Female patients younger than 40 years had a %EWL of 47.3% (± 28%), while females ≥ 50 years had a %EWL of 38% (± 22.5%) ($p = 0.04$).

Male patients younger than 40 years had a %EWL of 50.2% (± 39%), while males ≥ 50 years had a %EWL of 47.1% (± 10%) ($p = 0.83$) (Table 1).

Female patients with baseline BMI < 35 had a 53.7% (± 22.3%) EWL compared with 32.5% (± 16.7%) EWL for baseline BMI > 40 ($p < 0.01$).

Male patients with baseline BMI < 35 had a 50.1% (± 12.3%) EWL compared with 32.2% (± 17.1%) EWL for baseline BMI > 40 ($p < 0.02$) (Table 2).

There was no effect of gender, age, or baseline BMI on %TBWL. In terms of absolute numbers of kilograms lost, TBWL was significantly more in males, and in patients with higher weights (baseline BMI > 40) in both sexes, with baseline BMI > 40 ($p = 0.000$ and 0.000, respectively).

Multiple linear regression was used to study the effect of age, BMI, and gender on weight loss outcome and the results were as follows: age, gender, and baseline BMI had a significant effect on weight loss in the whole group of 184 patients (*p* value = 0.027, 0.000 and 0.000, respectively). The value for the Durbin-Watson test was 2.24, which indicated that there was no residual correlation between variables (Table 3).

Linear regression was also used to study the effect of age and baseline BMI on weight loss using 4 different age and sex subgroups (Table 4): there was a significant effect of baseline BMI on weight loss outcome in all 4 groups, but age had an effect on weight loss only in the group of females younger than 40 year.

Durbin-Watson test revealed no residual correlation between the variables in all 4 groups (2.04, 2.42, 1.85, and 2.41, respectively).

Discussion

This study demonstrates that there was a significant effect of age on weight loss in females at the time of balloon removal at 6 months, with more weight loss (as measured by % excess weight loss) in the younger age group compared with patients ≥ 50 years. There was no difference in % excess weight loss in the younger versus older male patients. There was a significant effect of baseline BMI in both genders on extent of weight loss at 6 months after the intervention, with more excess weight loss in the group with lower baseline BMI.

The effect of baseline BMI, age, and gender on weight loss outcome after bariatric surgery is controversial. Several

Table 3 Linear regression analysis: effect of gender, age, and baseline BMI on weight loss

	Coefficient	P
Constant	− 6.76	0.015
Gender	3.475	0.000
Age	0.073	0.027
Baseline BMI	0.36	0.000
Durbin-Watson	2.18	
R^2	22.1%	

Dependent variable: weight loss

Table 4 Linear regression analysis: Effect of age and baseline BMI on weight loss in 4 groups

	Females < 40 year	Females ≥ 50 year	Males < 40 year	Males ≥ 50 year
Age	$p = 0.046$	$p = 0.837$	$p = 0.688$	$p = 0.909$
Baseline BMI	$p = 0.001$	$p = 0.002$	$p = 0.007$	$p = 0.003$
Durbin-Watson	2.04	2.42	1.85	2.41

Dependent variable: weight loss

bariatric surgery studies reported lesser weight loss in older patients [11–15, 19]. Based on 489 patients who underwent bariatric surgery with a median follow-up of 36 months, Scozzari et al. demonstrated that BMI trend over time was significantly modified by baseline age; patients aged ≥ 52 years showed a significantly lower BMI decrease and a greater weight regain in the long-term follow-up compared with younger age groups [16].

On the other hand, several other surgical studies failed to demonstrate an effect of advancing age on the outcome of bariatric surgery [20–22].

Baseline BMI has been shown to negatively correlate with excess weight loss after bariatric surgery [19, 22–24]. This was in agreement with our findings where patients with lower baseline BMI had more excess weight loss compared with those with higher baseline BMI.

Very few studies looked at age and baseline BMI as predictors of weight loss in patients undergoing the IGB therapy:

Lopez-Nava et al. reported that TBWL was higher in patients with higher starting weight (similar to our data) but that %EWL is greater in women and in the less obese, but there was no effect of age on the degree of weight loss [17].

On the other hand, Peker et al. observed that weight loss plateaued at 3 months and that IGB therapy was more effective in those with a BMI > 40 kg/m^2 than in those with BMI between 30 and 39 kg/m [2, 18].

Several hypotheses may explain the relationship between age and weight loss after bariatric interventions [25]. One explanation is that, prior to surgery, older patients typically present with more comorbidities and decreased mobility which could explain the lower weight loss outcome compared with younger counterparts [16, 26, 27]. It is also known that increasing age is associated with reduced energy requirement and blunted lipolytic activity, in particular, in response to sympathetic activity [28–31]. This would suggest that older obese patients have a decreased capacity to derive energy through mobilization of lipid from fat stores [29, 30].

This study has few limitations: it did not take into consideration the incidence of comorbid conditions such as hypertension, hyperlipidemias, and diabetes mellitus in the study groups which could influence the results of the study. Another limitation is the small sample size of the male patients, which is a common problem in bariatric studies. Therefore, we cannot be confident that the lack of significant effect of age in males is not just because of a type 2 error (small sample size). Future studies will hence be needed on larger cohorts.

Conclusions

Female patients younger than 40 years had greater amount of %EWL than patients older than 50 years at 6 months after IGB insertion.

There was no difference in %EWL in the younger versus older male patients, although a firm conclusion cannot be ascertained due to the small sample size of male patients, which is a problem in the majority of bariatric studies.

Lower baseline BMI was significantly correlated with greater excess weight loss in both sexes. Age (in female patients) and baseline BMI (both sexes) can be used to optimize patient selection in order to enhance the effectiveness of endoscopic balloon therapy. Further studies with larger sample size are needed to further investigate such predictors of weight loss.

Compliance with Ethical Standards

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

Ethical Statement The study was approved by the institution ethics committee.

Consent Statement Informed consent was obtained from all individual participants included in the study.

Statement of Human and Animal Rights The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national).

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