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Efficacy and Safety of Intragastric Balloon Therapy Compared to a Multidisciplinary Weight Loss Program (OPTIFAST) in a Real-World Population: A Propensity Score Matching Analysis

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Keywords
Body weight · Body mass index · Intragastric balloon · Hypocaloric diet · Obesity · Weight loss

Abstract

Introduction: Obesity is a major global health problem associated with comorbidities such as diabetes, cardiovascular disease, and cancer. Bariatric surgery is recognized to be the most effective weight loss intervention, but it is highly invasive and costly and can have serious side effects. Intragastric balloon (IGB) placement by endoscopy and hypocaloric diets are among a number of techniques that have been used in patients unsuitable for, or unwilling to undergo, obesity surgery. In this study, we compared the efficacy, safety, and cost-effectiveness of the hypocaloric OPTIFAST program (OPT) with endoscopic IGB placement for weight loss. ***Methods:*** In this retrospective observational cohort propensity score-weighted comparison (performed May 2014 to December 2020), participants with a BMI of 30–55 kg/m^2, aged 18–70 years, were randomized to OPT or IGB for 26 weeks, followed by a weight maintenance phase. Patients were matched according to age, gender, and BMI. The study outcomes were percentage excess body weight lost, total body weight lost (TBWL), and percentage TBWL (%TBWL). ***Results:*** A total of 148 participants (75% of those randomized; 74 OPT, 74 IGB) made up the ITT population. Mean age was 44.1 ± 10.4 years, and the patients were predominantly female (77%). Baseline BMI was 44.1 ± 10.4 kg/m^2. At 26 weeks, %TBWL in the OPT group was 19.6 ± 6.8% versus 11.9 ± 6.7% for IGB ($p < 0.001$). At 52 weeks, %TBWL for OPT was 18.2 ± 9.0% versus 12.0 ± 6.6% for IGB ($p < 0.001$). The OPT cohort also experienced significantly fewer adverse events compared with the IGB group. ***Conclusion:*** IGB placement and OPT induce clinically meaningful weight loss. However, OPT appears to induce clinically superior weight loss and has economic advantages through lower rates of complications and adverse events.

The manuscript was prepared and revised according to the STROBE Statement – checklist of items.

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Introduction

Obesity is one of the most important public health issues, and its incidence is increasing worldwide. Around the globe, according to the World Health Organization, 1.4 billion adults over 20 years old are overweight and an estimated 500 million are obese. The prevalence of obesity has tripled since 1980, and it is estimated that 60% of the world's population (i.e., 3.3 billion people) could be overweight or obese by 2030, if recent trends continue [1]. A recently published cross-sectional study conducted in 16 European countries demonstrated that 47.6% of European adults were overweight (54.5% of men, 40.8% of women) and 12.8% obese (14.0% of men, 11.5% of women), depending on a number of different factors including age, education level, and geographical region [2].

Obesity is associated with a number of comorbidities including type 2 diabetes mellitus, hypertension, dyslipidemia, cardiovascular disease, cerebrovascular disease, sleep apnea, osteoarthropathy, and some cancers [3–5]. Overweight and obesity are also related to increased mortality rates [6, 7]. Obesity is estimated to reduce average life expectancy and is currently causing a major economic burden on health insurance [8, 9].

Conventional treatments, such as diet therapy, regular physical activity, and behavioral modification, are important and essential for managing obesity. However, those treatments alone are often ineffective [10]. Bariatric surgery is the most effective weight loss intervention, resulting in long-term sustained weight loss and long-term resolution of comorbidities [11]. Despite these advantages, bariatric surgery is still extremely invasive and costly and is likely to cause a vast number of complications that can be fatal [4, 5]. While its effectiveness in the long term has yet to be demonstrated, intragastric balloon (IGB) therapy, first reported by Nieben et al. in 1982 [12], is a less invasive and – at least potentially – a more cost-effective option for the treatment of obesity than surgery [13–17]. The presence of an IGB delays gastric emptying, causing a premature sensation of satiety and decreased food consumption [18]. IGB has been shown to be more effective than a lifestyle intervention program in achieving short-term weight loss [19]. A current systematic review of 26 studies (n = 6,101) found the percentage of excess body weight lost (%EBWL) at the time of removal (6 months) to be 36.2 ± 6.3% [20]. In recent meta-analysis of 68 observational studies, pain and nausea were frequent side effects, occurring in 33.7% and 29% of subjects, respectively. The pooled early removal rate was 7.5%. Serious adverse events were infrequent. Migration of the device occurred in 1.4%, small bowel obstruction in 0.3%, and gastric perforation in 0.1% of cases [21].

The OPTIFAST program is a medically supervised high-intensity program that comprises low-calorie meal replacements, behavioral and lifestyle education, and instruction and encouragement in increasing physical activity. The OPTIFAST program has been proven effective in achieving acute and sustained weight loss ranging from 10.5% to 16.1% after 6–12 months [22–27]. Regarding safety outcomes, while serious adverse events are rare, mild adverse events (e.g., dizziness, headache, gastrointestinal symptoms, alopecia, and hepatobiliary disorders) occur in approximately 10% of participants [28, 29]. This study aimed to compare the efficacy and safety of IGB therapy with that of the multidisciplinary weight loss program (OPTIFAST) in a real-world population of individuals who had chosen not to consider surgical therapy and, in addition, to analyze and compare the incremental costs of the two interventions.

Materials and Methods

This was a retrospective, comparative study conducted at the Obesity Center of the Departments of Surgery and Gastroenterology, DGD Clinics Sachsenhausen, Frankfurt am Main, Germany. Patients' data from 2014 to 2020 were collected from medical records. The study was reviewed and approved by the Ethics Committee of the regional regulatory institution, Landesärztekammer Hessen (2021-2433-evBO). Due to the retrospective and anonymized nature of the data evaluation, patient informed consent was not required.

Patients

Six hundred patients aged 18–65 years, who had obesity (body mass index [BMI] >30 kg/m^2), were admitted to the Obesity Center, Departments of Surgery and Gastroenterology, DGD Clinics Sachsenhausen, Frankfurt am Main, Germany, between 2014 and 2020, and had chosen not (or not yet) to undergo obesity surgery were included in the study. Patients were classified into the following three categories according to their BMI: class I obesity (BMI 30–34.9 kg/m^2), class II obesity (35–39.9 kg/m^2), and class III obesity (≥40 kg/m^2). Results were expressed as change in BMI, weight loss in kilograms, %EBWL, and percentage of total body weight lost (%TBWL). Weight loss parameters were calculated according to the international bariatric indication [30].

IGB Procedures

All IGB devices were placed and removed under unconscious sedation. The standard inclusion criteria for the IGB procedures in the obesity center were: (1) age between 20 and 75 years; (2) BMI ≥27 kg/m^2; (3) the presence of one or more obesity-related disease [impaired glucose tolerance (type 2 diabetes, etc.), dyslipidemia, hypertension, hyperuricemia/gout, coronary artery disease, cerebral infarction, nonalcoholic fatty liver disease, menstrual abnormalities/sterility, respiratory disorders, osteoarthropathy, and re-

nal disease]; and (4) failure of previous therapeutic lifestyle modification for at least 6 months. The exclusion criteria were: (1) active peptic ulcer; (2) inflammatory bowel disease; (3) cancer; (4) history of gastrectomy; (5) hiatal hernia (>5 cm in diameter); (6) pregnancy; (7) psychological disorders inadequately controlled by drug treatment; (8) chronic therapy with aspirin, anti-inflammatory agents, anticoagulants, or steroids.

Placement of the device was preceded by diagnostic endoscopy to exclude possible lesions. The IGB was inserted below the gastroesophageal junction and inflated with saline (400–700 mL of 1,000 mL saline mixed with 10 mL 1% methylene blue) until the balloon distended to fill the gastric fundus. All patients received the same post-operative care: on the first post-operative day, intravenous saline, proton pump inhibitors, antiemetics, and antispastics were administered; on the second post-operative day, if oral liquid intake was tolerated, the patient was discharged with a specific balanced hypocaloric diet. After completion (or discontinuation) of therapy, the IGB was completely deflated and removed by endoscopy, with a dedicated instrument ("balloon killer" needle and grasper) or routine endoscopic devices (injection needle and polypectomy snare).

Operators' subjective technical notes and findings, such as differences in balloon appearance and position, as well as problems and difficulties encountered in removal procedure, were collected and analyzed. All patients undergoing IGB therapy received accompanying nutritional counseling three times: once immediately post-insertion and twice during the following 12-month period.

Multidisciplinary Weight Loss Program

The multidisciplinary weight loss program used was a 52-week hypocaloric diet program called Optifast52® (OPT; franchise holder, Nestlé Inc., Vevey, Switzerland). In the first 12-week *fasting phase*, patients received a balanced-formula low-calorie diet. Depending on the initial body weight, daily consumption consisted of 5 (to 7) shakes (160 kcal each) that fully replaced normal food, corresponding to an energy content of 800 kcal. Five shakes were ingested per day, dissolved in 300 mL water, providing a total daily intake of 800 kcal (3,200 kJ), 87 g protein, 12 g fat, and 75 g carbohydrate, plus the recommended daily intake of vitamins, minerals, and trace elements. Patients were advised to drink at least 2.5 L of additional fluid each day, preferably water, tea, or low-calorie soft drinks. This fasting phase was followed by a 6-week *refeeding phase*, during which solid food was reintroduced and formula diet progressively replaced by normal diet without changing total energy intake, accompanied by six medical examinations, six exercise units, two behavioral therapy sessions with a specialist psychologist, and six nutrition counseling sessions. Refeeding was followed by a 7-week *stabilization phase* in which energy intake was raised incrementally to an individual level allowing weight stabilization, accompanied by three medical examinations, four exercise units, as well as four behavioral therapies and three nutrition counseling sessions. Finally, each patient underwent a 26-week maintenance phase, in which nutritional education and behavioral modification were intensified to learn coping strategies and achieve long-term weight control, accompanied by six medical examinations, 13 exercise units, 22 behavioral therapy, and five nutrition counseling sessions.

Once a week, participants visited the study center to have their health status monitored and take part in supervised exercises. The exercise course, which is routinely carried out as part of the standardized weight loss program, combined cardiovascular and muscle training. Training intensity was increased gradually, starting at 30% of full capacity, then increasing to 70% in 1–2 exercise series of 15–25 repetitions, and finally 100% with 1–3 series of 15–25 repetitions. The program was adjusted to suit each participant's individual fitness level and disease status at the discretion of the trainer. A dietician supervised the group throughout the study and provided nutritional and behavioral counseling, supported by a specialized psychologist.

Ideal body weight was calculated according to the Lorentz formula. Adverse events, including mortality and complications, were also recorded.

Costs

Costs for the IGB procedures included balloon costs (monthly subscription) of €1,000, costs of consultations and appointments with the attending physician (average €20/visit) and dietitian (average €15/visit), costs of balloon insertion and removal (€1,200), and other related costs. The OPT program consists of a 12-week diet with total meal replacement (5 servings per day) and two subsequent phases of transition, initially to a food-based diet with 2–3 meal replacement servings per day for 12 weeks, reducing to 1 meal replacement serving a day for the following 24 weeks (€14.70 per serving). The complete OPT program requires nearly 800 servings of OPT with ex-factory costs for payers of €1,500 and an additional €1,800–€2,000 for the weight management program (appointments and consultations with physician, dietitian, and physiotherapist).

Propensity Score Matching and Statistical Analysis

Patient data were recorded using a computerized database. Propensity score (PS) matching methodology was used to reduce potential bias and adjust potential confounding effects according to the differences in baseline characteristics between the OPT and IGB groups [31]. PSs were estimated using IBM SPSS version 25.0 and Phyton 3.0, which estimates PS using regression as the predicted probability, according to the following three factors: age, gender, and BMI. Adequacy of the PS model was examined by plotting the PS distributions in the OPT versus IGB groups. The absolute standardized differences were used to diagnose the balance after matching, and all standardized mean differences after matching were less than 0.1. After PS matching, 198 patients were subjected to the analysis. The data were analyzed using IBM SPSS version 25.0 and Microsoft® Office Excel 365.

The variables were checked for normal distribution using both visual and analytical methods. Descriptive analysis was presented as number (percentage) and mean ± standard deviation. Since the data were normally distributed, the independent sample *t* test (Student's *t* test) and one-way ANOVA were performed for group comparisons and a paired sample *t* test was performed for time point comparisons. Statistical significance was predetermined as $p < 0.05$.

Results

Study Population

The medical records of 586 patients were screened, and the eligibility of 275 individuals (144 IGB, 131 OPT) confirmed. Of these, 11 patients with IGB withdrew with-

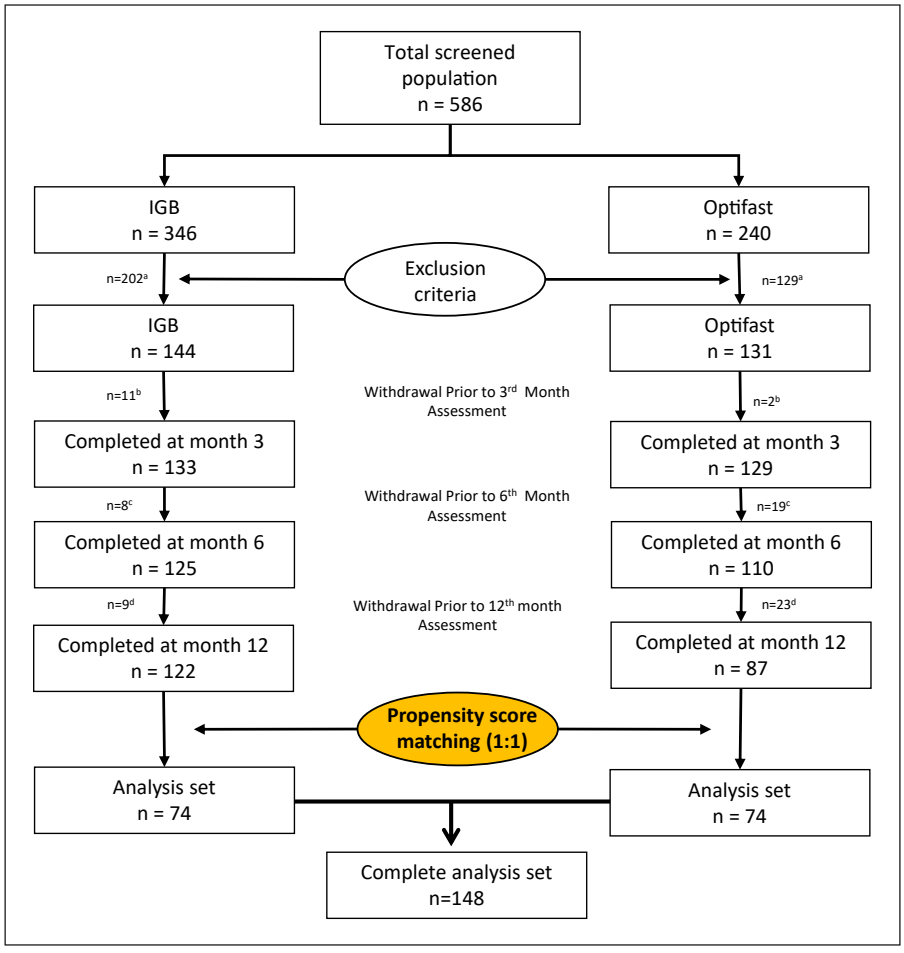

Fig. 1. Consort diagram. IGB: [a]BMI >30 kg/m^2 (13), age >18 and <65 years (4), incomplete documentation (185); [b]adverse events: nausea (4), recurrent vomiting (4), spontaneous rupture (3); [c]adverse events: migration (3), hyperinflation (2), spontaneous rupture (1), gastric ulcers (1), mechanic pancreatitis (1); [d]adverse events: insufficient weight loss (6), therapy-resistant dysphagia (1), gastric ulcers (1), mechanic pancreatitis (1). Optifast: [a]BMI >30 kg/m^2 (57), age >18 and <65 years (5), incomplete documentation (47); [b]adverse events: hunger (2); [c]adverse events: hunger (1), dizziness (3); lost to follow-up (15); [d]adverse events: heartburn (2), dizziness (1); lost to follow-up (17).

in the first 3 months due to adverse events (4 nausea, 4 recurrent vomiting, 3 spontaneous rupture) and 2 patients withdrew from the OPT program (hunger). Between 3 and 6 months, 8 patients with IGB (3 migration, 2 hyperinflation, 1 spontaneous rupture, 1 gastric ulcer, 1 mechanic pancreatitis) and 4 patients (1 hunger, 3 dizziness) from OPT group withdrew due to adverse events, and 15 patients in OPT group were lost to follow-up. In the period up to the 12th month, 9 patients (6 insufficient weight loss, 1 therapy-resistant dysphagia, 1 gastric ulcer, 1 mechanic pancreatitis) with IGB and 9 patients (4 dizziness, 3 hunger, 2 heartburn) in the OPT group withdrew due to adverse events and 17 patients in the OPT group were additionally lost to follow-up. Finally, PS matching (according to gender, age, and BMI) was applied to 122 patients in the IGB cohort and 87 patients in the OPT group, and 74 patients were allocated to each group (Fig. 1). These patients were demographically similar, typically middle-aged (44.1 ± 10.4 years), and predominantly female (77%). The baseline characteristics of the groups are presented in Table 1.

Weight Loss Outcomes

While both treatment groups showed weight reduction at all time points analyzed (months 3, 6, and 12), the weight loss achieved in the OPT group was significantly higher at each of these time points (17.2 ± 7.2 vs. 11.1 ± 5.5 kg at month 3; 22.8 ± 10.0 vs. 13.0 ± 7.6 kg at month 6; 21.1 ± 12.2 vs. 12.7 ± 7.2 kg at month 12, respectively, for OPT and IGB). Although decrease in BMI was greater in the OPT group, the difference between the two groups was not statistically significant in the 3rd and 6th months (5.8 ± 2.1 vs. 3.9 ± 2.3 kg/m^2 at month 3; and 7.8 ± 3.1 vs. 6.6 ± 2.3 kg/m^2 at month 6, for OPT and IGB, respectively) and reached statistical significance after 12 months (7.3 ± 4.0 vs. 4.8 ± 3.1 kg/m^2, for OPT and IGB, respectively). TBWL% was significantly higher in the OPT group at all time points (14.8 ± 5.0% vs. 9.4 ± 4.1% at

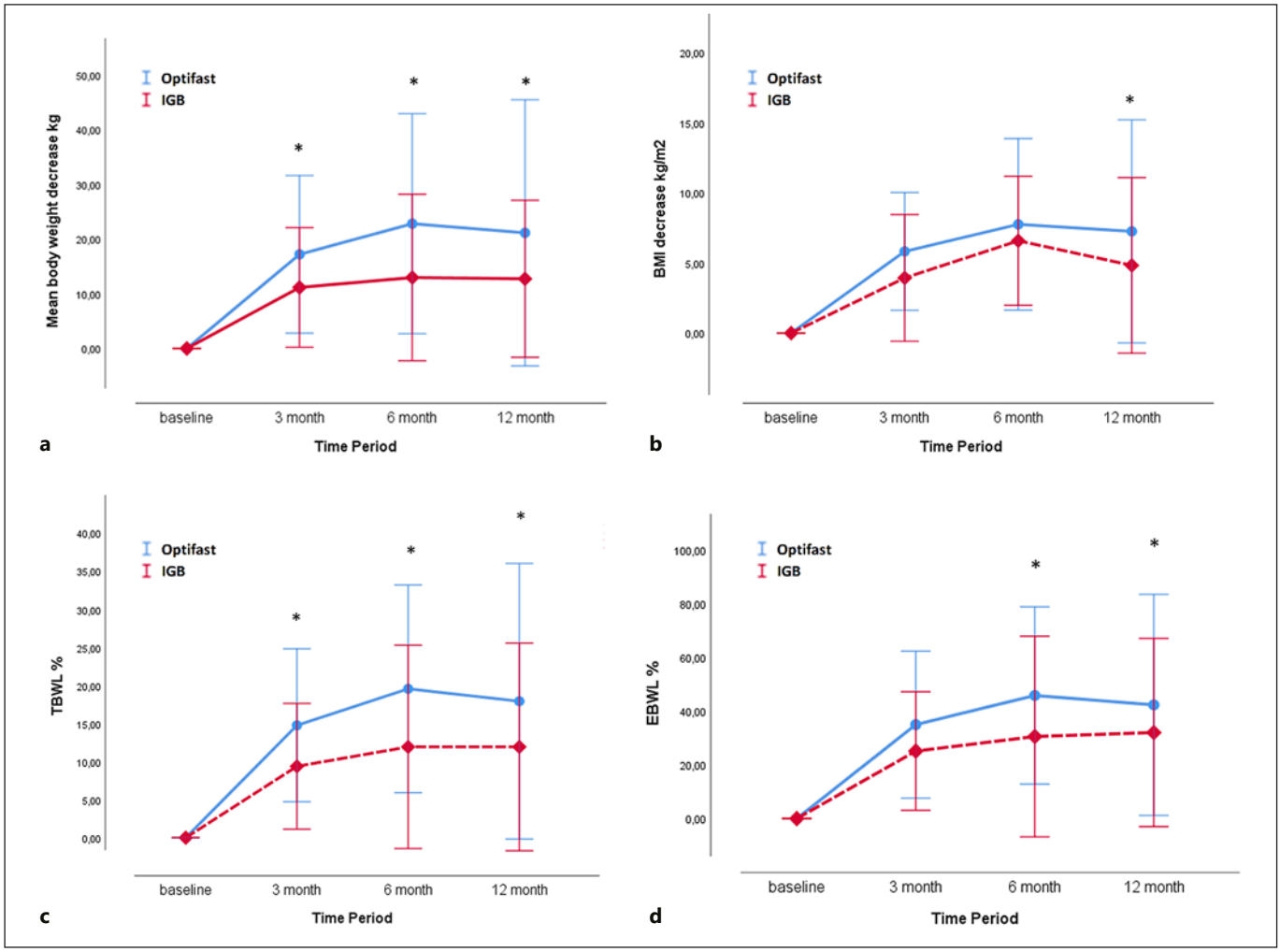

Fig. 2. Change in weight loss parameters during follow-up. BMI, body mass index; IGB, intragastric balloon; %EBWL, percentage of excess body weight loss; %TBWL, percentage of total body weight loss. *$p < 0.005$; Student's *t* test.

Table 1. Baseline characteristics

Baseline characteristics	IGB ($n = 74$)	Optifast ($n = 74$)
Gender		
Female, *n* (%)	57 (77)	57 (77)
Male, *n* (%)	17 (23)	17 (23)
Age, mean ± SD, years	44.1±10.4	44.3±10.8
BMI, mean ± SD, kg/m^2	38.0±8.2	39.5±5.3
Weight, mean ± SD, kg	109.6±23.2	114.8±20.5
Height, mean ± SD, m	1.7±0.1	1.7±0.1
Classification of BMI, kg/m^2		
30–34.9 (obesity class I), *n* (%)	23 (31.1)	15 (20.3)
34.9–39.9 (obesity class II), *n* (%)	30 (40.6)	31 (41.9)
≥40.0 (obesity class III), *n* (%)	21 (28.4)	28 (37.8)
Excess weight, mean ± SD, kg	45.8±22.7	50.8±16.6

BMI, body mass index; IGB, intragastric balloon. No statistical significance between groups.

Table 2. Change in weight loss parameters according to baseline BMI

Weight loss parameters	BMI, classification	Month 3		Month 6		Month 12	
		IGB (mean ± SD)	Optifast (mean ± SD)	IGB (mean ± SD)	Optifast (mean ± SD)	IGB (mean ± SD)	Optifast (mean ± SD)
Weight loss, kg	Obesity class I	11.3±5.1	15.8±7.0	9.8±6.9	18.2±8.8	9.4±3.7	15.3±10.0
	Obesity class II	12.0±4.8	15.5±5.6	13.2±5.6	21.4±8.3	17.4±9.2	21.0±9.4
	Obesity class III	16.5±0.7	19.7±8.3	18.7±7.0	26.8±11.3	12.0±5.1	24.7±14.8
p value		0.374	0.156	0.076	0.095	0.258	0.128
ΔBMI, kg/m^2	Obesity class I	4.1±1.8	5.3±2.1	5.4±1.2	6.1±2.8	2.9±1.0	5.0±3.3
	Obesity class II	5.1±1.7	5.3±1.8	7.3±1.4	7.3±2.4	6.2±4.3	7.1±2.9
	Obesity class III	6.2±0.4	6.6±2.3	6.7±2.6	9.2±3.3	4.6±1.9	8.7±4.8
p value		0.121	0.082	0.687	0.020*	0.348	0.045*
%TBWL	Obesity class I	10.3±4.8	15.7±6.1	10.4±7.4	18.0±8.1	10.2±4.3	14.8±9.5
	Obesity class II	11.8±4.1	14.3±4.7	12.9±5.8	19.5±6.3	16.0±9.6	19.0±7.6
	Obesity class III	11.8±1.6	14.8±4.9	14.4±5.7	20.4±6.8	9.6±3.3	19.4±10.0
p value		0.564	0.593	0.772	0.792	0.368	0.367
%EBWL	Obesity class I	29.0±14.4	45.8±17.4	30.7±21.3	52.1±22.5	33.5±14.6	42.1±27.0
	Obesity class II	30.4±10.7	35.1±11.8	31.6±13.6	47.5±14.9	37.1±21.2	45.9±17.9
	Obesity class III	20.5±3.9	29.3±10.2	28.2±12.9	40.6±13.4	18.8±5.9	38.5±19.3
p value		0.564	0.002**	0.867	0.045*	0.086	0.531

BMI, body mass index; IGB, intragastric balloon; %EBWL, percentage of excess body weight lost; %TBWL, percentage of total body weight lost; ΔBMI, change in BMI. * $p < 0.005$, ANOVA.

month 3; 19.6 ± 6.8% vs. 11.9 ± 6.7% at month 6; and 18.2 ± 9.0% vs. 12.0 ± 6.6% at month 12, for OPT and IGB, respectively). Although the OPT group showed a higher percentage of EBWL, the difference between the two groups was not statistically significant in the 3rd month (35.0 ± 13.7% vs. 25.1 ± 11.0%, for OPT and IGB, respectively) and was significantly higher in the 6th and 12th month (45.8 ± 16.5% vs. 30.5 ± 18.7% at month 6, and 42.3 ± 20.6% vs. 32.0 ± 17.5% at month 12, for OPT and IGB, respectively). All weight loss parameters from each of the time points are presented in Figure 2 (see also online suppl. Table 1; for all online suppl. material, see www.karger.com/doi/10.1159/000524895).

In general, no significant differences between weight loss parameters were observed in different BMI groups. Only after the first 3 months of the OPT program was a lower BMI found to be related to a higher EBWL; this difference decreased thereafter and was no longer apparent after 12 months (Table 2).

At all time points, the proportion of participants who lost at least 5%, 10%, or 15% of total body weight was higher in the OPT group. In the case of more than 15% body weight loss, the difference was statistically significant at all three time points (Fig. 3).

Adverse Events

There was a significantly greater rate of adverse events that led to discontinuation of IGB therapy compared with OPT (19.4% vs. 6.8%; $p < 0.001$). Adverse events following IGB insertion included early removal because of insufficient weight loss (6 events), nausea (4), recurrent vomiting (4), spontaneous rupture (4), migration (3), hyperinflation (2), gastric ulcer (2), mechanic pancreatitis (2), therapy-resistant dysphagia (1) (Fig. 1). Adverse events leading to discontinuation of the weight loss program in the OPT group were dizziness (4), hunger (3), and heartburn (2) (Fig. 1).

Costs

Costs were calculated as Euros per kg weight loss and Euros per decrease in BMI units at the 6th and 12th month time points for the complete analysis set (74 IGB; 74 OPT) and for the total screened population that fit the study inclusion criteria (144 IGB; 131 OPT). IGB was found to incur significantly higher costs per kg and per BMI unit lost in comparison with OPT after both 6 and 12 months, both in the complete analysis set and in the total screened population (Table 3).

Table 3. Costs of the two procedures per kg body weight and per BMI unit

	Complete analysis set			Total screened population		
	IGB (mean ± SD)	OPT (mean ± SD)	*p* value	IGB (mean ± SD)	OPT (mean ± SD)	*p* value
Cost per kg weight loss, €/kg						
6th month	318.7±116.4	117.7±51.6	<0.001**	526.2±196.2	133.6±61.0	<0.001**
12th month	490.1±197.6	170.2±59.1	<0.001**	809.2±343.1	193.3±66.7	<0.001**
Cost per BMI unit, €/BMI unit						
6th month	980.0±401.1	343.3±163.8	<0.001**	1,880.1±524.7	389.9±141.9	<0.001**
12th month	1,290.3±510.4	495.2±217.7	<0.001**	2,194.6±591.6	562.4±221.1	<0.001**

BMI, body mass index; IGB, intragastric balloon; OPT, Optifast weight loss program. ** $p < 0.001$ significant, Mann-Whitney U test.

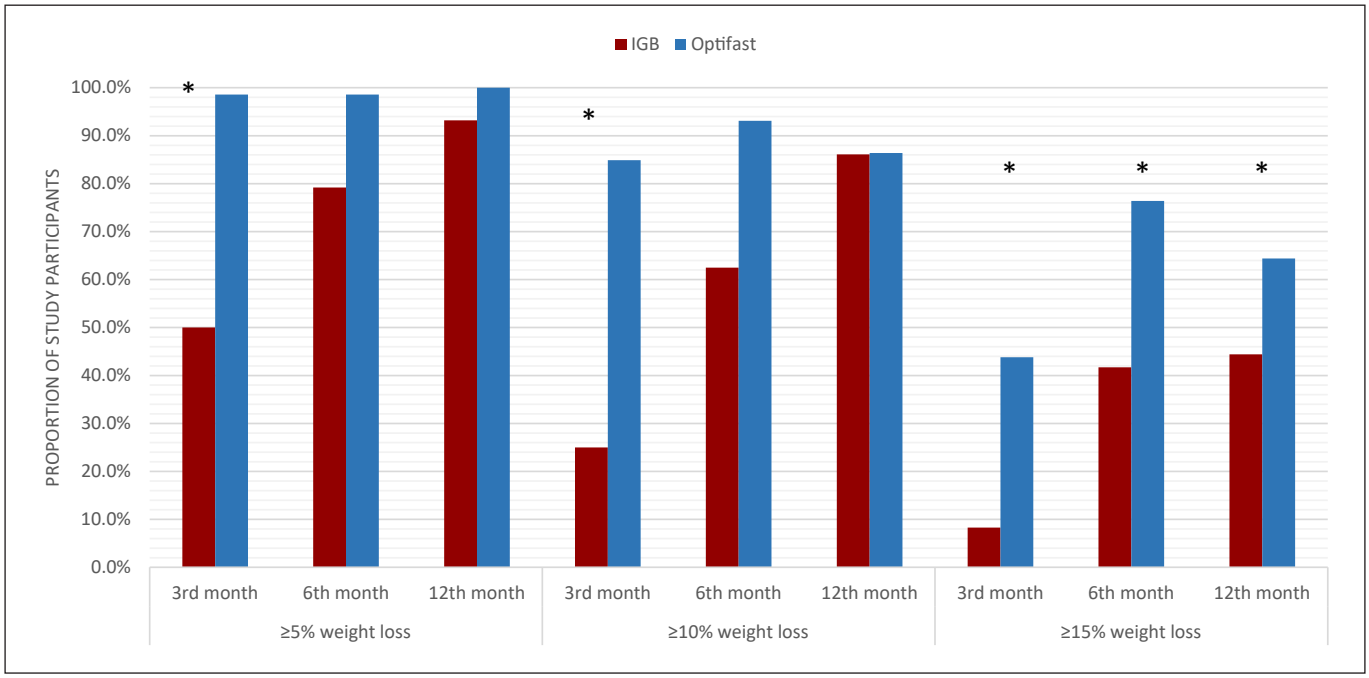

Fig. 3. Percentage of participants who lost at least 5%, 10%, or 15% of total body weight at 3rd, 6th, and 12th months. *Significant difference between groups.

Discussion

IGB placement and commercial weight loss programs such as OPT have gained significant popularity and attraction over the last years, especially for the treatment of individuals with a BMI between 30 and 40 kg/m^2, with various publications demonstrating both to be effective and safe [13, 32]. To date, however, there have been no studies comparing the outcomes of these two nonsurgical weight loss procedures.

This clinical trial compared 1-year outcomes of two nonsurgical weight loss interventions, OPT, and IGB, in Patients with a BMI >30 kg/m^2, including patients of obesity class I, II, and III who chose not (or not yet) to undergo bariatric surgery, despite theoretical eligibility. OPT resulted in superior weight loss compared with IGB placement during the 12 months following therapy baseline. The 6-month mean %TBWL of 19.6% found in the OPT group in our study was consistent with values of 20.4% and 14.9% previously reported by Bischoff et al.

and Ard et al., respectively. Our 12-month follow-up %TBWL in the OPT group was 18.2%, similar to the 17.9% and 10.5% previously reported by the same two study groups, respectively [5, 27]. Our results for the IGB group were also in line with previous reports; the 6-month %TBWL of 11.9% was comparable with the 11.4% reported by Agnihotri et al. [12] and 11.8% reported by Vargas et al. [18], although higher than the values reported by Ponce et al. (8.4%) [33] and Courcoulas et al. (10.2%) [19]. At 12 months, we observed a %TBWL for 12.0% in the IGB group, i.e., within the same range as the 13.9% and 14.7% %TWBL reported by Fayad et al. and Agnihotri et al., respectively [34, 35].

We found OPT to be associated with fewer adverse events than IGB therapy. In our study, 19.4% of IGB patients experienced adverse events requiring balloon removal. In a review by Tate and Geliebter [14], the rate of adverse events following IGB placement reached 28.2%, with a serious adverse event rate of 10.5%. In line with our study, the reasons reported for early balloon removal were abdominal pain, nausea/vomiting, balloon deflation, and balloon intolerance [20]. The most common AEs in the OPT participants were mild and able to be easily corrected by increased fluid and fiber intake.

The influence of behavioral modifications and lifestyle changes in Patients with obesity cannot be overestimated, especially with regard to weight loss maintenance in the longer term. While patients undergoing IGB implant in Germany receive nutritional counseling prior to implantation and twice more during the 12-month period, these patients could greatly benefit from a more structured and more closely monitored support program. The FDA currently recommends a structured lifestyle program beginning 6 months prior to implantation and continuing until 6 months post-procedure, including monthly nutrition counseling [36]. By optimizing preprocedural preparation and increasing pre- and post-procedural patient-clinic contact, this would present an opportunity to positively influence therapy outcomes, add motivation through faster and better results, and pave the way for long-term maintenance of the achieved weight loss.

It could be argued that our study, with its retrospective, single-institutional, and observational design, is a fairly accurate illustration of routine clinical practice for the comparison of two EBTs. Our study has several strengths, including the fact that our cohort was drawn from routine clinical practice, the robustness of our PS-weighting methodology, and the availability of an adequate sample size for comparison estimates.

The results of this trial should be interpreted within the context of the limitations of the study design: first, although we attempted to reduce bias with a secondary propensity matched analysis, unknown or uncaptured factors may have affected outcomes due to the retrospective design of the study. The frequency of individual clinic visits was higher for OPT, and this could bias results in favor of OPT. The high frequency of contact is a feature of OPT, and because the contact protocols were not equal between groups, we cannot make specific inferences about the individual effect of the observed outcomes. On the other hand, while both treatments were initially payable by the patients, a number of German health insurance companies offer remuneration of up to 80% for patient expenditure on approved diet/fitness programs. Since patients may be more motivated to make a success of entirely privately financed therapies, a bias toward better outcomes of IGB is possible. In addition, due to lacking data, we have no information concerning changes affecting other weight-dependent comorbidities such as hypertension, dyslipoproteinemia, and obstructive sleep apnea.

Conclusion

This PS-matched analysis demonstrated that a medically supervised high-intensity program comprising meal replacements, behavioral education, and a supervised physical exercise program led to clinically significantly greater weight loss at 26 and 52 weeks compared with IGB placement. Moreover, despite incurring higher costs as a result of its more intensive need for personnel and time resources, OPT was found to be more economical in relation to actual weight and BMI reduction and has additional clinical and economic advantages due to its very low complication and adverse event rates. Patients undergoing IGB placement could greatly benefit from an accompanying structured lifestyle and behavioral modification program with regular nutritional counseling, starting well in advance of IGB placement.

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Statement of Ethics

The study was reviewed and approved by the Ethical Review Board of the regional regulatory institution, Landesärztekammer Hessen (ref. No. 2021-2433-evBO). Due to the retrospective and anonymized nature of the data evaluation, patient informed consent was not required.

Conflict of Interest Statement

Miriam Oster, Nathalena Hein, Sophia Theodoridou, and Heiner Krammer have no conflicts of interest to declare. Aysegül Aksan has received consultation fees and research funding from Vifor Pharma and Immundiagnostik AG. Jürgen Stein has received consulting fees from AbbVie, Bristol Myers Squibb, Dr. Schär, Falk, Ferring, Fresenius Kabi, Immundiagnostik, Janssen, Medice, MSD, Pfizer, Pharmacosmos, Shire, Takeda, Thermo Fisher, and Vifor and lecturing fees from Vifor Pharma, and is an advisory board member for AbbVie, Bristol Myers Squibb, Dr. Schär, Ferring, Fresenius Kabi, Immundiagnostik, Janssen, MSD, NPS, Pharmacosmos, Takeda, Vifor, and Shield.

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Author Contributions

Conceptualization: M.O., A.A, and J.S. Methodology, writing – original draft preparation, review, and editing, and visualization: A.A. and J.S. Software and formal analysis: A.A. Validation: M.O., N.H., A.A, and J.S. Investigation: H.K. Resources: N.H., H.K., and J.S. Data curation: A.A., S.T., and J.S. Supervision and funding acquisition: J.S. Project administration: J.S. and M.O. All authors read and approved the submitted version of the manuscript.

Data Availability Statement

The data are available from the corresponding author upon reasonable request.

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