

# Intragastric Balloon Treatment for Obesity: Results of a Large Single Center Prospective Study

Davor Štimac · Sanja Klobučar Majanović ·  
Tamara Turk · Borivoj Kezele · Vanja Licul ·  
Željka Crnčević Orlić

Published online: 14 December 2010  
© Springer Science+Business Media, LLC 2010

## Abstract

**Background** The intragastric balloon is a widely used method in the treatment of obesity indicated for those patients who have failed to achieve and maintain the weight loss with conventional measures or for preparation of patients who are candidates for bariatric surgery.

**Methods** From April 2007 to April 2009, 171 consecutive patients (111 females, 60 males; mean age  $39.2 \pm 10.5$ , mean weight  $123.2 \pm 27.1$  kg) were evaluated before and 6 months after bioenteric intragastric balloon (BIB) placement by assessment of anthropometric and biochemical parameters. **Results** The mean BMI during balloon treatment declined from  $41.9 \pm 7.3$  to  $36.0 \pm 7.9$  kg/m<sup>2</sup> ( $p < 0.001$ ) with a percentage of excess weight loss of  $39.7 \pm 23.6$  and percentage of excess body mass index loss of  $39.5 \pm 25.1$ . A significant improvement in blood pressure, glycemia, and triglyceride level but not in total cholesterol, high-density lipoprotein, and low-density lipoprotein cholesterol levels was seen.

**Conclusion** Results of this large prospective single center study confirmed that intragastric balloon is useful and safe method for promoting weight loss. Due to improvement of metabolic parameters, treatment with BIB results in reduction of cardiovascular risk and provides a sustained benefit on liver function in obese patients.

**Keywords** Bioenteric intragastric balloon · BIB · Obesity · Weight loss · Fatty liver · Cardiovascular risk

## Introduction

Obesity with its devastating health consequences is a worldwide problem and one of the greatest public health challenges in the twenty-first century [1]. The prevalence of obesity in Croatia and other Mediterranean countries is also rapidly rising [2].

The health benefits of weight reduction have been well established but clinically meaningful, and permanent weight loss is frequently difficult to achieve [3, 4]. The conventional treatments (reduced calorie diets, increased physical activity, behavioral modification) are long-lasting and often frustrating procedures with only partial results. Pharmacological therapy has also an important role in the management of obesity, but in spite of the enormous efforts to develop weight loss drugs, only orlistat is currently available and approved for the medical treatment of obesity [5, 6]. Bariatric surgery is the most effective weight loss method available, resulting in long-term sustained weight loss [7]. However, surgical procedures are invasive and burdened with numerous complications, even fatal [8]. Obese subjects with high surgical risk, who do not qualify for the bariatric procedure, constitute a therapeutic problem.

Therefore, there has been a need to critically evaluate the non-surgical therapeutic methods and to improve them. The endoscopic placement of an intragastric balloon constitutes a non-surgical intervention to lose weight. The bioenteric intragastric balloon (BIB®; BioEnterics Corp., Carpinteria, CA, USA), introduced in 1991, is a spherical, elastic, smooth, and seamless balloon made of silicone elastomer that is resistant to gastric acid. Besides BIB, which is the

D. Štimac (✉) · B. Kezele · V. Licul  
Division of Gastroenterology, Department of Internal Medicine,  
University Hospital Rijeka,  
Krešimirova 42,  
Rijeka 51 000, Croatia  
e-mail: davor.stimac@ri.t-com.hr

S. Klobučar Majanović · T. Turk · Ž. Crnčević Orlić  
Division of Endocrinology and Metabolism,  
Department of Internal Medicine, University Hospital Rijeka,  
Krešimirova 42,  
Rijeka 51 000, Croatia

most widely used balloon, some other, air-filled, models (Heliosphere Bag, Endogast) have recently become available [9].

According to recent Cochrane meta-analysis, BIB does not show convincing evidence of significant long-term weight loss as compared with conventional management, and data regarding changes in metabolic parameters are lacking [10]. This clinical prospective study has been designed to evaluate the effectiveness of intragastric balloon application in inducing weight loss and changes in metabolic parameters associated with weight reduction.

## Patients and Methods

### Design of the Study

A prospective single center study was conducted on 171 consecutive obese patients (111 females (65%), 60 males (35%); mean age  $39.2 \pm 10.5$ , range 19–61, mean weight  $123.2 \pm 27.1$  kg, mean BMI  $41.6 \pm 7.5$  kg/m<sup>2</sup>) who had undergone the BIB procedure between April 2007 and April 2009. The study was approved by the local ethical committee and was concordant with Helsinki Declaration. All study participants provided written informed consent.

All patients were screened for major endocrine disorders before admission to the study. Inclusion criteria were BMI > 35 kg/m<sup>2</sup> or BMI > 30 kg/m<sup>2</sup> in patients with comorbidities (type 2 diabetes mellitus, dyslipidemia, hypertension). Exclusion criteria were (1) history of malignancy within the previous 5 years, (2) previous bariatric or gastrointestinal surgery, (3) present alcohol or drug abuse, (4) hormonal or genetic causes of obesity, (5) use of anticoagulants or nonsteroidal anti-inflammatory drugs, (6) pregnancy, and (7) gastric or esophageal varices, angiectasis, large hiatal hernia (>5 cm), grade III or IV esophagitis, duodenal, or gastric ulcer lesions considered to be high risk for bleeding.

The study subjects underwent complete physical examination, anthropometry (body weight, BMI, waist, and hip circumferences), blood pressure measures, and determination of serum triglycerides, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol, glucose, and liver enzymes (ALT, GGT) at baseline and after 6 months. Blood samples were obtained from each patient after an overnight fast, and laboratory analyses were performed by standardized methods. Psychological support and advice were provided to all participants in the study through telephone consultations and regular monthly visits.

Statistical analyses were performed with SPSS 15.0 software (SPSS, Chicago, IL, USA). For comparisons, both parametric (Student's *t* test) and nonparametric (Wilcoxon) tests were used for values normally or not-normally distributed. Data were expressed as means  $\pm$  SD. Statistical

significance was defined as  $p < 0.05$ . Data were analyzed on an intention-to-treat basis.

### Procedure

BIB insertion was performed after diagnostic upper endoscopy, under conscious sedation with midazolam, to rule out abnormalities that would preclude the patient from participation in the study, according to above-mentioned exclusion criteria. Esophagitis and acute gastroduodenal mucosal lesions were present in four (2.3%) and two (1.2%) of patients, respectively, that only postponed balloon insertion. After control endoscopy revealed they were effectively treated with proton pump inhibitor, those patients were included in the study and successfully completed BIB treatment. After being placed in the stomach in collapsed state, the balloon was inflated with 600 mL of saline solution stained with 10 mL methylene blue to allow appropriate follow-up in case of deflation. After each placement, the patient was monitored at least for 3 h to verify tolerance of the balloon. Once able to tolerate fluids, patients were discharged from the hospital with a regular proton pump inhibitor and instructions for a specific eating regimen. The patients were advised to follow a fully liquid diet for the first 3 weeks, half-solid food during the fourth week, and then to continue with the regular meals according to specific dietary instructions. The BIB was removed 6 months later under endoscopic control using the BIB removal kit.

### Outcomes

Primary outcome was to evaluate the effectiveness of the balloon in inducing weight loss so main outcome measures were changes in body weight, BMI, waist and hip circumference, percentage of excess weight loss [(%EWL = weight loss/initial weight – weight at BMI 25)  $\times$  100], and percentage of excess body mass index loss [(%EBMIL = initial BMI – BMI at BIB removal/initial BMI – 25)  $\times$  100]. Secondary outcomes included changes in lipid profile (low-density lipoprotein, high-density lipoprotein, total cholesterol, and triglyceride levels), glucose levels, liver enzyme (ALT, GGT) levels, and blood pressure.

## Results

A total of 165 patients (97%) completed the study. No serious complications were observed in the course of treatment with the BIB. However, nearly all patients complained of discomfort, nausea, and vomiting for the first few days. The symptoms disappeared or lessened remarkably after the first week in all but three patients

resulting in early removal of the balloon (in two patients at second week and one patient at third week after placement, respectively). Intra-gastric balloon was prematurely extracted in another three patients on their personal requirement because of psychological intolerance (within the first week in two patients) and due to vanishing of anticipated effect on food intake in one patient 2 months after BIB insertion. Generally, treatment was well tolerated.

The balloon treatment caused a considerable body weight reduction throughout the study (Fig. 1). The average weight loss was 16.9 kg (range 0–42;  $p<0.0001$ ). The overall mean BMI reduction of 5.8 kg/m<sup>2</sup> was also significant ( $p<0.0001$ ). This represented a mean %EWL of  $39.7\pm23.6$  and %EBMIL of  $39.5\pm25.1$ . The most substantial BMI loss was observed in the most obese patients.

However, 51 patients (31%) lost less than 10% of their initial body weight, while 13 of these patients lost less than 5% of their initial body weight (Fig. 2). The pattern of changes in waist and hip circumferences paralleled the changes in weight and BMI (Table 1).

A significant improvement in blood pressure, glycemia, and triglyceride level but not in total cholesterol, HDL, and LDL cholesterol levels was seen. Compared to baseline values, there was a significant decrease in ALT and GGT values (Table 2).

## Discussion

The intra-gastric balloon technique is widely used for those patients who have failed to achieve and maintain the weight loss with conventional measures. Compared with surgical treatment, BIB can be attractive to patients as it is less

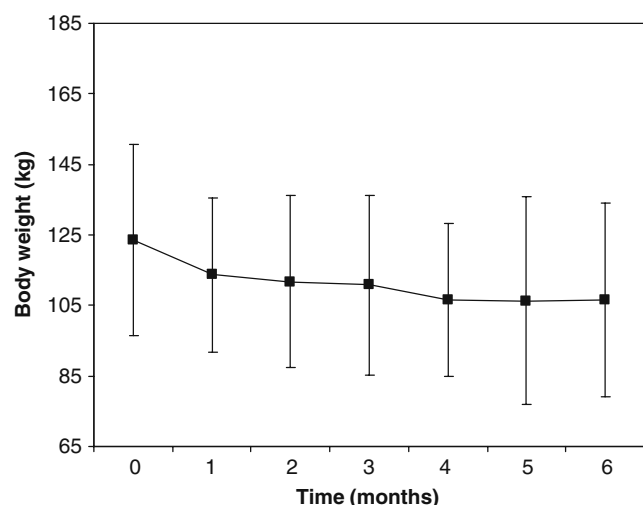


**Fig. 1** Progressive weight loss throughout the study

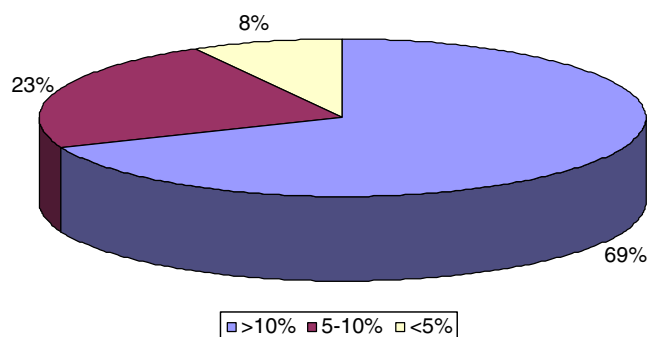


**Fig. 2** Percentage of patients who lost >10%, 5–10%, or <5% of initial weight after 6 months balloon treatment

invasive than surgery. On the other hand, BIB has an important role in the preoperative treatment of morbidly obese patients who are scheduled to undergo bariatric surgery by reducing mortality and morbidity risks [11, 12].

It is considered to be a method of facilitating the implementation of new dietary and behavioral habits [13]. The presence of balloon in the stomach delays gastric emptying, causing a premature sensation of satiety and thus resulting in decreased food consumption.

We observed a loss of 14% of initial weight at the end of the treatment, a quantity considered sufficient to obtain health benefits because it is well-known that even a modest reduction of weight results in significant reduction of comorbidities and obesity-related mortality [14]. The weight reduction is in accordance with other large series of balloon treatment. Herve et al. demonstrated 12-month-long observation of patients after endoscopic treatment with BIB. The mean weight loss at the time of balloon removal was 12 kg and 1 year after the removal 8.6 kg [15]. In agreement with our results, a multicenter study performed in Brazil showed the mean weight reduction of  $15.2\pm10.5$  kg, as well as Spanish authors who reported mean % EWL was 41.6 in their large group of patients [16, 17]. However, Ganesh et al. reported a modest impact of BIB treatment on body mass reduction, only 5.9 kg after 6 months of therapy and 1.9 kg at 1-year follow-up [18]. Furthermore, Mathus-Vliegen and Tytgat presented that the proportion of patients who maintained 10% of baseline weight loss had dropped from 75% to 47% during the year following BIB removal, and Dastis et al. demonstrated that intra-gastric balloon therapy was associated with weight loss maintenance at 2.5 years in a quarter of participants [19, 20]. The latest Cochrane systematic review over intra-gastric balloon in the treatment of obesity states that it is a temporary anti-obesity treatment, which induces only a short-term weight loss [10]. For most obese people, long-term weight loss is still difficult to achieve, and current therapies for obesity do not provide sufficient support for obese subject to adhere to the required life style changes.

**Table 1** Weight loss parameters at baseline and at the end of the study

|                          | Day 0<br>Mean±SD | Day 180<br>Mean±SD | <i>p</i> | Difference |
|--------------------------|------------------|--------------------|----------|------------|
| Weight (kg)              | 123.2±27.1       | 106.3±27.3         | 0.0001   | −16.9      |
| BMI (kg/m <sup>2</sup> ) | 41.6±7.5         | 35.8±7.9           | 0.0001   | −5.8       |
| Waist circumference (cm) | 127.8±16.7       | 113.3±18.9         | 0.0001   | −14.5      |
| Hip circumference (cm)   | 127.9±12.2       | 116.3±10.8         | 0.0001   | −11.6      |

A combination of therapies might prove valuable: In a nonrandomized controlled trial, a 6-month course of sibutramine after BIB removal allowed limiting weight regain at 1.8 kg compared to 6.8 kg in patients receiving no weight-loss medication [21]. The use of an intragastric balloon must be integrated into a weight-care program that must be continued after balloon removal to maintain the weight reduction.

Obesity plays a key role in the metabolic syndrome [22]. Visceral fat accumulation, above all in the liver, is associated with a cluster of metabolic alterations, i.e., type 2 diabetes, hypertension, and dyslipidemia. The main link among obesity, fatty liver, and the metabolic syndrome is represented by insulin resistance [23, 24]. In obese patients, insulin sensitivity impairment and hepatic injury is significantly associated with increased levels of liver enzyme [25]. As previously reported, enzyme levels, even within the upper half of the normal range, may predict the early stages of fatty liver disease in obese subjects [26]. After 6 months of BIB placement, we observed a significant decrease of both enzymes. In accordance with other studies, we confirm that weight loss may reduce the risk of liver injury by decreasing the liver enzyme levels [27]. In this way, even temporary treatment by means of BIB, associated with diet restriction, may provide a sustained benefit on liver function and on insulin sensitivity.

Participants in our study experienced favorable overall metabolic effects. Weight loss associated with BIB treatment resulted in a significant decline in both systolic and diastolic blood pressure, improvement in glycemic control, and decrease in concentration of serum triglycerides. The exception to this pattern has been cholesterol concentration. Contrary to the expectations, there were no significant differences in LDL, HDL, and total cholesterol concentration despite significant weight reduction. Konopko-Zubrzycka et al., on the other hand, demonstrated a decrease in concentration of LDL and total cholesterol and increase in plasma HDL in patients with morbid obesity [28].

An excessive visceral accumulation of adipocytes that constitute metabolically active tissue is associated with greater cardiovascular risk. Cutoffs indicating a significantly increased risk are waist circumference over 80 cm in women and over 94 cm in men. So, decrease in waist circumference is particularly important in diminishing cardiovascular risk in obese patients. Treatment with BIB led to significant reduction in waist circumference.

Strengths of the current study relative to previous trials include a large sample size, lower attrition rate, and intention-to-treat analysis. The lack of control group, randomization, and longer follow-up strategy represent limitations of present study.

**Table 2** Changes in blood pressure and biochemical parameters before insertion of BIB and at its removal

|                            | Day 0<br>Mean ± SD | Day 180<br>Mean ± SD | <i>p</i> | Difference |
|----------------------------|--------------------|----------------------|----------|------------|
| Systolic BP (mmHg)         | 130.9±14.5         | 124.2±14.1           | 0.0045   | −6.7       |
| Diastolic BP (mmHg)        | 85.9±9.5           | 81.9±10.5            | 0.016    | −4.0       |
| Blood glucose (mmol/L)     | 5.2±1.1            | 4.6±0.8              | 0.0004   | −0.6       |
| BUN (mmol/L)               | 4.3±1.2            | 3.6±1.0              | 0.0007   | −0.7       |
| GGT (IU/L)                 | 33.3±23.3          | 24.7±16.9            | 0.008    | −8.6       |
| ALT (IU/L)                 | 34.7±31.5          | 26.5±23.1            | 0.008    | −8.2       |
| Triglycerides (mmol/L)     | 1.34±0.99          | 0.92±0.75            | 0.003    | −0.4       |
| Total cholesterol (mmol/L) | 4.95±1.02          | 4.96±1.05            | 0.942    | 0.01       |
| HDL (mmol/L)               | 0.80±0.49          | 0.76±0.63            | 0.648    | −0.04      |
| LDL (mmol/L)               | 2.99±0.8           | 3.0±0.8              | 0.922    | 0.01       |

## Conclusion

This is one of the largest single center reported cohorts of obese patients who underwent BIB insertion for the treatment of obesity. The results of this prospective study, despite its limitations, confirmed that intragastric balloon represents an effective and safe method for promoting weight loss. Due to improvement of metabolic parameters, treatment with BIB results in reduction of cardiovascular risk and provides a sustained benefit on liver function in obese patients.

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

## References

- James WP. The epidemiology of obesity: the size of the problem. *J Intern Med*. 2008;263:336–52.
- Fister K, Kolčić I, Milanović SM, et al. The prevalence of overweight, obesity and central obesity in six regions of Croatia: results from the Croatian Adult Health Survey. *Coll Antropol*. 2009;33 Suppl 1:25–9.
- Fontaine KR, Redden DT, Wang C, et al. Years of life lost due to obesity. *JAMA*. 2003;289:187–93.
- Poirier P, Giles TD, Bray GA, et al. Obesity and cardiovascular disease: pathophysiology, evaluation, and effect of weight loss. *Circulation*. 2006;113:898–918.
- Rucker D, Padwal R, Li SK, et al. Long term pharmacotherapy for obesity and overweight: updated meta-analysis. *BMJ*. 2007;335:1194–9.
- Li M, Cheung BM. Pharmacotherapy for obesity. *Br J Clin Pharmacol*. 2009;68(6):804–10.
- Bult MJ, van Dalen T, Muller AF. Surgical treatment of obesity. *Eur J Endocrinol*. 2008;158:135–45.
- Goldfeder LB, Ren CJ, Gill JR. Fatal complications of bariatric surgery. *Obes Surg*. 2005;16:1050–6.
- Tsesmeli N, Coumaros D. Review of endoscopic devices for weight reduction: old and new balloons and implantable prostheses. *Endoscopy*. 2009;41:1082–9.
- Fernandes M, Atallah AN, Soares BG, et al. Intragastric balloon for obesity. *Cochrane Database Syst Rev*. 2007;(1):CD004931.
- Alfalalah H, Phillipe B, Ghazal F. Intragastric balloon for preoperative weight reduction in candidates for laparoscopic gastric bypass with massive obesity. *Obes Surg*. 2006;16:147–50.
- Frutos MD, Morales MD, Lujan J, et al. Intragastric balloon reduces liver volume in super-obese patients, facilitating subsequent laparoscopic gastric bypass. *Obes Surg*. 2007;17:150–4.
- Zago S, Kornmüller AM, Agagliati D, et al. Benefit from bio-enteric intra-gastric balloon (BIB) to modify lifestyle and eating habits severely obese patients eligible for bariatric surgery. *Minerva Med*. 2006;97:51–64.
- Goldstein DJ. Beneficial health effects of modest weight loss. *Int J Obes Relat Metab Disord*. 1992;16:397–415.
- Herve J, Wahlen CH, Schaeken A, et al. What becomes of patients one year after intragastric balloon removed? *Obes Surg*. 2005;15:864–70.
- Sallet JA, Marchesini JB, Paiva DS, et al. Brazilian multicenter study of the intragastric balloon. *Obes Surg*. 2004;14:991–8.
- Lopez-Nava G, Rubio MA, Prados S, et al. BioEnterics intra-gastric balloon (BIB). Single ambulatory Spanish experience with 714 consecutive patients treated with one or two consecutive balloons. *Obes Surg*. 2010; in press.
- Ganesh R, Rao AD, Baladas HG, et al. The bioenteric intragastric balloon (BIB) as a treatment for obesity: poor results in Asian patients. *Singapore Med J*. 2007;48:227–31.
- Mathus-Vliegen EM, Tytgat GN. Intragastric balloon for treatment-resistant obesity: safety, tolerance, and efficacy of 1-year balloon treatment followed by a 1-year balloon-free follow-up. *Gastrointest Endosc*. 2005;61:19–27.
- Dastis NS, Francois E, Deviere J, et al. Intragastric balloon for weight loss: results in 100 individuals followed for at least 2.5 years. *Endoscopy*. 2009;41(7):608–11.
- Machytka E, Klvan P, Hanuskova I, et al. Use of pharmacotherapy for long-term maintenance of weight loss following explanation of intragastric balloon (BIB). *Gut*. 2007;57:A290.
- Alberti KG, Zimmet PZ, Shaw J. The metabolic syndrome—a new worldwide definition. *Lancet*. 2005;366:1059–62.
- Bugianesi E, McCulloch AJ, Marchesini G. Insulin resistance: a metabolic pathway to chronic liver disease. *Hepatology*. 2005;42:987–1000.
- Wallace TM, Utzschneider KM, Tong J, et al. Relationship of liver enzymes to insulin sensitivity and intra-abdominal fat. *Diabetes Care*. 2007;30:2673–8.
- Marchesini G, Avagnina S, Barantani EG, et al. Aminotransferase and gamma-glutamyltranspeptidase levels in obesity are associated with insulin resistance and the metabolic syndrome. *J Endocrinol Invest*. 2005;28:333–9.
- Chang Y, Ryu S, Sung E, et al. Higher concentrations of alanine aminotransferase within the reference interval predict nonalcoholic fatty liver disease. *Clin Chem*. 2007;53:686–92.
- Ricci G, Bersani G, Rossi A, et al. Bariatric therapy with intragastric balloon improves liver dysfunction and insulin resistance in obese patients. *Obes Surg*. 2008;18:1438–42.
- Konopko-Zubrzycka M, Kowalska I, Wroblewski E, et al. The effect of intragastric balloon on serum lipids level in patients with morbid obesity. *Pol Merkurius Lekarski*. 2009;26(155):430–4.