Intragastric Balloon for Overweight Patients

Flavio Augusto Martins Fernandes, Jr, MD, MSc, Gustavo L. Carvalho, MD, PhD, Diego L. Lima, MD, Prashanth Rao, MD, Phillip P. Shadduck, MD, Isabelle D. Montandon, Juscielle de Souza Barros, Ingrid Lais Vieira Rodrigues

ABSTRACT

Background and Objectives: Current treatments for overweight adults include reduced-calorie diet, exercise, behavior modification, and selective use of medications. Many achieve suboptimal results with these measures and progress to obesity. Whether the intragastric balloon (IGB), a reversible device approved for treatment of obesity, is a safe and effective option in overweight adults is less well studied. We conducted a study to prospectively analyze the safety and effectiveness of IGB in overweight adults, to compare the results to a simultaneously studied cohort of obese patients, and to share procedural tips for safe IGB placement and removal.

Methods: One hundred thirty-nine patients were evaluated in this prospective, nonrandomized study. Twenty-six overweight [body mass index (BMI), 26–30)] and 113 obese (BMI > 30) patients underwent outpatient, endoscopic IGB placement under intravenous sedation. The IGB was filled with a 550–900 mL (average, 640 mL) solution of saline, radiological contrast, and methylene blue, with an approximate final proportion of 65:2:1. The patients were followed up at 1–2 weeks and then monthly for 6 months. At 6 months, they underwent IGB removal via an esophageal overtube to optimize safety, and then they were observed for 6 more months.

Results: IGB time was 190 ± 36 d in the overweight patients and 192 ± 43 d in the obese patients. Symptoms of IGB intolerance included nausea and pain, which were transiently present in 50–95% of patients for several days, and necessitated early IGB removal in 6% of patients. There were no procedure-related complications and no IGB-related esophagitis, erosion, perforation, or obstruction. The percentage of excess weight loss (EWL%) was 96 ± 54% in the overweight group and 41 ± 26% in the obese group ($P < 0.001$).

Conclusion: In overweight adults failing standard treatments, IGB placement for 6 months had an acceptable safety profile and excellent weight loss.

Key Words: Endoscopic device, Intragastric balloon, Obesity, Overtube. Overweight.

INTRODUCTION

In comparison with the normal-weight population, the overweight population has increasing morbidity, including dyslipidemia, diabetes, hypertension, coronary artery disease, cerebrovascular disease, liver disease, respiratory disorders, polycystic ovary syndrome, and some cancers.[1,2] Overweight often progresses to obesity, with even greater morbidity and mortality. There is a growing desire, both at the individual and the public health level, to address metabolic and weight disorders at the initial overweight stage. The standard recommendations for treating overweight individuals are based on the tri-pronged approach of reduced-calorie diets, increased physical activity, and behavioral change.[1–4] Current evidence reveals that this approach results in weight loss of only 4–10% over 4–12 months.[5] Some strategies add weight-loss medications, including sibutramine and orlistat, considered adjunctive therapies to dietary, physical activity, and behavioral changes.[6,7] The failure of these approaches may allow progression of overweight to obesity and need for weight-loss surgery, including Roux-en-Y gastric bypass and sleeve gastrectomy.

Faculty of Medical Sciences, University of Pernambuco, Recife, Brazil (Drs Martins Fernandes, Carvalho, and Lima and Ms de Souza Barros and Ms Rodrigues).

Clinica Cirurgica Videolaparoscopica Gustavo Carvalho, Recife, Brazil (Dr Carvalho).

TOA Surgical Specialists, Durham, North Carolina, USA (Drs Lima, Shadduck).

Global Hospitals and Mamata Hospital, Mumbai, India (Dr Rao).

North Carolina Specialty Hospital; Department of Surgery, Duke Regional Hospital; and Department of Surgery, Duke University, Durham, North Carolina, USA (Dr. Shadduck).

Disclosures: GLC reports personal (consultant) fees from Silimed (Rio De Janiero, Brazil) and nonfinancial support from Karl Storz (Tuttlingen, Germany) outside the submitted work. PPS reports personal (consultant) fees from Allergan Medical (Parsippany, New Jersey, USA), personal (clinical research and consultant) fees from LifeCell (Branchburg, New Jersey, USA), personal (consultant) fees from Teleflex Medical (Wayne, Pennsylvania, USA), and personal (consultant) fees from TransEnterix (Morrisville, North Carolina, USA), outside the submitted work. FAMF, DLL, PR, IDM, JSB, and ILVR declare that they have no conflicts of interest.

Address correspondence to: Gustavo Carvalho, MD, PhD, MBA, Rua Visconde de Jequitinhonha, 1144 Sl.910 CEP: 51030-020 Recife–PE, Brazil. Telephone: +55 81 99971-9698, Fax: +55 81 2129-1910, E-mail: glcmd1@gmail.com

DOI: 10.4293/JSLS.2015.00107

The intragastric balloon (IGB), a reversible, endoscopically placed, space-occupying device approved for limited-term use in obese patients,[8,9] is generally perceived to be an intervention after failure of lifestyle modifications and pharmaceuticals, but before weight loss surgery, in the spectrum of treatment options for obesity.[10–12] IGB safety and effectiveness are well established in the treatment of obesity, as documented in many retrospective studies, prospective clinical trials, and, recently, 2 systematic reviews and meta-analyses.[11–18]

Because the IGB is a reversible, nonsurgical procedure that has demonstrated effectiveness in patients with obesity, extending its application to the overweight population seems logical and attractive from both a clinical and a public health perspective.[3,16,19–21] However, its safety, effectiveness, and value in overweight individuals have not been well studied.[18,19] An IRB-approved, prospective study was undertaken to help determine the results of the IGB in overweight adults and to compare these results with those in a simultaneously studied group of obese patients.

MATERIALS AND METHODS

Patients

A prospective, single-institution study was conducted at the University of Pernambuco (Recife, Brazil) from June 2006 through November 2011. The study was approved by the Institutional Review Board of the University of Pernambuco. One hundred forty-eight consecutive adults aged 18–65 years participated in the study, and 139 of those completed the study and were available for analysis. Twenty-six patients were overweight (BMI 26–30) and 113 were obese (BMI > 30). In all participants, standard lifestyle interventions had failed, with or without medications, with weight loss of <10%. Exclusion criteria included pregnancy; coexistent upper gastrointestinal (GI) disease, including hiatal hernia, grade 3–4 esophagitis, esophageal stricture, megaesophagus, esophagogastric varices, esophageal cancer, and prior esophageal surgery; inflammatory bowel disease; and major neurologic, psychologic, cardiac, pulmonary, hepatic, renal, or other organ system dysfunction. All patients who chose to participate in the study provided their informed consent. All study enrollees underwent evaluation in a multidisciplinary weight loss clinic, including consultations with an endocrinologist, nutritionist, psychologist, gastroenterologist, and bariatric surgeon.

IGB Placement

The IGB (Silimed, Rio de Janeiro, Brazil) was supplied empty and delicately rolled up inside a thin silicone sheath, making placement and positioning in the gastric fundus by endoscope possible. The device consists of a smooth, transparent silicone shell that assumes a round shape when placed in the gastric fundus and filled with fluid. IGB placement is summarized in **Figure 1**. Immediately before placing the IGB, a diagnostic upper GI endoscopy was performed with the patient under conscious sedation, to rule out coexistent conditions that might have precluded placement. A snare holding the tip of the balloon sheet was then introduced with the endoscope, and the balloon was filled under endoscopic guidance. The filling procedure was continually monitored until an optimal ratio of IGB volume to gastric fundus capacity was achieved for each patient. Filling to the optimal size for each stomach required 550–900 mL (average, 640 mL). Fixed volumes of iopamidol contrast (20 ml Lopamiron; Bracco Imaging, Courcouronnes, France) and 2% methylene blue (10 mL) were added to 520–870 mL of saline, with a final proportion of ~65:2:1.

Patient Follow-Up

Patients were evaluated in the clinic 1–2 weeks after IGB placement, monthly for 6 months after IGB placement, 6 months after IGB removal, and additionally as needed. Routine evaluations were performed by the nutritionist, psychologist, and surgeon. Weight was measured, and clinical evaluations were performed at every visit. Routine laboratory studies were performed before IGB placement and removal. Abdominal ultrasound was performed before IGB removal for scientific purposes, to obtain data on the abdominal and subcutaneous fat in this population. These data have been published separately.[31]

IGB Removal

Six months after IGB placement, the patients underwent endoscopy under conscious sedation, with routine use of an esophageal (25-cm-long) silicone double overtube (Guardus overtube; US Endoscopy, Mentor, Ohio, USA) for airway protection. The balloon was punctured, deflated, and removed with a polypectomy snare through the overtube (**Figures 2**, **3**).

Data Analysis

Data analysis was performed by an independent biostatistician. Weight (kg), weight loss (kg), and EWL% (based on ideal BMI = 25) were calculated. Data are presented as

Figure 1. IGB placement. (**A**) A polypectomy snare is used to grasp the tip of balloon sheet, and the balloon is inserted together with the endoscope. (**B**) Retrograde view of the endoscope (J-maneuver) showing the balloon totally inserted into the stomach fundus, just before it is filled. (**C**) Two syringes are used to fill the balloon. The blue syringe contains a solution of saline, radiological nonionic contrast (iopamiron) 20 mL, and methylene blue 1% 20 mL; the other syringe contains only saline. (**D**) When the fluid in the IGB reaches 100–150 mL, the sheet ruptures. (**E**) The filling is carefully monitored to so that the balloon reaches the most suitable size. At 350 mL, the balloon assumes a perfectly round shape. (**F**) After the balloon is filled completely, the insertion catheter is removed without any special maneuver, and the valve is carefully checked for leakage.

the mean, standard deviation, and range. The normal distribution of variables was assessed with the D'Agostino Pearson test. For variables with normal distribution, Student's *t*-test was used for paired samples and the *Z*-test for independent samples. For variables without normal distribution, the Mann-Whitney test was used to compare the means of 2 independent samples and the Wilcoxon test to compare the means of paired samples.

RESULTS

Of the 148 study participants, 9 (1 overweight, 8 obese) withdrew because of IGB intolerance requiring early IGB removal, leaving 139 patients who completed the study: 26 overweight and 113 obese. The mean initial weight was 78.4 ± 9.6 kg in the overweight group and 99.8 ± 22.9 kg in the obese cohort (**Table 1**). The average time with the balloon was 189.6 ± 36.1 days in the overweight group and 191.5 ± 42.7 days in the obese group.

There were no procedure-related complications caused by the endoscopic introduction or removal of the IGB. The most common adverse events were early symptoms of IGB intolerance: nausea (95%), vomiting (90%), and epigastric pain (50%), which was transient in all but the 9 patients (6% of the initial 148 patients) who had early IGB removal. There were no cases of esophagitis, gastric erosion, gastric perforation, peptic ulcer, or gastrointestinal obstruction. There were no deaths.

After removal of the IGB at 6 months, the mean weight in the overweight group was 68.5 ± 9.1 kg, yielding an average weight loss of 9.8 ± 5.1 kg. The final mean weight in the obese group was 88.8 ± 20.6 kg, for an average weight loss of 10.9 ± 7.5 kg ($P = .32$). These data yield a mean EWL% of 96 ± 54% in the overweight cohort and 41.0 ± 25.7% in the obese cohort ($P < 0.001$; **Table 2**). Based on their EWL%, 7.7% of the overweight patients and 20.4% of the obese patients had unsatisfactory results,

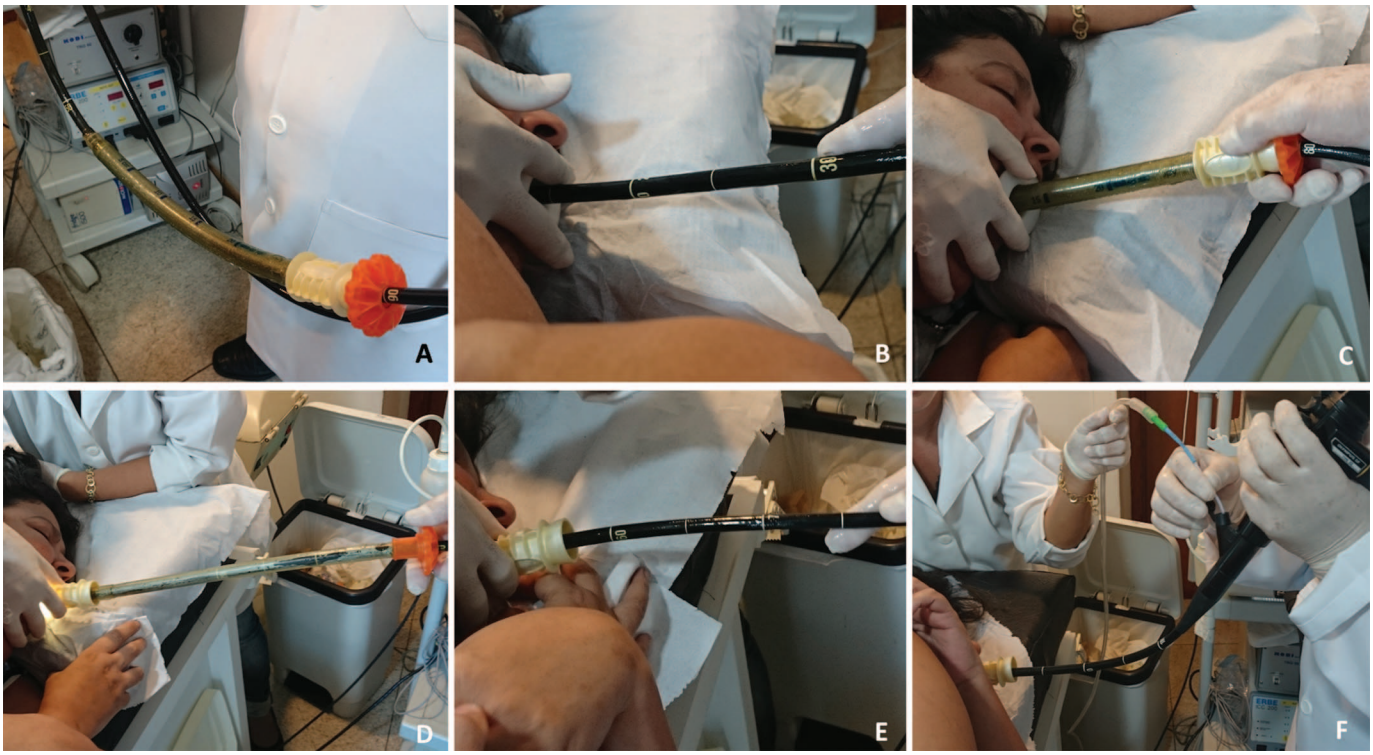

Figure 2. A silicone double overtube is used to protect the airways during the removal procedure. (**A**) The overtube is placed over the endoscope. (**B**) The endoscope is inserted into the stomach. (**C**) Once the tip is inside the stomach, excess liquid is extracted, and the double overtube is carefully inserted into the esophagus. (**D**) The endoscope and the softer inner part of the overtube are removed. (**E**) Now, the endoscope can be safely reinserted into the stomach to proceed with balloon removal. (**F**) A needle is inserted, to puncture the balloon and remove the liquid by suction.

15.4% of the overweight group, and 51.3% of the obese group had good results, and 76.9% of the overweight patients and 28.3% of the obese patients experienced very good results.

DISCUSSION

Overweight patients have fewer therapeutic alternatives than obese patients, if they experience failure of standard interventions (reduced calorie diets and increased exercise). The IGB is a therapeutic alternative that is less invasive than surgery, is reversible and temporary, and can result in significant weight loss.[8–18]

In the present study, the placement and removal of the balloon were performed on an outpatient basis with the patient under conscious sedation (**Figures 1–3**). During the IGB removal, an overtube device was placed to protect the airway (**Figures 2, 3**). In many studies of IGB placement, general anesthesia was used for placement and removal.[16,17,18,22,23] In some of these studies, patients stayed in the hospital for 24 hours. A multicenter retrospective study reported that conscious sedation offers greater safety for avoiding aspiration than general anesthesia. In the same study, the use of general anesthesia was associated with a 4.8% rate of aspiration.[22] The use of conscious sedation, airway protection with an overtube, and performance by an experienced endoscopist may explain the absence of severe endoscopy-related complications in the present study.[17,18]

Early transient symptoms of intolerance are common with the IGB. In the current study, 90% of the patients presented with mild symptoms of IGB intolerance and 25% presented with more intense symptoms that required hospitalization; IGB removal was necessary in 9 of the initial 148 patients (6%). These numbers are similar to those reported by Genco et al[14] and Roman et al.[23] Sallet et al[15] reported a 3.4% withdrawal rate, and 4.6% of patients required hospital admission because of symptoms of intolerance. In a meta-analysis, Imaz et al[12] found that 8.6% of their patients experienced nausea and vomiting, 5% presented with abdominal pain, and 1.1% had early IGB

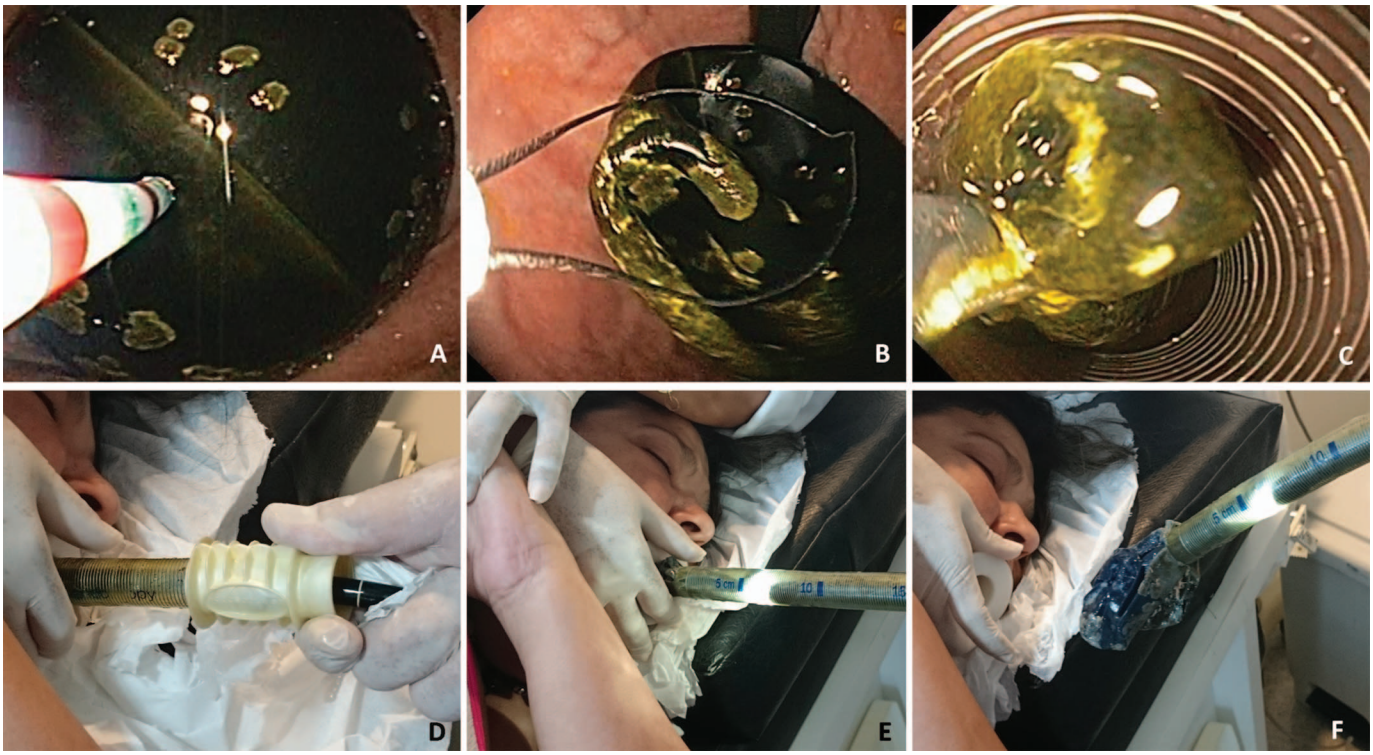

Figure 3. Balloon removal. (**A**) After puncture, the suction catheter is inserted and the balloon is deflated. (**B**) A polypectomy snare is used to grasp the empty balloon in one corner; in the unlikely event that the balloon has no corner, but is flat, the use of double-hook forceps is recommended. (**C**) Part of the balloon is gently brought inside the overtube (~20%). (**D**) The assembly with the endoscope, balloon, and overtube are removed ensemble. (**E, F**) The balloon and the overtube are removed simultaneously, enhancing the protection of the airways and thus ensuring the procedure's safety.

Table 1.
Characteristics of the Overweight and Obesity Groups

	Overweight	Obesity	*P*
Patients, n	26	113	
Sex, %			
Male	3.85 %	35.40 %	
Female	96.15 %	64.60 %	
Age, years	38.81 ± 11.18 (18–56)	36.97 ± 10.75 (18–64)	0.47*
Weight, kg	78.4 ± 9.6 (58.9–98)	99.8 ± 22.9 (72.4–205)	<0.0001**
BMI (kg/m^2)	28.58 ± 1.17 (26.22–29.97)	35.82 ± 5.32 (30.12–55.61)	<0.0001**
Balloon volume, ml	637.50 ± 57.29 (480–730)	668.70 ± 60.60 (530–900)	0.03**
Period with balloon, days	189.63 ± 36.10 (100–252)	191.46 ± 42.69 (98–375)	0.8**

Data are the mean ± SD (range) unless otherwise specified.

*Z test.

** Mann-Whitney test.

Table 2.
Comparison Between IGB effect in weight loss of overweight and obese patients.

	Overweight	Obesity	*P*
Weight (kg)			
Before	78.4 ± 9.6	99.8 ± 22.9	
After[a]	68.5 ± 9.1	88.8 ± 20.6	
BMI (kg/m^2)			
Before	29.0 ± 1.5	35.8 ± 5.3	
After[b]	25.3 ± 1.9	31.9 ± 5.0	
Weight range, kg	9.8 ± 5.1	11.0 ± 7.5	0.32*
Weight loss, %	12.44 ± 6.27	10.96 ± 6.20	0.36**
EWL%	95.81 ± 54.49	41.01 ± 25.70	<0.001

[a]Comparison between before and after IGB means by Wilcoxon test, with $P < 0.001$.

[b]Comparison between before and after IGB means by Student's *t*-test, with $P < 0.0001$.

*Mann-Whitney test.

***Z* test.

withdrawal. What factors predict IGB intolerance? In our review of the literature, we found no relationship between patient BMI and IGB intolerance and no relationship between IGB volume and signs of intolerance. Placement of the balloon in the gastric fundus is related to more abdominal pain and reflux symptoms, whereas placement in the antrum is related to more nausea and vomiting.[24]

The early intolerance symptoms of nausea, vomiting, and epigastric pain usually resolve within the first 24–48 hours after balloon placement. These symptoms are minimized and managed by routine implementation of a liquid diet for the first 3 days after IGB placement and the use of proton pump inhibitors and antiemetics. When the symptoms of intolerance do not improve within 48 h, the patient is hospitalized and given fluids and medications intravenously for 24 h. The criterion for early balloon removal in our study was no improvement in intolerance symptoms with inpatient management and intravenous medications.

At the end of the 6-month IGB treatment period, 100% of the overweight patients (26/26) and 98% of the obese patients (111/113) showed significant weight loss. The effectiveness of the IGB is generally reported as a percentage of weight loss (based on preintervention weight) or percentage of excess weight loss (based on weight above BMI 25). Weight loss of 5–15% of initial weight is generally needed to reduce weight-related morbidity.[4,25] Herve et al[16] and Angrisani et al[26] classified their results into 3 categories using the EWL%: (1) EWL% <20, unsatisfying result; (2) EWL% 20–50, good result; and (3) EWL% >50, very good result. In the current trial, the mean percentage of weight loss was 12.4% in the overweight group and 11.0% in the obese group, and the EWL% averaged 96% in the overweight group and 41% in the obese group ($P < 0.001$).

Most studies of the IGB have included only obese patients (BMI >30). There are few studies that evaluated the IGB in overweight patients (BMI 25–30). Herve et al[16] reported an EWL% of 43.4 in overweight patients, Sallet et al[15] described an EWL% of 76.7 in their patients with a BMI of 25–30, Dastis et al[27] found that patients with a BMI of 28–29 had an EWL% of 60, and Mui et al[28] reported an EWL% of 87. In the current study, 77.3% of the overweight individuals had very good results, and only 9.1% of overweight individuals experienced unsatisfactory results. Although the collective experience of the IGB in overweight patients is still fairly limited, it appears to compare favorably to what has been seen with the IGB in the obese population, as reported by Dumonceau[11] in his meta-analysis, where he noted that "it is important to inform candidates about the percentage of nonresponders with the use of the intragastric balloon," because 20–40% of patients fail to achieve significant weight loss.

The primary mechanism of action of the IGB in obese patients is to produce early satiety by its restrictive effect. It is believed that the IGB has a similar mechanism in overweight patients. Other mechanisms of action may also be important. Nikolic et al[30] demonstrated a relation-

ship between the hyperresponsiveness of ghrelin, BMI, and greater weight loss. Two other studies focusing on the hormonal and metabolic profiles of patients with the IGB reported conflicting results.[8,29] Further research is needed in this area to improve our understanding of the effects of the IGB, especially in overweight patients.

Because the IGB is intended to be a temporary and reversible intervention (removed after 6 months) the long-term effectiveness of the approach remains to be established. In a double-blind randomized controlled trial published by Genco et al,[14] patients were divided into 2 groups: one with IGB for 3 months followed by a sham procedure for 3 months, and the other with a sham procedure for 3 months followed by IGB for 3 months. Weight loss after 6 months was higher in the group that had the balloon in the first 3 months. The authors opined that the balloon had an effect on feeding behavior that persisted even after its removal. Alfredo et al[32] conducted a prospective, 6-year study in obese patients and found that serial IGB placements further improved weight loss. Based on these findings, the restrictive effect of the balloon may provide a positive reinforcement that persists beyond removal, with early satiety and weight loss promoting continued behavioral change[27] and with improved lung function, metabolic parameters, and body fat distribution.[31,33]

CONCLUSION

In overweight adults in whom standard weight reduction treatments with lifestyle changes and pharmaceutical interventions had failed, IGB placement for 6 months had an acceptable safety profile and resulted in excellent weight loss. Symptoms of IGB intolerance were mild, were treated with over-the-counter medications, and were self-limiting in most patients. There were no major gastrointestinal complications and no deaths. In 92.3% of the overweight patients, weight loss was either very good or good, with a mean EWL% of 96%. The results of the present study, along with the earlier literature, support further clinical study of the IGB in overweight adults.

References:

1. WHO. Obesity: preventing and managing the global epidemic. Report of a WHO Consultation. *Health Organ Tech Rep Ser*. 2000;894:1–253.

2. Buchwald H. The evolution of metabolic/bariatric surgery. *Obes Surg*. 2014;24:1126–1135.

3. Hainer V, Toplak H, Mitrakou A. Treatment modalities of obesity: what fits whom? *Diabetes Care*. 2008;31(Suppl 2):S269–S277.

4. Wolf AM, Woodworth KA. Obesity prevention: recommended strategies and challenges. *Am J Med*. 2009;122:S19–S23.

5. Neligan PJ, Williams N. Nonsurgical and surgical treatment of obesity. *Anesthesiol Clin North Am*. 2005;23:501–523.

6. Cannon CP, Kumar A. Treatment of overweight and obesity: lifestyle, pharmacologic, and surgical options. *Clin Cornerstone*. 2009;9:55–68.

7. Bray GA. Drug treatment of obesity. *Rev Endocr Metab Disord*. 2001;2:403–418.

8. Nieben OG, Harboe H. Intragastric balloon as an artificial bezoar for treatment of obesity. *Lancet*. 1982;1:198–199.

9. Schapiro M, Stanley B, Frank B, et al. Obesity and the gastric balloon: a comprehensive workshop. Tarpon Springs, FL, March 19–21, 1987. *Gastrointest Endosc*. 1987;33:323–327.

10. Gostout CJ, Rajan E. Endoscopic treatments for obesity: past, present, and future. *Gastroenterol Clin North Am*. 2005;34:143–150.

11. Dumonceau JM. Evidence-based review of the bioenterics intragastric balloon for weight loss. *Obes Surg*. 2008;18:1611–1617.

12. Imaz I, Martínez-Cervell C, García-Alvarez EE, et al. Safety and effectiveness of the intragastric balloon for obesity: a meta-analysis. *Obes Surg*. 2008;18:841–846.

13. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. *JAMA*. 2004;292:1724–1737.

14. Genco A, Cipriano M, Bacci V, et al. BioEnterics intragastric balloon (BIB): a short-term, double-blind, randomised, controlled, crossover study on weight reduction in morbidly obese patients. *Int J Obes*. 2006;30:129–133.

15. Sallet JA, Marchesini JB, Paiva DS, et al. Brazilian multicenter study of the intragastric balloon. *Obes Surg*. 2004;14:991–998.

16. Herve J, Wahlen CH, Schaeken A, et al. What becomes of patients one year after the intragastric balloon has been removed? *Obes Surg*. 2005;15:864–870.

17. Carvalho GL, Barros CB, Okazaki M, et al. An improved intrgastric balloon procedure using a new balloon: preliminary analysis of safety an efficiency. *Obes Surg*. 2011;21:924–927.

18. Carvalho GL, Barros CB, Moraes CE, et al. The use of an improved intragastric balloon technique to reduce weight in pre-obese patients: preliminary results. *Obes Surg*. 2011;21:924–927.

19. Czernichow S, Batty GD. Withdrawal of sibutramine for weight loss: where does this leave clinicians? *Obes Facts*. 2010; 3:155–156.

20. Curfman GD, Morrissey S, Drazen JM. Sibutramine: another flawed diet pill. *N Engl J Med*. 2010;363:972–974.

21. Ogden CL, Yanovski SZ, Carroll MD, Flegal KM. The epidemiology of obesity. *Gastroenterology*. 2007;132:2087–2102.

22. Messina T, Genco A, Favaro R, et al. Intragastric balloon positioning and removal: sedation or general anesthesia? *Surg Endosc*. 2011;25:3811–3814.

23. Roman S, Napoléon B, Mion F, et al. Intragastric balloon for "non-morbid" obesity: a retrospective evaluation of tolerance and efficacy. *Obes Surg*. 2004;14:539–544.

24. Oesch S, Rüegg C, Fischer B, et al. Effect of gastric distension prior to eating on food intake and feelings of satiety in humans. *Physiol Behav*. 2006;87:903–910.

25. Billington CJ, Epstein LH, Goodwin NJ, et al. Overweight, obesity, and health risk. *Arch Intern Med*. 2000;160:898–904.

26. Angrisani L, Lorenzo M, Borrelli V, et al. Is bariatric surgery necessary after intragastric balloon treatment? *Obes Surg*. 2006; 16:1135–1137.

27. Dastis NS, François E, Deviere J, et al. Intragastric balloon for weight loss: results in 100 individuals followed for at least 2.5 years. *Endoscopy* 2009;41:575–580.

28. Mui WL, Ng EK, Tsung BY, et al. Impact on obesity-related illnesses and quality of life following intragastric balloon. *Obes Surg*. 2010;20:1128–1132.

29. Konopko-Zubrzycka M, Baniukiewicz A, Wróblewski E, et al. The effect of intragastric balloon on plasma ghrelin, leptin, and adiponectin levels in patients with morbid obesity. *J Clin Endocrinol Metab*. 2009;94:1644–1649.

30. Nikolic M, Boban M, Ljubicic N, et al. Morbidly obese are ghrelin and leptin hyporesponders with lesser intragastric balloon treatment efficiency: ghrelin and leptin changes in relation to obesity treatment. *Obes Surg*. 2011;21:1597–1604.

31. Cabral LC, Carvalho GL, de Melo RA, et al. Analysis of subcutaneous and visceral fat after gastric balloon treatment. *JSLS*. 2015;19:e2015.00023.

32. Alfredo G, Roberta M, Massimiliano C, et al. Long-term multiple intragastric balloon treatment: a new strategy to treat morbid obese patients refusing surgery: prospective 6-year follow-up study. *Surg Obes Relat Dis*. 2014;10:307–311.

33. Mafort TT, Madeira E, Madeira M, et al. Six-month intragastric balloon treatment for obesity improves lung function, body composition, and metabolic syndrome. *Obes Surg*. 2014;24:232–240.