Horizon Scanning in Surgery: Application to Surgical Education and Practice

Endoluminal treatments for obesity

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Disclaimer

This report is not a comprehensive systematic review. Rather, it is an assessment of an emerging surgical procedure or technology in which the methodology has been limited in one or more areas to shorten the timeline for its completion.

Therefore, this report is a limited evidence-based assessment that is based on a search of studies published in the peer-reviewed literature. This report is based on information available at the time of research and cannot be expected to cover any developments arising from subsequent improvements in health technologies. This report is based on a limited literature search and is not a definitive statement on the safety, effectiveness or cost-effectiveness of the health technology covered.

This report is not intended to be used as medical advice or to diagnose, treat, cure or prevent any disease, nor should it be used for therapeutic purposes or as a substitute for a health professional's advice. The Australian Safety and Efficacy Register of New Interventional Procedures – Surgical (ASERNIP-S) does not accept any liability for any injury, loss or damage incurred by use of or reliance on the information.

Objective

This horizon scanning assessment provides short, rapidly completed, 'state of play' documents. These provide current information on technologies to alert clinicians, planners and policy makers of the advent and potential impact of a new or emerging procedure or device. This information can then assist clinicians, planners and policy makers to control and monitor the introduction of new health technologies as well as assist in the prioritization and allocation of resources to promote efficient utilization of available resources.

This report is a preliminary summary of the safety, effectiveness and cost-effectiveness of endoluminal treatments for obesity

Introduction

Background

The rapid rise of obesity has led to the introduction of various new treatments in the past decade. Despite the fact that the basic principle of weight loss is relatively straightforward - reduce food consumption and increase physical activity- attaining and maintaining long-term weigh loss can be very challenging. The initial treatment for obesity involves dietary management, exercise and behavioural modifications, but long-term studies on the use of these treatments, in conjunction with supplemental drug therapy, have failed to demonstrate sustained weight loss in the vast majority of patients. To date, surgery is considered by many to be the most effective therapy for this complex disorder particularly for patients with body mass indexes (BMI) of 35 or greater with underlying comorbidities such as diabetes, sleep apnea and hypertension (Cote et al 2009). Studies have demonstrated that extreme forms of obesity (≥40 BMI) are unlikely to respond to dietary, behavioral or pharmacological treatment.

Relapse rates of up to 90% have been documented for non-surgical treatments of morbid obesity, irrespective of the choice of conservative treatment (Council of Scientific Affairs 1988, Segal et al. 1994).

In contrast, clinical trials have demonstrated that surgery can lead to substantial weight loss and decrease obesity-related comorbidities and mortality rates (Stylopoulos et al 2009). It is therefore unsurprising that bariatric surgery is one of the most rapidly growing areas of surgical practice today. However, despite the comparative effectiveness of surgery, patients undergoing surgical procedures are prone to a range of complications and adverse events. In addition, surgery is only suitable for a subset of obese patients. In recent times, laparoscopic techniques have become increasingly preferred because they are associated with low mortality (1-2%) and complication rates. There is also a growing interest in emerging procedures that utilize endoluminal technology. To date, endoluminal techniques for the treatment of obesity include procedures for preoperative weight loss, revision surgery and stand-alone weight loss procedures. Endoluminal surgery is performed entirely through the gastrointestinal tract utilizing flexible endoscopy and has garnered considerable attention because of its reduced invasiveness, potentially lower patient risk and the reversible nature of some of these procedures/technologies. In addition, if this new approach is successfully developed, endoluminal bariatric surgery may extend the current indications for intervention to older patients, those with multiple comorbidities and even patients with mild obesity.

Investigators have begun to refer to endoluminal techniques collectively as Natural Orifice Transluminal Endoscopic Surgery (NOTES). The Natural Orifice Surgery Consortium for Assessment and Research (NOSCAR), consisting of surgeons and gastrointestinal endoscopists, has been formed to establish guidelines for the development and clinical use of this new technology (http://www.noscar.org/).

Burden of disease

Obesity has been described as the fastest growing public health challenge worldwide. In the last 30 years, the United States has experienced a considerable increase in the prevalence of obesity, which doubled from 15.1% to 30.9% between 1976-1980 and 1999-2000. In 2003-2004, approximately 66.3% men and women aged 20 years or older were overweight or obese. The National Health and Nutrition Examination Survey (NHANES) data revealed that 32.42% of Americans were obese and 4.8% were extremely obese (BMI≥40 kg/m^2). The combined prevalence increased with age, with more than 70% of those aged 60 years or older classified as overweight or obese (NHANES 2010).

In 2006, more than 177,000 people underwent bariatric surgery in the United States. However, this number represents less than 1% of patients who meet the criteria for surgery. By 2018, it is estimated that obesity will account for more than 21% of health care spending, with a cost of $1425 per person, which is a considerable increase from $361 per person in 2009 (Executive HM 2009).

Being overweight or obese has serious implications towards health. Obesity has been identified as a leading risk factor for a range of diseases such as cardiovascular disease (heart disease and stroke), type 2 diabetes, musculoskeletal disorders (e.g. osteoarthritis) and some types of cancer (e.g. endometrial, breast and colon (World Health Organization 2010).

Technology

Most emerging endoluminal technologies or procedures attempt to mimic the clinical efficacy of bariatric surgery. The technologies currently undergoing evaluation include devices for endoluminal suturing or stapling and transluminal anastamosis, which reduce the size of the stomach, and implantable prostheses that restrict the intake and absorption of food.

1) Implantable prostheses

Intragastric balloon

Intragastric balloons are designed to partially fill the stomach and mimic an intragastric benzoar. Intragastric balloons were introduced in the early 1980s, most of which were intragastric air-filled pouches with volumes ranging from 20 mL to 500 mL. These early balloons were associated with very high failure and complication rates and were largely abandoned.

The BioEnterics® Intragastric Balloon (BIB® System) (INAMED Health, Santa Barbara, CA, United States) was introduced in the mid-1990s. It consists of a transparent silicone balloon that is inflated via a silicone catheter through a self-sealing radio-opaque valve. The balloon is generally filled with 400 mL to 700 mL of sterile saline and is left in place for up to 6 months; beyond this, the risk of spontaneous deflation is considered too high. Due to their relatively limited durability, intragastric balloons are often employed as a first-stage procedure in super obese patients (BMI≥50 kg/m^2) as a means of reducing the operative risks of a more durable second-stage surgical intervention.

Other balloons being investigated include the Heliosphere® (Helioscopie Medical Implants, Vienne, France), Silimed Gastric Balloon (Silimed, Rio de Janeiro, Brazil) and Ullorex® Oral Intragastric Balloon (Phagia Technologies, Inc., Fort Lauderdale, FL, United States), which are relative new compared to the BIB System. The Heliosphere is a double-bag polymer balloon covered with a silicone envelope. Unlike the BIB, the Heliosphere is filled with air and is therefore much lighter (approximately 30 g). Proponents of the Heliosphere state that the use of air-filled balloons may reduce the risk of digestive intolerance experienced with fluid-filled balloons. The Silimed Gastric Balloon consists of a smooth transparent silicone shell that becomes spherical when filled with saline solution. The primary difference between the Silimed balloon and the other intragastric balloons lies in the placement and removal techniques, which are purportedly safer and faster (Carvalho et al 2009).

The Ullorex balloon attempts to completely remove the need for endoscopic placement and removal. It consists of a large capsule that is injected with citric acid and swallowed within a 4-minute period. The injected acid reacts with sodium? bicarbonate and slowly inflates the balloon with carbon dioxide to a volume of 300 cm^3. The balloon has a plug which is eventually degraded by stomach acid over 25 to 30 days, thus allowing the balloon to deflate and pass through the digestive tract (Martin et al 2007).

Endobarrier

Also known as the duodenal-jejunal bypass sleeve, the EndoBarrier™ Gastrointestinal Liner (GI Dynamics, Inc., Lexington, MA, United States) is a 60-cm long fluoropolymer liner that is anchored endoscopically in the duodenum to create a duodenal-jejunum bypass. The device

reduces nutrient and caloric uptake by creating a physical barrier between ingested food and the intestinal wall.

2) Endoscopic gastric reduction techniques

TOGA

The transoral gastroplasty or TOGA® system (Satiety Inc., Palo Alto, CA, United States) creates a restrictive gastric pouch that induces the feeling of satiety after a small meal. This procedure is performed under general anaesthesia and patients are required to stay for at least one night for monitoring. The TOGA system is currently only available through participation in an FDA clinical trial.

EndoCinch

In 1998, the Bard® EndoCinch™ Suturing System (C.R. Bard, Inc., Murray Hill, NJ, USA) became the first flexible endoscopic suturing device to be approved by the FDA. To date, it has been utilized to treat over 5000 patients for gastro-oesophageal reflux disease. Recently, researchers have explored the possibility of using the EndoCinch in endoluminal vertical gastroplasty (EVG) as a means of achieving weight loss (Fogel et al 2008). Another group of researchers have used the EndoCinch to induce weight loss by reducing the aperture of the gastrojejunal anastamosis in a small cohort (Thompson et al 2006).

3) Postoperative plication of dilated gastric pouch and gastrojejunostomy

ROSE procedure

The Restorative Obesity Surgery Endoscopic (ROSE) procedure utilizes a second-generation prototype endoscopic suturing and tissue plicating device known as the EndoSurgical Operating System (EOS) (USGI Medical, Inc., San Clemente, CA, United States). The EOS creates full thickness tissue plications by deploying tissue anchors to reduce the size of both the gastric pouch and the gastrojejunal anastomosis. To date, the ROSE procedure has primarily been explored as a potential revision surgery procedure for patients who have regained weight after Roux-en-Y gastric bypass.

StomaphyX

Another similar device, the StomaphyX® (EndoGastric Solutions, Inc., Redwood City, CA, United States), was developed for transoral tissue approximation (connection) and ligation within the gastrointestinal tract using SerosaFuse™ fasteners (EndoGastric Solutions, Inc., Redwood City, CA, United States). These non-resorbable fasteners are used to create full-thickness folds in the serosa of the stomach. To date, StomaphyX has been utilized to reduce the volume of the small stomach pouch created during primary bariatric procedures such as Roux-en-Y gastric bypass, which may have stretched over time (Mikami et al 2010), and for repair of gastric leaks during reoperation (Overcash 2008).

Stage of development

Table 1 : Regulatory status of endoluminal devices

Device/technology	Manufacturer	FDA approval	CE Mark
BIB® system	Inamed Health (United States)	No (currently undergoing FDA trials)	Yes
Heliosphere ® Bag	Helioscopie Medical Implants (France)	No	Yes
Ullorex® Oral Intragastric Balloon	Phagia Technologies (United States)	No	No
Silimed Gastric Balloon	Silimed (Brazil)	No	No
Endobarrier™ Gastrointestinal Liner	GI Dynamics (United States)	No	Yes
TOGA® System	Satiety Inc. (United States)	No	No
EndoCinch™ Suturing System	C.R. Bard (United States)	Yes (for the treatment of GERD)	No
Endosurgical Operating System (ROSE procedure)	USGI Medical Inc. (United States)	Yes	No
StomaphyX®	EndoGastric Solutions (United States)	Yes	No
Endoscopic Suture Device (ESD®)	Wilson-Cook Medical (United States)	Yes	No

Current clinical trials

Comparative Study of Intragastric Balloon and Pharmacotherapy for Non-Morbid Obesity. ClinicalTrials.gov identifier: NCT00355979. Start date: March 2006. Expected completion: March 2008 (results not published).

The Safety and Efficacy of the ReShape Intragastric Balloon in Obese Subjects. ClinicalTrials.gov identifier: NCT01061385. Start date: February 2010. Expected completion: N/A.

ReShape Intragastric Balloon for the Treatment of Obesity (ITALYIII). ClinicalTrials.gov identifier: NCT01024465. Start date: September 2009. Expected completion: May 2010.

Efficacy of Preoperative Intra Gastric Balloon in Morbidly Obese Patients Selected for Gastric By-Pass (BIGPOM). ClinicalTrials.gov identifier: NCT00504036. Start date: September 2007. Expected completion: March 2010.

A Study of BioEnterics® Intragastric Balloon (BIB®) System to Assist in the Weight Management of Obese Subjects. ClinicalTrials.gov identifier: NCT00730327. Start date: June 2008. Expected completion: March 2012.

Study of EndoBarrier Liner for Treatment of Type 2 Diabetes Study. ClinicalTrials.gov identifier: NCT00986349. Start date: October 2009. Expected completion: October 2010.

Safety and Efficacy Study of EndoBarrier in Subjects With Type II Diabetes and Obesity. ClinicalTrials.gov identifier: NCT00985114. Start date: October 2009. End date: October 2011.

Post Marketing Study in Subjects Who Have Type 2 Diabetes Using the EndoBarrier™ Gastrointestinal Liner. ClinicalTrials.gov identifier: NCT01114438. Start date: July 2010. Expected completion: N/A.

Study for Short Term Weight Loss in Candidates for Bariatric Surgery (EndoBarrier). ClinicalTrials.gov identifier: NCT00985491. Start date: October 2008. End date: April 2010.

A Pilot Trial of the EndoBarrier™ Flow Restrictor for Glycemic Improvement in Type 2 Diabetics. ClinicalTrials.gov Identifier: NCT00973960. Start date: September 2009. Expected completion: June 2010.

Transoral Gastroplasty for the Treatment of Morbid Obesity (TOGA®). ClinicalTrials.gov Identifier: NCT00661245. Start date: July 2008. Expected completion: October 2010.

Endoscopic Bariatric Stapling Pilot Study (TOGA®). ClinicalTrials.gov Identifier: NCT01067625. Start date: February 2006. Expected completion: December 2015.

Evaluation of the Safety and Effectiveness of StomaphyX for Transoral Incisionless Reduction of the Enlarged Gastric Pouch and Stoma (ClinicalTrials.gov identifier: NCT01025076). Expected study completion date: February 2010.

StomaphyX versus Sham for Revisional Surgery in Post-Roux-en-Y Patients to Reduce Regained Weight (ClinicalTrials.gov identifier: NCT00939055). Expected study completion date: July 2011.

Current treatment and alternatives

To date, there is no gold-standard bariatric procedure and the selection of the operative technique is often influenced by patient characteristics and/or surgeon preference. Some of the main bariatric procedures currently utilized are adjustable gastric banding, Roux-en-Y gastric bypass (RYGB), biliopancreatic diversion with duodenal switch (BPD-DS) and sleeve gastrectomy (NIDDK 2009).

Adjustable gastric banding involves placing a hollow band made of silicone rubber around the stomach near its upper end, creating a small pouch and a narrow passage into the rest of the stomach. The band is inflated with saline through a tube that connects the band to an access port placed under the skin. The band can be tightened or loosened over time according to the needs of the patient (National Institutes of Health 2004). The small pouch created with the band fills with food quickly due to the restricted passage of food from the top of the stomach (pouch) to the bottom, thus inducing a feeling of satiety and decreasing food intake.

RYGB is one of the most commonly performed bariatric procedures worldwide. During this procedure, a small stomach pouch is created to restrict food intake. Following this, a Y-shaped section of the small intestine is attached to the pouch to allow food to bypass the lower portion of the stomach, the duodenum, and the first portion of the jejunum. As this Y-connection is moved farther down the gastrointestinal tract, the amount of bowel capable of fully absorbing nutrients is progressively reduced. This reduces the amount of calories and nutrients absorbed by the body. In some cases, a cholecystectomy is also performed to avoid the formation of gallstones that may result from rapid weight loss (NIDDK 2009).

BPD-DS involves the creation of a small stomach pouch (partial gastrectomy) while leaving the pyloric valve intact. The small intestine is rearranged to separate the flow of food from the flow of bile and pancreatic juices, thereby inhibiting the absorption of calories and nutrients. The duodenum is divided near the pyloric valve and the small intestine is divided as well. The portion of the small intestine that was previously connected to the large intestine is attached to the short duodenal segment next to the stomach. The remaining segment of the duodenum that is connected to the pancreas and gallbladder is attached closer to the large intestine (approximately 76 cm from the colon). The portion of the small intestine connected to large intestine is then attached to the short duodenal segment next to the stomach. This separates the digestive enzymes and food into two different segments, preventing digestion until the final short 30-inch section of the intestine before the colon (Miller 2004).

Sleeve gastrectomy, also known as “tube gastrectomy”, “longitudinal gastrectomy” and “vertical gastrectomy” is essentially a partial gastrectomy. However, the medical community has long considered the weight loss achieved by sleeve gastrectomy alone to be insufficient for the treatment of morbidly obese patients. Due to this, sleeve gastrectomy has often been utilized as a first-stage procedure that is followed with biliopancreatic diversion or gastric bypass (Frezza 2007), or is part of a multi-stage procedure. However, there is increasing interest in the use of sleeve gastrectomy as a single-stage procedure. The resulting decrease in stomach size after sleeve gastrectomy inhibits distension of the stomach, causing it to become full sooner and inducing the sensation of satiety.

Literature review

Search criteria

Keyword/MeSH terms utilized:

("Bariatric Surgery" [Mesh] OR "Bariatric" [Mesh] OR "Gastroplasty" [Mesh]), ("Obesity" [Mesh] OR "Obesity, Abdominal" [Mesh] OR "Obesity, Morbid" [Mesh]), Bariatric, obese, weight loss, endosco*, transluminal, NOTES, incisionless, incision-free, scarless, transoral, transluminal, edoluminal.

Database utilized:

PubMed, EMBASE

Inclusion criteria

Table 2: Inclusion criteria for identification of relevant studies

Characteristic	Criteria
Publication type	Systematic reviews, randomised controlled trials; non-randomised comparative studies; case series studies (up to March 2010).
Patient	Adult (≥18 years) male or female patients (overweight, obese or super obese)
Intervention	Endoluminal/NOTES bariatric procedures for weight loss
Comparator	Non-surgical/surgical treatments for obesity and sham treatment
Outcome	Weight loss outcomes, quality of life, adverse events
Language	English only

Included studies

5166 studies were identified for inclusion in this report. When possible, comparative studies were prioritized for inclusion. If no comparative studies were available for a particular procedure or technology, case series studies were considered for inclusion based on cohort size. Case series studies with less than 10 patients and case reports were excluded from this assessment.

Closer investigation of potential studies revealed a total of 19 studies eligible for inclusion. Table 3, in the following page, describes the level of evidence and characteristics of the included studies (intervention, follow-up) in greater detail.

Table 3: Characteristics of included studies

Study/location	Level of evidence (Appendix B)	Intervention and number of patients	Duration of follow-up
Implantable prostheses			
Genco et al 2006 *Italy*	Level II RCT	Group A (first 3 months BIB): 16 patients Group B (first 3 months sham, followed by BIB): 16 patients	6 months
Mathus-Vliegen et al 2005 *Netherlands*	Level II RCT	Group 1 (3 months sham, followed by BIB every 3 months): 23 patients Group 2 (BIB every 3 months): 20 patients	2 years (1 year balloon free follow up)
Mathus-Vliegen 2003 *Netherlands*	Level II RCT	BIB: 17 patients Sham: 17 patients	6 months
Martin et al 2007 *United States*	Level II RCT	Group 1 (placebo capsule or one/two/three Ullorex balloons): 6 patients Group 2 (one Ullorex balloon): 6 patients	2 weeks
Busetto et al 2004 *Italy*	Level III-3 Comparative	Case group (BIB + LAGB): 43 patients Control group (LAGB):43 patients	Case group: 1.1±10. years Control group: 4.4±1.8 years
Milone et al 2005 *United States*	Level III-3 Comparative	BIB: 57 patients Sleeve gastretomy: 20 patients	6 months
De Castro et al 2010 *Spain*	Level II RCT	BIB: 15 patients Heliosphere: 18 patients	6 months
Trande et al 2008 *Italy*	Level IV Case series	Heliosphere: 17 patients	6 months
Forestieri et al 2006 *Italy*	Level IV Case series	Heliosphere: 10 patients	6 months
Carvalho et al 2009a *Brazil*	Level IV Case series	Silimed gastric balloon: 14 patients	6 months
Carvalho et al 2009b *Brazil*	Level IV Case series	Silimed gastric balloon: 20 patients	5-6 months
Rodriguez et al 2009 *Peru*	Level II RCT	Endobarrier: 12 patients Sham: 6 patients	6 months
Schouten et al 2010 *Netherlands*	Level II RCT	Endobarrier: 30 patients Diet control: 11 patients	3 months
Tarnoff et al 2009 *United States*	Level II RCT	Endobarrier: 25 patients Diet control: 14 patients	3 months
Endoscopic gastric reduction techniques			
Fogel et al 2008 *Venezuela*	Level IV Case series	EndoCinch: 64 patients	12 months
Deviere et al 2008 *Belgium*	Level IV Case series	TOGA: 21 patients	6 months
Moreno et al 2008 *Belgium*	Level IV Case series	TOGA: 11 patients	6 months
Potoperative placation of dilated gastric pouch and gastrojejunostomy			
Mullady et al 2009 *United States*	Level IV Case series	ROSE procedure: 20 patients	3 months

MIkami et al 2010	Level IV	StomaphyX: 39 patients	12 months
United States	Case series		

*RCT: randomized controlled trial

Critical appraisal

Randomized controlled trial evidence

Seven RCTs (Level II evidence) were considered eligible for appraisal and inclusion in this report. Evidence tables for these RCTs are presented in Appendix C in device and alphabetical order.

Intragastric balloon

BioEnterics Intragastric Balloon

A total of 4 RCTs investigating BIB were retrieved for inclusion in this report. Three RCTs attempted to compare BIB to sham treatment (Mathus-Vliegen et al 2005 [sham balloon placement], Mathus, Vliegen et al 2003 [sham balloon placement], Genco et al 2006 [endoscopic examination without placement), while one compared BIB to another intragastric balloon, the Heliosphere (De Castro et al 2010). The method utilized for patient randomization was clearly stated in two of the four RCTs (Mathus-Vliegen et al 2005, Genco et al 2006). Both assessors and patients were blinded to group assignment in all four RCTs. Baseline patient characteristics (age, sex, BMI) were deemed comparable in two trials (De Castro et al 2010, Genco et al 2006), at least partially comparable (age and weight) in another (Mathus-Vliegen et al 2005) and unclear in the remaining trial (Mathus-Vliegen et al 2003). Power calculations were not performed in any of these four RCTs. In one study (Mathus-Vliegen et al 2005), the authors noted that the study was initially part of a large (140 patients) multicentre trial, but the study protocol could not be initiated in the other 2 centers within the United States (Mathus-Vliegen et al 2005). In addition, all four trials reported explicit inclusion and exclusion criteria. The inclusion criteria used to recruit patients generally included those with treatment resistant obesity and clinically suitable for treatment (according to National Institutes of Health criteria), one study (Mathus-Vliegen et al 2003) chose to include only patients who have not received treatment for obesity. Patients were generally excluded if they had any conditions that would interfere with balloon positioning or safety, for example ulcerative or bleeding lesions, hiatal hernia >3cm and previous gastrointestinal surgery.

Interventions were well described in all four studies, all clearly described the balloon placement procedure and the study protocol. However, two RCTs did not report the balloon removal procedure (Mathus-Vliegen et al 2003, Genco et al 2006) and three RCTs did not clarify if any adjustments to volume were performed (Mathus-Vliegen et al 2003, Genco et al 2006, De Castro et al 2010). All patients were required to adhere to a calorie restricted diet throughout each study; however, one study (Mathus-Vliegen et al 2003) did not state the upper limit for patients' caloric intake. Objective measurements were utilized for most patient outcomes, with the exception of patient complaints and quality of life measures which were self-reported. Adverse events were well documented in all RCTs. The length of follow-up was clearly stated in all four RCTs, ranging from 6 months to 24 months. Losses to follow-up were clearly documented (with reasons) in three RCTs (De Castro et al 2010, Mathus-Vliegen et al 2005, Mathus-Vliegen et al 2003). Intention to treat analysis was performed in only one RCT (Mathus-Vliegen et al 2005).

Ullorex oral intragastric balloon

One RCT examining the safety of the Ullorex balloon was retrieved for inclusion (Martin et al 2007). The randomization method was not reported and was only applied to the first 6 patients (Cohort 1). In this RCT, the Ullorex balloon was compared to a placebo capsule. Investigators were blinded to treatment allocation (Cohort 1 only). There was no indication that baseline patient characteristics were comparable between those who received Ullorex or placebo. No power calculations were performed to determine if the patient cohort was sufficiently large. The inclusion and exclusion criteria were stated clearly. However, the inclusion criteria appeared to be uncharacteristically broad, selecting patients that had BMI >30kg/m^2 for more than 6 months, which may not be representative of patients who would generally require this treatment (e.g. treatment-resistant obese patients etc.). The study protocol was adequately described. Patients were required to maintain a balanced diet throughout the study, however the definition of a "balanced" diet was not provided. Most outcomes (weight loss, food intake) were measured objectively, except for satiety ratings (VAS scales). Adverse events were adequately detailed within the study. The follow-up duration was clearly stated. Reasons for losses to follow-up were provided and overall patient dropout was considerable when one takes into account the size of the study cohort. No intention to treat analysis was performed.

Endobarrier

Three RCTs investigating the Endobarrier were retrieved for inclusion (Rodriguez et al 2009, Schouten et al 2010, Tarnoff et al 2009). All three compared Endobarrier to sham or diet control. The randomization method was clearly stated in two out of three RCTs. Blinding was not implemented is any of these RCTs and power calculations were not performed. Baseline patient demographics were comparable in all studies. All three RCTs utilized explicit inclusion and exclusion criteria. In general, patients who were on anticoagulants and those who had inflammatory bowel disease or previous surgery that may affect Endobarrier implantation were excluded. The implantation and explanation procedure was described in only one RCT (Schouten et al 2010), one study referred to previous studies to indicate that a similar procedure was utilized (Rodriguez et al 2009), while another provided brief details on the procedure (Tarnoff et al 2008). All patients had to follow a restricted diet during the study; however, only two of these RCTs provided sufficient detail on these diets (Schouten et al 2010, Rodriguez et al 2009). Objective outcome measures were used. Losses to follow-up were described adequately with reasons for each case in two RCTs (Rodriguez et al 2008, Schouten et al 2010). One study did not provide reasons for patient dropouts within the control group (Tarnoff et al 2009). Intention to treat analyses was performed in one of the three Endobarrier RCTs (Rodriguez et al 2008).

Non-randomized comparative evidence

Intragastric balloons

BIB

Two non-randomized comparative studies (Level III evidence) were retrieved for inclusion in the report; both investigated the safety and effectiveness of the BIB (Busetto et al 2002, Milone et al 2005). For one of these studies (Busetto et al 2002), the BIB was tuilised as preoperative weight reduction prior to LAGB, not as standalone therapy. One study reported retrospective data collection (Milone et al 2005), while both utilized historical controls (Milone et al 2005, Busetto et al 2002). Inclusion and exclusion criteria was briefly detailed in one study (Busetto et al 2002), the other study (which utilized retrospective data) reported only a

general inclusion criteria (Milone et al 2005). The interventions were adequately described in both studies and included both the placement and removal procedures for the BIB. Both studies utilized objective outcome measures. Adverse events were generally well described in both studies. The length of follow-up was clearly reported in both studies but one study did not report if losses to follow-up occurred (Busetto et al 2002), the remaining study did not experience any patient dropout (Milone et al 2005).

Case series evidence

A total of 9 case series (Level IV evidence) studies with more than 10 patients were identified and selected for inclusion. Four of these Level IV studies investigated the safety and efficacy of intragastic balloons (Heliosphere and Silimed), the remaining 5 studies were performed to determine the safety and efficacy of endoluminal tissue approximation techniques for revision bariatric surgery and/or first stage treatment prior to definitive bariatric surgery. Evidence tables for these case series studies are presented in Appendix C in device and alphabetical order.

Intragastric balloons

Heliosphere

One RCT[1] and two Level IV studies on the Heliosphere balloon were retrieved for inclusion (Trande et al 2008, Forestieri et al 2006). Of the case series studies, an explicit inclusion and exclusion criteria was reported in one study (Trande et al 2008). Heliosphere insertion and extraction was adequately described in both studies. In addition, objective outcomes (BMI, %EWL) were utilized in both studies to determine effectiveness and adverse events were adequately described. Statistical tests were employed in one study (Trande et al 2008). The follow up duration was 6 months for both studies and there appears to be no losses to follow-up.

Silimed gastric balloon

Two case series studies on the Silimed balloon were retrieved (Carvalho et al 2009a, Carvalho et al 2009b). One study documented the use of Silimed as a means of reducing weight in pre-obese patients (n=20) while the other included both pre-obese and obese patients (n=14). Inclusion and exclusion criteria were employed in one of these papers (Carvalho et al 2009a) while the other did not report the use of an exclusion criteria (Carvalho et al 2009b). The placement and removal of the Silimed balloon was clearly described in both papers. Objective outcomes were utilized (weight loss, BMI) and adverse events were clearly documented. Follow up duration was 6 months for both papers, but neither reported patient dropout rates. It is assumed from the data that all patients were present at final follow-up.

EndoCinch

One Level IV study, involving 64 patients, on EndoCinch was retrieved for inclusion (Fogel et al 2008). Clear inclusion and exclusion criteria were provided. The intervention (endoluminal vertical gastroplasty utilizing the EndoCinch) was described in detail and objective outcome measurements were utilized. Adverse events were adequately described and statistical

[1] Described in the BIB section as it compared Heliosphere to BIB (De Castro et al 2010).

methods were employed to determine significance. The follow-up duration was 12 months. At 12 months, 5 patients were lost to follow-up. However, reasons for dropout were not provided.

ROSE procedure

One case series study on the ROSE procedure was retrieved for inclusion (Mullady et al 2009). A general inclusion criteria was employed (weight regain after gastric bypass), but no exclusion criteria was provided. The intervention was described in detail, objective outcome measures were utilized. However, adverse events were not adequately reported (lacked actual data) and no statistical tests were performed to determine significance. The duration of follow-up was 3 months and there appears to be no follow-up losses.

TOGA

Two case series studies on the TOGA procedure were selected for inclusion (Deviere et al 2008, Moreno et al 2008). Detailed inclusion and exclusion criteria were provided in both studies. In both studies, patients who had treatment-resistant obesity (non-surgical treatments) and fulfilled the NIH surgical treatment criteria (BMI≥40kg/m^2 or ≥35kg/m^2 with one or more comorbidities) were selected for inclusion. The TOGA procedure was well described in both studies. However, both studies lacked detail with regards to the patients' dietary modifications, particularly total daily caloric intake, throughout the study.

Both studies reported objective outcome measures (BMI, weight loss) as well as subjective quality of life measures. Adverse events were well documented and statistical tests were utilized in both studies. Follow up duration was 6 months and only one of these studies (Moreno et al 2008) experienced a loss of follow-up (1 patient at 6 months).

StomaphyX

One Level IV study (n=39) on StomaphyX was retrieved for inclusion (Mikami et al 2010). A limited selection criteria was utilized, however an exclusion criteria was not employed. The StomaphyX procedure was clearly described however it is unclear if patients were required to follow a strict diet during this study. The study reported objective outcome measures and adverse events were adequately described. Statistical tests were not utilized. Patient follow-up lasted 6 months and there was considerable patient dropout. No explanations were provided for these losses to follow-up.

Safety and efficacy

Safety

Implantable prostheses

BIB

Randomized trial evidence

One study reported that no mortalities or complications related to endoscopy, BIB placement or removal were observed in both sham and treatment groups (Genco et al 2006). One RCT on BIB (Mathus-Vliegen et al 2005) stated that balloon removal resulted in one Mallory-Weiss laceration and one episode of minor gastric bleeding due to forceps injury, both patient recovered without hospitalization.

Compared to sham-treated patients (n=17) (Mathus-Vliegen et al 2003), the 17 patients who received the BIB had significantly more complaints of nausea (11.1% vs. 1.3%; p<0.05), belching (55.6% vs. 14.1%; p<0.05) and heartburn (24.1% vs. 10.3%; p<0.05). However, these symptoms abated as the study progressed (Mathus-Vliegen et al 2003). Similarly, another RCT (Mathus-Vliegen et al 2005) stated that phone consultations during the first 3 days after BIB placement revealed many complaints in patients who were randomized to received the BIB (n=20) from the start of the study (62.1% nausea, 60.3% vomiting, 48.3% abdominal cramps), but these symptoms were no longer present (all 0%) when patients underwent BIB replacement at 3 months. Mathus-Vliegen et al (2005) also reported that severe esophagitis was present in 2 patients and was related to the prohibited use of NSAIDs. Both resolved when NSAID use was discontinued. Esophageal erosions were evident in 10 patients and gastric erosions in 4 patients when the balloon was first removed; however, both these were not present at follow-up endoscopy. Three balloons deflated spontaneously (Mathus-Vliegen et al 2005); no other RCT reported any incidences of spontaneous BIB deflation.

One RCT (De Castro et al 2010) noted that some patients had dyspeptic symptoms, but no data was presented. At 1 month after discharge, 20% (3/15) of BIB patients had chronic vomiting and dehydration despite treatment, this intolerance led to early removal of the BIB (De Castro et al 2010). Another RCT reported that 3 patients (7%) required BIB removal due to nausea, vomiting and abdominal cramps, while another 2 patients (5%) requested balloon adjustments (removal of saline, 120 mL) due to nausea and abdominal cramps (Mathus-Vliegen et al 2005). In another cohort (Genco et al 2006), the authors noted that 17/32 (53.12%) patients developed symptoms of gastroesophageal reflux, which was controlled by doubling omeprazole dosage (40mg/die). Epigastric pain, nausea and vomiting were common (>75% each) after the first 60 minutes after BIB placement and during the following 48 hours (Genco et al 2006).

Of the 4 RCTs involving BIB, one trial was performed specifically to determine the impact of chronic gastric distention as a result of BIB placement (Mathus-Vliegen et al 2003). The results for the first 13 weeks indicated that a significantly higher number of BIB patients (n=17) had supine reflux compared to sham patients (n=17) (63.6% vs. 11.8%; p<0.01). In the sham-balloon[2] treated group, patients experienced initial improvement by weight loss despite absence of BIB. However, following a further 13 weeks with BIB, there was an exacerbation of an already present grade A esophagitis in one patient, a newly developed esophagitis in 2 patients and an ulceration at the gastroesophageal junction in 1 patient.

Non-randomized comparative evidence

Busetto et al (2004) observed total balloon-related complication rates of 7% for patients treated with sequential therapy (BIB followed by LAGB; case group): 1 spontaneous elimination of balloon, 1 severe vomiting with dehydration, 1 cutaneous allergic reaction of unknown origin. In comparison to patients who received LAGB only (control group), the authors reported that the total rate of conversion to open surgery or mini-laparotomy was 16.3% in the control group, significantly higher relative to the case group (0%; p<0.05). In addition, major band-related surgery was required by significantly more patients in the control group compared to the case group (11.6% vs. 0%; p<0.05). Meanwhile, minor port-related surgery was performed in one case group patient (2.3%) compared to 9 patients in the control group (20.9%; p<0.01). These results suggest that the use of BIB prior to LAGB can potentially decrease the risk of conversion to open surgery and the risk of intraoperative complications in super obese patients treated with LAGB.

Milone et al (2005) reported that 4 BIB patients (7%) had their balloon removed: 1 balloon dysfunction, 1 abdominal pain, 2 noncompliance. Another patient had spontaneous elimination of the BIB in the stool. Meanwhile 2 other patients (3%) had complications that did not lead to balloon removal: 1 severe vomiting and mild dehydration, 1 skin reaction of unknown origin (Milone et al 2005).

Heliosphere

Randomized trial evidence

De Castro et al (2010) noted that the insertion of the Heliosphere balloon was impossible in 2 patients (11%) due to the rigidity of the device at the pharynx, which caused severe patient discomfort. As a result, both patients underwent placement under general anesthesia. Compared to BIB removal, Heliosphere removal was considerably more difficult. One patient required surgical laparoscopic removal of the Heliosphere while three patients underwent rigid esophagoscopy for removal. In all four patients, the deflated Heliosphere balloons could not be pulled out through the cardia as the hook forceps tore the external pouch of the balloon in every attempt. Overall, 30% of Heliosphere patients experienced an adverse event at removal ($p=0.021$). As a result of these findings, the investigators stopped this study prematurely due to safety concerns (De Castro et al 2010). In terms of patient tolerance, the incidence of epigastric pain, gastroesophageal reflux and vomiting at 1, 3 and 6 months were similar between BIB and Heliosphere patients. However, the BIB had higher early removal rates (20%) compared to the Heliosphere due to chronic vomiting and dehydration (De Castro et al 2010).

Case series evidence

Trande et al (2008) reported no technical issues for Heliosphere insertion. However, there was one clinical severe adverse event - acute coronary syndrome - at the time of insertion. Forestieri et al (2006) reported that the insertion procedure was slightly difficult in all cases due to the rigidity and large size of the device which led to patient discomfort. In addition, 5 system failures (50% of patients) occurred during the positioning of the balloon: in 2 patients, it was impossible to unscrew the steel cannula after air inflation while in 3 patients, the pulling thread that opens the balloon from its wrapper ruptured. Trande et al (2008) reported that balloon removal was more difficult relative to insertion, but was successful in most patients (15/17 patients, 88%). One patient had distal migration of the balloon while another underwent surgery due to balloon fragmentation (Trande et al 2008). Meanwhile, Forestieri et al (2006) stated that one balloon could not be located and was assumed to have passed through the stool.

Patients seem to have tolerated the Heliosphere well in both studies. Trande et al (2008) reported dyspeptic symptoms on the first 3 days post-insertion. Early nausea was present in 100% of patients while vomiting occurred in 70.5% of patients. These symptoms disappeared with medical therapy and abated after the first 3 days (Trande et al 2008). Forestieri et al (2006) stated that no serious complications were observed, with only nausea and vomiting the first few days after treatment.

[2] 13 weeks sham followed by 13 weeks BIB

Ullorex

Randomized trial evidence

Martin et al (2007) reported that there were no new electrocardiographic changes throughout the trial. In addition, laboratory tests (chemistry panels, complete blood count, urinalyses) did not suggest any clinically significant abnormalities. A total of 67 adverse events were reported and 48 (72%) could be attributed to the Ullorex balloon (38 gastrointestinal, 4 head and neck, 5 vomiting, 1 skin). One serious adverse event occurred in a subject who received three balloons. This participant experienced nausea, vomiting and dehydration, necessitating hospitalization, intravenous hydration and deflation of the balloons with an endoscope. However, this serious adverse event was likely caused by patient noncompliance as the patient consumed nonapproved food (solid fatty food) immediately after Ullorex placement (Martin et al 2007).

Similed gastric balloon

Case series evidence

Both studies reported that the Similed balloon was successfully placed and removed without any complications (Carvalho et al 2009a, Carvalho et al 2009b). Carvalho et al (2009a) stated that there were no instances of balloon loss in the esophagus or tracheal aspiration during the removal of the device.

Both papers observed initial complications after placement, which included nausea, vomiting and epigastric pain. Carvalho et al (2009a) stated that 11 patients (21%) experienced epigastric pain which led to early termination of the treatment. It is unclear what "early termination of treatment" meant as it is inferred by the authors that all patients completed the 6 month study. There were 2 cases (14.3%) of spontaneous balloon deflation, one after 6 months of treatment and the other at almost 6 months. Both balloons did not migrate to the intestine and were removed successfully (Carvalho et al 2009a). Carvalho et al (2009b) reported 2 cases of deflation as well.

Endobarrier

Randomized trial evidence

Safety outcomes related to the implantation and explantation of the Endobarrier were reported in all three Endobarrier RCTs (Rodriguez et al 2009, Schouten et al 2010, Tarnoff et al 2009). One RCT (Schouten et al 2010) noted that there were no procedure-related adverse events during implantation or explantation of the Endobarrier. Meanwhile, another RCT (Rodriguez et al 2009) reported incidences of procedural nausea (4.6%) and procedural vomiting (3.1%). The third RCT (Tarnoff et al 2009) reported that 5 patients (19%) required multiple implantation attempts in the same setting due to difficulties advancing the catheter or positioning the anchor in the duodenal bulb. The sole procedure-related adverse event was noncardiac chest pain. Explantation was uneventful in all patients (n=25) (Tarnoff et al 2009).

Two of the three Endobarrier RCTs reported no incidences of "severe" adverse events during follow-up (Rodriguez et al 2009, Schouten et al 2010). Rodriguez et al (2009) reported that all Endobarrier patients experienced at least one episode of mild or moderate abdominal pain and 4 subjects had mild or moderate vomiting episodes (abdominal pain: 30.8%, 20 incidences; vomiting: 10.8%, 7 incidences), no such events were reported for the sham group (Rodriguez et al 2009). Schouten et al (2010) stated that all 26 patients (100%) in the Endobarrier group experienced at least one adverse event during follow-up compared to 3

patients (23.3%) in the diet control group (no p-value stated). Of all the adverse events observed (both groups), 61.3% were “mild” and 38.7% were “moderate”. Adverse events with the highest frequency in the Endobarrier group were nausea (76.9%) and upper abdominal pain (50%), both mainly occurring in the first week after the procedure. The investigators also reported that pseudopolyp formation and implant site inflammation (observed during explanation or follow-up endoscopy) were noted in 50.0% and 38.5% of Endobarrier patients, respectively (Schouten et al 2010).

Tarnoff et al (2009) stated that there were no signs or symptoms of biliary or pancreatic duct obstruction. Five adverse events were considered “serious”: gastrointestinal hemorrhage (n=3), abdominal pain (n=1) and vomiting (n=1). A total of 16 Endobarrier patients (61.5%) reported at least one adverse event. Of the 56 adverse events observed, a total of 48 (86%) were possibly or definitely related to the Endobarrier (16 abdominal pain, 7 nausea, 8 vomiting, 11 abdominal distention, 4 gastrointestinal hemorrhage, 1 constipation, 1 epigastric discomfort) (Tarnoff et al 2009).

Rodriguez et al (2009) reported that a total of 5 Endobarriers were explanted (41.6%) prematurely: 3 due to adverse events and 2 due to device migration (unsymptomatic). Tarnoff reported that 5 Endobarriers were removed (19.2%) before the end of the trial due to intraluminal hemorrhage (n=3), sleeve obstruction (n=1) and anchor migration (n=1). Meanwhile Schouten et al (2010) stated that 8 patients had their Endobarrier removed (26.7%) due to severe nausea and vomiting (sleeve obstruction, n=1), epigastric pain (n=2), device migration (n=5).

Endoscopic gastric reduction techniques

EndoCinch

Case series evidence

Fogel et al (2008) reported that most patients left the procedure with a mild sore throat; however, no actual numbers were reported. One patient experienced vomiting during recovery but had no other difficulties. This patient returned home approximately 1 hour after recovery. Two other patients reported reflux-life symptoms after the procedure, both resolved spontaneously after 24 hours. There were no serious adverse events and no patients were required overnight observation.

TOGA

Case series evidence

Both studies on TOGA reported no serious adverse events (Deviere et al 2008, Moreno et al 2008).

One study noted that the most commonly reported procedure- or device-related adverse events were pain (16 patients, 76%), vomiting (7 patients, 33%), nausea (6 patients, 28.5%) and transient dysphagia (6 patients, 28.5%). Other isolated adverse events included temporomandibular dysfunction (1 patient, 4.8%) which persisted for 7 days and superficial phlebitis (data not reported) (Deviere et al 2008).

Similarly, the second study reported that pain, specifically transient epigastric pain, was the most common procedure-related adverse event (11 patients, 100%). Other adverse events include throat pain (3 patients, 27.3%), esophagitis (2 patients, 18.2%), nausea (2 patients, 18.2%), mild dysphagia (3 patients, 27.3%), superficial phlebitis (1 patient, 9%) and worsening cervical pain (1 patient, 9%). All either spontaneously resolved or were treated medically (Moreno et al 2008).

Postoperative plication

ROSE procedure

Case series evidence

Most patients who underwent the ROSE procedure experienced mild post-procedure abdominal bloating and several had mild sore throats for several days after the procedure (no data reported). Two patients were admitted for overnight observation, one for mild bleeding during the procedure and the other for post-procedure nausea and vomiting. All other patients (90%) were discharged on the day of the procedure after observation in the post-procedure unit (Mullady et al 2009).

StomaphyX

Case series evidence

Mikami et al (2010) reported that the majority of patients who received the StomaphyX experienced sore throats which resolved within 48 hours (39 patients, 87.1%). Epigastric pain was observed in 39 patients (76.9%) and lasted for a few days (Mikami et al 2010).

Efficacy

Implantable prostheses

BIB

Randomized trial evidence

Three of four RCTs reported efficacy outcomes for BIB. Two of these compared BIB to sham treatment (Mathus-Vliegen et al 2005, Genco et al 2006), while the remaining RCT compared BIB to another intragastric balloon, the Heliosphere (De Castro et al 2010). The comparison between BIB and Heliosphere will be presented in the *Heliosphere* section. The most common outcomes reported were weight loss and change in BMI. Quality of life outcomes were reported in one RCT (De Castro et al 2010).

Mathus-Vliegen et al (2005) randomized patients to two groups: Group1 – sham balloon placement for 3 months, followed by BIB placement every 3 months for the remainder of the year; and Group 2 – BIB placement every 3 months for a whole year. Intention to treat analysis indicate that at 3 months, both Group 1 and Group 2 patients achieved comparable mean weight loss (11.2kg vs. 12.9kg, respectively) despite the fact that Group 1 had not actually received the BIB. From 3 months to 6 months, Group 1 (which were undergoing the first 3 months of BIB treatment) lost a mean of 8.8kg, which was twice the mean weight loss (3.9kg) in group 2 (which were undergoing the second 3-month period of BIB treatment) ($p<0.003$). However, the authors reported that mean total weight loss beyond 6 months were similar for both groups (Group 1: 20.0kg vs. Group 2: 16.7kg). At the end of the first year, Mathus-Vliegen et al (2005) reported that a mean overall weight loss of 21.3kg was observed for both groups together. Mean weight loss at 1 year did not differ significantly between both patient groups.

Per protocol analysis of the 33 patient who actually completed the 2-year study revealed that in the first 3 months, BIB patients lost more weight compared to those who received sham treatment (mean 15.4kg vs. 11.6kg), but this difference was not statistically significant. Analysis revealed that mean weight loss was significantly different in months 3 to 6 (Group 1:

9.7kg vs. Group 2: 6.5kg; p=0.037) and in months 6 to 9 (Group 1: 3.0kg vs. Group 2: 5.9kg; p=0.025). However, correction for multiple testing with the Bonferroni method eliminated this significance. After 6 and 9 months, weight loss was similar for both patient groups. However, after 3 months, a weight loss of at least 13kg was noted in significantly more Group 2 patients (67%) compared to Group 1 patients (24%) (p=0.01(Mathus-Vliegen et al 2005).

In the second RCT examining weight loss between BIB and sham treatment (Genco et al 2006), patients were allocated to two groups: Group A – BIB removed after 3 months and not followed by another BIB; and Group B – patient received sham treatment for 3 months, followed by BIB treatment for 3 months. After the first 3 months, mean weight loss was 15±6kg for Group A (BIB) and 3±1kg in Group B (sham) (p<0.001). In addition, mean BMI reduction at 3 months was significantly greater for Group A patients compared to Group B patients (5.8±0.5 kg/m^2 vs. 0.4±0.2 kg/m^2; p<0.001). Mean % Excess Weight Loss (EWL) was significantly higher in Group A compared to Group B (34.0±4.8% vs. 2.1±1%; p<0.001). However, in the following 3 months, weight loss was significantly higher in Group B (which had BIB placed) compared to Group A (which had BIB removed) (13±8kg vs. 6±3kg; p<0.001). This was also reflected by a significantly greater mean BMI reduction in Group B patients (5.1±0.5kg/m^2 vs. 1.1±0.3kg/m^2; p<0.001).

During the sham phase for each group, BMI reduction was significantly greater for Group A compared to Group B (1.1±0.3kg/m^2 vs. 0.4±0.2kg/m^2; p<0.05) and this was also reflected by % EWL which was greater for Group A as well (4.6±5.1% vs. 2.1±1%; p<0.05). After crossover, %EWL was significantly higher in Group B than in Group A (31±4.8% vs. 4.6±5.1%; p<0.001) (Genco et al 2006).

Non-randomized comparative evidence

At 6 months, the non-randomized historically controlled study by Busetto et al (2009) stated that the BMI of patients who were treated with sequential therapy (BIB followed by LAGB) decreased from 58.4±6.6kg/m^2 to 49.3±6.2kg/m^2 (p<0.001) (Busetto et al 2004). Absolute weight loss achieved was 26.4±10.2kg (range: 5kg to 53kg) while %EWL was 26.1±9.3% (range: 5.1 to 55.2%). There was no significant correlation between the length of balloon treatment and the extent of weight loss. The time frame between BIB removal to LAGB was a mean of 31.3±15.8 days (range: 1 to 216 days). Patients gained some weight during this interval, but this was not statistically significant. Nevertheless, analysis indicated that the length of waiting time between BIB and LAGB was significantly related to the degree of weight gain (R: 0.491; p<0.01). The %EWL curves indicated that the %EWL for BIB was comparable to the %EWL observed in the first 6 months after surgery in patients who only underwent LAGB (26.1±9.3 vs. 25.3±12.4%, respectively). The total %EWL 6 months after banding in the case group (BIB followed by LAGB) was significantly greater compared to patients who received LAGB only (33.6±12.5% vs. 25.3±12.4%; p<0.01). However, Busetto et al (2004) did not notice any significant differences in terms of %EWL between both groups at 1 year (36.5±12.5% vs. 32.9±16.3%), 2 years (31.5±16.0 vs. 33.5±16.3%) and 3 years (32.3±20.7 vs. 34.0±18.5%).

Milone et al (2005) performed a retrospective chart review of 20 patients who underwent LSG and compared the results to control data obtained from the literature for patients who underwent BIB (from 2 studies: Busetto et al 2004 and Weiner et al 1999). Weight-related outcomes (Table 4) indicated that although preoperative BMI was higher in the LSG group, the change in BMI and weight loss was considerably greater for LSG patients compared to the BIB controls. Nevertheless, each patient from the LSG and BIB groups had an improvement in comorbidities such as hypertension, osteoarthritis and sleep apnea. These improvements were accompanied by a decrease in the use of associated medications (Milone

et al 2005), but actual data for these results was not reported. Statistical analysis of the results was not undertaken.

Table 4: Comparison of the literature between LSG and BIB in super-obese patients (BMI≥50kg/m^2) (Milone et al 2005).

Author	Preop BMI (kg/m^2)	Follow-up (months)	Mean weight (kg)	%EWL	BMI loss (kg/m^2)	Final BMI (kg/m^2)	Mean weight loss (kg)
Busetto 2004 (BIB, n=43)	58.4	5.4	171	26.1	9.4	49	26
Weiner 1999 (BIB, n=17)	60.2	4	195	21	6.4	53.8	18
Gagner (LSG, n=20)	68.9	6	200	34.9	15.9	53.0	46

Heliosphere

Randomized trial evidence

At 6 months after balloon insertion, both Heliosphere (n=18) and BIB (n=15) patients experienced significant weight loss (De Castro et al 2010). The body weight of Heliosphere patients decreased from 119±17kg to 106±18kg (p<0.001) while the body weight of BIB patients decreased from 121±18kg to 108±17kg (p<0.001). Both patient groups did not differ significantly in terms of mean weight loss at 1, 3 and 6 months follow-up. At 6 months post-implantation, mean weight loss was 12.8±8kg for Heliosphere and 14.1±9kg for BIB. Meanwhile, mean BMI loss was 4.6±3kg/m^2 for Heliosphere vs. 5.5±3kg/m^2 for BIB and mean %EWL was 27%±16 for Heliosphere vs. 30.2%±19 (no p-values reported). Overall, 15 (45.5%) out of 33 patients (total study population) lost >10% of their initial weight 6 months after intragastric balloon placement. Mean waist circumference decreased significantly for both groups, from 119.7cm to 111.8cm for the Heliosphere group (p<0.05) and from 120.5cm to 111cm for the BIB group (p<0.05) (De Castro et al 2010).

12 months after removal of the balloons, 26 subjects were re-evaluated (in addition to 3 patients who were excluded due to non-compliance, 3 others went on to have bariatric surgery and one was lost to follow-up). Mean weight for Heliosphere and BIB patients were 116±19kg and 108±13kg, respectively. Both did not differ significantly to their baseline weights (De Castro et al 2010), indicating that the patients in both treatment groups could not maintain weight loss 12 months after balloon removal.

Quality of life, as measured by total Gastrointestinal QOL index (GICLI) scores (n=27) (Table 5), were comparable at baseline with no significant differences at 6 months after insertion. However, Heliosphere patients achieved significantly greater improvement in physical dysfunction scores compared to BIB patients (p<0.03)

Table 5: GICLI scores in Heliosphere and BIB groups.

	Heliosphere (baseline)	Heliosphere (6 months' follow up)	BIB (baseline)	BIB (6 months' follow up)
Total score	92.2±18	102.4±23	86.9±17	83.6±12
Gastrointestinal symptoms	3±0.4	3.1±0.7	2.9±0.6	2.5±0.4
Physical dysfunction	1.5±0.6	2.5±0.7*	1.2±0.6	1.5±0.9
Emotional dysfunction	2.4±0.9	2.3±0.8	2.4±0.9	2.6±0.8
Social dysfunction	2.1±1.1	3±1	2.3±0.9	2.4±0.7
Effect of treatment	3.4±1.1	3.4±1.4	3.3±0.7	2.7±1.3

* p=0.03 vs. BIB

Case series evidence

Trande et al (2008) reported that overall mean weight loss at 6 months was 11±9kg (p=0.02 vs. baseline) and BMI decreased by 4±3 kg/m^2 (p<0.01 vs. baseline). Fourteen patients (82.4%) had BMI ≥35 at the time of balloon removal. At 6 months, Forestieri et al (2006) stated that patients treated with Heliosphere lost a mean of 17.5±16.2kg, which translated to a 5.2±13.1kg/m^2 decrease in BMI (no statistical test performed).

Ullorex

Randomized trial evidence

Martin et al (2007) randomly assigned their first 6 patients to placebo or 1, 2 or 3 balloons. Meanwhile the final 6 patients to be enrolled received 1 Ullorex balloon. Due to the fact that the patient population of this study is very small, it is unclear if there was any benefit for the randomization. Nevertheless, the authors reported that patients in Cohort 1 (first 6 patients) lost a significant amount of weight from baseline to 2 weeks after Ullorex placement (mean: 1.5±1.7kg; p<0.05). However, it is important to note that 2 of the patients in Cohort 1 had a placebo tablet, which confounds these results. Meanwhile, patients who received only 1 balloon (last 6 patients, Cohort 2) also lost a similar amount of weight (1.2±1.5kg) (Martin et al 2007).

Food intake was tested for patients in Cohort 2 from baseline to week 1. Analysis indicated that energy intake (kcal) decreased by 149±146 kcal (24.4%) from baseline to week 1, but this was not statistically significant. There was a significant decrease in kcal from fat and carbohydrates (p<0.05) but not protein. VAS scales indicates no significant changes in terms of satiety after Ullorex placement (Martin et al 2007).

Silimed gastric balloon

Case series evidence

At 6 months, Carvalho et al (2009a) reported that BMI decreased from 35.7±5.7kg/m^2 to 31.8±5.5kg/m^2 in preobese and obese patients treated with Silimed. The overall mean weight loss at 6 months was 11.3±6.2kg and %EWL was 45.5±36.7% (Carvalho et al 2009a) compared to baseline values. Meanwhile, for preobese patients, Carvalho et al (2009b) reported that after completing 5-6 months treatment, mean weight decreased from 74.6±9.8kg

to 65.9±9.4kg (p<0.01), while mean BMI decreased from 27.6±2.0kg/m^2 to 24.5±2.6kg/m^2 (p<0.01).

b) Endobarrier

Randomized trial evidence

All three RCTs on Endobarrier reported efficacy outcomes (Schouten et al 2010, Tarnoff et al 2009, Rodriguez et al 2009). Two RCTs randomized patients to Endobarrier (with diet control) or diet control alone (Schouten et al 2010, Tarnoff et al 2009), while the remaining RCT randomized patients to Endobarrier or sham endoscopy (Rodriguez et al 2009). In addition to weight loss outcomes, all three RCTs reported changes in the severity of comorbidities (e.g. diabetes/glycemic control) after Endobarrier implantation.

Weight loss, as reported by Schouten et al (2010), after 1, 12 and 24 weeks post-implantation are presented below (Table 5).

Table 6: BMI change and %EWL after 1, 12 and 24 weeks post-implantation of Endobarrier (Schouten et al 2010).

	No. of patients	Endobarrier group	Subjects	Diet control group	p-value*
Preoperative BMI	30	48.9±6.2	11	49.2±7.1	0.68
BMI (1wk)	25	46.3±6.6	11	48.1±6.4	0.51
%EWL (1wk)	25	7.5±5.1	11	5.3±1.8	0.08
BMI (12 wk)	24	43.4±6.7	11	47.3±6.7	0.23
%EWL (12 wk)	24	19.0±10.9	11	6.9±6.1	0.00
BMI (24 wk)	3	44.1±5.2	-	-	N/A
%EWL (24wk)	3	24.3±5.8	-	-	N/A

* Two-sample t-test.

Weight loss was not significantly different between the Endobarrier and diet control patients at the first week. However, at 12 weeks post-implantation, the Endobarrier group achieved significantly greater %EWL compared to the diet control group (19% vs. 6.9%; p<0.002). However, the mean reduction in BMI at 12 weeks was 5.5kg/m^2 for the Endobarrier group, which was not significantly different to the 1.9kg/m^2 change observed in the diet control group. In the 3 patients who retained the device for 24 weeks, %EWL was 24.3%. However, the diet control group only remained in follow-up for 12 weeks and therefore no statistical comparison could be made. Overall, 88% of Endobarrier patients achieved >10% EWL, compared with 27.3% of control patients (p=0.05) (Schouten et al 2010).

Similarly, Tarnoff et al (2009) reported that the average %EWL at 12 weeks post-implantation was significantly greater for the Endobarrier group (22.1%±8%) compared to the diet control group (5.3%±6.6%) (p=0.02). This corresponds to a mean absolute weight loss of 10.3±3.2kg (range: 4.5kg to 18kg) for Endobarrier patients and 2.6±3.5kg (range: 0kg to 7.7kg) for diet control patients. At the end of this trial, 92% (23/25) of Endobarrier patients and 21% (3/14) of diet control patients achieved at least 10% EWL (p=0.0001) (Tarnoff et al 2009).

When patients who underwent Endobarrier implantation were compared to those who received sham endoscopy (Rodriguez et al 2009), mean reduction in body weight was actually comparable between both treatment arms throughout the first 12 weeks of the study in both intention to treat and per protocol populations. The Endobarrier arm tended towards achieving more weight loss after week 12; however this did not reach statistical significance.

At week 20, mean intention to treat weight reduction was 10.2±1.3kg for the Endobarrier patients compared to 7.1±4.3kg for the sham patients. By week 24, there were only 3 sham patients left in the study; mean weight loss were similar in both arms (Rodriguez et al 2009).

With regards to diabetic outcomes, Schouten et al (2010) reported that fasting glucose levels and HbA1c values decreased marginally in both Endobarrier and diet control groups at 12 weeks, but these changes were not statistically significant. Nevertheless, the investigators noted that 6/8 (75%) diabetic patients in the Endobarrier group decreased their insulin dosages and/or oral antidiabetic medications after 1 week. At 12 weeks, ongoing improvements were still evident in 5 patients (continuous decrease in medication requirements), whereas one patient completely stopped diabetic medication. One patient did not achieve any decrease in medication intake, while another patient was not accounted for in the results. Tarnoff et al (2009) stated that all 4 diabetic patients in the study (3 randomized to Endobarrier) improved by week 1 and maintained this status throughout the trial. In one Endobarrier patient, diabetic status continued to improve and was resolved[3] at 12 weeks' follow-up.

In the RCT by Rodriguez et al (2009), all patients were diabetics and were being treated with at least one oral antidiabetic drug (OAD). At week 12, for the intention to treat population, the authors noted that 42% of Endobarrier patients had ceased treatment with any OAD, while 17% of sham patients had ceased OAD use. In the completer population, 40% of Endobarrier patients and 25% of sham patients that remained on this study had ceased OAD therapy. At week 12, intention to treat HbA1c values decrease by 1.3±0.9% for the Endobarrier arm compared to a decrease of 0.8±0.3% in the sham arm, which was not significantly different. This was maintained at week 24. In contrast, the change in fasting plasma glucose levels were actually greater for Endobarrier patients (mean decrease, 50±18mg/dL) compared to sham patients (mean increase, 25±29mg/dL) (p=0.042) for the intention to treat population. However, this difference was no longer evident at week 12 and week 24. At week 1 follow up for the completer population, 80% of Endobarrier patients and sham patients had a reduction in postprandial glucose excursions compared to baseline. However, postprandial plasma glucose area under the curve decreasedby 22% from baseline values in the Endobarrier group compared with a 16% increase in the sham group (p=0.016) for the completer population. This was also evident for the intention to treat population: postprandial plasma glucose AUC decreased by 19% in Endobarrier patients and increased by 11% in sham patients (p=0.014). There was no change in postprandial insulin levels in either treatment group (Rodriguez et al 2009).

c) EndoCinch

Case series evidence

In the study by Fogel et al (2008), patients were retrospectively divided into subpopulations for analysis due to the large BMI range (25.0 to 60.2 kg/m^2) of the cohort. These subgroups were Group I (n=33): baseline BMI≥40kg/m^2; Group II (n=19): baseline BMI 35-40 kg/m^2; and Group III (n=12): baseline BMI <35 kg/m^2. Fifty nine patients (94.1%) completed the 12 months of follow-up and weight loss outcomes for the total population and subgroups are presented in Table 6. Compared to baseline, mean BMI for the total population decreased significantly at 1, 3 and 12 months (Table 6). In addition, all three subgroups achieved significant excess weight loss for each follow-up time point.

[3] defined as off medications with normal fasting glucose and normal glycosalated hemoglobin.

Table 7: Weight related outcomes (Fogel et al 2008)

	Baseline	1 month	3 months	12 months
Total population	N=64	N=62	N=61	N=59
Mean BMI (kg/m2)	39.9±5.1	36.5±4.8*	33.5±4.5*	30.6±4.7*
Mean %EWL		21.1±6.2	39.6±11.3	58.1±19.9
% patients with >30% EWL		9.7	83.6	96.6
% patients with <15% EWL		14.5	0.0	0.0
% follow-up		96.9	95.3	92.2
Group I	N=33	N=32	N=31	N=29
Mean BMI (kg/m2)	43.4±3.8	39.7±3.8*	36.4±3.7*	33.5±4.0*
Mean %EWL		18.6±4.5	34.6±8.0	48.9±10.3
p-value vs. group II		0.119	0.035	0.037
p-value vs. group III		<0.001	<0.001	<0.001
% patients with >30% EWL		0.0	71.0	96.6
% patients with <15% EWL		21.9	0.0	0.0
% follow-up		97.0	93.9	87.9
Group II	N=19	N=19	N=19	N=19
Mean BMI (kg/m2)	38.5±1.2	35.3±1.2*	32.4±1.4*	29.8±2.3*
Mean %EWL		20.6±4.3	39.4±7.1	56.5±13.9
p-value vs. group I		0.119	0.035	0.037
p-value vs. group III		<0.001	0.001	<0.001
% patients with >30% EWL		5.3	89.5	94.7
% patients with <15% EWL		5.3	0.0	0.0
% follow-up		100.0	100.0	100.0
Group III	N=12	N=11	N=11	N=11
Mean BMI (kg/m2)	32.4±2.4	29.5±2.2*	27.3±2.2*	24.4±2.4*
Mean %EWL		29.5±6.7	54.0±13.5	85.1±24.0
p-value vs. group I		<0.001	<0.001	<0.001
p-value vs. group II		<0.001	0.001	<0.001
% patients with >30% EWL†		45.5	100.0	100.0
% patients with <15% EWL†		0.0	0.0	0.0
% follow-up loss		8.3	8.3	8.3

NA: Not applicable; * Statistically significance (P<0.001) when compared to baseline data; †% is the number of patients with relevant value division by the no. of patients with follow-up.

At 12 months, Fogel et al (2008) noted that statistically significant differences in %EWL were demonstrated by the subpopulations .The results suggest that patients treated with endoluminal vertical gastroplasty utilizing the EndoCinch can achieve significant excess weight loss at 12 months. Overall, %EWL was significantly greater for those with BMI<35kg/m^2 when compared to the other subgroups.

By the end of the study, 96.6% of the total population achieved >30% EWL and there were no patients with <15% EWL.

d) ROSE procedure

Case series evidence

Technical success (defined as successful placement of tissue anchors) was achieved in 85% (17/20) of patients. The stomal diameter was reduced by an average of 65%. Meanwhile, the gastric pouch length was reduced by an average of 36%. Average weight loss at 1 and 3 months was 5.8kg and 8.8kg, respectively compared to baseline (Mullady et al 2009).

e) TOGA

Case series evidence

Both case series studies on TOGA reported efficacy outcomes. In addition to weight loss outcomes, both studies also presented anatomic results and changes in quality of life.

Deviere et al (2008) stated 18/21 patients (85.7%) received two sleeves. One patient received a single sleeve while 2 other patients had a partial sleeve due to technical difficulties. The proximal staple line gap (between the angle of His and proximal staple line) or mid gap (between the proximal and distal staple lines) was observed endoscopically or on barium swallow in 11 patients prior to discharge. Of these, 2 had partial sleeves and the remaining 8 had fully intact sleeves and continuous staple lines. At 6 months, staple line gaps were visible endoscopically or on barium swallow in 13 patients. Of these, 3 (23%) had incomplete distal sleeves while 5 (38.5%) had fully intact sleeve and stable line; no results were provided for the remaining 5 patients. At 1, 3 and 6 months, mean %EWL was 16.2%, 22.6% and 24.4%, respectively. Absolute mean weight loss was 8.0kg, 11.1kg and 12.0kg at 1, 3 and 6 months, respectively. The average BMI decreased from 43.3 kg/m^2 pretreatment to 38.5 kg/m^2 at 6 months ($p<0.0001$).

In the second study (Moreno et al 2008), mean weight loss was 9.9kg, 17.5kg and 24.0kg at 1, 3 and 6 months, ,respectively, which translated to a statistically significant decrease in weight from 119.8kg to 109.9kg, 102.3kg and 95.8kg ($p<0.01$ for all time points). Meanwhile, mean BMI decreased from 41.6kg/m^2 to 38.1kg/m^2, 35.4kg/m^2 and 33.1kg/m^2 at 1, 3 and 6 months, respectively ($p<0.01$ for all time points). At 3 months, 2 patients received additional restrictions due to insufficient weight loss. There was no indication that these patients were excluded from the analysis.

Quality of life measures (Deviere et al 2008) (Table 7), specifically SF-36, which measures overall quality of life, and IWQOL-Lite, which measures quality of life specific to obesity, indicated that patients experienced considerable improvements. Six of the eight SF-36 components were significantly improved (physical functioning, role physical, bodily pain, general health, vitality, social functioning; $p<0.05$ for each one). Meanwhile, every component of the IWQOL-Lite surgery were significantly improved ($p<0.05$) (Table 7).

Similarly, SF-36 and IWQOL-Lite outcomes in the second study (Moreno et al 2008) demonstrated significant improvement in all components for both surveys (Table 8).

Table 8: Quality of life outcomes (Deviere et al 2008)

i) SF-36

	Baseline	6 months	Change	p-value
Physical functioning	35.2	46.2	11.4	0.0008
Role physical	36.1	46.1	10.4	0.0012
Bodily pain	40.2	48.0	6.6	0.02
General health	40.6	49.3	9.7	0.001
Vitality	43.6	54.8	10.7	0.0009
Social functioning	41.6	47.7	4.4	0.03
Role emotional	38.1	42.3	3.9	0.27
Mental health	41.8	46.0	2.6	0.26

ii) IWQOL-Lite

	Baseline	6 months	Change	p-value
Physical functioning (raw)	41.6	25.8	16.9	<0.0001
Self esteem (raw)	23.1	13.9	8.8	<0.0001
Sexual life (raw)	10.8	8.7	2.8	0.03
Public distress (raw)	12.9	8.8	5.1	0.003
Work (raw)	10.3	6.1	4.0	0.002
Total (raw)	98.8	62.7	37.7	<0.0001
Physical functioning (converted)	30.4	66.5	38.5	<0.0001
Self esteem (converted)	42.5	75.5	31.5	<0.0001
Sexual life (converted)	57.2	74.6	17.5	0.03
Public distress (converted)	60.7	80.9	25.3	0.003
Work (converted)	60.6	87.1	25.0	0.002
Total (converted)	45.4	74.5	30.4	<0.0001

Table 9: Quality of life outcomes (Moreno et al 2008)

i) SF-36

	Baseline	6 months	p-value
Physical functioning	38.9	54.7	<0.001
Role-physical	42.2	55.8	<0.001
Bodily pain	44.6	54.5	<0.001
General health	40.4	56.7	<0.001
Vitality	44.4	58.3	<0.001
Social functioning	39.0	54.8	<0.001
Role-emotional	41.0	54.1	<0.001
Mental health	40.0	50.0	<0.001
Self-reported health transition	3.0	1.5	0.017

ii) IWQOL-Lite

	Baseline	6 months	p-value
Physical function	36.5	16.7	0.005
Self-esteem	25.4	14.4	0.009
Sexual life	12.2	6.7	0.015
Public distress	13.2	7.1	0.005
Work	8.8	5.0	0.007
Total	96.0	49.9	0.007

f) StomaphyX

Case series evidence

Weight loss outcomes, as reported by Mikami et al (2010) are reported in Table 9. However, no statistical tests were performed to detect significance. All 39 patients reported a feeling of increased early satiety at 2 weeks post-treatment.

Table 10: Weight loss outcomes (Mikami et al 2010)

i) Postoperative weight loss

Time	Weight loss (kg)	Subjects
2 weeks	3.9 (1.2-17.7)	39
1 month	5.4 91.3-18.6)	34
2 months	6.7 (2.3-22.2)	26
3 months	6.7 (2.7-22.7)	15
6 months	8.7 (2.3-25.4)	13
12 months	10.0 (2.3-29.5)	6

ii) Postoperative % excess body weight loss

Time	Excess body weight loss (%)	Subjects
2 weeks	7.4 (2.5-13.0)	39
1 month	10.6 (3.0-21.2)	34
2 months	13.1 (4.0-28.0)	26
3 months	13.1 (4.1-30.9)	15
6 months	17.0 (4.2-36.0)	13
12 months	19.5 (5.7-38.0)	6

The authors observed that 11 patients had unexpected results after the StomyphyX procedure. Three patients who had late dumping syndrome after their original gastric bypass procedure had their postprandial diarrhea resolved. Meanwhile, 8 patients who suffered with gastric esophageal reflux experienced an improvement in symptoms at their 1-month follow up (Mikami et al 2010).

Cost impact

A search of the literature did not reveal any cost effectiveness studies on endoluminal treatments for obesity. Without long-term comparative studies, accurate cost effectiveness analyses for these new interventions are unlikely to be published.

If these endoluminal techniques lead to shorter hospital stays, lower reoperation rates and lower morbidity rates, these techniques may potentially reduce heathcare costs by virtue of these factors if the techniques eventually prove to be valid alternatives to more invasive surgical procedures currently in use.

Clinical practice guidelines and consensus statements

Specific guidelines on the use of these new endoluminal techniques are practically non-existent due to the emerging nature of these procedures and devices. The Institute for Clinical Systems Improvement (ICSI) released a health care guideline (Prevention and Management of Obesity) that specifically mentions the intragastric balloon (ICSI 2009). The guideline noted that this device is not FDA approved, but has been extensively utilized in South America and Europe, and is approved in Canada and Mexico. It also states that since the intragastric balloon is a non-surgical modality, U.S practitioners can expect to see patients who have traveled out of the country to obtain this treatment. Hence, practitioners need to be familiar with its concept and it is likely to be an immediate source of interest if FDA approval is obtained (ICSI 2009).

The American Society for Metabolic and Bariatric Surgery (ASMBS) released a position statement in 2009 on emerging endosurgical interventions for the treatment of obesity. In it, the Society states that endoluminal innovations and novel devices and technologies should be limited to clinical trials done in accordance with the ethical guidelines of the ASMBS and designed to evaluate the safety and efficacy of the intervention. The results of appropriate trials should include the generation of data for risk-benefit analysis, assessment of disability, durability and the resource use associated with the intervention. If evidence supports the use of a new intervention, several other factors should be considered before clinical application outside the controlled environment of a clinical trial. The use of the new intervention should be practices as parts of a comprehensive treatment program. Patients must be educated with honest and informed consent about the procedures to be used, including any lack of knowledge relating to the duration of effectiveness. Training and skill acquisition with the technique and technology are mandatory and must include didactic and hand-on education. In addition, the ability or availability of physicians and surgeons willing and able to manage potential complications to a specific intervention in morbidly obese patients is advised (ASMBS 2009).

Training and education impact

As endoluminal procedures and technologies continue to be developed and tested, appropriate benchmarks will need to be established regarding acceptable outcomes for these procedures. Both primary and revisional endoluminal treatments must be carefully evaluated in order to elucidate effectiveness, safety and long-term durability. In future, if these procedures are deemed effective, surgeons may require additional endoscopic training. As these endoluminal technologies develop, a greater emphasis on training bariatric surgeons in basic and advanced endoscopic techniques will be necessary. In addition, the development of guidelines for this type of training will be essential to ensure patient safety.

Summary

Of the procedures and devices in this report, the most extensively studied to date are the intragastric balloons, specifically the BIB. The most common adverse events for intragastric balloons were nausea and vomiting, both of which were consistently reported across the included studies. Although generally self-limiting, these complaints can occur in up to 62% 60% of patients in the first 3 days post-placement. In one study, chronic vomiting led to balloon removal in up to 20% of patients. One small comparative study with historical controls indicated that the preoperative use of BIB may be useful in reducing the risks of LABG in super obese patients. Another study indicated that BIB placement tend to counteract the beneficial changes that occur after weight loss (improvement of manometry and pH values). In addition, balloon placement had adverse events, but not so much when placed from the beginning as when position after a period of substantial weight loss (Mathus-Vliegen et al 2003). Preliminary evidence on the Heliosphere suggests that further refinement of the removal procedure is necessary. One study noted that the high complication rates (30%) during Heliosphere removal led to the trial stopping prematurely. Despite the fact that there are numerous studies on intragastric balloons, particularly BIB, there is very little evidence in terms of the long-term durability of weight loss. When BIB was compared to sham treatment, one RCT could not identify an independent benefit of BIB treatment beyond sham (dietary modifications, exercise and behavioral therapy) could not be identified in the first 3 months. However, BIB treatment for 1 year led to substantial weight loss, most of which was maintained in the second year after BIB removal. In contrast, the other reported that BIB can lead to significantly greater weight reduction (in conjunction with dietary modifications) compared to sham treatment. One retrospective literature review study noted that LSG is better at inducing weight loss compared to BIB for multi-stage bariatric procedures.

Meanwhile, the early evidence on the effectiveness of the Endobarrier was encouraging. In comparison to diet control alone, patient who received the Endobarrier lost significantly more weight and also experienced considerable improvements in their diabetic symptoms. However, when compared to patients who received sham endoscopy, those who underwent Endobarrier treatment did not lose significantly more weight compared to the sham controls at 20 weeks' follow up. Clearly, more comparative studies with appropriate controls are necessary to elucidate the true effectiveness of this device. Self-limiting nausea (up to 77%) and upper abdominal pain (up to 30%) were common in patients who received the Endobarrier and some serious complications were evident, with early removal being required in 20% to 40% of patients.

Case series evidence on the two endoscopic gastric reduction techniques (TOGA and EVG with the EndoCinch) indicates that both techniques are feasible and safe. The included studies on TOGA also suggest that patients experienced a significant improvement in quality of life. Meanwhile, evidence to date on revisional endoluminal procedures after gastric bypass (ROSE and StomaphyX) implies that both are feasible with no severe complications. However, these studies are limited to small patient cohorts and some have considerable losses to follow-up.

Overall, the evidence base for most endoluminal treatments for obesity is very limited and mostly consists of low level evidence with small patient cohorts. Early evidence suggests that these techniques may be a valid alternative for multi-stage bariatric surgery or perhaps revision bariatric surgery in patients who have regained weight after gastric bypass. However, some studies also present conflicting results.

Recommendation

Additional long-term comparative studies (with appropriate controls) are necessary before any firm conclusions can be made regarding the safety and effectiveness of these emerging procedures and devices. Until then, these procedures and devices should only be utilized in a clinical trial setting. In addition, future research is necessary to determine if the there are particular patient subgroups that may particularly benefit from certain procedures. Due to the fact that these techniques are relatively new and are undergoing active development, they need to be monitored as refinements occur that will no doubt alter their safety and efficacy profiles.

References

Busetto L, Segato G, De Luca M, Bortolozzi E, MacCari T, Magon A, Inelmen EM, Favretti F, Enzi G. Preoperative weight loss by intragastric balloon in super-obese patients treated with laparoscopic gastric banding: a case-control study. *Obesity Surgery* 2004; 14(5): 671-676.

Coté GA, Edmundowicz SA. Emerging technology: endoluminal treatment of obesity. *Gastrointestinal Endoscopy* 2009; 70(5): 991-999.

Council on Scientific Affairs. Treatment of obesity in adults. *JAMA* 1988; 260(17): 2547-2551.

De Castro ML, Morales MJ, Del Campo V, Pineda JR, Pena E, Sierra JM, Arbones MJ, Prada IR. Efficacy, Safety, and Tolerance of Two Types of Intragastric Balloons Placed in Obese Subjects: A Double-Blind Comparative Study. *Obesity Surgery* 2010 [Epub ahead of print].

Carvalho GL, Barros CB, Moraes CE, Okazaki M, de Novaes Lima Ferreira M, Silva JS, de Albuquerque PP, de Macedo Cavalcanti Coelho R. The Use of an Improved Intragastric Balloon Technique to Reduce Weight in Pre-obese Patients-Preliminary Results. *Obesity Surgery* 2009a [Epub ahead of print]

Carvalho GL, Barros CB, Okazaki M, Novaes ML, Albuquerque PC, Almeida NC, Albuquerque PP, Wakiyama C, Vilaça TG, Silva JS, Coelho RM. An improved intragastric balloon procedure using a new balloon: preliminary analysis of safety and efficiency. *Obesity Surgery* 2009b; 19(2): 237-242.

Devière J, Ojeda Valdes G, Cuevas Herrera L, Closset J, Le Moine O, Eisendrath P, Moreno C, Dugardeyn S, Barea M, de la Torre R, Edmundowicz S, Scott S. Safety, feasibility and weight loss after transoral gastroplasty: First human multicenter study. *Surgical Endoscopy* 2008; 22(3): 589-598.

Executive HM. The cost of obesity in the United States. http://www.executivehm.com/news/cost-of-obesity-in-the-united-states/ [Accessed March 2010].

Fogel R, De Fogel J, Bonilla Y, De La Fuente R. Clinical experience of transoral suturing for an endoluminal vertical gastroplasty: 1-year follow-up in 64 patients. *Gastrointestinal Endoscopy* 2008; 68(1): 51-58.

Forestieri P, De Palma GD, Formato A, Giuliano ME, Monda A, Pilone V, Romano A, Tramontano S. Heliosphere Bag in the treatment of severe obesity: preliminary experience. *Obesity Surgery* 2006; 16(5): 635-637.

Genco A, Cipriano M, Bacci V, Cuzzolaro M, Materia A, Raparelli L, Docimo C, Lorenzo M, Basso N. BioEnterics Intragastric Balloon (BIB): a short-term, double-blind, randomised, controlled, crossover study on weight reduction in morbidly obese patients. *International Journal of Obesity (London)* 2006; 30(1): 129-133.

Martin CK, Bellanger DE, Rau KK, Coulon S, Greenway FL. Safety of the Ullorex oral intragastric balloon for the treatment of obesity*. Journal of Diabetes Science and Technology* 2007; 1(4): 574-581.

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. *Gastrointestinal Endoscopy* 2005; 61(1): 19-27.

Mathus-Vliegen EM, van Weeren M, van Eerten PV. LOS function and obesity: the impact of untreated obesity, weight loss, and chronic gastric balloon distension. *Digestion* 2003; 68(2-3): 161-168.

Mikami D, Needleman B, Narula V, Durant J, Melvin WS. Natural orifice surgery: initial US experience utilizing the StomaphyX device to reduce gastric pouches after Roux-en-Y gastric bypass. *Surgical Endoscopy* 2010; 24(1):223-228.

Miller K. Obesity: surgical options. *Best Practice and Research: Clinical Gastroenterology* 2004; 18(6):1147-1165.

Milone L, Strong V, Gagner M. Laparoscopic sleeve gastrectomy is superior to endoscopic intragastric balloon as a first stage procedure for super-obese patients (BMI > or =50). *Obesity Surgery* 2005; 15(5): 612-617.

Moreno C, Closset J, Dugardeyn S, Baréa M, Mehdi A, Collignon L, Zalcman M, Baurain M, Le Moine O, Devière J. Transoral gastroplasty is safe, feasible, and induces significant weight loss in morbidly obese patients: results of the second human pilot study. *Endoscopy* 2008; 40(5): 406-413.

Mullady DK, Lautz DB, Thompson CC. Treatment of weight regain after gastric bypass surgery when using a new endoscopic platform: initial experience and early outcomes (with video). *Gastrointestinal Endoscopy* 2009; 70(3): 440-444.

Natural Orifice Surgery Consortium for Assessment and Research (NOSCAR). http://www.noscar.org/ [Accessed March 2010].

NHANES. National Health and Nutrition Examination Survey 2009-2010. http://www.cdc.gov/nchs/nhanes/nhanes2009-2010/nhanes09_10.htm [Accessed June 2010].

NIDDK. Bariatric Surgery for Severe Obesity 2009. http://win.niddk.nih.gov/publications/PDFs/gasurg12.04bw.pdf [Accessed May 2010].

Overcash WT. Natural orifice surgery (NOS) using StomaphyX for repair of gastric leaks after bariatric revisions. *Obesity Surgery* 2008; 18(7): 882-885.

Rodriguez L, Reyes E, Fagalde P, Oltra MS, Saba J, Aylwin CG, Prieto C, Ramos A, Galvao M, Gersin KS, Sorli C. Pilot clinical study of an endoscopic, removable duodenal-jejunal bypass liner for the treatment of type 2 diabetes. *Diabetes Technology and Therapeutics* 2009; 11(11): 725-732.

Schouten R, Rijs CS, Bouvy ND, Hameeteman W, Koek GH, Janssen IM, Greve JW. A multicenter, randomized efficacy study of the EndoBarrier Gastrointestinal Liner for presurgical weight loss prior to bariatric surgery. *Annals of Surgery* 2010; 251(2): 236-s43.

Segal L, Carter R, Zimmet P. The cost of obesity: the Australian perspective. *Pharmacoeconomics* 1994; 5(Suppl 1): 45-52.

Stylopoulos N, Aguirre V. Mechanisms of bariatric surgery and implications for the development of endoluminal therapies for obesity. *Gastrointestinal Endoscopy* 2009; 70(6): 1167-1175.

Tarnoff M, Rodriguez L, Escalona A, Ramos A, Neto M, Alamo M, Reyes E, Pimentel F, Ibanez L. Open label, prospective, randomized controlled trial of an endoscopic duodenal-jejunal bypass sleeve versus low calorie diet for pre-operative weight loss in bariatric surgery. *Surgical Endoscopy* 2009; 23(3): 650-656.

Thompson CC, Slattery J, Bundga ME, Lautz DB. Peroral endoscopic reduction of dilated gastrojejunal anastomosis after Roux-en-Y gastric bypass: a possible new option for patients with weight regain. *Surgical Endoscopy* 2006; 20(11): 1744-1748.

Trande P, Mussetto A, Mirante VG, De Martinis E, Olivetti G, Conigliaro RL, De Micheli EA. Efficacy, Tolerance and Safety of New Intragastric Air-Filled Balloon (Heliosphere BAG) for Obesity: the Experience of 17 Cases. Obesity Surgery 2008 [Epub ahead of print].

World Health Organization. Health topics: Obesity. http://www.who.int/topics/obesity/en/ [Accessed June 2010].

Appendix A

Additional papers not included in the safety and efficacy section of this assessment

Article reference	N=	Conclusions	Reason for exclusion
Chiellini C, Iaconelli A, Familiari P, Riccioni ME, Castagneto M, Nanni G, Costamagna G, Mingrone G. Study of the effects of transoral gastroplasty on insulin sensitivity and secretion in obese subjects. *Nutr Metab Cardiovasc Dis* 2010; 20(3):202-207.	9	TOGA allows a significant weight loss 3 months after the intervention as well as an amelioration of insulin sensitivity with subsequent reduction of the insulin secretion.	Less than 10 patients.
Closset J, Germanova D, Loi P, Mehdi A, Moreno C, Devière J. Laparoscopic Gastric Bypass as a Revision Procedure After Transoral Gastroplasty. *Obesity Surgery* 2009; [Epub ahead of print].	71	Laparoscopic RYGBP post-TOGA can be done without any trouble. The performance of TOGA does not interfere with the short term results of laparoscopic RYGBP.	Study examines the safety and efficacy of Laparoscopic RYGBP in patients where TOGA failed. No data on TOGA presented.
Overcash WT. Natural orifice surgery (NOS) using StomaphyX for repair of gastric leaks after bariatric revisions. *Obesity Surgery* 2008; 18**(7)**: 882-885.	2	The StomaphyX can resolve gastric leaks.	Less than 10 patients.
Ryou M, Mullady DK, Lautz DB, Thompson CC. Pilot study evaluating technical feasibility and early outcomes of second-generation endosurgical platform for treatment of weight regain after gastric bypass surgery. *Surg Obes Relat Dis*. 2009; 5(4):450-454.	5	The ROSE procedure is effective in reducing the size of both the gastrojejunal anastamosis and the gastric pouch and could be an alternative therapy for weight regain in gastric bypass patients.	Less than 10 patients.
Thompson CC, Slattery J, Bundga ME, Lautz DB. Peroral endoscopic reduction of dilated gastrojejunal anastomosis after Roux-en-Y gastric bypass: a possible new option for patients with weight regain. *Surgical Endoscopy* 2006; 20(11): 1744-1748.	8	Endoscopic reduction of dilated gastrojejunal anastamosis with the EndoCinch appears technically feasible and safe.	Less than 10 patients.

Appendix B

NHMRC Evidence Hierarchy: designations of 'levels of evidence' according to type of research question

Level	Intervention 1	Diagnostic accuracy 2	Prognosis	Aetiology 3	Screening Intervention
I 4	A systematic review of level II studies	A systematic review of level II studies	A systematic review of level II studies	A systematic review of level II studies	A systematic review of level II studies
II	A randomized controlled trial	A study of test accuracy with: an independent, blinded comparison with a valid reference standard,5 among consecutive persons with a defined clinical presentation6	A prospective cohort study[7]	A prospective cohort study	A randomized controlled trial
III-1	A pseudorandomized controlled trial (i.e. alternate allocation or some other method)	A study of test accuracy with: an independent, blinded comparison with a valid reference standard,5 among non-consecutive persons with a defined clinical presentation6	All or none8	All or none8	A pseudorandomized controlled trial (i.e. alternate allocation or some other method)
III-2	A comparative study with concurrent controls: ▪ Non-randomized, experimental trial9 ▪ Cohort study ▪ Case-control study ▪ Interrupted time series with a control group	A comparison with reference standard that does not meet the criteria required for Level II and III-1 evidence	Analysis of prognostic factors amongst persons in a single arm of a randomized controlled trial	A retrospective cohort study	A comparative study with concurrent controls: ▪ Non-randomized, experimental trial ▪ Cohort study ▪ Case-control study
III-3	A comparative study without concurrent controls: ▪ Historical control study ▪ Two or more single arm study10 ▪ Interrupted time series without a parallel control group	Diagnostic case-control study6	A retrospective cohort study	A case-control study	A comparative study without concurrent controls: ▪ Historical control study ▪ Two or more single arm study
IV	Case series with either post-test or pre-test/post-test outcomes	Study of diagnostic yield (no reference standard)11	Case series, or cohort study of persons at different stages of disease	A cross-sectional study or case series	Case series

Explanatory notes

1 Definitions of these study designs are provided on pages 7-8 *How to use the evidence: assessment and application of scientific evidence* (NHMRC 2000b).

2 The dimensions of evidence apply only to studies of diagnostic accuracy. To assess the effectiveness of a diagnostic test there also needs to be a consideration of the impact of the test on patient management and health outcomes (Medical Services Advisory Committee 2005, Sackett and Haynes 2002).

3 If it is possible and/or ethical to determine a causal relationship using experimental evidence, then the 'Intervention' hierarchy of evidence should be utilized. If it is only possible and/or ethical to determine a causal relationship using observational evidence (ie. cannot allocate groups to a potential harmful exposure, such as nuclear radiation), then the 'Aetiology' hierarchy of evidence should be utilized.

4 A systematic review will only be assigned a level of evidence as high as the studies it contains, excepting where those studies are of level II evidence. Systematic reviews of level II evidence provide more data than the individual studies and any meta-analyses will increase the precision of the overall results, reducing the likelihood that the results are affected by chance. Systematic reviews of lower level evidence present results of likely poor internal validity and thus are rated on the likelihood that the results have been affected by bias, rather than whether the systematic review itself is of good quality. Systematic review *quality* should be assessed separately. A systematic review should consist of at least two studies. In systematic reviews that include different study designs, the overall level of evidence should relate to each individual outcome/result, as different studies (and study designs) might contribute to each different outcome.

5 The validity of the reference standard should be determined in the context of the disease under review. Criteria for determining the validity of the reference standard should be pre-specified. This can include the choice of the reference standard(s) and its timing in relation to the index test. The validity of the reference standard can be determined through quality appraisal of the study (Whiting et al 2003).

6 Well-designed population based case-control studies (eg. population based screening studies where test accuracy is assessed on all cases, with a random sample of controls) do capture a population with a representative spectrum of disease and thus fulfil the requirements for a valid assembly of patients. However, in some cases the population assembled is not representative of the use of the test in practice. In diagnostic case-control studies a selected sample of patients already known to have the disease are compared with a separate group of normal/healthy people known to be free of the disease. In this situation patients with borderline or mild expressions of the disease, and conditions mimicking the disease are excluded, which can lead to exaggeration of both sensitivity and specificity. This is called spectrum bias or spectrum effect because the spectrum of study participants will not be representative of patients seen in practice (Mulherin and Miller 2002).

7 At study inception the cohort is either non-diseased or all at the same stage of the disease. A randomized controlled trial with persons either non-diseased or at the same stage of the disease in *both* arms of the trial would also meet the criterion for this level of evidence.

8 All or none of the people with the risk factor(s) experience the outcome; and the data arises from an unselected or representative case series which provides an unbiased representation of the prognostic effect. For example, no smallpox develops in the absence of the specific virus; and clear proof of the causal link has come from the disappearance of small pox after large-scale vaccination.

9 This also includes controlled before-and-after (pre-test/post-test) studies, as well as adjusted indirect comparisons (ie. utilize A vs B and B vs C, to determine A vs C with statistical adjustment for B).

10 Comparing single arm studies ie. case series from two studies. This would also include unadjusted indirect comparisons (ie. utilize A vs B and B vs C, to determine A vs C but where there is no statistical adjustment for B).

11 Studies of diagnostic yield provide the yield of diagnosed patients, as determined by an index test, without confirmation of the accuracy of this diagnosis by a reference standard. These may be the only alternative when there is no reliable reference standard.

Note A: Assessment of comparative harms/safety should occur according to the hierarchy presented for each of the research questions, with the proviso that this assessment occurs within the context of the topic being assessed. Some harms are rare and cannot feasibly be captured within randomized controlled trials; physical harms and psychological harms may need to be addressed by different study designs; harms from diagnostic testing include the likelihood of false positive and false negative results; harms from screening include the likelihood of false alarm and false reassurance results.

Note B: When a level of evidence is attributed in the text of a document, it should also be framed according to its corresponding research question eg. level II intervention evidence; level IV diagnostic evidence; level III-2 prognostic evidence.

Source: Hierarchies adapted and modified from: NHMRC 1999; Bandolier 1999; Lijmer et al. 1999; Phillips et al. 2001.

Appendix C

Extraction tables for included studies.

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr>
<td>Busetto L, Segato G, De Luca M, Bortolozzi E, Maccari T, magon A, Inelman EM, Favretti F, Enzi G (2004).

Obesity Surgery

Aim: to investigate the usefulness of preoperative treatment with BIB intragastric balloon in super-obese patients before undergoing laparoscopic adjustable gastric banding.

Conflicts of interest: None reported.</td>
<td>BIB followed by LAGB vs. LAGB alone.

Procedure
Patients in the BIB/LAGB group had to successfully complete BIB treatment prior to undergoing LAGB. Placement and removal of the BIB were performed under deep sedation. The deflated BIB was introduced through the mouth and positioned within the stomach cavity. The balloon was injected with 500-700 mL of saline and methylene blue (50:1 ratio).

LAGB was done with the Lap-Band® system. At discharge, patients were required to follow a modified liquid diet for 4 weeks, followed by a solid diet.

Dietary/behavioral modifications: Both liquid and solid diets were arranged to fit a 24-hour energy intake of 2.5MJ (40% proteins, 35%</td>
<td>Level of evidence: III-2

Inclusion criteria: Not stated.

Exclusion criteria: Not stated.

Duration of follow-up: 6 months

Losses to follow-up: Not reported.</td>
<td>Case patients were selected for evaluation from 225 obese patients treated with the BIB followed by LAGB. 43 patients successfully completed this sequential treatment and were included for evaluation in this study.

Control patients were selected from a historical series of 483 morbidly obese patients surgically implanted with LAGB before the introduction of the BIB into clinical use. 43 control patients were selected consecutively to match case patients according to sex, age and BMI.

Study period
BIB: Jan 1999 – April 2003
Control: Jan 1996 – December 1998.</td>
<td>Baseline characteristics
<table>
<tr><th></th><th>BIB pre-surgical</th><th>Lap-Band® alone</th></tr>
<tr><td>Age (years)</td><td>43.3±10.5 (26-67)</td><td>42.8±10.5 (20-63)</td></tr>
<tr><td>Height (m)</td><td>1.71±0.10 (1.40-2.00)</td><td>1.69±0.10 (1.50-2.00)</td></tr>
<tr><td>Body weight (kg)</td><td>171.0±25.4 (114-264)</td><td>163±22.7 (131-225)</td></tr>
<tr><td>BMI (kg/m2)</td><td>58±6.6 (47.9-74.4)</td><td>56.9±5.7(46.7-70.2)</td></tr>
</table>
Data presented as mean±SD (range). No significant differences between groups were observed.

Operative data
<table>
<tr><th></th><th>BIB pre-surgical</th><th>Lap-Band® alone</th></tr>
<tr><td>General data</td><td></td><td></td></tr>
<tr><td>Operative time (min)</td><td>82.5±20.9 (20-120)</td><td>102.6±35.1* (45-180)</td></tr>
<tr><td>Hospital stay (days)</td><td>3.0±0.2 (2-4)</td><td>3.3±0.8 (2-6)</td></tr>
<tr><td>Conversion</td><td></td><td></td></tr>
<tr><td>Conversion to open</td><td>0 (0%)</td><td>5/43 (11.6%)</td></tr>
<tr><td>Video assisted</td><td>0 (0%)</td><td>2/43 (4.7%)</td></tr>
<tr><td>Total</td><td>0 (0%)</td><td>7/43* (16.3%)</td></tr>
<tr><td>Intraoperative complications</td><td></td><td></td></tr>
<tr><td>Gastric bleeding</td><td>0/43 (0%)</td><td>2/43 (4/7%)</td></tr>
<tr><td>Trocar injury</td><td>0/43 (0%)</td><td>1/43 (2.3%)</td></tr>
<tr><td>Total</td><td>0/43 (0%)</td><td>3/43 (7.0%)</td></tr>
</table>
Data presented as mean±SD. *p<0.05 for student's t-test or Chi-square test.

Postoperative complications
<table>
<tr><th></th><th>BIB pre-surgical</th><th>Lap-Band® alone</th></tr>
<tr><td>Band-related complications</td><td></td><td></td></tr>
<tr><td>Pouch dilatation</td><td>3/43 (7.0%)</td><td>3/43(7.0%)</td></tr>
<tr><td>Slippage of the band</td><td>0/43 (0%)</td><td>1/43 (2.3%)</td></tr>
<tr><td>Port-related complications</td><td></td><td></td></tr>
<tr><td>Port leakage</td><td>1/43 (2.3%)</td><td>8/43* (18.6%)</td></tr>
<tr><td>Port twisting</td><td>0/43 (0%)</td><td>1/43 (2.3%)</td></tr>
<tr><td>Port infection</td><td>0/43 (0%)</td><td>1/43 (2.3%)</td></tr>
</table>
*p<0.05 Chi-square test.</td>
<td>Weight loss in super-obese patients with the intragastric balloon was similar to the weight loss obtained in the first 6 months after gastric banding alone. Therefore, the body weight of the patients treated with sequential therapy was lower than in controls at surgery and in the first months thereafter.

However this difference was no longer apparent over time and the weight loss attained by both groups were very similar from 1 year after banding.

Preoperative treatment with the intragastric balloon should not be viewed as a means to improve the long term results of gastric banding. Sequential therapy such as this should be considered</td>
</tr>
</table>

Study details	Intervention	Study design and inclusion/exclusion criteria	Study population	Results	Author(s) conclusions
	carbohydrates, 25% fats).			%EWL curves The %EWL produced by BIB was identical to the %EWL observed in the first 6 months after LAGB in the control group treated with LAGB alone (26.1±9.3% vs. 25.3±12.4%). %EWL 6 months after banding was higher in the case group than in the control group (33.6±12.5 vs. 25±12.4%, p<0.01). No significant differences in%EWL were observed at 1 year, 2 years and 3 years follow-up.	for patients with extreme obesity.
Mathus-Vliegen E, Tytgat GN, 2005. *Gastrointentinal endoscopy* Aim: to investigate the effectiveness, the safety and the tolerance of a new intragastric balloon. Conflicts of interest: BioEnterics Corp. provided the balloon and sham placement assemblies.	BIB and sham (Group 1) Procedure BIB: Balloon placement assembly was inserted at a distance from the incisor teeth, calculated to place the assembly 10cm distal from the gastroesophageal junction. Sham treatment: the collapsed balloon was not present in the assembly. A syringe was attached to the balloon fill tube and the balloon (or stomach for the sham procedure) was filled with 500 mL of saline. Adequate positioning was confirmed by a radiologist. Exchange procedures were scheduled at 3, 6 and 9 months. After each placement or exchange, patients were monitored for 3 hours to verify tolerance.	Level of evidence: II Method of randomization: Random number table. Allocation concealment:/blinding: The design of the devices was such that neither the patient nor the investigator could perceive a difference between the sham-balloon and real-balloon placement. Both the operator and patient were blinded to group assignment. Duration of follow-up: 24 months Losses to follow-up: Group 1: 1 lost due to balloon intolerance, 1 due to no cooperation Group 2: 5 lost due to inadequate weight loss, 2 lost due to balloon intolerance. Inclusion criteria: Age ≥18 years, failure to achieve weight loss within a supervised weight-control program, stable BMI ≥32kg/m2 (fluctuation of ≤1	Group 1 (n=23) Sham balloon placement for 3 months, followed by a balloon every 3 months for the remainder of the year (3 balloons). Group 2 (n=20) Balloon placement every 3 months for the first year (4 balloons). Study period: Not reported.	Weight loss (intention to treat) 3-month follow up: Mean weight loss: sham, 1.2kg (9% of initial body weight); BIB; 12.9kg (10.4%) (p=not significant). 3 to 6 month follow up Mean weight loss: sham, .8kg (7.9%) of body weight; BIB, 3.9kg (3.9%) (p<0.003). Total weight loss after 6 months: sham, 20.0kg (16.1%); BIB, 16.7 (13.4%) (p=??). At 12 months, a mean loss of 21.3kg (17.1%)v was observed, which was comparable between the groups. Apart of the development of gallbladder stones in 5 patients, there was a decrease in comorbidity. ¾ of patients achieve a 10% weight loss and almost ½ attained a weight loss of greater than 20%. At 2 years, patients gained weight, but remained 12.7kg (9.9%) below the initial body weight. A weight loss of 10% or greater and 15% or greater was maintained by 47% and 33%, respectively. Weight loss (per protocol analysis) 33 patients completed the 2 year study. In the first 3months, patients in group 2 lost more weight numerically (15.4kg, 12.4%) compared with group 1 (11.6kg, 9.3%). Weight loss differed significantly in months 3 to 6 (group 2: 6.5kg vs group 1:9,7kg; p=0.037), and in months 6 to 9 (group 2: 5.7kg vs. group 1: 3.0kg; p=0.025). However correction for multiple testing using the Bonferroni method removed this significance. Overall weight loss after 6 and 9 months were similar for both groups. After 3 months, weight loss of 13kg or greater was achieved in a significantly greater number of patients in group 2 vs group 1 (67% vs. 24%; p=0.01). At 12 months, an average of 25.6kg (20.5%) had been lost. Over 88% of patients achieved 10% to 15% weight loss. At 24 months, a weight loss of 14.6kg (11.4%) was maintained. Weight loss of 10% or greater and 15% or greater was sustained over 2 years by 55% and 39% of patients, respectively. Patient tolerance and safety 3 patients suffered from severe nausea, vomiting and abdominal cramps. All of which indicate intolerance of the balloon. All 3 recovered after balloon removal.	The authors concluded that the BIB itself and the technique for positioning are safe. However the BIB was not a suitable treatment option for 20% of patients. Independent benefit of balloon treatment beyond diet and behavioral therapy could not be demonstrate in the first 3 months. Balloon treatment for 1 year resulted in substantial weight loss, the greater part of which was maintained during the balloon-free second year.

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td>Dietary/behavioral modifications:
Patients were asked to adhere (with dietitian support) to a calorie-restricted diet (1000-1500kcal per day I presume??).</td><td>BMI unit over the previous 4 months)

Exclusion criteria:
A hormonal or genetic cause for obesity, malignancy within the previous 5 years, pregnancy or a desire to become pregnant, alcoholism and drug abuse.
Contraindications specific to BIB: gastrointestinal lesions, large (>3cm) haital hernia, grade C-D esophagitis, peptic ulceration, varices or angiectasias and previous bariatric or abdominal surgery (due to potential presence of adhesions)</td><td></td><td>2 patients from group1 requested balloon adjustment due to nausea and abdominal cramps, 120 mL of saline was removed.
Phone consultations revealed many complaints during the first 3 days after balloon placement, however there were almost no complaints at the exchange in balloon-balloon treated patients (group 2).
At initial endoscopy, small haital hernia was present in 6 patients and esophagitis was present in 5 patients.
During follow-up, endoscopy revealed severe esophagitis in 2 patients and was related to the use of NSAIDs. Both resolved after NSAID use was discontinued.
Severe esophagitis developed in a patient with small haital hernia after substantial weight loss (32.6kg).
Esophageal erosion was discovered in 10 patients and gastric erosion in 4 patients when the first balloon was removed. These findings disappeared at follow-up endoscopy.
Balloon removal resulted in one Mallory-Weiss laceration and one episode of minor gastric bleeding because of injury caused with a forceps. Both patients recovered uneventfully.
3 balloons deflated spontaneously, 2 passed spontaneously, one was removed endoscopically.
Balloon content cultures were sterile in 80%, oropharyngeal flora and yeast were cultured in the remaining 20%</td><td></td></tr>
<tr><td>Mathus Vliegen E, van Weeren M, van Eerten PV (2003).

Digestion

Aim: To investigate the influences of untreated obesity, weight loss, and chronic gastric balloon distention on the lower esophageal sphinter (LOS).

Conflicts on interest: None disclosed.</td><td>BIB vs. sham

Procedure
After an endoscopy to rule out mucosal lesions and the measure the distance between incisor teeth and the gastro-esophageal junction, a balloon placement assembly was inserted up to 10cm beyond the gastro-esophageal junction. The assembly consisted of a sheath with the collapsed balloon (empty for sham group) and a balloon fill tube. The balloon (or stomach) was filled with 500 mL of saline.

During the second 13 week period of the trial.</td><td>Level of evidence: II

Method of randomization: Not reported. Patients were randomised to balloon or sham treatment for the first 13 weeks.

Allocation concealment: Both the operator and patient were blinded to group assignment in the first phase (first 13 weeks).

Duration of follow-up: 39 weeks.

Losses to follow-up: During the blinded first phase, 4 balloon patients with undetectable LOS at the start were lost to analysis.
During the second phase, 6 patients were lost to analysis:</td><td>32 patients (26 females) with a mean age of 40.9±11.2(S.D) years were approved to enter this study. Mean weight and BMI were 128.2±3.9kg and 44.3±1.3kg/m2.

Balloon treatment: 17 patients
Sham: 17 patients

Study period: Not reported.</td><td>Data of sham-balloon-treated and balloon-balloon treated patients at the start and after 13 and 26 weeks of treatment
<table>
<tr><th></th><th>Start</th><th>13 weeks</th><th>26 weeks</th><th colspan="3">pvalue</th></tr>
<tr><th></th><th></th><th></th><th></th><th>T1vsT2</th><th>T2vsT3</th><th>T1vsT3</th></tr>
<tr><td>Sham balloon</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>N</td><td>17</td><td>17</td><td>13</td><td>17</td><td>13</td><td>13</td></tr>
<tr><td>Body weight (kg)</td><td>129.6 ± 22.0</td><td>117.2 ± 21.5</td><td>102.4 ± 17.0</td><td>***</td><td>***</td><td>***</td></tr>
<tr><td>LOSP (mmHg)</td><td>14.6 ± 6.0</td><td>17.2 ± 5.2</td><td>17.4 ± 6.4</td><td>NS</td><td>NS</td><td>NS</td></tr>
<tr><td>Overall LOS length (cm)</td><td>3.0 ± 0.7</td><td>3.6 ± 0.7</td><td>3.0 ± 0.6</td><td>*</td><td>**</td><td>NS</td></tr>
<tr><td>Total time at pH<4 (%)</td><td>6.1 ± 3.5</td><td>4.1 ± 3.2</td><td>7.5 ± 4.6</td><td>NS</td><td>**</td><td>NS</td></tr>
<tr><td>Time upright at pH<4 (%)</td><td>8.0 ± 3.9</td><td>5.5 ± 4.1</td><td>7.6 ± 4.5</td><td>*</td><td>*</td><td>NS</td></tr>
<tr><td>Time supine at pH<4 (%)</td><td>2.8 ± 4.5</td><td>1.6 ± 2.3</td><td>6.7 ± 9.1</td><td>NS</td><td>*</td><td>NS</td></tr>
<tr><td>No. of reflux episodes</td><td>64.9 ± 34.4</td><td>48.0 ± 33.0</td><td>80.7 ± 46.9</td><td>NS</td><td>NS</td><td>NS</td></tr>
<tr><td>Meal related</td><td>13.6 ± 10.4</td><td>6.8 ± 6.3</td><td>9.5 ± 7.0</td><td>**</td><td>NS</td><td>NS</td></tr>
<tr><td>Meal and</td><td>49.0 ±</td><td>32.1 ±</td><td>43.0 ±</td><td>*</td><td>NS</td><td>NS</td></tr>
</table></td><td>Impaired LOS function and increase gastro-esophageal reflux were observed in 25% of untreated obese patients. Weight loss ameliorated manometry and pH values, but subsequent balloon positioning tended to counteract these beneficial changes. In patients on balloon treatment since the beginning of the study, adverse events appear to wear off after prolonged treatment.</td></tr>
</table>

Study details	Intervention	Study design and inclusion/exclusion criteria	Study population	Results	Author(s) conclusions
	All eligible patients received an intragastric balloon. Patients who received the BIB in the first 13 week period had to have lost at least 6.5kg in order to receive a second balloon. This weight loss was not required in patients who received sham treatment in the first phase. Manometry and 24hr pH measurements were performed at the start, after 13 weeks of either balloon or sham treatment and after a second 13 weeks of balloon treatment. Measurements were performed with balloons in situ. Dietary/behavioral modifications: Utilized but no details provided.	2 patients with insufficient weight loss were not allowed to continue. 2 sham patients had their balloons removed due to intolerance. 1 sham patient was not cooperative at balloon placement and 1 sham patient with inadequate T2 tracings. Inclusion criteria: Patients above the age of 18 years with BMI >32kh/m2 who did not receive treatment for their obesity. Exclusion criteria: any conditions that would interfere with the safety of balloon positioning including ulcerative or bleeding lesion of the sigestive tract, large (>3cm) haital hernia, and previous bariatric or major intra-abdominal surgery. Poor physical condition or non-cooperation that thwarted regular endoscopic control and the use of non-steroidal anti-inflammatory drugs or anti-coagulants were also excluded.		<table><tr><td>postprandially</td><td>24.4</td><td>22.8</td><td>21.7</td><td></td><td></td><td></td></tr><tr><td>Energy intake (MJ)</td><td>12.0 ± 4.2</td><td>4.9 ± 1.2</td><td>4.7 ± 1.1</td><td>***</td><td>NS</td><td>***</td></tr><tr><td>% proteins/fat/ carbohydrates in food</td><td>15/44/41</td><td>22/33/45</td><td>19/33/43</td><td></td><td></td><td></td></tr><tr><td>Balloon-balloon</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>N</td><td>11</td><td>11</td><td>9</td><td>11</td><td>9</td><td>9</td></tr><tr><td>Body weight (kg)</td><td>125.2 ± 24.8</td><td>112.5 ± 21.8</td><td>105.8 ± 20.8</td><td>***</td><td>NS</td><td>***</td></tr><tr><td>LOSP (mmHg)</td><td>15.1 ± 4.8</td><td>17.4 ± 7.4</td><td>17.3 ± 7.5</td><td>NS</td><td>NS</td><td>NS</td></tr><tr><td>Overall LOS length (cm)</td><td>2.9 ± 0.7</td><td>2.8 ± 0.5</td><td>2.9 ± 0.8</td><td>NS</td><td>NS</td><td>NS</td></tr><tr><td>Total time at pH<4 (%)</td><td>5.9 ± 4.3</td><td>5.4 ± 1.9</td><td>5.9 ± 2.0</td><td>NS</td><td>NS</td><td>NS</td></tr><tr><td>Time upright at pH<4 (%)</td><td>8.8 ± 7.1</td><td>5.3 ± 2.2</td><td>6.6 ± 3.5</td><td>NS</td><td>NS</td><td>NS</td></tr><tr><td>Time supine at pH<4 (%)</td><td>1.6 ± 1.9</td><td>6.7 ± 6.8</td><td>4.6 ± 5.4</td><td>*</td><td>NS</td><td>NS</td></tr><tr><td>No. of reflux episodes</td><td>62.6 ± 32.0</td><td>63.3 ± 14.3</td><td>65.4 ± 22.2</td><td>NS</td><td>NS</td><td>NS</td></tr><tr><td>Meal related</td><td>8.8 ± 6.7</td><td>7.3 ± 4.3</td><td>6.2 ± 4.2</td><td>NS</td><td>NS</td><td>NS</td></tr><tr><td>Meal and postprandially</td><td>40.4 ± 31.4</td><td>38.7 ± 16.6</td><td>38.0 ± 15.7</td><td>NS</td><td>NS</td><td>NS</td></tr><tr><td>Energy intake (MJ)</td><td>13.4 ± 5.4</td><td>5.6 ± 1.7</td><td>6.3 ± 1.7</td><td>***</td><td>NS</td><td>*</td></tr><tr><td>% proteins/fat/ carbohydrates in food</td><td>15/44/41</td><td>22/33/45</td><td>19/33/43</td><td></td><td></td><td></td></tr></table> Mucosal injury and complaints The affects of the presence of the balloon was studies in 22 patients who underwent endoscopy at the start and after 13 and 26 weeks. Four patients showed abnormalities at the start: 2 had small haital hernia with grade A esophagitis, 1 had an isolated grade A esophagitis and 1 had gastritis. For sham-balloon-treated patients, endoscopic finding paralleled the manometry and pH-metry data. After initial improvement by weight loss without a balloon, a further 13 weeks of true balloon treatment resulted in an exacerbation of an already present grade A esophagitis, a newly developed esophagitis in 2 patients and ulceration and the gastri-esophageal junction in 1 patient.	

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td></td><td></td><td></td><td>In balloon-balloon treated patients, one patient had grade A esophagitis that healed after 13 weeks but grade B esophagitis was seen after 26 weeks.

Significantly more complaints of nausea (11.1 vs. 1.3%), belching (55.6 vs. 14.1%) and heartburn (24.1 vs. 10.3%) were mentioned during the first period by balloon-treated patient than by sham-treated patients. These symptoms abated in the second phase.

Patients who received a balloon after an initial sham period reported significantly more nausea (51.9% vs. 0%), vomiting (38.3% vs. 2.2%) and heartburn (46.9% vs. 24.4%) as compared with those who continued balloon treatment.</td><td></td></tr>
<tr><td>Genco A, Cipriano M, Bacci V, Cuzzolaro M, Materia A, Raparelli L, Docimo C, Lorenzo M, Basso N. (2006)

International Journal of Obesity

Aim: to evaluate the real, short-term, efficacy of the BIB for weight reduction in morbidly obese patients

Conflicts of interest: None disclosed</td><td>BIB or sham.

Procedure
All procedures were performed by fully trained staff with previous experience of at least 50 BIB placements.

After sedation, the patient's esophagus, stomach and duodenum were examined and a quick test for Helicobacter pilory was was performed. The balloon was inserted into the gastric fundus and inflation (500 mL saline and 10 mL methylene blue) was performed under direct vision.

At the end of the treatment period (3 months), patients from Group A had their BIB removed and was not followed by another balloon. In group B, patients received sham</td><td>Level of evidence: II

Method of randomization: sealed envelope method.

Allocation concealment: Evaluator physician blinded to patient randomisation.

Duration of follow-up: 6 months.

Losses to follow-up: Not reported.

Inclusion criteria: patients were selected in accordance to National Institutes of Health criteria and guidelines for obesity. Only patients with no medical or psychological contraindications who agreed to comply with the follow-up controls were considered eligible for randomization.

Exclusion criteria: oesophagitis (>2grade) Haital hernia (>5cm), peptic ulcer or its previous complications, Crohn's disease, major</td><td>32 patients (24 female; mean age: 36.2±5.6 years, range 25-50 years; mean BMI: 43.7±1.5 kg/m2, range 40-45kg/m2, mean excess weight: 66±9, range: 49-78kg; mean %excess weight: 43.1±13.1, range: 36-65).

Group A: 16 patients
Group B: 16 patients

Study period: January 2003 – December 2003.</td><td>Groups A and B patient characteristics
<table><tr><th></th><th>Group A</th><th>Group B</th></tr><tr><td>Age (years)</td><td>36.2±5.2 (25-50)</td><td>36.3±5.9 (25-50)</td></tr><tr><td>Sex</td><td>4M/12F</td><td>4M/12F</td></tr><tr><td>BMI (kg/m2)</td><td>43.9±1.1 (40-45)</td><td>43.6±1.8 (40-45)</td></tr><tr><td>Excess weight</td><td>65±11 (51-77)</td><td>67±9 (49-78)</td></tr><tr><td>% excess weight</td><td>43.5±12.9 (35-65)</td><td>42.9±13.2 (35-65)</td></tr><tr><td>History of obesity (months)</td><td>84±11 (78-90)</td><td>84±12 (79-94)</td></tr></table>Results presented as mean±SD (range)

Patient symptoms after first 60 min and 48 hours after BIB or sham procedure
<table><tr><th></th><th colspan="2">Epigastric pain</th><th colspan="2">Nausea</th><th colspan="2">Vomiting</th></tr><tr><td>BIB</td><td>13/16*</td><td>14/16</td><td>12/16</td><td>14/16</td><td>13/16</td><td>14/16</td></tr><tr><td>Sham</td><td>1/16</td><td>2/16*</td><td>3/16</td><td>5/16</td><td>0/16</td><td>0/16</td></tr></table>*p<0.001
There were no mortalities and no complications related to endoscopy, balloon placement and removal.

BMI during different times of the study
<table><tr><th></th><th>Initial BMI</th><th>BMI loss after 3 months</th><th>BMI after 3 months</th><th rowspan="3">Crossover</th><th>BMI loss 3 months after crossover (kg/m2)</th><th>Final BMI (kg/m2)</th></tr><tr><td>Group A</td><td>43.9±1.1</td><td>5.8±0.5*</td><td>38.0±2.6§</td><td>1.1±0.3</td><td>37.0±3.4</td></tr><tr><td>Group B</td><td>43.6±1.8</td><td>0.4±0.2</td><td>43.1±2.8</td><td>5.1±0.6*</td><td>38.8±3.1</td></tr></table>*p<0.001; §p<0.001

At the end of the first 3 months, mean weight loss was 15±66 and 3±1kg in group A (BIB)</td><td>The authors concluded that the treatment of obese patients with BIB is a safe and effective procedure in association with appropriate diet.</td></tr>
</table>

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td>treatment for the first 3 months. After this period, Group B patients underwent BIB placement.

Dietary/behavioral modifications: 4 days after placement, patients were instructed to begin a 1000kcal diet (about 50% carbohydrate, 26% lipids, 24% proteins). At 1month after placement, omeprazole was given at 20mg/die.</td><td>psychiatric disease, disorders of alimentary pattern, pregnancy, previous gastrointestinal surgery, chronic therapy with steroids, NSAID or anticoagulants, alcohol or drug abuse, structural abnormalities or gastrointestinal tract, lesions with increased risk of bleeding, severe liver disease, any contraindication to endoscopy, Sibutramine and Orlistat treatment.</td><td></td><td>and in group B (sham), respectively (p<0.001), with a mean BMI of 38.0±2.6kg/m2 in group A and of 43.1±2.8kg/m2 in group B (p<0.001).

%EWL during different times of the study
<table>
<tr><th></th><th>Initial EW</th><th>%EWL after 3 months</th><th rowspan="3">Crossover</th><th>%EWL after 3 months from crossover</th><th>Final % EWL</th></tr>
<tr><td>Group A</td><td>43.5±12.9</td><td>34.0±4.8</td><td>4.6±1.1</td><td>38.5±5.1</td></tr>
<tr><td>Group B</td><td>42.9±13.2</td><td>2.1±1</td><td>31±4.8</td><td>33.6±4.9</td></tr>
</table>
There were no mortalities and no complications related to endoscopy, balloon placement and removal.</td><td></td></tr>
<tr><td>Martin CK, Bellanger DE, Rau KK, Coulon S, Greenway FL. (2007)

Journal of Diabetes Science and Technology

Aim: to test the safety of the Ullorex oral intragastric balloon (for weight loss) in a sample of human participants.

Conflicts of interest: This research was supported by a grant from Phagia Technologies (manufacturer of Ullorex)</td><td>Ullorex balloon or placebo.

Procedure
The balloon was administered by the study coordinator, under the supervision of the study surgeon, orally with water while and intravenous line was in and place and the participant was in a sitting position. 30 minutes after swallowing the Ullorex balloon, an abdominal X-ray followed by barium swallow was performed to ensure proper placement of the device. This was repeated at weeks 2 and 4. If the balloon was still present in the stomach at week 4, x-ray and barium swallow were repeated weekly until week 6. If</td><td>Level of evidence: II

Method of randomization: The first 6 patients were assigned rando mLy to receive a placebo capsule or 1, 2 or 3 balloons. The last 6 participants all received one balloon.

Allocation concealment: The first 6 participants and study staff were blind to treatment. The last 6 participants were not blind to treatment.

Duration of follow-up: 2 weeks

Losses to follow-up: 2 patients. One due to dissatisfaction with weight loss, the other due to severe reactions towards the placement of 3 balloons (mainly due to noncompliance of diet restrictions).</td><td>12 patients (8 women, age: 36.8±10.4 years [21-64 years], body weight: 146.7±25.8kg, BMI: 51±3.5kg/m2).

Cohort 1 (first 6 patients): 2 randomised to placebo, 2 to one balloon, 1 to two balloons and 1 to three balloons.

Cohort 2 (last 6 patients): all received one balloon.

Study period: Not reported.</td><td>Number of balloons administered, inflation status and weeks at which balloons passed out of body.
<table>
<tr><th>Subject identification</th><th>No. balloons</th><th>Balloon(s) fully inflated</th><th>Week balloon(s) deflated</th><th>Week balloon(s) passed</th></tr>
<tr><td colspan="5">Cohort 1</td></tr>
<tr><td>1</td><td>2</td><td>No</td><td>Never inflated</td><td>2.5</td></tr>
<tr><td>2</td><td>0 (3 placebo capsules)</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>3</td><td>3</td><td>Partial, 1cm</td><td>1</td><td>2</td></tr>
<tr><td>4</td><td>1</td><td>Yes</td><td>2</td><td>2</td></tr>
<tr><td>5</td><td>1</td><td>Yes</td><td>4</td><td>6</td></tr>
<tr><td>6</td><td>0 (3 placebo capsules)</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="5">Cohort 2</td></tr>
<tr><td>7</td><td>1</td><td>Yes</td><td>2</td><td>6 (extracted)</td></tr>
<tr><td>8</td><td>1</td><td>Yes</td><td>3</td><td>3</td></tr>
<tr><td>9</td><td>1</td><td>Yes</td><td>2</td><td>6 (extracted)</td></tr>
<tr><td>10</td><td>1</td><td>Yes</td><td>2</td><td>4</td></tr>
<tr><td>11</td><td>1</td><td>Yes</td><td>4</td><td>4</td></tr>
<tr><td>12</td><td>1</td><td>Yes</td><td>2</td><td>6 (extracted)</td></tr>
</table>
No. of adverse events (AE) during the study and number/percentage of AEs attributable to the device
<table>
<tr><th>Type AE</th><th>No. AEs</th><th>No. AEs related to device</th><th>%AE related to device</th></tr>
</table></td><td>The authors stated that the Ullorex was successfully utilized in this study with one serious adverse event that was mainly due to patient noncompliance. Body weight and food intake data suggests that the Ullorex can be tested further as a possible treatment for obesity.</td></tr>
</table>

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr>
<td></td>
<td>still present, the balloon was removed endocopically or deflated to allow passage in the stool.

Dietary/behavioral modifications: a dietician instructed participants to consume a liquid diet for the first day after swallowing the balloon capsules. On the second day, semisolids (soups, gelatins and broths) could be consumed. A balanced diet to be followed throughout the study was provided by the dietician (no specific details provided). The dietician reviewed dietary records and saw patients on biweekly visits.</td>
<td>Inclusion criteria: BMI above 30 kg/m2 for more than 6 months, ability to swallow a capsule of the same size as the Ullorex within a 4 minute period.

Exclusion criteria: history of sleep apnea, stroke, myocardial infarction, or cardiac revascularization within 6 months of randomization. In addition, participants with a history of esophageal atresia, gastrointestinal stenosis, gastrointestinal obstruction, severe esophagitis, esophageal varices, dysphagia, achalasia, hiatus hernia, gastroparesis, gastric varices, adhesive peritonitis or abnormalities of the esophagus, stomach or pylorus were also excluded. Medications that were specifically excluded: chronic use of NSAIDs including aspirin, antiangina medications, antiarrhythmia medication, anticoagulants, or medications for congestive heart failure. Participants taking medications to control blood pressure or serum lipids were required to be on stable dose for 3 months prior to the trial. Pregnant women, people who abuse substances, including alcohol and people who regularly ate large quantities of sweet foods/drinks were also</td>
<td></td>
<td>
<table>
<tr><td>Gastrointestinal</td><td>42</td><td>38 (2 unknown)</td><td>90</td></tr>
<tr><td>Head and neck</td><td>9</td><td>4</td><td>44</td></tr>
<tr><td>Vomiting</td><td>5</td><td>5</td><td>100</td></tr>
<tr><td>Skin</td><td>3</td><td>1</td><td>33</td></tr>
<tr><td>Other</td><td>8</td><td>0</td><td>0</td></tr>
</table>

A total of 67 AEs were reported during the study and 48 (72%) of these AEs were attributable to Ullorex. One serious adverse event was reported during the trial. The participant who received 3 balloons (cohort 1) developed nausea, vomiting and dehydration, necessitating hospitalization, intravenous hydration, and deflation of the balloons with an endoscope. Patient noncompliance to dietary instructions was the likely cause of the adverse experience (patient consumed non-approved foods immediately after balloon placement)

Body weight and energy intake (cohort 2 only) for each patient
<table>
<tr><td></td><td colspan="7">week</td></tr>
<tr><td>Subject</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>Cohort 1</td><td colspan="7"></td></tr>
<tr><td>1
weight(kg)</td><td>130.9</td><td>-</td><td>127.6</td><td>-</td><td>128.6</td><td>-</td><td>128.3</td></tr>
<tr><td>2
weight(kg)</td><td>116.4</td><td>-</td><td>112.8</td><td>-</td><td>112.7</td><td>-</td><td>111.4</td></tr>
<tr><td>3
weight(kg)</td><td>168.9</td><td>-</td><td>167.1</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>4
weight(kg)</td><td>147.0</td><td>-</td><td>147.7</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>5
weight(kg)</td><td>131.8</td><td>-</td><td>128.3</td><td>-</td><td>129.4</td><td>-</td><td>129.2</td></tr>
<tr><td>6
weight(kg)</td><td>185.1</td><td>-</td><td>185.0</td><td>-</td><td>185.2</td><td>-</td><td>187.5</td></tr>
<tr><td>Cohort 2</td><td colspan="7"></td></tr>
<tr><td>7
weight(kg)
EI (kcal)</td><td>119.3
421</td><td>-
364</td><td>118.3
462</td><td>118.3
280</td><td>118.1
-</td><td>-
-</td><td>114.7
-</td></tr>
<tr><td>8
weight(kg)
EI (kcal)</td><td>182.5
888</td><td>-
630</td><td>180.0
597</td><td>-
-</td><td>182.6
-</td><td>-
-</td><td>181.6
-</td></tr>
<tr><td>9
weight(kg)
EI (kcal)</td><td>125.3
1063</td><td>-
736</td><td>126.3
615</td><td>126.0
610</td><td>126.4
-</td><td>-
-</td><td>128.3
-</td></tr>
<tr><td>10</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td>
<td></td>
</tr>
</table>

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td></td><td>excluded.</td><td></td><td>
<table>
<tr><td>weight(kg)
EI (kcal)</td><td>181.3
589</td><td>-
422</td><td>178.3
592</td><td>179.0
620</td><td>179.3
-</td><td>-
-</td><td>130.2
-</td></tr>
<tr><td>11
weight(kg)
EI (kcal)</td><td>131.5
401</td><td>-
232</td><td>131.4
210</td><td>132.9
352</td><td>132.7
-</td><td>-
-</td><td>130.2
-</td></tr>
<tr><td>12
weight(kg)
EI (kcal)</td><td>140.1
304</td><td>-
388</td><td>138.5
883</td><td>136.9
439</td><td>136.4
-</td><td>-
-</td><td>136.6
-</td></tr>
</table>

Cohort 1: Analysis indicated that patients lost a significant amount of weight overall from baseline to 2 weeks after balloon placement (p<0.05). Specifically, they lost a mean of 1.5±1.7kg.
Due to the small number of patients who received placebo (n=2), no statistical analysis was conducted for this group.
Cohort 2: Overall mean weight loss was similar to cohort 1 (-1.2±1.5kg).

Food intake
Due to different times at which the balloon deflated and/or passed through the gastrointestinal tract, food intake was analyzed only from baseline to week 1. Energy intake decreased by 149±146 kcal (24.4%) from baseline to week 1 (p=0.055), with a significant decrease in kilocalories from fat and carbohydrate (p<0.05) but not protein.

VAS was utilized to measure subjective ratings of satiety before and after meals at week 1 compared to baseline values. No significant difference was noted (p>0.20).</td><td></td></tr>
<tr><td>Milone L, Strong V, Gagner M. (2005)

Obesity Surgery

Aim: to compare laparoscopic sleeve gastrectomy (LSG) and the BIB as a first stage procedure for effective initial weight loss before more definitive surgery.

Conflicts of interest: None stated.</td><td>BIB vs. LSG.

Procedure
LSG
The operation involved laparoscopically removing the greater curvature of the stomach from the angle of His to the distal antrum, creating a thin gastric tube of 150-200 mL over a 60Fr bougie.

BIB
The deflated BIB was introduced</td><td>Level of evidence: III-3

Duration of follow-up: 6 months.

Losses to follow-up: None.

Inclusion criteria: BMI≥50 kg/m2.

Exclusion criteria: None reported.</td><td>LSG: Retrospective chart review was performed for the last 20 consecutive patients (13 females) with BMI≥50 kg/m2 who underwent LSG.

Average BMI: 68.8 kg/m2 (60.0-85.1)
Average age: 43 years (27-63 years)
Average weight: 200kg (157-247kg)

BIB: 57 historical controls (24 females)</td><td>Comparison between LSG and BIB in super-obese patients (BMI≥50 kg/m2)
<table>
<tr><th>Author</th><th>Preop BMI</th><th>Follow-up (months)</th><th>Mean weight (kg)</th><th>%EWL</th><th>BMI loss (kg/m2)</th><th>Final BMI (kg/m2)</th><th>Mean weight loss (kg)</th></tr>
<tr><td>Busetto (BIB, n=43)</td><td>58.4</td><td>5.4</td><td>171</td><td>26/1</td><td>9.4</td><td>49</td><td>26</td></tr>
<tr><td>Weiner (BIB, n=17)</td><td>60.2</td><td>4</td><td>195</td><td>21</td><td>6.4</td><td>53.8</td><td>18</td></tr>
<tr><td>Gagner (LSG, n=20)</td><td>68.9</td><td>6</td><td>200</td><td>34.9</td><td>15.9</td><td>53.0</td><td>46</td></tr>
</table>

For LSG patients, there was only one postoperative complication involving one trochar-site infection in the LSG.</td><td>Although the BIB procedure shows efficacy in reducing weight, the LSG group does so faster and to a greater amount. Therefore suggesting that LSG may be a superior procedure as first-stage treatment for super-obesity.</td></tr>
</table>

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td>endoscopically through the mouth and positioned in the stomach cavity. The balloon was injected with 500-700 mL of saline and methylene blue (50:1). After inflation, the valve was closed and the balloon position was endoscopically checked again. The BIB was removed 6 months after placement as an outpatient procedure.

Dietary/behavioral modifications: Not reported.</td><td></td><td>obtained from the literature from 2 different series that underwent BIB.

Average BMI: 60.2 (Weiner et al), 58.4±6.6 (Busetto et al)
Average age: 38 years (20-56) (Weiner et al), 43 years (33-54) (Busetto et al)
Average weight: 195 kg (202-275) (Weiner et al), 171kg (134-305) (Busetto et al)

Study period: May 2001 – December 2003.</td><td>Four BIB (7%) patients had the BIB removed: one for balloon dysfunction, one for abdominal pain, two for noncompliance. One patient experienced spontaneous elimination of the balloon in stool. Two patients (3%) had complications that did not require BIB removal: one severe vomiting with mild dehydration and the other a skin reaction of unknown origin.

Although preoperative BMI was higher in the LSG group, the change in BMI and weight loss was markedly greater in LSG patients compared to BIB patients. BMI decreased for the LSG from 69 to 53 kg/m2 and for BIB from 59 to 51 kg/m2.

Each patient from LSG and BI group had an improvement in comorbidities such as hypertension, osteoarthritis and sleep apnea. This was accompanied by a decrease in the use of associated medications.</td><td></td></tr>
<tr><td>De Castro ML, Morales MJ, Del Campo V, Pineda JR, Pena E, Sierra JM, Arbones MJ, Prada IR. (2010)

Obesity Surgery

Aim: to evaluate the efficacy, safety and tolerance of the heliosphere balloon vs. the BIB balloon.

Conflicts of interest: this study was supported by a grant from the Science and Technology Ministry of Spain.</td><td>Heliosphere vs. BIB.

Procedure
After diagnostic endoscopy, balloon positioning was performed under conscious sedation. The balloons were passed and located beneath the inferior esophageal sphincter. The balloons were slowly inflated with air (960cm3, which gives a final inflation volume of 700cm3) or filled with 700cm3 of saline plus 10 cm3 of methylene blue dye.
During the first 48 hours after insertion, intravenous saline (30-35</td><td>Level of evidence: II

Method of randomization: Not stated.

Allocation concealment: Both patient and assessor blinded to treatment.

Duration of follow-up: 12 months

Losses to follow-up: Three subjects excluded due to non-compliance with scheduled follow-ups.

Inclusion criteria: patients who are morbid obesity (BMI>40 kg/m2), in preparation for bariatric surgery to reduce surgical risk or not candidates</td><td>33 patients (69.7% female) were enrolled to this study.
Mean age: 43.9±10 years (19-61 years)
Mean weight: 120.3±17kg (94-161kg)
Mean BMI: 44.2±5 kg/m2 (34.5-54.6).

Heliosphere: 18 subjects BIB: 15 subjects

Study period: March 2006 – April 2008.</td><td>Baseline characteristics
<table><tr><th></th><th>Heliosphere (n=18)</th><th>BIB (n=15)</th></tr><tr><td>Mean age (years)</td><td>42.7±12</td><td>45.4±8</td></tr><tr><td>Percent female</td><td>13 (72.2%)</td><td>10 (66.7%)</td></tr><tr><td>Mean weight (kg)</td><td>119±17</td><td>121±17</td></tr><tr><td>Mean BMI (kg/m2)</td><td>44.2±5</td><td>44.2±6</td></tr><tr><td>BMI >40</td><td>13 (72.2%)</td><td>12 (80%)</td></tr><tr><td>GIS total score</td><td>32.8±3</td><td>29.4±7</td></tr><tr><td>GICLI total score</td><td>92.2±18</td><td>86.9±17</td></tr></table>GIS: gastroesophageal reflux disease impact scale; GICLI: Gastrointestinal quality of life index.

Safety
Endoscopic times were shorter for Heliosphere at placement and balloon retrieval: 7.8±2 vs. 12.5±3 min (p=0.001). However, balloon insertion under conscious sedation was impossible in 2 Heliosphere patients due to the rigidity of the device at the pharynx causing severe patient discomfort, so they had to be placed under general anaesthesia.
System failure at positioning was observed in one BIB patient due to problems injecting the saline through the catheter.
At the time of removal (6 months), 2 Heliosphere bags were not found in the stomach; both were assumed to have passed through in stool.</td><td>Both Heliosphere and BIB achieved significant weight loss with good tolerance in obese patients. Hwoever, the Heliosphere bag has severe technical problems that need to be solved.</td></tr>
</table>

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td>mL/kg/day), pantoprazole (40mg/day), metoclopramide (30mg/day) and butylscopolamine bromide (20mg t.i.d.) were administered.

Dietary/behavioral modifications: All patients were discharged and sent home on a 100kcal diet, oral multivitamin supplements and proton pump inhibitors.</td><td>for bariatric surgery, BMI 35-40 with obesity-related diseases that riles our bariatric surgery and BMI 35-40 in patients who had failed many attempts at weight loss.

Exclusion criteria: presence of an organic disease of the upper digestive tract, a hiatus hernia of diameter >3cm and patients on anti-inflammatory agents or anticoagulants.</td><td></td><td>Balloon removal was more difficult in Heliosphere patients: one patient required surgical removal by laparoscopy, in 3 other patients a rigid esophagoscopy was required following attempted endoscopic extraction. Overall, 30% of Heliosphere bags had an adverse event at removal (p=0.021). Due to these safety concerns, this study was stopped prematurely.

Weight loss
Body weight significantly decreased at 6 months after balloon insertion in both patient groups. Heliosphere from 119±17 to 106±18kg and BIB from 121±8 to 108±17kg (p<0.001), with no differenced between both groups at 1, 3 and 6 months.
At 6 months post-placement, the mean weight loss was 12.8±8kg for Heliosphere and 14.1±9kg for BIB balloon. The mean BMI loss and %EWL were 4.6±3 kg/m2 and 27±16% for Heliosphere patients and 5.5±3 kg/m2 and 30.2±19% for BIB patients.
15 patients (45.5%) lost >10% of their initial weight 6 months after balloon placement. All 30 patients kept the balloon for 6 months.
Waist circumference decreased significantly (p<0.005) in both groups from 119.7 to 111.8cm for Heliosphere patients and from 120.5 to 111cm for BIB patients.
12 months after balloon removal, 26 subjects were re-evaluated. Their mean weights were 116±19kg for Heliosphere and 108±13kg for BIB, both were not significantly different with respect to baseline values.

GICLI scores for quality of life in both groups
<table>
<tr><th></th><th>Heliosphere</th><th>Heliosphere (6 months)</th><th>BIB</th><th>BIB (6 months)</th></tr>
<tr><td>Total score</td><td>92.2±18</td><td>102.4±23</td><td>86.9±17</td><td>83.6±12</td></tr>
<tr><td>Gastrointestinal symptoms</td><td>3±0.4</td><td>3.1±0.7</td><td>2.9±0.6</td><td>2.5±0.4</td></tr>
<tr><td>Physical dysfunction</td><td>1.5±0.6</td><td>2.5±0.7*</td><td>1.2±0.6</td><td>1.5±0.9</td></tr>
<tr><td>Emotional dysfunction</td><td>2.4±0.9</td><td>2.3±0.8</td><td>2.4±0.9</td><td>2.6±0.8</td></tr>
<tr><td>Social dysfunction</td><td>2.1±1.1</td><td>3±1</td><td>2.3±0.9</td><td>2.4±0.7</td></tr>
<tr><td>Effect of treatment</td><td>3.4±1.1</td><td>3.4±1.4</td><td>3.3±0.7</td><td>2.7±1.3</td></tr>
</table>
Tolerance
Tolerance was considered very good in both groups. Some patients had some dyspeptic symptoms (epigastric pain and vomiting) during the first 48 hour after insertion. Mean time of hospitalization was 2.2±0.4 days, without any differences between both balloons.

At 1 month after discharge, 3 patients had intolerance to the BIB (30%) with continuing vomiting and dehydration despite appropriate treatment, so early removal was necessary.</td><td></td></tr>
</table>

Study details	Intervention	Study design and inclusion/exclusion criteria	Study population	Results	Author(s) conclusions
				Digestive tolerance at 3 and 6 months revealed no differences between the balloons. Gastroesophageal reflux scores were measured by GIS scale in 27 patients, indicating no differences between groups or significant changes with respect to baseline scores and 1, 3, and 6 months post-balloon scores (data not shown).	
Trande P, Mussetto A, Mirante VG, De Martinis ED, Olivetti G, Conigliaro RL, Micheli EAD (2008) *Obesity Surgery* Aim: to evaluate the efficacy, tolerance and safety of Heliosphere in patients with morbid and non-morbid obesity. Conflicts of interest: None reported.	Heliosphere BAG Procedure Heliosphere insertion was performed under general anesthesia and endoscopic control. Prior to insertion, the balloon sheath was lubrication with lidocaine gel. It was passed through the esophagus, down to the stomach and positioned in the gastric fundus. After positioning, the Heliosphere was released from its silicone sheath and inflated with 960cc of air. Dietary/behavioral modifications: For the 1st and 2nd day post-placement, patients had a liquid diet and were discharged on day 3 with a diet consisting of semi-solids (1000kcal) for the rest of the study.	Level of evidence: IV Duration of follow-up: 6 months. Inclusion criteria: failure to achieve weight loss with diet control, BMI ≥35 kg/m2. Exclusion criteria: malignancy within previous 5 years, pregnancy, alcoholism, drug abuse and psychosis. Contraindications include gastrointestinal lesions and previous bariatric surgery.	17 patients Male: 8 (47.1%) Mean age: 43±10 (18-65) years Mean BMI: 46±8 (35-58) kg/m2 Study period: March 2006 – September 2006.	Heliosphere insertion successful in 100% of patients. One adverse event during insertion: acute coronary syndrome. Balloon removal was more difficult, successful in 15/17 cases. Distal migration evident in 1 patient and another patient underwent surgery due to balloon fragmentation. Weight loss BMI decreased 4±3 (range: +0.33 to -11) (p<0.01). Weight loss was 11±9kg (p=0.02). 14/17 maintained a BMI≥35 at the time of Heliosphere removal. Tolerance Some dyspeptic symptoms during first 3 days after insertion. Early nausea evidence in 100% of patients, vomiting in 71%. All resolved with treatment. Early satiety evident in all patients.	The Heliosphere showed a good profile for safety and tolerance. Technical problems at the time of removal set a low safety profile.
Forestieri P, De Palma GD, Formato A, Giuliano ME, Monda A, Pilone V, Romano A, Tramontano S	Heliosphere BAG Procedure Patients underwent unconscious insertion of the Heliosphere (except	Level of evidence: IV Duration of follow-up: 6 months. Inclusion criteria: According to	10 patients Male: 5 (50%) Mean age: 35.2±15.7 (17-49) years Mean BMI: 43.3±8.1 (35-51.2) kg/m2	Heliosphere positioning was slightly difficult in all patients due to rigidity and large size causing patient discomfort. System failure occurred in 50% of patients. At removal, Heliosphere could not be found in the stomach of one patient. Heliosphere spontaneously deflated in 3 patients. No serious complications observed (nausea and vomiting in first 3 days).	Although weight loss was satisfactory, the Heliosphere cannot be considered an advance for temporary treatment of morbid

Study details	Intervention	Study design and inclusion/exclusion criteria	Study population	Results	Author(s) conclusions
(2006) *Obesity surgery* Aim: To evaluate the safety and efficacy of Heliosphere. Conflicts of interest: None of the authors had commercial affiliation with manufacturer.	for the first 2 patients). After positioning in the gastric fundus beneath the inferior esophageal sphincter, the balloong was released and inflated with 960cc of air. This fives a final inflation volume of 700cc as the air is compressed. Dietary/behavioral modifications: All patients began liquid diet from day 3 post-placement and discharged on day 4. Patients followed a diet of approximately 1000kcal a day (146g carbohydrate, 68g lipid, 1g/kg ideal weight protein).	guidelines of bariatric surgery. Exclusion criteria: Not stated.	Study period: September 2004 – December 2004.	Weight loss BMI loss was 5.2±13.1 kg/m2. Weight loss was 17.5±16.2kg (5-33). Early satiety sensation was experienced in all patients after eating.	obesity. This balloon has instrumental and technical problems that need to be solved.
Carvalho GL, Barros CB, Okazaki M, Novaes ML, Albuquerque PC, Ameida NC, Albuquerque PPC, Wakiyama C, Valica TG, Silva JSN, Coelho RM (2009a). *Obesity Surgery* Aim: to test safety and effectiveness of new placement and removal procedures for Silimed balloon. Conflicts of interest: One of the authors	Silimed Gastric Balloon. Procedure The extremity of the Silimed sheath was anchored to the endoscope extremity using a polipectomy snare. The balloon was inserted and released near the pylorus. It was then positioned in the gastric fundus and filled with saline (mean 650mL) and Iopamiron contrast (20mL) and methylene blue (10mL). For removal, a double silicone overtube is inserted into the	Level of evidence: IV Duration of follow-up: 6 months. Inclusion criteria: Not stated. Exclusion criteria: absolute contraindications include presence of haital hernia, active peptic ulcer, severe esophagitis, hemorrhagic risk, crohn's disease, cancer, diverticule and/or esophageal stenosis, serious cardiopulmonary/renal/hepatic disease, previous gastric surgery, psychological disturbances, sweet eaters and reluctance to follow	14 patients Male: Not reported Mean age: Not reported Mean BMI: Not reported Study period: June 2006 – July 2007	Silimed balloon successfully placed in all patients. Initial complications include: nausea, vomiting and epigastric pain. Epigastric pain occurred in 11 patients (21%) leading to early termination of treatment. No occurrence of serious complications such as serious esophagitis, peptic ulcer and gastric perforation/erosion. The only late complication was 2 cases of spontaneous deflation. Weight loss Mean BMI decreased from 35.7±5.7 to 31.8±5.5 kg/m2. Mean weight loss was 11.3±6.2. %EWL was 46.5±36.7%.	This new balloon might be a safe and effective alternative to the treatment of weight loss.

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td>(Barros) is affiliated with the manufacturer.</td><td>esophagus. The Silimed balloon is then cut or a catheter is used to empty it before extraction.</td><td>protocol.</td><td></td><td></td><td></td></tr>
<tr><td>Carvalho GL, Barros CB, Moraes CE, Okazaki M, de Novaes Lima Ferreira M, Silva JSN, Albuquerque PPC, de Macedo Cavalcanti Coelho R (2009b).

Obesity Surgery

Aim: To present preliminary results of the Silimed balloon.

Conflicts of interest: One of the authors (Barros) is affiliated with the manufacturer.</td><td>Silimed Gastric Balloon

Procedure
The extremity of the Silimed sheath was anchored to the endoscope extremity using a polipectomy snare. The balloon was inserted and released near the pylorus. It was then positioned in the gastric fundus and filled with saline (mean 650mL) and Iopamiron contrast (20mL) and methylene blue (10mL). For removal, a double silicone overtube is inserted into the esophagus. The Silimed balloon is then cut or a catheter is used to empty it before extraction.</td><td>Level of evidence: IV

Duration of follow-up: 5 to 6 months.

Inclusion criteria: Not reported.

Exclusion criteria: Not reported.</td><td>20 patients
Male: Not reported
Mean age: 37 (15-64) years
Mean BMI: 27.6 (21.6-29.9) kg/m2

Study period: June 2006 – June 2009.</td><td>Silimed balloon successfully placed and removed in all patients.

Adverse events
There were no late complications such as severe esophagitis, peptic ulcer and gastric perforation or erosion. There were 2 cases of spontaneous deflation, both balloons were removed uneventfully.

Weight loss
Mean final weight was 65.9±9.4 kg and mean final BMI was 24.5±2.6 kg/m2 (p<0.05 for both).</td><td>Preliminary data suggest that the Silimed balloon might be a safe and effective treatment for weight loss in pre-obese patients.</td></tr>
<tr><td>Rodriguez L, Reyes E, Fagalde P, Oltra MA, Saba J, Aylwin CG, Prieto C, Ramos A, Galvao M, Gersin KS, Sorli C (2009).

Diabetes Technology & Therapeutics

Aim: to trial a</td><td>Endobarrier vs. sham.

Procedure
Implantation and explantation of the Endobarrier was performed as described in earlier studies (no additional details provided)

Dietary/behavioral modifications: All patients</td><td>Level of evidence: II

Method of randomization: Not stated.

Allocation concealment: None.

Duration of follow-up: 24 weeks

Losses to follow-up: Endobarrier: at 6 months, 2</td><td>18 T2DM patients were randomized in a 2:1 ratio to receive either Endobarrier or the sham procedure.

Endobarrier: 12 patients
Sham: 6 patients.

Study period: January 2007 – February 2008</td><td>Baseline demographics and subject characteristics in the ITT population
<table>
<tr><th></th><th>All (n=18)</th><th>Endobarrier (n=12)</th><th>Sham (n=6)</th><th>p-value*</th></tr>
<tr><td>Age (years)</td><td>47±10</td><td>45±7</td><td>51±13</td><td>>0.05</td></tr>
<tr><td>Gender (%male/%female)</td><td>39/61</td><td>33/67</td><td>50/50</td><td>>0.05</td></tr>
<tr><td>Ethnicity (%white)</td><td>100</td><td>100</td><td>100</td><td>NA</td></tr>
<tr><td>Body weight (kg)</td><td>104.3±20.8</td><td>103.4±21.3</td><td>106.2±21.6</td><td>>0.05</td></tr>
<tr><td>BMI (kg/m2)</td><td>38.9±6.1</td><td>38.9±5.9</td><td>39.0±7.2</td><td>>0.05</td></tr>
<tr><td>HbA1c (%)</td><td>9.1±1.7</td><td>9.2±1.7</td><td>9.0±2.0</td><td>>0.05</td></tr>
<tr><td>FPG (mg/dL)</td><td>195±77</td><td>199±71</td><td>185±94</td><td>>0.05</td></tr>
<tr><td>Postprandial glucose</td><td></td><td>31226±11570</td><td>27558±11480</td><td>>0.05</td></tr>
</table></td><td>The Endobarrier rapidly normalized glycemic control in obese T2DM patients.</td></tr>
</table>

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr>
<td>completely endoscopic, removable, duodenal-jejunal bypass liner (Endobarrier) to treat T2DM.

Conflicts of interest: This study was funded by GI Dynamics Inc. (manufacturer of the Endobarrier)</td>
<td>maintained their baseline caloric intake for the first 2 weeks after the endoscopic procedure and subsequently counseled about low calorie diet, exercise and lifestyle modification. Patients ingested a liquid diet for the first week postimplantation, pureed food during week 2 and solid foods thereafter. Recommended caloric intake after week 2 was a maximum of 1200 calories/day for women and 1500 calories/day for men.</td>
<td>patients were explanted. Sham ITT: 2 patients were lost to follow up at 6 months.

Inclusion criteria: Age ≥18 and ≤55 years with type 2 diabetes mellitus (T2DM) for ≤10 years and had an HbA1c ≥7% and ≤10%, fasting plasma glucose (FPG) ≤240mg/dL, and BMI >30kg/m2 and ≤50 kg/m2. The only T2DM medications were metformin and/or a sulfonylurea. Women were postmenopausal, surgically sterile, or not pregnant and taking oral contraceptives.

Exclusion criteria: subjects excluded if they had weight loss >4.5kg 3 months prior to screening or were using weight loss medications or a history of gastrointestinal tract abnormalities. All subjects had to discontinue NSAIDs, corticosteroids and drugs known to affect gastrointestinal motility</td>
<td></td>
<td>
<table>
<tr><td>AUC (mg/dL.min)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Duration of diabetes (years)</td><td>3.7±2.4</td><td>3.5±2.5</td><td>4.2±2.1</td><td>>0.05</td></tr>
<tr><td>Comorbidities (%)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hypertension</td><td>50</td><td>58</td><td>33</td><td></td></tr>
<tr><td>Hyperlipidemia</td><td>33</td><td>25</td><td>50</td><td></td></tr>
<tr><td>Hepatosteatosis</td><td>83</td><td>92</td><td>67</td><td></td></tr>
</table>
Data presented as mean±SD. NA: not applicable. *Comparison between Endobarrier and sham group.

Oral antidiabetic medication (OAD)
At week 12 (ITT population), 42% of Endobarrier patients had ceased treatment with any OAD, compared to sham where 17% had ceased OAD use.
For the completer population, by week 12, 50% of Endobarrier patients and 25% of sham patients had ceased OAD use.
At week 24, 40% of Endobarrier patients and 25% of sham patients remaining on the study had ceased OAD therapy.

Body weight and glycemic control
For the first 12 weeks, mean body weight loss was equivalent between treatment arms for both ITT and completer study groups.
At week 1, mean ITT weight change was -4.0±0.4kg in the Endobarrier arm vs. -4.0±0.6kg in the sham arm.
At week 20, mean ITT weight change was -10.2±1.3 in the Endobarrier arm vs. -7.3±4.3kg in the sham arm.
At week 24, there were only 3 sham subjects remaining.

Mean baseline HbA_{1a} values for the ITT Endobarrier and sham arms were 9.2% and 9.0%, respectively (p>0.05).
At week 12, ITT HBA_{1c} change was -1.3±0.9% in the Endobarrier arm compared to -0.8±0.3% change in the sham arm (p>0.05).
At week 24, ITT HBA_{1c} change was -2.4±0.7% in the Endobarrier arm and -0.8±0.4% change in the sham arm (p>0.05).
Similarly, for the completer population, HBA1c did not differ significantly at all time points between both arms.

Both Endobarrier and sham arms had similar baseline fasting plasma glucose (FPG) concentrations.
At week 1, ITT FPG change in the Endobarrier arm was -50±15mg/dL and sham arm was +25±29mg/dL (p=0.042).
At week 12, ITT FPG change was -45±26mg/dL for the Endobarrier arm and -8±35mg.dL for the sham arm (p>0.05).
</td>
<td></td>
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</table>

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td></td><td></td><td></td><td>
At week 24, ITT FPG change was -83±39mg/dL for the Endobarrier arm and +16±42mg/dL for the sham arm (p>0.05).

At week 1, postprandial plasma glucose excursions decreased in 80% of Endobarrier patients and 25% of sham patients compared to baseline (p=0.01 for both arms).
Postprandial plasma glucose area under the curve (AUC) decreased from baseline by 22% in the Endobarrier arm compared to a 16% increase in the sham arm (p=0.016 between arms).
No change in postprandial insulin concentrations were noted in either arm.
At week 1 in the ITT population, postprandial plasma glucose AUC was reduced from baseline by 19% in the Endobarrier arm compared with an 11% increase in the sham arm (p=0.014 between arms).

Safety and tolerability
All observe adverse events were mild or moderate.
All 12 Endobarrier patients experienced mild or moderate vomiting episodes, none requested removal of the device.
3 Endobarrier patients had their device explanted due to adverse event related to device migration or turning including moderate abdominal pain (n=1), nausea and moderate vomiting (n=1), and mild abdominal pain and vomiting (n=1).
2 other device migrations were observed at the time of removal (n=1) and scheduled endoscopy (n=1), both were removed.

Device related adverse events
<table>
<tr><th>Adverse event</th><th>Endobarrier [% (n)]</th></tr>
<tr><td>Upper abdominal pain</td><td>30.8 (20)</td></tr>
<tr><td>Vomiting</td><td>10.8 (7)</td></tr>
<tr><td>Abdominal pain</td><td>4.6 (3)</td></tr>
<tr><td>Nausea</td><td>7.7 (5)</td></tr>
<tr><td>Symptoms of hypoglycemia*</td><td>7.7 (5)</td></tr>
<tr><td>Blood iron decreased</td><td>6.2 (4)</td></tr>
<tr><td>Flatulence</td><td>4.6 (3)</td></tr>
<tr><td>Procedural nausea</td><td>4.6 (3)</td></tr>
<tr><td>Procedural vomiting</td><td>3.1 (2)</td></tr>
<tr><td>Blood cholesterol increased</td><td>3.1 (2)</td></tr>
<tr><td>Erosive duodenitis</td><td>3.1 (2)</td></tr>
<tr><td>Constipation</td><td>1.5 (1)</td></tr>
<tr><td>Diarrhea</td><td>1.5 (1)</td></tr>
<tr><td>Gastritis</td><td>1.5 (1)</td></tr>
<tr><td>Headache</td><td>1.5 (1)</td></tr>
<tr><td>HDL-C decreased</td><td>1.5 (1)</td></tr>
</table>
</td><td></td></tr>
</table>

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td></td><td></td><td></td><td>
<table>
<tr><td>Esophagitis</td><td>1.5 (1)</td></tr>
<tr><td>Pain</td><td>1.5 (1)</td></tr>
<tr><td>Serum ferritin decreased</td><td>1.5 (1)</td></tr>
</table>
HDL-C: high density lipoprotein cholesterol. *in all 5 episodes, blood glucose values were >100mg/dL.
</td><td></td></tr>
<tr><td>Tarnoff M, Rodriguez L, Escalona A, Ramos A, Neto M, Alamo M, Reyes E, Pimentel F, Ibanez L. (2009)

Surgical Endoscopy

Aim: To evaluate the safety and efficacy of the duodenal-jejunal bypass liner (Endobarrier) for weight loss before bariatric surgey.

Conflicts of interest: None disclosed.</td><td>Endobarrier or diet control.

Procedure
After Endobarrier implantation, plain abdominal radiography of the kidneys, ureters and bladder; completion of a satiety questionnaire; and safety assessments were performed at monthly intervals. Control subjects were seen for a history, physical examination, collection of baseline data and fasting blood tests.

Dietary/behavioral modifications: Weight loss counseling on diet, exercise and lifestyle modification advice was provided for the subjects in both groups only at the baseline visit. All subjects were instructed to stay on a liquid diet for the first postimplantation week, followed by pureed diet for the second week. All subjects advanced to regular diet at 2 weeks (caloric intake not detailed).</td><td>Level of evidence: II

Method of randomization: Patients were randomized using computer-generated code.

Allocation concealment: None.

Duration of follow-up: 12 weeks

Losses to follow-up: 5 Endobarrier subjects (intraluminal haemorrhage in 3 patients, sleeve obstruction in one and anchor migration in one) and 10 control subjects (no details provided).

Inclusion criteria: age 18-55 years, BMI≥35 with significant comorbidities (i.e. hypertension, hyperlipidemia or diabetes) or BMI 40-60 (with out without comorbid conditions), history of failure with nonsurgical weight loss methods, candidates for Roux-en-Y bypass, willing to comply to study requirements, signed informed consent forms.

Exclusion criteria: subjects requiring prescription</td><td>40 patients were randomized to receive either Endobarrier or diet control.

Endobarrier: 26 patients (25 successfully implanted, 15 women)
Mean age: 38±10.1 years (range: 23-56 years)
Mean BMI: 42±5.1 (range: 35-54)
Mean weight:114±20.9kg (range: 81-172 kg)

Diet control: 14 patients
Mean age: 43 ± 10.6 years (range: 25-57 years).
Mean BMI: 40±3.5 (range: 36-47)
Mean weight: 108±12.0 (range: 86-122kg)

Study period: Not reported.</td><td>
Weight loss
At 12 weeks, average %EWL was 22.1±8% for Endobarrier group and 5.3±6.6% for control group (p=0.02). Absolute weight reduction was 10.3±3.2kg for Endobarrier and 2.6±3.5kg for controls. 23 (92%) of the 25 Endobarrier subjects and 3 (21%) of the 14 diet control subjects had achieved at least 10% EWL (p=0.0001) [note the 5 explanted patients were not included in analysis].

Satiety
Endobarrier: At 12 weeks, 17/19 subjects reported greater satiety after device implantation. One subject reported less satiety, while another reported no change.
Diet control: At 12 weeks, all 4 remaining control subjects reported less satiety.

T2DM
Four subjects had T2DM (3 Endobarrier, 1 control).
All 4 diabetics improved by week 1 and maintained this status throughout the trial.
Diabetic status of one Endobarrier subject improved further and was resolved at week 12.
("improvement" was defined as reduced oral hypoglycemic/insulin medications and "resolved" was defined as off medications with normal FPG and normal glycosylated haemoglobin).
%EWL and HbA1c data reported below for each subject:
<table>
<tr><th>Subject</th><th>Baseline HbA1c (%)</th><th>Week 12 HbA1c (%)</th><th>Medication status</th><th>%EWL</th></tr>
<tr><td>101 (diet)</td><td>12.6</td><td>7.8</td><td>Discontinued at week 1</td><td>+0.8</td></tr>
<tr><td>122 (device)</td><td>5.5</td><td>5.8 (week 8)</td><td>Discontinued at week 1</td><td>31.6</td></tr>
<tr><td>202 (device)</td><td>7.8</td><td>7.1</td><td>Decreased at week 9</td><td>20.3</td></tr>
<tr><td>219 (device)</td><td>6.6</td><td>6.0</td><td>Decreased at week 8</td><td>22.9</td></tr>
</table>
Implantation safety
5 subjects required multiple implantation attempts in the same setting due to difficulty advancing the catheter or positioning the anchor in the duodenal bulb.
One procedural adverse event: noncardiac chest pain.
Mean implantation time was 38.9±27 min with an average fluoroscopy time of 13.3±6.7 min.
</td><td>The duodenal-jejunal bypass liner (Endobarrier) achieves noninvasive duodenal exclusion and short term weight loss. Long term RCT for weight loss and treatment of T2DM was underway.</td></tr>
</table>

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td></td><td>anticoagulation therapy, iron deficiency and iron deficiency anemia, inflammatory bowel disease or conditions of the gastrointestinal tract, such as ulcers or Crohn's disease, subjects whom treatment would have presented an unreasonable risk, pancreatitis or other serious organic conditions, symptomatic coronary artery disease or pulmonary dysfunction, gallstones before implantation, infections at implantation, severe coagulopathy, upper gastrointestinal bleeding conditions, or congenital or acquired intestinal telangiectasia, congenital or acquired anomalies of the gastrointentinal tract (atresias or stenoses), pregnant or had intentions of becoming pregnant during the study duration, unresolved alcohol or drug addiction, HIV positive, hepatitis B/C, mentally retarded or emotionally unstable, previous gastrointestinal surgery that may affect placement or function of device, unable to discontinue NSAIDs during implantation period, H. pylori positive, taking weight loss medication, family or history of preexisting symptoms of lupus erythematosus, scleroderma or other autoimmune connective tissue disorder,</td><td></td><td>Explantation safety
All 25 devices successfully explanted endoscopically. Mean explantation time was 21±17 min with a mean fluoroscopy time of 4.1±4.2 min.

Device in situ safety
No signs or symptoms of biliary or pancreatic duct obstruction observed throughout trial.
No clinically significant abnormal blood values were reported, except for one subject that experienced an acute drop in hemoglobin and hematocrit due to intraluminal hemorrhage (no details if this was device related).
16 Endobarrier subjects reported at least one adverse event.
Of the 56 reported adverse events, 68 (86%) were possibly or definitely device related:
<table>
<tr><td>Abdominal pain</td><td>16</td></tr>
<tr><td>Nausea</td><td>7</td></tr>
<tr><td>Vomiting</td><td>8</td></tr>
<tr><td>Abdominal distension</td><td>11</td></tr>
<tr><td>Gastrointestinal hemorrhage</td><td>4</td></tr>
<tr><td>Constipation</td><td>1</td></tr>
<tr><td>Epigastric discomfort</td><td>1</td></tr>
</table>
5 adverse events were considered severe (gastrointestinal hemorrhage: 3, abdominal pain: 1 and vomiting: 1).</td><td></td></tr>
</table>

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td></td><td>gastroesophgeal reflux disease, history of kidney stones, participating in another ongoing trial.</td><td></td><td></td><td></td></tr>
<tr><td>Schouten R, Rijs CS, Bouvy ND, Hameeteman W, Koek GH, Janssen IMC, Greve JM. (2010)

Annals of Surgery

Aim: To report on the European experience with Endobarrier for weight loss in morbidly obese patients and its affect on T2DM.

Conflicts of interest: This study was supported by GI Dynamics (manufacturer of Endobarrier)</td><td>Endobarrier vs. diet control.

Procedure
The implantation of the Endobarrier was performed under general anesthesia with endotracheal intubation and the patient in lateral decubitus. Initial access to the stomach and duodenum was achieved by a standard gastroscope through which a quidewire is advanced into the duodenum. The encapsulated device (on a custom catheter) is tracked over the guidewire into the duodenum. After full extension of the sleeve, the anchor is deployed in the duodenam bulb 0.5cm distally from the pylorus.
After the first 8 implantations, the delivery technique of the capsule to the duodenum was changed from delivery under direct endoscopic control to delivery under fluoroscopic control. Device removal was facilitated with a custom</td><td>Level of evidence: II

Method of randomization: computer generated randomization. Due to the design of the study, randomization was employed in a 3:1 fashion favoring the device using randomized permutated blocks stratified by center.

Allocation concealment: None.

Duration of follow-up: 3 months (10 patients up to 8 months)

Losses to follow-up: 4 devices were removed prior to the 12 or 24 week study period. 5 patients in the 24 week group had the device removed due migration (only 3 patients kept the device for the full 24 weeks. Overall, 18/26 patients completed the study.

Inclusion criteria: aged between 18 and 55 years, BMI between 40 and 60 kg/m-2 or above 35 kg/m2 with obesity related comorbidities.

Exclusion criteria: anticoagulation use, inflammatory bowel disease, known bacterial infection at</td><td>A total of 41 patients participated in this study

Endobarrier: 30 patients
Age: 40.9 (20-59) years
Male/female: 8/22
Weight: 142.5 (114-189)kg
BMI: 48.9 (39-60) kg/m2

Diet control: 11 patients)
Age: 41.2 (19-57) years
Male/female: 2/9
Weight: 137.5 (86-160)kg
BMI: 49.2 (37-60) kg/m2

Study period: Not reported.</td><td>A total of 30 procedures were performed, of which 26 were successful. Implantation failed in 4 patients mainly due to anatomic problems (e.g. sharp curve between pylorus and duodenal bulb.
No adverse events occurred during the implant or explant procedures.
Overall, 18/26 Endobarrier patients completed the study.
Data indicated that the investigators took less time with the procedure as they gained experience.

Adverse events
<table>
<tr><th></th><th>Device group (n=26)</th><th>Control group (n=11)</th></tr>
<tr><td>Patients with ≥1 adverse event</td><td>26 (100%)</td><td>3 (27.3%)</td></tr>
<tr><td>Nausea (first week)</td><td>20 (76.9%)</td><td>1 (9.1%)</td></tr>
<tr><td>Upper abdominal pain (first week)</td><td>13 (50.0%)</td><td>-</td></tr>
<tr><td>Pseudopolyp formation (explant)</td><td>13 (50.0%)</td><td>-</td></tr>
<tr><td>Implant site inflammation (explant)</td><td>10 (38.5)</td><td>-</td></tr>
<tr><td>Vomiting (first week)</td><td>6 (23%)</td><td>-</td></tr>
<tr><td>Adverse drug reaction</td><td>2 (7.7%)</td><td>-</td></tr>
<tr><td>HbA1c increase</td><td>-</td><td>1 (9.1%)</td></tr>
<tr><td>Hypercholesterolemia</td><td>-</td><td>1 (9.1%)</td></tr>
<tr><td>Other</td><td>19 (73.1%)</td><td>1 (9.1%)</td></tr>
</table>
None of the adverse events were classified as severe. Of all the adverse events, 61.3% were considered mild, and the remaining 38.7% as moderate. All minor adverse events either resolved spontaneously or after temporary medication with no further sequelae.

Weight loss after 1, 12 and 24 weeks
<table>
<tr><th></th><th>N</th><th>Device group</th><th>N</th><th>Control group</th><th>p-value</th></tr>
<tr><td>Preoperative BMI</td><td>30</td><td>48.9±6.2</td><td>11</td><td>49.2±7.1</td><td>0.68</td></tr>
<tr><td>BMI (1wk)</td><td>25</td><td>46.3±6.6</td><td>11</td><td>48.1±6.4</td><td>0.51</td></tr>
<tr><td>%EWL (1wk)</td><td>25</td><td>7.5±5.1</td><td>11</td><td>5.3±1.8</td><td>0.08</td></tr>
<tr><td>BMI (12 wk)</td><td>24</td><td>43.4±6.7</td><td>11</td><td>47.3±6.7</td><td>0.23</td></tr>
<tr><td>%EWL (12 wk)</td><td>24</td><td>19.0±10.9</td><td>11</td><td>6.9±6.1</td><td>0.00</td></tr>
<tr><td>BMI (24 wk)</td><td>3</td><td>44.1±5.2</td><td>-</td><td>-</td><td>N/A</td></tr>
<tr><td>%EWL (24wk)</td><td>3</td><td>24.3±5.8</td><td>-</td><td>-</td><td>N/A</td></tr>
</table></td><td>The Endobarrier is a feasible and safe noninvasive device with excellent short term weight loss results. The device also has a significant long-term effect on T2DM.</td></tr>
</table>

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td>grasper that grasps the polypropylene tether on the anchor. A foreign body retrieval hood at the tip of the endoscope was utilized to prevent damage to the stomach or esophagus.

Dietary/behavioral modifications: Both device and control patients had to follow a low calorie diet under strict supervision of a dietitian. In the first study week, patients were prescribed a liquid diet with a maximum of 600 kcal per day plus 1500 mL of clear fluids. From the second week until the end of the study, patients were allowed a normal diet with a maximum of 1200kcal (female subjects) or 1500kcal (male subjects) plus 1500 mL of clear fluids.</td><td>time of implant, severe coagulopathy, anomalies, or previous surgery of the gastrointestinal tract and patients with severe reflux disease.</td><td></td><td>The % of patients who had more than 10% weight loss at 12 weeks was 88% in the device group and 27.3% in the control group (p<0.05).

Diabetes
At baseline, 8/26 patients (30.8%) in the Endobarrier group and 2/11 patients (18.2%) in the diet control group had diabetes, this difference was not significant.

<table><tr><th></th><th>Device group (n=8)</th><th>Control group (n=2)</th><th>p-value</th></tr><tr><td>Preoperative fasting glucose (mmol/L)</td><td>11.1±4.3</td><td>7.6±2.4</td><td>0.23</td></tr><tr><td>Preoperative HbA1c (%)</td><td>8.8±1.7</td><td>7.3±0.1</td><td>0.04</td></tr><tr><td>Fasting glucose (12 wk)</td><td>9.3±3.8</td><td>6.7±1.1</td><td>0.13</td></tr><tr><td>HbA1c (12 wk)</td><td>7.7±1.8</td><td>6.9±0.6</td><td>0.32</td></tr></table>
6/8 diabetic patients in the device group decreased insulin dosages and/or oral antidiabetic medication after 1 week. At 12 weeks, there was ongoing improvement in 5 patients (continuous lowering of medication requirements) while one patient had completely stopped medication.

Laboratory results
No significant differences were observed between groups for total bilirubin, gamma GT, SGOT, SGPT, LDH, ALK phosphatase, total cholesterol, HDL, LDL, triglycerides, amylase, lipase and insulin level.
No parameters were out of the normal range and there were no signs of liver or pancreatic dysfunction in the Endobarrier group.</td><td></td></tr>
<tr><td>Fogel R, Fogel JD, Bonilla Y, La Fuente RD (2008).

Gastrointestinal Endoscopy

Aim: To evaluate the safety and feasibility of a transoral suturing procedure (EndoCinch) for weight loss.</td><td>EndoCinch Suturing System.

Procedure
Patients underwent endoluminal vertical gastroplasty (EVG) with the EndoCinch, an investigational device for EVG, mounted on an Excere 145 gastroscope (Olympus Medical System Corp, Japan) that uses a 3-0</td><td>Level of evidence: IV

Duration of follow-up: 12 months.

Inclusion criteria: BMI between 28 and 44 kg/m2 (this criterion was listed after the first 10 patients as investigators became more confident with the procedure), age between 16 and 62 years and patient's agreement to comply with regular follow-up</td><td>64 patients
Male: 15 (23.4%)
Mean age: 31.5±10.1 (16-62) years
Mean BMI: 39.9±5.1 (28.0-60.2) kg/m2

Study period: October 2003 – November 2005.</td><td>Patients were retrospectively divided to subgroups due to the large BMI range of the overall sample.

Group 1 (BMI ≥40 kg/m2): 33 patients
Mean age: 32.5±10.6 (18-62) years
Mean BMI: 43.4±3.8 (40.0-60.2) kg/m2

Group 2 (BMI 35-40 kg/m2): 19 patients
Mean age: 30.1±10.3 (16-58) years
Mean BMI: 38.5±1.2 (35.6-39.9) kg/m2

Group 3 (BMI<35 kg/m2): 12 patients
Mean age: 31.1±8.5 (21-47) years
Mean BMI: 32.4±2.4 (28.0-34.8) kg/m2</td><td>EVG using a continuous suture pattern is associated with significant weight loss. Additional studies are needed to demonstrate long-term safety and efficacy.</td></tr>
</table>

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr>
<td>Conflicts of interest: Funding for and assistance with data analysis and manuscript review were provided by CR Bard (manufacturer of EndoCinch).</td>
<td>polypropylene suture. All patients received general anaesthesia. The EVG procedure performed was conceptualized from previous experience within over 85 GERD cases with the EndoCinch device. After stitching was completed, patients were monitored for at least 1 hour after recovering from anaesthesia.

Dietary/behavioral modification: Patients were placed on a liquid, sugar-free diet for 3 days. A 7 day soft-solids diet was prescribed at the patient's first follow-up visit (postoperative day 3). After this, patients were allowed to eat what he or she wished. However, they were encouraged to make healthy selections.</td>
<td>visits.

Exclusion criteria: history of stroke, history of heart attack, uncontrolled diabetes, a>3cm haital hernia or any prior gastric surgery.

Study period: October 2003 to November 2005.</td>
<td></td>
<td>Weight related outcomes

<table>
<tr><th></th><th>Baseline</th><th>1 month</th><th>3 months</th><th>12 months</th></tr>
<tr><td>Total population</td><td>N=64</td><td>N=62</td><td>N=61</td><td>N=59</td></tr>
<tr><td>Mean BMI (kg/m2)</td><td>39.9±5.1</td><td>36.5±4.8*</td><td>33.5±4.5*</td><td>30.6±4.7*</td></tr>
<tr><td>Mean %EWL</td><td>NA</td><td>21.1±6.2</td><td>39.6±11.3</td><td>58.1±19.9</td></tr>
<tr><td>% patients with >30% EWL</td><td>NA</td><td>9.7</td><td>83.6</td><td>96.6</td></tr>
<tr><td>% patients with <15% EWL</td><td>NA</td><td>14.5</td><td>0.0</td><td>0.0</td></tr>
<tr><td>% follow-up</td><td>NA</td><td>96.9</td><td>95.3</td><td>92.2</td></tr>
<tr><td>Group 1</td><td>N=33</td><td>N=32</td><td>N=31</td><td>N=29</td></tr>
<tr><td>Mean BMI (kg/m2)</td><td>43.4±3.8</td><td>39.7±3.8*</td><td>36.4±3.7*</td><td>33.5±4.0*</td></tr>
<tr><td>Mean %EWL</td><td>NA</td><td>18.6±4.5</td><td>34.6±8.0</td><td>48.9±10.3</td></tr>
<tr><td>p-value vs. group 2</td><td></td><td>0.119</td><td>0.035</td><td>0.037</td></tr>
<tr><td>p-value vs. group 3</td><td></td><td><0.001</td><td><0.001</td><td><0.001</td></tr>
<tr><td>% patients with >30% EWL</td><td>NA</td><td>0.0</td><td>71.0</td><td>96.6</td></tr>
<tr><td>% patients with <15% EWL</td><td>NA</td><td>21.9</td><td>0.0</td><td>0.0</td></tr>
<tr><td>% follow-up</td><td>NA</td><td>97.0</td><td>93.9</td><td>87.9</td></tr>
<tr><td>Group 2</td><td>N=19</td><td>N=19</td><td>N=19</td><td>N=19</td></tr>
<tr><td>Mean BMI (kg/m2)</td><td>38.5±1.2</td><td>35.3±1.2*</td><td>32.4±1.4*</td><td>29.8±2.3*</td></tr>
<tr><td>Mean %EWL</td><td>NA</td><td>20.6±4.3</td><td>39.4±7.1</td><td>56.5±13.9</td></tr>
<tr><td>p-value vs. group 1</td><td></td><td>0.119</td><td>0.035</td><td>0.037</td></tr>
<tr><td>p-value vs. group 3</td><td></td><td><0.001</td><td>0.001</td><td><0.001</td></tr>
<tr><td>% patients with >30% EWL</td><td>NA</td><td>5.3</td><td>89.5</td><td>94.7</td></tr>
<tr><td>% patients with <15% EWL</td><td>NA</td><td>5.3</td><td>0.0</td><td>0.0</td></tr>
<tr><td>% follow-up</td><td>NA</td><td>100.0</td><td>100.0</td><td>100.0</td></tr>
<tr><td>Group 3</td><td>N=12</td><td>N=11</td><td>N=11</td><td>N=11</td></tr>
<tr><td>Mean BMI (kg/m2)</td><td>32.4±2.4</td><td>29.5±2.2*</td><td>27.3±2.2*</td><td>24.4±2.4*</td></tr>
<tr><td>Mean %EWL</td><td>NA</td><td>29.5±6.7</td><td>54.0±13.5</td><td>85.1±24.0</td></tr>
<tr><td>p-value vs. group 1</td><td></td><td><0.001</td><td><0.001</td><td><0.001</td></tr>
<tr><td>p-value vs. group 2</td><td></td><td><0.001</td><td>0.001</td><td><0.001</td></tr>
<tr><td>% patients with >30% EWL</td><td>NA</td><td>45.5</td><td>100.0</td><td>100.0</td></tr>
<tr><td>% patients with <15% EWL</td><td>NA</td><td>0.0</td><td>0.0</td><td>0.0</td></tr>
</table>
</td>
<td></td>
</tr>
</table>

Study details	Intervention	Study design and inclusion/exclusion criteria	Study population	Results	Author(s) conclusions
				% follow-up | NA | 91.7 | 91.7 | 91.7 NA: Not applicable; * statistically significant (p<0.001) when compared to baseline data. Adverse events Most patients (data not presented) left the procedure with mild sore throat and were able to return to their normal activities the same day as the procedure. One patient was vomiting during recovery, but had no further difficulties returned home after an hour after recovery. Two patients had reflux symptoms after the procedure, both resolved within 24 hours. There were no serious adverse events.	
Mullady DK, Lautz DB, Thompson CC (2009) *Gastrointentinal Endoscopy* Aim: To assess technical success and safety of Revision Obesity Surgery Endoscopic (ROSE) procedure for the placement of tissue anchors to reduce the diameter of the gastrojejunal anastomosis (GJA) and size of the gastric pouch. Conflicts of interest: One of the authors is a consultant for and is on the advisory board of USGI Medical (manufacturer of the EndoSurgical Operating System [EOS] used for ROSE).	ROSE procedure utilising the EOS (designed to crease full-thickness tissue plications). Procedure All procedures were performed under general anesthesia and was planned as an outpatient procedure. All patients underwent initial diagnostic upper endoscopy for measurement of the GJA and pouch with a through-the-scope measuring device. The esophagus was intubated and the tissue approximator was advanced into the gastric pouch. A small tissue grasper was also advanced through a channel and used to grasp tissue at the rim of the GJA or in the gastric pouch and pull it into the open tissue approximator, which creates a full thickness	Level of evidence: IV Duration of follow-up: 3 months Losses to follow-up: None. Inclusion criteria: must have regained weight after gastric bypass (Roux-en-Y). Exclusion criteria: None.	20 patients were included in this study. Mean age: 48 (36-62) years Mean weight regain: 13.3 (0.9-34.6) kg Mean BMI: 36.7 (28.4-48.8) kg/m2 All patients had a dilated stoma and/or pouch, which was thought to be contributing to their weight regain. Average GJA: 25 (8-35) mm Average pouch length: 7 (4-14) cm Study period: Not reported.	Procedural outcomes Tissue anchors could be placed in 17 (85%) of the patients, with a total of 101 anchor pairs placed (68 GJA, 33 pouch). Average number of total tissue plications at GJA: 3.4 (0-7) Average reduction in GJA diameter: 16 (0-26)mm (65% reduction) Average number of total tissue plications at pouch: 1.7 (0-6) Average reduction in gastric pouch length: 2.5 (0-5)cm (36% reduction) Weight loss Average weight loss at 1 month: 5.8kg Average weight loss at 3 months: 8.8kg For 3 patients here plication failed, they gained an average of 5.5kg despite dietary restrictions. Adverse events/complications Most patients (data not provided) had mild post-procedure abdominal bloating and several had mild sore throats for several days after the procedure. One patient was admitted overnight for mild bleeding during the procedure. One patient was admitted overnight for post-procedure vomiting and nausea, which resolved the next day.	The ROSE procedure is technically feasible and appears safe in reducing not only the size of the GJA but also the gastric pouch. It may provide an endoscopic alternative for weight regain in gastric bypass patients.

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td>tissue fold. Anchors are then utilized to complete the tissue plicationm. These steps were repeated at the rim of the GJA and in the pouch.

Dietary/behavioral modifications: All patients were placed on proton pump inhibitors twice daily to prevent ulcer formation. All patients were instructed to follow a diet consisting of clear liquids, no more than 8oz per hour for 1 to 2 days, followed by soft solids for 2 weeks.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Deviere J, Valdes GO, Herrera LC, Closset J, Le Moine O, Eisendrath P, Moreno C, Dugardeyn S, Barea M, la de Torre R, Edmundowicz S, Scott S (2008).

Surgical Endoscopy

Aim: To evaluate the safety and feasibility in human subjects of a new transoral restrictive procedure (TOGA) for the treatment of obesity.

Conflicts of interest: Research support provided by Satiety</td><td>Transoral gastroplasty with the TOGA system.

Procedure
Patients underwent upper endoscopy to determine the location of the z line. Laparoscopic access was gained to view the outside of the stomach during the procedure and to ensure that no collateral organs or structures were clamped or stapled (this was eliminated before end of study after procedural risk was judged to be low). A guide wire was used to introduce a 60Fr Savary bougie to dilate prior to device introduction. The</td><td>Level of evidence: IV

Duration of follow-up: 6 months

Losses to follow-up: None.

Inclusion criteria: NIH surgical treatment criteria (BMI≥40 kg/m2 or ≥35 kg/m2 with one or more comorbidities), history of obesity for at least 2.5 years, history of failure with nonsurgical weight loss methods, agreement to comply with substantial diet restrictions, an understanding of the risks, willingness to comply to protocol requirements.

Exclusion criteria: history of gastrointestinal inflammatory</td><td>21 patients (17 female) were enrolled in 2 centers.

Mean age: 43.7±9.7 years
Mean BMI: 43.3±5.0 kg/m2

Study period: Not reported.</td><td>Technical outcomes
18 patients received 2 sleeves. 2 patients received a partial second sleeve due to technical difficulties.
Mean hospital stay was 1.6 nights (range: 1-3) with individual patients being treated for pain, nausea, dysphagia. Two patients were kept in for 3 nights (one having pain and nausea, the other having superficial phlebitis).

Safety
No serious adverse events were observed.
The most commonly reported procedure- device-related adverse events were vomiting, pain, nausea and transient dysphagia.

Procedure-related adverse events:
<table>
<tr><th>Event</th><th>No. of patients</th><th>Duration (days)</th></tr>
<tr><td>Vomiting</td><td>7</td><td>0-3</td></tr>
<tr><td>Pain (other)</td><td>13</td><td>1-6</td></tr>
<tr><td>Nausea</td><td>6</td><td>1-3</td></tr>
<tr><td>Dysphagia</td><td>6</td><td>1-4 (18 for one patient)</td></tr>
<tr><td>Pharyngitis</td><td>1</td><td>5</td></tr>
<tr><td>Temporomandibular dysfunction</td><td>1</td><td>7</td></tr>
<tr><td>Dorsal pain</td><td>1</td><td>3</td></tr>
<tr><td>Throat pain</td><td>1</td><td>2</td></tr>
</table></td><td>Early experience indicates that the TOGA procedure may be safe and feasible.</td></tr>
</table>

Study details	Intervention	Study design and inclusion/exclusion criteria	Study population	Results	Author(s) conclusions
Inc. (manufacturer of the TOGA system).	TOGA sleeve stapler was introduced over the guidewire and a smaller endoscope was introduced through a channel in the device. A 45mm transmural line (with serosa-to-serosa apposition) connecting the anterior and posterior stomach, beginning at the angle of His and extending distally, parallel to the lesser curvature. The stapling process was repeated to add a second staple line, extending the new sleeve distally to create an 80-90mm sleeve, approximately 19mm in diameter. The sleeve outlet was then constricted with the TOGA restrictor, additional restrictions were placed to reduce the sleeve outlet to 10-12mm. Dietary/behavioral modification: Patients were provided with a postprocedure book containing diet, nutrition and exercise guidelines. They were instructed to consume thin liquids for the first 2 weeks, thicker liquids at 2 weeks and pureed foods at 3 weeks. After 4 weeks, patients were allowed to add solid	disease, significant esophageal disease, severe coagulopathy or upper GI bleeding conditions, congenital or acquired anomalies of the GI tract, haital hernia ≥2cm, BMI >55 kg/m2, severe cardiopulmonary disease, infectious disease or cancer, pregnancy, current alcohol/drug addiction, psychosis or mental instability, previous gastric/esophageal/ pancreatic/bariatric surgery, current infection, history of scleroderma, uncontrolled thyroid disease and participation in a conflicting study.		<table><tr><td>Worsening of cervical pain</td><td>1</td><td>5</td></tr><tr><td>Superficial phlebitis</td><td>NR</td><td>46</td></tr></table> Anatomic results A proximal line gap (between the angle of His and proximal staple line) or mid gap (between the proximal and distal staple lines) was observed endoscopically or on barium swallow in 11/21 (52.4%) patients prior to discharge. 2 patients had partial second sleeves, 8 patients had fully intact sleeves and continuous staple lines. Average sleeve outlet size was 10.8mm. At 6 months, staple line gaps were observed in 13/21 (61.9%) patients, 3 patients had incomplete distal sleeves and 5 patients and fully intact sleeves and staple lines. Weight loss *Mean %EWL* 1 month: 16.2% 3 months: 22.6% 6 months: 24.4% *Mean absolute weight loss* 1 month: 17.6lbs 3 months: 24.5lbs 6 months: 26.5lbs *Average BMI decrease* 43.3 kg/m2 pretreatment to 37.8 kg/m2 at 6 months (p<0.0001). Comorbidities and medication 7 patients had a history of T2DM at baseline, treatment consisted of oral medication (n=4), diet (n=2) and insuline (n=1). 4/7 patients had HBA1c levels that indicated their T2DM was not optimally controlled (HBA1c>7.0). At follow up (6 patients at six months, 1 patient at 11 months), mean HBA1c decreased from 7.6 to 6.6. This decreased was apparent in 6/7 T2DM patients (one remained under 6.0). 1 patient decreased diabetes medication (metformin). 1 patient increased insulin dosage to reduce HBA1c from 10.8 to 7.1. 2/4 patients with HBA1c>7.0 pretreatment decreased to <7.0 at follow-up. 8 patients had a history of hypertension at baseline. At 6 months, no changes were observed for hypertensive medication usage. However, 4/8 hypertensive patients were no longer measured as hypertensive. One patient who was	

<table>
<tr><th>Study details</th><th>Intervention</th><th>Study design and inclusion/exclusion criteria</th><th>Study population</th><th>Results</th><th>Author(s) conclusions</th></tr>
<tr><td></td><td>food to their diet and counseled to continue to adhere to a low calorie diet emphasizing protein and small meal size and avoidance of high calorie liquids.</td><td></td><td></td><td>previously hypertensive registered as hypertensive.

3 patients were hyperlipidemic and 4 had low HDL levels at baseline.
At 6 months, 2/3 hyperlipidemic patients were no longer hyperlipidemic.
3/4 low HDL patients tested above 35mg/dL and one new patient was tested below this level.
At 6 months, 2 patients discontinued hyperlipidemic drug use while 1 patient initiated drug treatment.

Quality of life measures
a)SF-36
<table>
<tr><th></th><th>Baseline</th><th>6 months</th><th>Change</th><th>p-value</th></tr>
<tr><td>Physical functioning</td><td>35.2</td><td>46.2</td><td>11.4</td><td>0.0008</td></tr>
<tr><td>Role physical</td><td>36.1</td><td>46.1</td><td>10.4</td><td>0.0012</td></tr>
<tr><td>Bodily pain</td><td>40.2</td><td>48.0</td><td>6.6</td><td>0.02</td></tr>
<tr><td>General health</td><td>40.6</td><td>49.3</td><td>9.7</td><td>0.001</td></tr>
<tr><td>Vitality</td><td>43.6</td><td>54.8</td><td>10.7</td><td>0.0009</td></tr>
<tr><td>Social functioning</td><td>41.6</td><td>47.7</td><td>4.4</td><td>0.03</td></tr>
<tr><td>Role emotional</td><td>38.1</td><td>42.3</td><td>3.9</td><td>0.27</td></tr>
<tr><td>Mental health</td><td>41.8</td><td>46.0</td><td>2.6</td><td>0.26</td></tr>
</table>
b) IWQOL-Lite
<table>
<tr><th></th><th>Baseline</th><th>6 months</th><th>Change</th><th>p-value</th></tr>
<tr><td>Physical functioning (raw)</td><td>41.6</td><td>25.8</td><td>16.9</td><td><0.0001</td></tr>
<tr><td>Self esteem (raw)</td><td>23.1</td><td>13.9</td><td>8.8</td><td><0.0001</td></tr>
<tr><td>Sexual life (raw)</td><td>10.8</td><td>8.7</td><td>2.8</td><td>0.03</td></tr>
<tr><td>Public distress (raw)</td><td>12.9</td><td>8.8</td><td>5.1</td><td>0.003</td></tr>
<tr><td>Work (raw)</td><td>10.3</td><td>6.1</td><td>4.0</td><td>0.002</td></tr>
<tr><td>Total (raw)</td><td>98.8</td><td>62.7</td><td>37.7</td><td><0.0001</td></tr>
<tr><td>Physical functioning (converted)</td><td>30.4</td><td>66.5</td><td>38.5</td><td><0.0001</td></tr>
<tr><td>Self esteem (converted)</td><td>42.5</td><td>75.5</td><td>31.5</td><td><0.0001</td></tr>
<tr><td>Sexual life (converted)</td><td>57.2</td><td>74.6</td><td>17.5</td><td>0.03</td></tr>
<tr><td>Public distress (converted)</td><td>60.7</td><td>80.9</td><td>25.3</td><td>0.003</td></tr>
<tr><td>Work (converted)</td><td>60.6</td><td>87.1</td><td>25.0</td><td>0.002</td></tr>
<tr><td>Total (converted)</td><td>45.4</td><td>74.5</td><td>30.4</td><td><0.0001</td></tr>
</table></td><td></td></tr>
<tr><td>Moreno C, Closset J, Dugardeyn S, Barea M, Mehli A, Collignon L, Zalcman M, Baurain M, Le Moine O,</td><td>Transoral gastroplasty with the TOGA system.

Procedure
Patients underwent upper endoscopy, a</td><td>Level of evidence: IV

Duration of follow-up: 6 months

Losses to follow-up: One at 6</td><td>11 patients (7 female)

Mean age: 44.2±10.7 (26-59) years
Mean weight: 119.8±22.2 (81.5-</td><td>Technical results
Two sleeves were placed in all patients.
Mean number of restriction placed at the outflow of distal sleeve was 3.3 (range: 3-4).
All patients were hospitalized for one night.
Procedure time: 84 minutes</td><td>This second pilot trial confirmed the feasibility and safety of transoral gastroplasty.</td></tr>
</table>

<table>
<tr>
<th>Study details</th>
<th>Intervention</th>
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<td>Deviere J (2008).

Endoscopy

Aim: to assess safety, feasibility and weight losee results of the TOGA system at 6 months.

Conflicts of interest: Research support provided by Satiety Inc. (manufacturer of the TOGA system).</td>
<td>guide wire aws paled and a 60Fr bougie was introduced over the guidewire to dilate and test for any resistance prior to device introduction. The TOGA sleeve stapler was then introduced over the guidewire and the wire was removed. A 8.6mm or smaller endoscopt was introduced through a channel in the device for direct viewing of the stapling procedure. The stapler body was positioned along the lesser curvature of the stomach and tissue from the anterior and posterior walls of the stomach were stapled together. Creating a transmural staple line connecting the anterior and posterior stomach, beginning 1cm proximal to the Z lineand extending distally 4.5cm, parallel to the lesser curvature. This process was repeated to add a second staple line, extending the new sleeve distally to create a sleeve approximately 8-9cm in length. The distal sleeve outlet was narrowed using the TOGA restrictor until the outlet was <20mm.

Dietary/behavioral</td>
<td>months (refused to return to hospital).

Inclusion criteria: NIH surgical treatment criteria (BMI≥40 kg/m2 or ≥35 kg/m2 with one or more comorbidities), history of obesity for at least 2.5 years, history of failure with nonsurgical weight loss methods, agreement to comply with substantial diet restrictions, an understanding of the risks, willingness to comply to protocol requirements.

Exclusion criteria: : history of gastrointestinal inflammatory disease, significant esophageal disease, severe coagulopathy or upper GI bleeding conditions, congenital or acquired anomalies of the GI tract, haital hernia ≥2cm, BMI >55 kg/m2, severe cardiopulmonary disease, infectious disease or cancer, pregnancy, current alcohol/drug addiction, psychosis or mental instability, previous gastric/esophageal/ pancreatic/bariatric surgery, current infection, history of scleroderma, uncontrolled thyroid disease and participation in a conflicting study.</td>
<td>161)kg
Mean BMI: 41.6±4.3 (37.2-52.6) kg/m2

Study period: Not reported.</td>
<td>Safety
No serious adverse events were observed.

<table>
<tr><th>Event</th><th>No. of patients</th><th>Duration (days)</th><th>Outcome</th></tr>
<tr><td>Epigastric pain</td><td>11</td><td>1-4</td><td>Mild or moderate, treated by analgesics</td></tr>
<tr><td>Throat pain</td><td>3</td><td>2-6</td><td>Moderate, treated by paracetamol or local chlorhexidine</td></tr>
<tr><td>Esophagitis</td><td>2</td><td>2</td><td>Moderate, resolved with proton pump inhibitors</td></tr>
<tr><td>Nausea</td><td>2</td><td>1-23</td><td>Mild or moderate, spontaneously resolved or treated by alizapride</td></tr>
<tr><td>Dysphagia</td><td>3</td><td>2-30</td><td>Mild, spontaneously resolved</td></tr>
<tr><td>Vomiting</td><td>2</td><td>Single event</td><td>Spontaneously resolved</td></tr>
<tr><td>Superficial phlebitis, arm</td><td>1</td><td>19</td><td>Mild, spontaneously resolved</td></tr>
<tr><td>Worsening of cervical pain</td><td>1</td><td>5</td><td>Moderate, treated with analgesics</td></tr>
</table>

Anatomic results
Average sleeve outlet size was 1.56cm in diameter.
At 3 and 6 months, average sleeve outlet sizes were 2 cm and 2.4 cm, respectively.

At the end of the procedure, two patients had a mid-stoma (gap between proximal and distal staple lines).
At 6 months, 4 patients had a mid-stoma (<1cm).

Weight loss
Mean %EWL was 19.2%, 33.7% and 46.0% at 1, 3, and 6 months, respectively (p<0.05).
Absolute mean weight loss was 9.9, 17.5 and 24.0kg at 1, 3 and 6 months, respectively.
Mean weight decreased from 119.8kg to 109.9, 102.3, 95.8kg at 1, 3 and 6 months, respectively (p<0.01).
Mean BMI decreased from 41.6 kg/m2 to 38.1, 35.4 and 33.1 kg/m2 at 1, 3, and 6 months, respectively (p<0.01)

At 3 months, 2 patients were selected for additional restrictions due to insufficient weight loss and unsatisfactory sleeve outlet size. The number of additional restrictions placed at the outflow of the distal sleeve was 5, resulting in outlet sizes of 1.3cm and 2 cm. At 3 months after retreatment, sleeve outlet sizes were 2cm and 3.5cm. One patient had gained 0.7kg while the other lost 1.7kg after retreatment.</td>
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<tr><td></td><td>modifications: Patients were provided with a postprocedure book containing diet, nutrition and exercise guidelines. They were instructed to consume thin liquids for the first 2 weeks, thicker liquids at 2 weeks and pureed foods at 3 weeks. After 4 weeks, patients were allowed to add solid food to their diet.</td><td></td><td></td><td>Quality of life measures
<table><tr><th></th><th>Enrollment</th><th>6 months</th><th>p-value</th></tr><tr><td>IWQOL-lite</td><td></td><td></td><td></td></tr><tr><td>Physical function</td><td>36.5</td><td>16.7</td><td>0.005</td></tr><tr><td>Self-esteem</td><td>25.4</td><td>14.4</td><td>0.009</td></tr><tr><td>Sexual life</td><td>12.2</td><td>6.7</td><td>0.015</td></tr><tr><td>Public distress</td><td>13.2</td><td>7.1</td><td>0.005</td></tr><tr><td>Work</td><td>8.8</td><td>5.0</td><td>0.007</td></tr><tr><td>Total</td><td>96.0</td><td>49.9</td><td>0.007</td></tr><tr><td>SF-36</td><td></td><td></td><td></td></tr><tr><td>Physical functioning</td><td>38.9</td><td>54.7</td><td><0.001</td></tr><tr><td>Role-physical</td><td>42.2</td><td>55.8</td><td><0.001</td></tr><tr><td>Bodily pain</td><td>44.6</td><td>54.5</td><td><0.001</td></tr><tr><td>General health</td><td>40.4</td><td>56.7</td><td><0.001</td></tr><tr><td>Vitality</td><td>44.4</td><td>58.3</td><td><0.001</td></tr><tr><td>Social functioning</td><td>39.0</td><td>54.8</td><td><0.001</td></tr><tr><td>Role-emotional</td><td>41.0</td><td>54.1</td><td><0.001</td></tr><tr><td>Mental health</td><td>40.0</td><td>50.0</td><td><0.001</td></tr><tr><td>Self-reported health transition</td><td>3.0</td><td>1.5</td><td>0.017</td></tr></table></td><td></td></tr>
<tr><td>Mikami D, Needleman B, narula V, Durant J, Melvin WS (2010).

Surgical Endoscopy

Aim: To determine the effectiveness of StomaphyX to reduce gastric pouches after gastric bypass.

Conflicts of interest: None disclosed.</td><td>StomaphyX (endoluminal gastric pouch reduction).

Procedure
All procedures were performed under general anesthesiaAn initial upper endoscopy was performed using a gastroscope with an 8.6mm outer diameter. A gastroscope and StomaphyX were passed through a mousepiece as one unit. The StomaphyX device uses suction to draw tissue through an opening near the distal end of the device. A</td><td>Level of evidence: IV

Duration of follow-up: 12 months.

Losses to follow-up:
By 12 months, 33 patients were lost to follow-up.

Inclusion criteria: at least 2 years from original gastric bypass surgery and had gained at least 10% of lowest nadir weight.

Exclusion criteria: None.</td><td>39 patients (36 female)
Mean age: 47.8± (29-64)
Mean weight: 1080.0 (65.90-172..2)kg
Mean BMI (39.8 (22.7-63.2)kg/m2
Mean excess body weight: 51.1 (18.6-115.4) kg

Study period: Not reported.</td><td>Weight loss
All 39 patients described a feeling of increased satiety at 2 weeks post-treatment.

Postoperative weight loss:
<table><tr><th>Time</th><th>Weight loss (kg)</th><th>n</th></tr><tr><td>2 weeks</td><td>3.9 (1.2-17.7)</td><td>39</td></tr><tr><td>1 month</td><td>5.4 91.3-18.6)</td><td>34</td></tr><tr><td>2 months</td><td>6.7 (2.3-22.2)</td><td>26</td></tr><tr><td>3 months</td><td>6.7 (2.7-22.7)</td><td>15</td></tr><tr><td>6 months</td><td>8.7 (2.3-25.4)</td><td>13</td></tr><tr><td>12 months</td><td>10.0 (2.3-29.5)</td><td>6</td></tr></table>
Postoperative % excess body weight loss:
<table><tr><th>Time</th><th>Excess body weight loss (%)</th><th>n</th></tr><tr><td>2 weeks</td><td>7.4 (2.5-13.0)</td><td>39</td></tr><tr><td>1 month</td><td>10.6 (3.0-21.2)</td><td>34</td></tr><tr><td>2 months</td><td>13.1 (4.0-28.0)</td><td>26</td></tr><tr><td>3 months</td><td>13.1 (4.1-30.9)</td><td>15</td></tr></table></td><td>Endoluminal revision of gastric bypass patients with weight regain using the StomaphyX procedure may offer an alternative to open or laparoscopic revision bariatric surgery.</td></tr>
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<td>circular pleat of tissue is greater 1cm proximal to the anastomosis. This was completed by going in a circular fashion with the first fastener placed at the 6 o'clock position followed by 5 other fasteners. A second level of fasteners was placed 1cm proximal to the first row.
Dietary/behavioral modifications: All patients were required to undergo a session with a bariatric dietician. Patients were on a liquid diet for 2 weeks after the procedure. After 2 weeks, patients had six small meals per day.</td>
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<table>
<tr><td>6 months</td><td>17.0 (4.2-36.0)</td><td>13</td></tr>
<tr><td>12 months</td><td>19.5 (5.7-38.0)</td><td>6</td></tr>
</table>

Adverse events/complications
No major adverse events were observed.
34/39 (87.1%) patients had sore throats lasting less than 48 hours.
30/39 (76.9%) patients experienced epigastric pain that lasted for a few days.

11 patients had unexpected results after the StomaphyX procedure.
3 patients with late dumping syndrome had their postprandial diarrhea resolved.
8 patients with history of gastroesophgeal reflux experienced improved symptoms at 1-month post-treatment.
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