Effect of the Garren-Edwards Gastric Bubble on Gastric Emptying

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The Garren-Edwards Gastric Bubble (GEGB) was introduced in 1984 as an alternative to surgery (jaw wiring, gastrointestinal bypass, vertical banded gastroplasty) for the treatment of morbid obesity in patients who had failed behavior modification therapy or dietary management for weight reduction. Its mechanism of action is unclear and previous reports have not demonstrated any significant consistent alteration in gastric emptying (GE) as measured by radionuclide techniques. Other proposed mechanisms include: placebo, hormonal, mechanical "satiety", behavioral modification, and neuronal. In order to determine the effect of the GEGB on GE, ten obese (mean % overweight = 89%) patients, 27–50 yr old (mean = 36 yr), had solid GE scans before and 5 wk after endoscopic placement of the bubble. GE scans were performed in six patients after removal (12 = wk residence time). The meal consisted of 300 μCi [^{99m}Tc]sulfur colloid in the form of a 300 kcal egg sandwich (egg white 248 g, white bread 40 g, butter 6 g; composition = CHO 40:PR 40: FAT 20) with 180 ml deionized water. Images were obtained in the anterior and posterior projections at 15-min intervals for 1 hr (four patients) or 2 hr (six patients) and the %GE (decay corrected geometric mean) was calculated. Unlike other studies involving the GEGB, adjunctive therapy in the form of dieting and behavior modification were not employed in this study. The effect of the GEGB alone in the treatment of obesity has not been previously evaluated. There was a significant ($p < 0.025$) delay in gastric emptying at 1 hr (pre-bubble mean % gastric retention = 46%; bubble mean = 57%; n = 10). After removal, GE returned toward baseline (mean % gastric retention = 51%; n = 6) ($p < 0.05$) (Student's t-test). The average weight loss was 5.5 lb (n = 10; $p < 0.025$)*. One mechanism of action of the GEGB may be delayed gastric emptying resulting in early satiety and decreased food intake with resultant weight loss.

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Obesity, defined as the excessive storage of energy in the form of fat, affects 34 million people in America, 20% of whom are morbidly obese, i.e., sufficiently overweight to be in a life-threatening situation (*1*). Obesity adversely affects health and longevity. It is clearly associated with an increased incidence of hypertension, hypercholesterolemia, arthritis, pulmonary disorders (Pickwickian Syndrome), diabetes, cancer, and operative mortality. There is a 12-fold increase in mortality for morbidly obese people (>100% overweight) (*2*). Dieting is frequently unsuccessful or of only temporary benefit. Surgery (jaw wiring, intestinal bypass, vertical banded gastroplasty) is invasive and associated with a small but definite mortality (1%) and complication rate (8%).

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The Garren-Edwards Gastric Bubble (GEGB) (Fig. 1) was introduced in 1984 (*3,4*) and approved for the treatment of obesity by the FDA in 1985 (*1*). It is a cylindrically shaped inflatable (200 cc air) elastomeric plastic with the dimensions 3 cm × 4 cm that is inserted endoscopically into the fundus of the stomach. Initial enthusiasm led to the sale of over 20,000 bubbles in less than a year (*5,6*). Whether or not the bubble is efficacious in achieving long-term weight reduction is still controversial. Some uncontrolled trials of the bubble in conjunction with diet and behavior modification therapy have reported significant weight reduction (*7–12*). However, controlled trials have found that the bubble has no significant effect with regard to weight reduction beyond that of behavior modification alone (*13–17*).

The mechanism of action of the GEGB is also controversial (mechanical volume reduction --> satiety, placebo, hormonal, neuronal, etc.). Previous reports

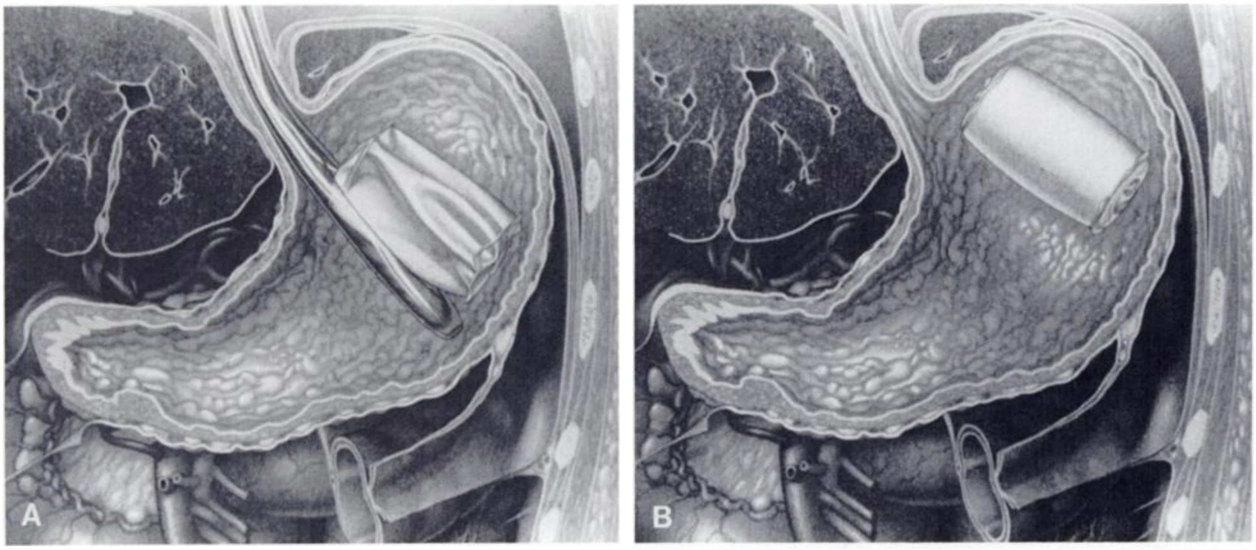

FIGURE 1
The Garren-Edwards Gastric Bubble. A: Insertion: after routine endoscopy, the bubble is inserted orally with a premeasured introducer tube and inflated with 200 cc of room air with a syringe and check valve mechanism. B: Inflation and release: after inflation, the insufflation cannula is removed and the bubble is released into the fundus of the stomach. Repeat endoscopy is done to ensure the integrity of the upper GI tract and to confirm that the GEGB is freefloating in the fundus.

have shown either a transient delay in gastric emptying (GE) but no long-term effect (*18*) or no effect at all (*19*) as measured by radionuclide techniques. Thus, it is paradoxical that a therapeutic intervention with equivocal efficacy has gained widespread acceptance and clinical application. The effect of the GEGB on gastric emptying independent of diet therapy and behavior modification as measured by radionuclide techniques has not been previously investigated.

METHODS AND MATERIALS

Patient Population

The patient population consisted of ten obese (mean % overweight = 89%; mean weight = 244 lb) women ranging in age from 27–50 yr old (mean = 36 yr) who responded to a newspaper article about the bubble. The subjects were informed that the purpose of the study was to evaluate the effectiveness of the GEGB in causing weight loss without adjunctive therapy (diet, behavior modification). All subjects agreed to participate in a study consisting of three phases—Phase I: a baseline period (4 wk); Phase II a bubble treatment period (12 wk); and Phase III a follow-up period (12 wk). Behavior modification and dietary therapy were not employed.

Bubble Insertion

GEGBs were inserted per orum and detached within the fundus of the stomach after inflation with 200–220 cc of air following preliminary endoscopic examination to exclude any gastric pathology (gastritis, erosions, ulcers, etc.) that may contraindicate bubble therapy. The subjects were given a prescription for Zantac (an H2 blocker; 150 mg PO BID for the first 2 mo and QD for the last 2 mo of the study) and were encouraged to take over-the-counter antacids PRN for stomach discomfort (as recommended by the manufacturer). The bubbles were endoscopically removed after a period of 12 wk gastric residence time and a postremoval endoscopic examination was performed in order to diagnose any gastric complications.

Gastric Scintigraphy

Radionuclide gastric emptying scans were performed on three occasions: (a) prior to bubble insertion (n = 10; baseline), (b) 5 wk after bubble insertion (n = 10), and (c) 4 wk postbubble removal (n = 6). Informed written consent and a negative serum pregnancy test were obtained in all patients. The radionuclide studies were approved by the Committee for the Investigation of Studies Involving Research in Human Beings and the Radiation Safety Office.

The meal consisted of 300 μCi of technetium-99m sulfur colloid bound to egg albumin in the form of a 300-kcal egg sandwich (eight egg whites = 248 g, two slices white toast = 40 g, two pats of butter = 6 g, and 180 ml deionized water) with the following composition: 40% carbohydrate, 40% protein, and 20% lipid. The subjects were instructed to consume the solid meal within 10 min after which imaging was commenced. Images 1 min in duration were obtained in both the anterior and posterior projections at 15-min intervals for a total period of 1 hr (n = 4) or 2 hr (n = 6) in the erect position with a large field-of-view gamma camera equipped with a low-energy, all purpose collimator interfaced to a computer (GE Star II). The subjects were permitted to sit or move around ad lib in between pictures.

The geometric mean counts (anterior counts x posterior counts)$^{1/2}$ were calculated for each 15-min interval after correction for radioactive decay by generating a gastric region of interest for each image. The percent gastric retention (GR) was calculated for each 15-min interval with the following formula: (decay corrected geometric mean counts @ t)/(geometric mean counts @ t = 0) X 100. Statistical analysis was performed by means of the Student's paired t-test. The lag phase was defined as the time from the completion of meal ingestion (t = 0) to the onset of the emptying phase (*20*). The T½ was defined as the time interval from t = 0 to 50% GE (or GR). The "area under the curve" analysis involved the calculation of the area encompassed by the gastric emptying curve (including a perpendicular dropped to the x axis from the curve @ T = 120 min) and the x and y axes as calculated by a computer software program (cricketgraph).

Laboratory Evaluation

Patients were not given specific behavioral or dietary advice in order to evaluate the effect of the bubble independent of behavior modification techniques. In order to measure food intake and appetitive behavior, the amount of food ingested in the course of a standard 30-min test meal as well as the patient's assessment records of hunger and stomach fullness, were evaluated in the laboratory. Utilizing a two-way mirror, test meals were conducted at pre-bubble, 2, 6, and 10 wk following bubble insertion, and 12 wk after bubble removal. The test meals have been standardized and consist of a mixture of bite-sized sandwiches called "solid food units" (SFUs). These are 15 kcal spirals of bread with one of six different fillings: ham, tuna, turkey, roast beef, egg, and cheese. The SFUs are of a small uniform size and are readily counted by an investigator sitting behind the two-way mirror. The SFUs are located in a picnic box and are unable to be seen by the subject. Each SFU that is removed from the box is electronically recorded. Subjects are given a standard amount of water to drink and are asked to rate their hunger, stomach fullness, and palatability of the SFUs. This allows one to quantitate the rate of eating, caloric intake, and to assess the patient's subjective feelings of hunger and fullness. At home, subjects were asked to record their daily food intake including calories and meal duration and rated their amount of stomach discomfort.

RESULTS

The GEGB caused a significant ($p < 0.025$) delay in GE at 1 hr (pre-bubble mean %GR = 46%, bubble mean %GR = 57%; n = 10). After removal, GE returned toward baseline (postbubble mean %GR = 51%; n = 6) and was not statistically different from the pre-bubble value (n = 10) ($p > 0.05$) (Fig. 2). The bubble resulted in a shift from left to right in the baseline gastric emptying curve. The $T_{1/2}$ was significantly prolonged by the bubble (pre-bubble $T_{1/2}$ = 57 min, bubble $T_{1/2}$ = 67 min; $p < 0.05$) and returned toward baseline after removal (post-bubble $T_{1/2}$ = 62 min; $p > 0.05$). The mean pre-bubble baseline $T_{1/2}$ for GE for these ten obese women was 57 min which is accelerated compared to our normal control value of 70 min obtained from a series of 12 normal male volunteers (age range 19–28; mean age 24) for this 300 kcal meal. The mean (± s.e.m.) pre-bubble baseline GR at 1 hr for the ten obese women was 46% ± 6 compared to 62% ± 5 for our ten normal volunteers which is a significant difference ($0.005 < p \leq 0.01$; Student's paired t-test).

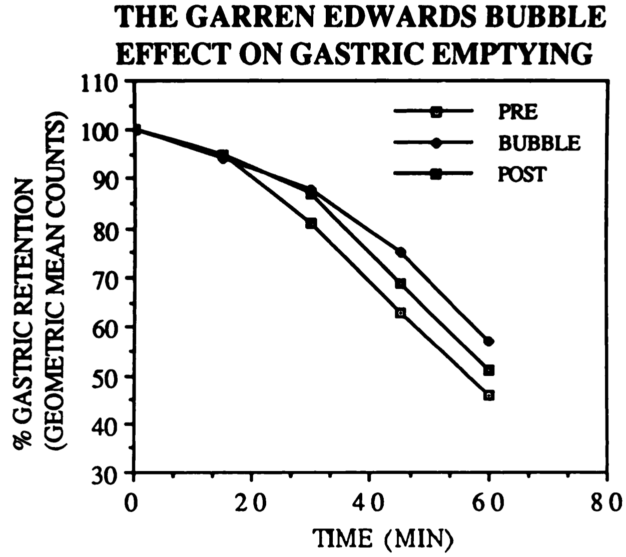

FIGURE 2
The GEGB causes a significant ($p < 0.025$) delay in GE at 1 hr (pre-bubble mean %GR = 46%, bubble mean %GR = 57%; n = 10). After removal, GE returns toward baseline (postbubble mean %GR = 51%; n = 6) and is not statistically different from the pre-bubble value (n = 10; $p > 0.05$) (I = s.e.m.).

Analysis of the "area under the curve" revealed a slight increase in area with the bubble primarily due to a prolongation of the lag phase. The lag phase was increased in duration by a factor of 2 (16 min --> 32 min.) but analysis of the slope of the emptying portion of the curves showed no significant difference (pre-bubble = −1.13, bubble = −1.2, and post-bubble = −1.2), indicating that the delay was due to prolongation of the lag phase but independent of the emptying phase. Although the post-bubble emptying curve returned toward baseline it was still slightly delayed compared to the pre-bubble curve primarily due to a failure of the lag phase to return to baseline level.

The average weight loss during bubble therapy was 5.5 lb. Four subjects lost ≥ 8 lb, three subjects lost < 6 lb, and 3 subjects gained < 4 lb. Most patients complained of stomach discomfort (Table 1: +++ = severe, ++ = moderate, + = mild) however, symptoms did not correlate with gastric pathology as assessed by endoscopy (Table 1). None of the bubbles were spontaneously deflated at the time of removal. The mean weight loss decreased from 5.5 lb with the bubble in place to 3.5 lb 3 mo after the bubble had been removed.

In the laboratory, subjects tended to eat less (mean meal units consumed per eating session: pre-bubble = 42; bubble = 26.6; $p < 0.025$) and for a shorter (20% decrease) period of time (eating session duration: pre-bubble = 24 min; bubble = 19.6 min; $p < 0.03$). Their initial rate of eating was unchanged by the bubble but

TABLE 1

Subject	Age (yr)	Wt (lb)	Ht (in.)	% Over wt	Wt loss	STM Sxs	Endoscopy results
1	50	224	65	82	19.3	+++	—
2	37	234	67	74	10.0	+	—
3	32	254	64	111	13.8	++	—
4	30	255	70	76	+1.0	–	—
5	29	240	69	72	+0.5	++	Ulcer
6	37	195	65	53	+3.5	+	—
7	27	284	67	114	8.0	+	Erosion
8	33	258	61	127	5.3	++	—
9	47	247	64	101	0.8	+	—
10	37	244	68	77	2.5	+	Gastritis
Mean	36	244	66	89	5.5		

plateaued earlier suggesting early satiety as a result of decreased gastric volume. The mean meal energy content consumed in the lab decreased by 38% (pre-bubble = 611 kcal --> bubble = 389 kcal); daily intake decreased by 25% (pre-bubble = 1721 kcal --> bubble = 1,294 kcal; $p < 0.01$); meal duration at home decreased by 13% (pre-bubble = 41.2 min --> bubble = 33.7 min; $p < 0.03$).

DISCUSSION

It is an interesting circumstance that the GEGB has achieved almost immediate widespread acceptance and use although its mechanism of action is not clearly understood and its efficacy in producing long term weight reduction remains controversial. Contrary to other previous reports (*18,19*), we have shown that the GEGB causes a delay in gastric emptying predominantly due to prolongation of the lag phase whereas the emptying phase remains unaffected.

It is interesting that the mean percent GE at 1 hr obtained for these obese subjects was accelerated compared to our normal control value for this solid meal. Although the two groups differed slightly in age (mean = 36 vs. 24 for obese vs. control, respectively) this would tend to minimize the difference in GE between the two groups if there was any effect at all. The accelerated emptying that occurs in these individuals may be a contributory factor to their obesity.

We have also demonstrated that bubble therapy resulted in a decrease in meal duration, and caloric intake both in the lab and at home. This suggests that one possible mechanism of action of the GEGB may be a delay in gastric emptying resulting in early satiety and decreased food intake with resultant weight loss. Our study is unlike previous studies in that the effect of the bubble was assessed independent of adjunctive therapy such as dieting and behavior modification. However, the GEGB alone did not produce any clinically significant long term weight loss (mean = 5.5 lb @ 5 wk, 3.4 lb @ 12 wk for n = 8) which is in agreement with previous controlled studies (*13–17*).

Contraindications to bubble therapy include: peptic ulcer disease or gastritis, structural anomalies of the esophagus or pharynx, hiatal hernia, and prior gastric surgery. As might be expected, the bubble may be associated with similar complications including: perforation of the upper gastrointestinal tract, aspiration pneumonia, intestinal obstruction (deflation and distal migration), gastritis and gastric ulceration (*6*). It is generally recommended that the bubble be removed after 3 mo since thereafter the risk of spontaneous deflation increases proportionately. None of our balloons deflated spontaneously. However, we had one case each of mild regional gastritis, a gastric erosion, and a gastric ulcer. The patient's subjective complaints of stomach discomfort did not seem to correlate with endoscopic findings.

In conclusion, the GEGB delays gastric emptying and may produce transient weight loss possibly by causing early satiety and temporarily, decreased food intake. However, in the absence of adjunctive dietary and behavior modification therapy, clinically significant long-term weight reduction is an unrealistic expectation for bubble therapy.

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REFERENCES

1. Health implications of obesity: National Institutes of Health Consensus Development Panel on the Health Implications of Obesity. *Ann Intern Med* 1985; 103:147–151.
2. Drenick EJ, Bale GS, Seltzer F, Johnson DG. Excessive mortality and causes of death in morbidly obese men. *JAMA* 1980; 243:443–445.
3. Garren LR, Garren M. The Garren Gastric Bubble: an endoscopic aid to treatment of morbid obesity [Abstract] *Gastroendoscopy* 1984; 30:153.
4. Garren M, Garren LR, Giordano F. The Garren Gastric Bubble: a treatment for the morbidly obese. *Endoscopy Review* 1984; 2:57–60.
5. Diagnostic and Therapeutic Technology Assessment evaluation of the Garren Gastric Bubble. *JAMA* 1986; 256; 19:3282–3284.
6. Schapiro M, Benjamin S, Blackburn G, et al. Obesity and the gastric balloon: a comprehensive workshop. *Gastrointestinal Endoscopy* 1987; 33:323–327.
7. Garren L, Garren M, Plotzker R, Werbitt W, Giordano F. The Garren-Edwards gastric bubble: an aid for weight loss in the obese [Abstract] *Int J Obes* 1987; 11:74.
8. Barkin JS, Goldberg RI, Phillips RS, et al. The effects of gastric bubble implant on weight change with and without compliance to a behavior modification program [Abstract]. *Gastrointest Endoscop* 1987; 33:168–169.
9. Good LI, Dolgin SM. Weight reduction with the Gar-

ren-Edwards Gastric Bubble [Abstract]. *Gastrointest Endoscop* 1987; 33:171.
10. Chapman DJ, Alberas H, Clark C. The effectiveness of the gastric bubble in the treatment of morbid obesity [Abstract] *Gastrointest Endoscop* 1987; 33:170.
11. Brown TH, Davidson PF, Terrell S, Rayford P, Larson GM. Balloon therapy for obesity: effects on gastric secretion, gastrin, CCK, and weight [Abstract]. *Gastrointest Endoscop* 1987; 33:150.
12. Farivar M, Perrotto J, Lyons K, Vecclery C. Garren-Edwards Gastric Bubble for obese patients [Abstract]. *Gastrointest Endoscop* 1987; 33:170.
13. Hogan RB, Johnston JH, Long BW, et al. The gastric bubble vs sham endoscopy: a prospective, randomized, controlled, double blinded comparison as an adjunct to a standard weight loss program [Abstract]. *Gastrointest Endoscop* 1987; 33:172.
14. Meshkinpour H, Hsu D, Farivar S. The effect of gastric bubble as a weight reduction device: a controlled, crossover study [Abstract]. *Gastroenterology* 1987; 92:1506.
15. Levine GM, Goldstein M, Lowe M, Scher K, Pusateri J. The gastric bubble fad or fantastic [Abstract]. *Gastroenterology* 1987; 92:1505.
16. Benjamin SB, Maher K, Ciarleglio C, et al. A double-blind cross over study of the Garren-Edwards anti-obesity bubble [Abstract]. *Gastrointest Endoscop* 1987; 33:168.
17. Lindor KD, Hughes RW, Ilstrup DM, Jensen MD. Intragastric balloons in comparison with standard therapy for obesity—a randomized, double-blind trial. *Mayo Clin Proc* 1987; 62:992–996.
18. Zeissman HA, Fahey FH, Collen MJ, Maher KA, Ciarleglio CA, Benjamin SB. Effect of the Garren-Edwards gastric bubble on gastric emptying [Abstract]. *J Nucl Med* 1987; 28:604.
19. Lee ME, Hanelin LG, Kozarek RA. Solid food gastric emptying in morbid obesity: influence of the Garren Edwards Gastric Bubble [Abstract]. *J Nucl Med* 1987; 28:604.
20. Siegel JA, Urbain JL, Adler LP, et al. Biphasic nature of gastric emptying. *GUT* 1988; 29:85–89.