Fundoplication Enhances Gastric Emptying

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Fundoplication of the stomach is an established surgical treatment of gastroesophageal reflux. Its mechanism of action remains unclear. To assess its effect on gastric emptying, 21 patients (11 men, 10 women), median age 47 years (range 19–72), underwent a gastric emptying study before and 6 months after fundoplication. Gastric emptying studies were performed after an overnight fast using a dual isotope technic. Solid and liquid emptying rates were assessed over 120 minutes. The time taken for 50% of the liquid marker to leave the gastric region was a median of 22 minutes before surgery (range 9–35) and 13 minutes after surgery (range 9–27) (p < 0.01). The percentage of solid remaining in the stomach 100 minutes after ingestion was 50% before surgery (range 19–90) and 44% after surgery (range 5–89) (p < 0.01). We conclude that gastric emptying of both solids and liquids tends to be increased following fundoplication. This observation suggests a further mechanism for the efficacy of this operation in the treatment of gastroesophageal reflux.

Nissens first described his antireflux procedure in 1956.1 Since then there have been numerous reports of fundoplication of the stomach in the treatment of gastroesophageal reflux, although technics have varied widely.2 The great majority of patients experience complete relief of heartburn and regurgitation following such operations.3-6 Despite its success in treatment of gastroesophageal reflux, its precise mechanism of action is not understood completely.7 Patients studied before and after fundoplication have shown an increase in lower esophageal sphincter pressure.3-6 However, not all patients who undergo fundoplication have an increase in lower esophageal sphincter pressure following surgery.7,8 It has also been shown that operation impairs the ability of the lower esophageal sphincter to completely relax. This creates a residual lower esophageal sphincter pressure at all times that acts as a barrier to gastric contents refluxing.9,10

Reports over the last few years have implicated delayed gastric emptying as a factor associated with patients suffering from gastroesophageal reflux.11,12 We noted that patients with recurrent reflux symptoms after fundoplication had abnormally delayed gastric emptying.13 However, we were unable to say what effect, if any, the operation itself may have had on gastric emptying. This study was therefore designed to assess the effect of fundoplication on solid and liquid emptying from the stomach in patients with gastroesophageal reflux disease.

Materials and Methods

Subjects

Twenty-one patients (11 men, 10 women), median age 47 (range 19–72), were studied after giving informed consent for the study. All patients were referred for surgical treatment following unsuccessful medical management of gastroesophageal reflux and described symptoms of heartburn and regurgitation. All had been symptomatic for more than 2 years and had objective evidence of gastroesophageal reflux on standard acid pH testing. Unequivocal esophagitis on endoscopy was observed in 11 patients. The surgical technique was a standard one with the fundus and upper part of the body of the stomach being mobilized and wrapped around the lower 4 to 5 cm of the esophagus. The wrap thus used both anterior and posterior walls of the stomach.2 The fundic wrap included the anterior vagus nerve and excluded the posterior vagus nerve and was performed with a No. 52 French Maloney bougie in position in the esophagus.

Radionuclide Assessment

Prior to surgery and again 6 months after surgery, patients underwent an assessment of solid and liquid gastric emptying using a radionuclide technic which has been reported previously.14 It is a dual isotope technic.
with the solid component being a 100 g hamburger patty incorporating 1–2 mCi of $^{99m}$Tc-sulphur colloid tagged to chicken liver. The liquid marker is 0.5–1.0 mCi of $^{133}$In-DTPA mixed in 150 ml of 10% dextrose. By use of computer drawn regions of interest that include the stomach but exclude the intestine, calculations are able to be made of several parameters of gastric emptying. Liquid emptying was assessed by the time for 50% of the liquid tracer to leave the gastric region (Liquid T50). Solid emptying characteristics were assessed by considering the time taken from ingestion until solid began to leave the stomach (lag period), the percentage of the marker remaining at 100 minutes and the rate at which marker left the stomach as a percentage per minute.

Data was analyzed using the Wilcoxon matched pairs signed ranks test. Results

All patients were available for follow-up at 6 months and assessed the early results of their operation as being good to excellent. Symptoms of heartburn and regurgitation were absent. In all patients, solid emptying was slower than liquid emptying and was characterized by a lag period followed by linear emptying. There was a significant decrease in the percentage of solid remaining at 100 minutes in the postoperative group compared with the preoperative group (Fig. 1). The lag period was not significantly altered but the rate of emptying was more rapid in the postoperative group (Table 1).

The liquid emptying was nonlinear and followed a monoexponential pattern. Liquid T50 was significantly faster also (Fig. 2) in the postoperative group compared to the preoperative group (Table 1).

Discussion

The success of a fundoplication in controlling the symptoms of heartburn and regurgitation has been well-established in short-term follow-up studies. Its success has been attributed primarily to its effect on the lower esophageal sphincter by simply increasing the mean resting pressure. It has also been shown to create an effective one-way valve mechanism, at least against sudden pressure increases. It may also produce a residual lower esophageal sphincter pressure that prevents transient lower esophageal sphincter relaxations and, therefore, gastroesophageal reflux.

Some patients with gastroesophageal reflux, both with and without esophagitis, have been found to have a delay in gastric emptying. The significance of this in the pathogenesis of gastroesophageal reflux is uncertain, but may relate to prolongation of the postprandial state or gastric distension and its effect on the lower sphincter. However, the delayed emptying does not appear to correlate with basal lower esophageal sphincter pressure.

| TABLE 1. Results of Gastric Emptying in Patients before and after Nissen Fundoplication |
|---------------------------------|-----------------|-----------------|
|                                | Preoperative    | Postoperative   | Significance Level |
| Number of subjects             | 21              | 21              |                  |
| Solid lag period (minutes)     | 51 (17–79)      | 49 (12–68)      | N.S.             |
| Solid linear rate (%/minute)   | 0.8 (0.2–1.5)   | 1.0 (0.4–1.7)   | $p < 0.01$       |
| Solid retention at 100 minutes (%) | 50 (19–90)   | 44 (5–89)       | $p < 0.01$       |
| Liquid T50 (minutes)           | 22 (9–35)       | 13 (9–27)       | $p < 0.01$       |

Data are median values with range. Significance levels are for the Wilcoxon sign rank test.
Our study shows that both solid and liquid gastric emptying are enhanced following fundoplication. Liquid gastric emptying was more rapid in all but five patients following operation. Solid emptying was also more rapid after surgery in 14 patients. The lag period for solid emptying did not alter significantly from preoperative assessment, with the increase in emptying being achieved by a more rapid rate of emptying rather than a shorter period prior to emptying commencing. Stress can delay gastric emptying and a possible explanation of our findings might be that the second test (i.e., after surgery) was performed with a more relaxed patient. However, reproducibility studies found no significant difference from the first test administration when compared with the second in the same subject. The reason for the increased gastric emptying may relate to increased fundal tone which in turn is a result of decreased fundal capacity following the fundoplication. Fundal tone is the principal determinant of gastric emptying of liquids, while antral activity is responsible for controlling the emptying of solids.

Decreased fundal capacity would thus be an explanation for the observed liquid emptying acceleration. Our present understanding of solid emptying makes the explanation for our observed increase in solid emptying more difficult to explain. Velasco et al. found no alteration in solid gastric emptying of ten patients or liquid gastric emptying in six patients studied before and after antireflux surgery. However, their patients had a posterior gastropexy operation and therefore probably had no alteration in their fundal capacity.

Although gastric drainage operations have been used in the treatment of gastroesophageal reflux, they generally have fallen from favor. It is worth noting that in our study six patients had delayed gastric emptying for solids before surgery (i.e., outside of our laboratory normal range), and five of these six patients had normal solid emptying after surgery. This means that one could not use a test such as ours before surgery, to select patients who should have gastric drainage procedure added to their antireflux operation. If delayed gastric emptying per se is found to be an important pathogenetic mechanism in the development of symptomatic gastroesophageal reflux, then enhancement of emptying by fundoplication may be a further mechanism by which this procedure achieves its excellent results.

References


