GENERAL THORACIC SURGERY

PHARYNGEAL REFLUX AFTER GASTRIC PULL-UP ESOPHAGECTOMY WITH NECK AND CHEST ANASTOMOSES

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Objective: Pharyngeal reflux after a gastric pull-up esophagectomy may cause aspiration. This study evaluates acid exposure to the esophageal remnant and to the pharynx after gastric pull-up esophagectomy and evaluates the impact of additional dissection of the esophagus that is necessary for neck anastomoses versus no neck exploration and proximal chest anastomoses. **Methods:** Forty-seven patients had circular stapled anastomoses in the apex of the right chest (n = 27 patients) or manually sutured neck anastomoses (n = 20 patients). A 24-hour double-pH study with the probes placed 3 cm cranial and 3 cm distal to the cricopharyngeal muscle was performed. The percent time pH less than 4 was registered 3, 6, and 12 months after the operation. **Results:** Mean acid exposure to the proximal pH probe ranged between 0.2% and 0.96% and between 1.45% and 6.5% to the distal pH probe during the 3 measurements. Acid exposure was always lower to the proximal than to the distal probe ($P = .001$). Patients with neck anastomoses had increasing acid exposure to the distal ($P = .023$) and proximal ($P = .002$) pH probes during the study year, whereas patients with chest anastomoses had similar acid exposure. **Conclusions:** Acid exposure to the esophageal remnant and to the pharynx increased during the first post-operative year in patients with neck anastomoses but not in patients with proximal chest anastomoses. The results suggest a less favorable acid clearance in patients with the neck approach. (J Thorac Cardiovasc Surg 1999;118:1078-83)

The gastric tube is a commonly used reconstruction after esophagectomy. One advantage of this procedure is that the preparation of the stomach is usually straightforward. Another good feature is that the length

of the reconstruction allows anastomoses in the neck with an intact vascular supply. A drawback is the remaining acid production of the gastric pull-up, and the potential side effects as anastomotic strictures and aspiration that the reconstruction may cause. Contrary to when an anastomosis is made in the apex of the chest, a cervical anastomosis adds a neck exploration to the already extensive procedure. The additional cervical exploration may also induce additional postoperative side effects on the remaining esophagus, which may induce reflux to the pharynx and aspiration. The aim of this study was to evaluate acid exposure to the esophageal remnant and to the pharynx and to compare the effect between the neck and chest approaches after gastric pull-up esophagectomy.

Methods

From May 1990 through January 1996, 35 male patients and 12 female patients underwent operation with an

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esophagectomy and a gastric pull-up at the Department of Surgery, Lund University, Lund, Sweden. The study was approved by the hospital ethics committee, and informed consent was obtained from all patients. All 47 patients had tumors, and none of the patients had undergone preoperative or postoperative adjuvant chemoradiotherapy. Twenty patients had neck anastomoses, and 27 patients had proximal chest anastomoses. These patients were evaluated, and combined proximal and distal pH studies in their remaining esophagus proximal and distal to the cricopharyngeal muscle were completed. Another group of 14 patients who underwent operation during the same time and who had the same gastric reconstruction was studied as a pilot group for the determination of the remaining acid secretion in the graft. This pilot group had only 1 pH probe, which was placed in the graft. For the latter group, only the results of the pH studies were reported.

The gastric tube was created with the aid of a linear stapling device (TLC 55; Ethicon, Stockholm, Sweden) or gastrointestinal anastomosis (Auto Suture, Stockholm, Sweden). The device was inserted into the lesser curvature approximately 7 cm proximal to the pylorus and fired multiply, creating a 5-cm wide tube along the greater curvature of the stomach. Pyloroplasty was not performed in any of the evaluated patients. The thoracic esophagus was dissected through a right posterolateral thoracotomy. When a neck anastomosis was chosen, the cervical esophagus was dissected through an additional incision that was run parallel to the left sternocleidomastoid muscle. All gastric pull-ups were placed in the posterior mediastinum. The chest anastomoses were stapled with a circular stapler (cartridge size 25, 28, or 31 mm; Premium CEEA; Auto Suture) and placed in the apex of the right chest. A 90-mm linear stapling device (RL 90; Ethicon) was used to resect the gastric remnant, including the opening from the previously inserted circular stapling device. When the stapled thoracic anastomosis was created, the largest possible cartridge was inserted. The end-to-end anastomoses in the neck were manually sutured to the remaining cervical esophagus with a monofilament 4-0 polydioxanone suture (PDS II; Ethicon) with a continuous single layer technique through all the layers.

Clinical data. A nurse who did not participate in the previous care of the patients performed the symptom assessments. Graded symptom scores of heartburn, regurgitation, and dysphagia were registered. Mild was defined as an awareness of signs or symptoms, but easily tolerated. Moderate was defined as discomfort sufficient to cause interference with normal activities. Severe was defined as incapacitating, with an inability to perform normal activities.

Proton pump inhibitors or histamine-2 antagonists were prescribed only to patients who had symptoms of reflux or who had postoperative anastomotic strictures. Two weeks before the pH studies, proton pump inhibitors were temporarily withdrawn, and histamine-2 antagonists were inhibited 1 week before the pH studies.

pH Studies. The pH studies in the main study group of 47 patients were performed with 2 antimony catheters

(Synectics, Stockholm, Sweden), assembled for simultaneous registrations, and placed 6 cm apart. To properly identify the level of the cricopharyngeal muscle and the level of the anastomoses, all pH studies were performed after the completion of an upper gastrointestinal endoscopy and a manometry study. The pH probes were placed 3 cm above and below the cricopharyngeal muscle, respectively, and connected to a 2-channel Digitrapper (Synectics) for a 24-hour pH registration. For each individual patient, the distances between the tips of the pH probes and the edge of the nares were recorded at the first study. The same distances were used for each patient during the 3 studies. The 14 patients in the pilot group had a single antimony pH catheter placed with the tip 30 cm from the nares, well inferior of the esophagogastric anastomoses, in the gastric reconstruction. The stored information was transferred into a computer and analyzed with the aid of a software package (pH-gram; Synectics), and data were analyzed for the total percent time pH less than 4. The settings of the pH registrations were the same as we used for regular esophageal pH studies in our laboratory.¹

Endoscopy. The endoscopies were repeated 3, 6, and 12 months after operation. The levels of the cricopharyngeal muscle and of the anastomosis were recorded. When an anastomotic stricture was present, it was endoscopically dilated before the pH study. Esophagitis was graded according to Savary and Miller,² but modified as follows: Grade 1 was characterized by a single oval or linear erosion; grade 2 was characterized as multiple linear erosions on more than 1 longitudinal fold; grade 3 was characterized as circumferential erosive lesions. Anastomotic strictures were separately noted and not regarded as grade 4 esophagitis.

Statistics. Parametric tests were preferred, and we used a logarithmic transformation to achieve normal distribution of the pH data proximal and distal to the cricopharyngeal muscle. All reported values were retransformed with the antilog of the previous transformation. The Student *t* test was used for comparison between 2 groups. Because the same group of patients was analyzed at 3 different times, we used a repeated measurements multivariate analysis of variance (ANOVA) model and Hotelling's trace test for comparisons between the groups. Missing values were substituted with the mean value for each anastomotic site at each evaluated time. For comparisons between 2 groups in data that were not normally distributed, we used the Mann-Whitney *U* test and Fisher exact test. The SPSS statistical package 8.0 for Windows (SPSS Inc, Chicago, Ill) was used for the statistical testing.

Results

pH Studies. Acid exposure measured in the gastric pull-up was expressed as the total percentage of time pH was less than 4 during a 24-hour study and was assessed 3, 6, and 12 months after the operation in 14 patients. We found, in general, high pH levels during the first postoperative year with a 3-month mean value of 46% (95% CI, 29%-63%; *n* = 14 patients), a 6-month mean

Fig 1. Acid exposure to the proximal pH probe increased during the study time in a group of patients with neck anastomoses but not in the group with chest anastomoses (ANOVA repeated measures, Hotelling trace test; $P = .002$).

Fig 2. Acid exposure to the distal pH probe increased during the study time in the group of patients with neck anastomoses but not in the group with chest anastomoses (ANOVA repeated measures, Hotelling trace test; $P = .023$).

value of 32% (95% CI, 14%-50%; $n = 13$ patients), and a 12-month mean value of 31% (95% CI, 9%-53%; $n = 11$ patients). The results did not significantly change during the study year (Hotelling trace, $P = .2$).

The main study group of 47 patients had a combined pH study in which the probes were placed proximally and distally to the cricopharyngeal muscle. The mean acid exposure expressed as the total percent time pH less than 4 to the proximal pH probe ranged during the 3 measurements between 0.2 and 0.96. The mean acid exposure to the distal pH probe ranged during the study year between 1.45 and 6.5 and was higher (the Student paired t test, $P = .001$) than the acid exposure to the proximal probe.

Acid exposure increased to the distal (Hotelling trace, $P = .023$) and to the proximal pH probe (Hotelling trace, $P = .002$) during the study year in the group of patients with neck anastomoses but not in the group of patients with proximal chest anastomoses (Figs 1 and 2).

Endoscopy. None of the patients who were studied had malignant anastomotic recurrences or pyloric strictures. The endoscopically assessed mean anastomotic height from the incisors was 21.2 cm (19.4-21.3 cm; 95% CI) for cervical anastomoses and 24.8 cm (23.8-25.3 cm; 95% CI) for chest anastomoses (the Student t test, $P < .001$).

At the 3-month follow-up, 8 patients were dilated for

Fig 3. Grades of heartburn after 3, 6, and 12 months are shown according to anastomotic site.

Fig 4. Grades of regurgitation after 3, 6, and 12 months are shown according to anastomotic site.

anastomotic strictures on 12 occasions. Five of the patients had chest anastomoses, and 3 of the patients had neck anastomoses. The distribution of the number of dilatations in each group was equal (Mann-Whitney U test, $P = .7$). After 6 months, no dilatation was required; after 12 months, when 23 patients were evaluated, 1 patient with a chest anastomosis had 2 dilatations.

Esophagitis was observed after 3 months in 2 of 20 patients with neck anastomoses (grade 1, $n = 1$; grade 2, $n = 1$) and in 7 of the 27 patients with chest anastomoses (grade 1, $n = 4$; grade 2, $n = 2$; grade 3, $n = 1$; Fisher exact test, $P = .3$). One patient with neck anastomosis had grade 1 esophagitis 6 months after the operation; after 12 months, 1 patient with chest anastomosis had grade 2 esophagitis.

Clinical data. Most of the patients had no symptoms of heartburn, regurgitation, or dysphagia 3 through 12 months after the operations. Occasional patients had

moderate and severe dysphagia (Figs 3-5). We found no difference in the distribution of the symptom scores between the 2 anastomotic sites at any time during the first postoperative year (Mann-Whitney U tests $0.181 < P < 1.0$).

During the follow-up year, between 2 and 8 patients with neck anastomoses and between 7 and 9 patients with chest anastomoses of the 47 patients who were evaluated were taking acid-reducing medicines.

Discussion

Both neck and chest anastomoses are traditionally used for reconstruction after esophagectomy. Transhiatal and thoroscopic esophagectomy are becoming more and more popular, and both procedures require an anastomosis in the neck. This study addresses the question whether the additional neck exploration and anastomosis also add side effects in terms of increased

Fig 5. Grades of dysphagia after 3, 6, and 12 months are shown according to anastomotic site.

pharyngeal reflux and aspiration compared with anastomoses in the apex of the chest.

The study group consists only of patients with malignant diagnoses, with identical gastric pull-up reconstructions sutured to the esophagus in the neck or in the apex of the right chest. None of the patients had undergone preoperative or postoperative radiochemotherapy or pyloroplasty, factors which otherwise might confound the results. In the case of an anastomotic stricture, it was endoscopically dilated before the esophageal pH study. To assure a correct placement of the pH probes, we performed both endoscopy and manometry before the pH studies. The patients were evaluated 3 times during the first postoperative year to evaluate the influence of time and to validate the results.

The construction of a gastric pull-up includes a complete vagotomy and a partial gastric resection. Although these 2 procedures independently are known to reduce the gastric acid output, we found in accordance with others³ a high acid exposure in the transposed stomach. The acid contents of the gastric pull-up and the fact that the emptying time is less favorable than in a normal esophagus⁴ predispose for reflux to the esophageal remnant and further to the airways.

As a consequence of the acid production of the gastric tube, we found that the acid exposure to the esophageal remnant caudal to the cricopharyngeal muscle was, for most patients, higher than the acid exposure to a normal distal esophagus.¹ Acid exposure to the pharynx was always less than to the esophageal remnant and was usually below the value of 1%, which is the upper limit of acid exposure to a normal proximal esophagus.⁵ Acid exposure both to the esophageal remnant and to the pharynx seemed to increase during the study year only in the group with neck anastomoses. The group of patients with chest anastomoses had sim-

ilar acid exposure to the distal and proximal probes during the study year and at the same levels as the patients with neck anastomoses had had 3 months after the operation. In the patients who had neck anastomoses, we sacrificed a mean 4 cm of the esophagus by performing an additional resection of the esophagus. This may, to some extent, explain an overall higher acid exposure to the esophageal remnant in the group with neck anastomoses but cannot explain the trend toward higher acid exposure 6 and 12 months after the operation compared with 3 months after the operation. This trend of higher acid exposure may be an effect of a less favorable esophageal clearance secondary to the dissection of the esophagus in the neck. Because the difference increased during the study year, it may be related to the healing process and to the development of scar tissue around the neck esophagus.

Benign anastomotic strictures and esophagitis occurred most frequently after 3 months, occurred thereafter only scarcely, and were equally distributed between the 2 anastomotic sites. Because the level of acid exposure to the remaining esophagus stayed at the same level or increased during the follow-up year and the prevalence of benign anastomotic strictures and esophagitis decreased, acid production in the gastric tube cannot alone explain the development of postoperative anastomotic strictures.

Overall symptoms of heartburn, regurgitation, and dysphagia after esophagectomy has previously been reported to various degrees.^{3,4,6-10} In this study few patients had symptom scores that indicated disabling symptoms, and the vast majority of patients had no or mild symptoms scores. No changes were noticed over time. The equal distribution of symptom scores in the 2 patient groups indicates no functional disadvantage of the neck approach.

We conclude that pH is high in a gastric pull-up

reconstruction. As a consequence of this, we found moderate acid exposure to the esophageal remnant and minimal acid exposure to the pharynx. The pattern of acid exposure to the remaining esophagus proximal to the anastomosis was not independent of the surgical exposure and anastomosis and was increasing in patients with neck exploration and anastomosis but not in the patients with anastomoses 4 cm lower in the apex of the chest. The increased acid exposure to the group of patients with neck anastomoses was not associated with more strictures or esophagitis, and we suggest that it may be the result of a less favorable clearance. Because this trend was increasing during the study year, it may be the result of the dissection and of the formation of scar tissue surrounding the esophageal remnant in the neck. In terms of symptoms of heartburn, regurgitation, and dysphagia, we found no difference between the neck approach compared with the chest approach. The question whether patients with neck anastomoses have a less favorable outcome and a higher risk of long-term complications because of aspiration needs to be solved.

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