Vagotomy, Antrectomy, and Roux-en-Y Diversion for Complex Reoperative Gastroesophageal Reflux Disease

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Objective
Failure of conventional surgical therapy for treatment of patients with gastroesophageal reflux disease (GERD) taxes the ingenuity of the esophageal surgeon. This study defines the role of vagotomy, antrectomy, and Roux-en-Y diversion coupled, when necessary, with resection of the esophagogastric junction as an alternative to other surgical procedures currently employed for these complicated cases.

Summary Background Data
Currently, the operation in question rarely is performed in the United States. Other procedures, such as interposition of short or long segments of intestine and total esophagectomy with gastric pull-up, are preferred. However, surgeons from Scandinavia, Great Britain, and Europe have published widely on the subject, some even preferring its use as a primary procedure in GERD.

Methods
This report reviews the indications and results of the operation in 36 patients who underwent operation between January 1970 and January 1994. Follow-up evaluation was available for review in 33 patients observed from 1 to 20 years postoperatively (average, 6½ years). Of these patients, 32 had undergone 66 previous operative procedures on the distal esophagus and stomach ranging from 1 to 6 per patient. There were no hospital deaths, but complications developed in nine patients (25%); only half of these complications were major. Of patients available for follow-up, 85% were improved by the operation, 24 of the 33 having excellent or good results.

Conclusions
The operation of vagotomy, antrectomy, and Roux-en-Y diversion, embodying the principles of acid suppression and alkaline diversion, has proved to be a successful alternative to other operative procedures currently favored in the United States for the treatment of the complex reoperative patient with GERD.
Gastroesophageal reflux disease (GERD) often can be managed successfully medically. When medical therapy fails, one of several fundoplication procedures can be applied successfully in 80% to 90% of patients. It is failure of conventional medical or surgical therapy or both, however, that taxes the ingenuity of the esophageal surgeon. A variety of solutions have been proposed, including total esophagectomy with gastric pull-up and limited esophagogastric resection with interposition of short or long intestinal segments. The concept of acid suppression by vagotomy and antrectomy, coupled with alkaline diversion by Roux-en-Y gastrojejunostomy with or without limited esophagogastrectomy proposed by one of us (FHE) nearly 40 years ago is a procedure currently used more commonly in Britain, Scandinavia, and Europe than in the United States. This article reviews the indications for and the results of its use by us in 36 patients who underwent operations during the past 24 years, some of whom have been reported on previously.

MATERIALS AND METHODS

Patients

From January 1970 to January 1994, 36 patients underwent the acid-suppression, alkaline-diversion procedure. Patient age ranged from 25 to 75 years, with a median age of 54 years. Seventeen patients were men and 19 were women. Pertinent associated disorders were esophageal stricture in 22; achalasia in 18; scleroderma in 3; Barrett’s esophagus in 4; esophageal ulcers in 2; and gastric ulcer in 1.

Of these patients, 32 had undergone 66 previous operative procedures on the distal esophagus and stomach ranging from 1 to 6, with a median of 2 previous operations per patient (Table 1). Three patients had their original operation performed by one of us (FHE). Four had not undergone previous surgeries; three of the four had scleroderma with undilatable strictures, and the fourth had a long history of severe GERD, with an extended peptic esophageal stricture associated with Barrett’s esophagus unresponsive to bougienage. Fundoplication was the most common previous procedure performed, usually of the Nissen variety. Esophagomyotomy, usually of the modified Heller type, was the next most common previous operation. Of the 22 esophagomyotomies, 2 were of the extended variety for suspected but unproved diffuse esophageal spasm.

The preoperative diagnosis necessitating the acid-suppression, alkaline-diversion procedure was GERD in all but six patients (Table 2). Five patients with GERD required reoperation because of post-Nissen dysphagia, whereas one patient with achalasia had undergone incomplete myotomy with persistent dysphagia requiring reoperation.

Surgical Technique

The surgical approach is governed by the need for resection of the distal esophagus and cardia, as in the presence of an “undilatable” stricture or severe ulcerative esophagitis. When localized resection of the involved area must be performed, a thoracic approach is required.
(Fig. 1A). A posterolateral thoracotomy, i.e., entering the chest through the bed of the nonresected seventh or eighth rib, is the preferred approach. Resections were required for 30 patients; 4 of these patients had resections performed previously elsewhere. Two patients with esophageal strictures underwent cardioplasties to relieve the obstructions; one patient required only surgical mobilization at the hiatus. Three patients did not require cardia operations.

After the mediastinal pleura is opened and the distal esophagus is mobilized, the hiatal attachments are divided to permit freeing of the proximal stomach by division of the short gastric and posterior gastric vessels (Fig. 1B). Use of a stapling device applied to the stomach just distal to the cardia permits division of the gastrointestinal tract at an appropriate level. Continuity is restored after dividing the esophagus proximal to the diseased area by advancing part of the mobilized gastric greater curvature and performing end-to-side esophagogastrectomy (Fig. 1C). An open anastomosis with an inner layer of running catgut and an outer layer of interrupted nonabsorbable sutures is preferred. A nasogastric tube is passed transnasally across the anastomosis into the intrathoracic stomach for postoperative decompression.

Although the thoracic incision may be extended as a thoracoabdominal incision, as it was in five of the patients studied, we currently prefer a separate abdominal incision to avoid some of the potential complications of transecting the costal arch and avoid the necessity of partial denervation of the diaphragm. Accordingly, the thoracotomy is closed with intercostal drainage in the usual fashion, and the patient is repositioned in a supine position for an upper midline incision to provide adequate exposure of the upper abdomen (Fig. 2A). The two-incision approach was employed in 28 patients and was performed in two stages in 4 patients. No thoracotomy was required in four patients who previously had undergone excisions of the cardia elsewhere.

Exposure of the upper stomach and hiatus is provided by mobilization of the left lobe of the liver (Fig. 2B). If an esophagogastrectomy has not been performed, both vagus nerves are isolated and divided, and the operation continues as an antrectomy, which, of course, was not required in the three patients who previously had undergone subtotal gastric resection elsewhere. One patient had a Roux-en-Y gastrojejunostomy performed at the time of gastrectomy, and the other two patients required conversion of Billroth II anastomoses to Roux-en-Y gastrojejunostomies.

Antrectomy is performed by partial division of the distal third of the stomach, beginning at the greater curvature and extending cephalad along the lesser curvature. The latter portion is closed with a stapler to permit performance of a small gastrojejunostomy. The stapled lesser curvature portion of the stomach is oversewn with interrupted nonabsorbable sutures, and the antrectomy is completed by ligation of the right gastroepiploic and right gastric arteries and division of the duodenum just distal to the pylorus. The duodenum is closed with a stapler and oversewn with interrupted nonabsorbable sutures. The left gastric artery must remain intact because this artery will constitute the major gastric blood supply when the fundus has been mobilized by division of the
short gastric vessels for performance of limited esophagogastrectomy.

Then the colon is elevated, the ligament of Treitz is identified, and a point on the jejunum 9 inches from the ligament is selected for division of the jejunum using the GIA stapler (U.S. Surgical Corp., Norwalk, CT). A retrocolic gastrojejunostomy is performed to the distal divided jejunum in an end-to-side fashion, and the previously stapled jejunal end is oversewn with interrupted nonabsorbable sutures (Fig. 2C). The gastrojejunostomy is performed using a running layer of catgut and an outer layer of interrupted nonabsorbable sutures. The proximal divided jejunum is anastomosed in an end-to-side fashion, after closing its stapled end with interrupted nonabsorbable sutures, to the jejunum at a point 18 inches beyond the gastrojejunostomy (Fig. 2C). Then the area is reperitonealized to prevent development of an internal hernia, and the abdomen is closed in the usual fashion, after placement of Penrose drains through a separate stab wound to the duodenal stump.

RESULTS

There were no postoperative deaths, but complications developed in nine patients (25%); five of these complications were major. One patient with Raynaud’s disease secondary to scleroderma developed gangrene of two toes after operation, and amputation was required. An empyema in one patient required decortication, and two gastrointestinal leakages, which were contained, resolved spontaneously, one from the duodenal stump and one from the posterior aspect of the stomach. The most serious complication occurred in a patient who had previously undergone an operative procedure on the cardia for removal of a leiomyoma and in whom ischemic contraction and near obliteration of the gastric remnant developed after operation, requiring gastrectomy and subsequent colon interposition. In retrospect, although the gastric remnant was viable after antrectomy, its blood supply must have been impaired at the earlier operation, resulting in this unusual postoperative complication. Two patients had urinary tract infections, one required bronchoscopy for retained pulmonary secretions, and another patient developed chemical pancreatitis that subsided without therapy.

Follow-up was obtained from 1 to 20 years after operation, with an average follow-up interval of 6 7/5 years and a median of 4 1/2 years for 29 patients, either by direct examination or by questionnaire response from the patient, his/her family, or physician during the past year. Results in four other patients who died of unrelated causes 1 to 18 years after operation and whose condition relative to the esophagus was known at the time of death also were included (Table 3). Two patients were unable to be included in follow-up review, and one patient underwent operation too recently for evaluation.

Patients were evaluated clinically using modified Viscick criteria. Patients who were asymptomatic were classified as having excellent results. Patients with only occasional symptoms not requiring treatment were classified as having good results, whereas patients with fair results had persistent symptoms, but to a lesser degree than preoperatively, for which they required treatment. Patients who were unimproved or in whom significant new postoperative symptoms developed that were related to the operation were classified as having poor results. Three patients required one or more peroral dilations in the first postoperative year, two of whom currently are classified as having excellent results; one is classified as having a good result. Another patient required postoperative revision of the Roux-en-Y jejunostomy but currently is asymptomatic and has been classified as having an excellent result. Thus, 28 of 33 patients (85%) were improved by operation, 15 with excellent results, 9 with good results, and 4 with fair results. Five patients were classified as having poor results.

Reference already has been made to one of the poor results, namely, the patient who had a previous operation on the cardia and in whom ischemic contraction of the stomach developed, requiring total gastrectomy and reconstruction with an interposed segment of colon. Another patient had persistent dysphagia caused by a recurrent stricture, ultimately requiring resection with colon interposition 3 years later. A third patient who had achalasia with postmyotomy reflux treated by a Belsey antireflux procedure with resulting obstruction leading to the acid-suppression, alkaline-diversion procedure has been disabled by vomiting, regurgitation, and weight loss from gastroparesis without evidence of an anastomotic stricture. This patient has been advised to have a gastrectomy and esophagealjejunostomy. A fourth patient had persistent dysphagia and regurgitation, requiring

<table>
<thead>
<tr>
<th>Table 3. RESULTS OF OPERATION</th>
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<tbody>
<tr>
<td><strong>Result</strong></td>
</tr>
<tr>
<td>Improved</td>
</tr>
<tr>
<td>Excellent</td>
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<tr>
<td>Good</td>
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<tr>
<td>Fair</td>
</tr>
<tr>
<td>Poor</td>
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<td>Total</td>
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* Two patients could not be observed for follow-up review. Another was operated on too recently for evaluation.

1 to 20 Years (Average, 6 2/3 Years; Median, 4 1/2 Years).
continued medical therapy until the time of death, 10 years after operation. The fifth patient required repeated dilations of a persistent esophageal stricture.

The dumping syndrome occurred only in one patient and was temporary in nature. Diarrhea or nocturnal aspiration was not observed in any of the patients, and no patient had gastrojejunal ulceration. We have been unable to identify stasis in the Roux-en-Y limb, which has been described as being responsible for postoperative symptoms in some patients undergoing Roux-en-Y gastrojejunostomy after gastric resection.19

DISCUSSION

The surgical management of complex problems related to GERD, often requiring a reoperative procedure, remains a controversial issue, as evidenced by the wide variety of procedures that have been advocated under such circumstances. This includes variations on classic antireflux procedures, such as the Collis-Nissen, Collis-Belsey, and Thal-Nissen procedures, resection with esophagogastrectomy or with interposition of short or long intestinal segments, and total esophagectomy with cervical esophagogastrostomy. Dissatisfaction with the results of some of these operative procedures, on which we have reported previously,16 led us to expand the use of the acid-suppression, alkaline-diversion concept by employing vagotomy, antrectomy, and Roux-en-Y gastrojejunostomy, a procedure developed at the Mayo Clinic in one of our laboratories (FHE) approximately 40 years ago.4 As originally designed, localized resection of the cardia in dogs was coupled with bilateral vagotomy to relieve the obstruction and eliminate the cephalic phase of gastric acid secretions; antrectomy was added to eliminate the gastric phase of acid secretion. Restoration of alimentary tract continuity by Billroth I gastroduodenostomy was part of the original experimental procedure. The technique of the operation as applied to humans originally employed a thoracoabdominal incision, the early results of which were favorable.5,20 A longer follow-up, however, on these and other patients, disclosed that the overall results were less positive because of recurrent strictures or regurgitation, or both.6 These findings emphasized the necessity of diverting the alkaline secretions, and subsequently, a Roux-en-Y alkaline-diversion procedure was employed to re-establish intestinal continuity after antrectomy in contrast to the originally proposed gastroduodenostomy; it has remained the procedure of choice ever since.

Clinical results with this approach to a complex problem are summarized in Table 4.7-15,21-25 Wells and Johnston21 were the first to report the clinical results of the procedure in patients with GERD but without stricture because no patient required an esophagogastrectomy. The largest experience by far is that of Fékété and Patéron13 of France, who reported on 83 patients, 80% of whom were considered to have been improved for a median follow-up time of 35 months, although none of the

### Table 4. REPORTED RESULTS FOR VAGOTOMY, ANTRECTOMY, AND ROUX-EN-Y DIVERSION

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Year</th>
<th>Patients</th>
<th>Resection</th>
<th>Results (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Improved</td>
</tr>
<tr>
<td>Wells and Johnston21</td>
<td>England</td>
<td>1955</td>
<td>12</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Holt and Large22</td>
<td>USA</td>
<td>1961</td>
<td>11†</td>
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<td>—</td>
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<td>Weaver et al.23a</td>
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<td>10</td>
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<tr>
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<td>1970</td>
<td>15</td>
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<tr>
<td>Roysten et al.25</td>
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<td>8</td>
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<td>Washier et al.7</td>
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<td>1986</td>
<td>57</td>
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<td>Hesselink et al.11</td>
<td>Holland</td>
<td>1988</td>
<td>22</td>
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<td>Rosetti et al.12</td>
<td>Switzerland</td>
<td>1990</td>
<td>43</td>
<td>0</td>
<td>83</td>
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<tr>
<td>Salo et al.9</td>
<td>Finland</td>
<td>1991</td>
<td>11</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Fékété and Patéron13</td>
<td>France</td>
<td>1992</td>
<td>83</td>
<td>0</td>
<td>80</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>293</td>
<td>15</td>
<td></td>
<td>90</td>
</tr>
</tbody>
</table>

* Late follow-up of patients originally reported by Holt and Large (1961).
† Not included in total.
NS = not stated.
patients required esophagogastrectomies. The overall improvement rate among the 293 patients reported was 90%, although only 5% required resections of strictures.

The series currently being reported differs from that reported in the literature by virtue of the large number of patients requiring limited esophagogastrectomy and by the preponderance of multiple, previous operative procedures that had been conducted on these patients before vagotomy, antrectomy, and Roux-en-Y gastrojejunostomy so that one might have anticipated less positive results than those reported in the literature. However, the overall improvement rate of 85% for a median follow-up period of 4½ years suggests that, even in the extremely complex situation, improvement can be expected after this operative approach in nearly nine tenths of the patients treated.

The operation, however, is not without problems and although no deaths occurred, the complication rate of 25% is significant. The fact that two patients required subsequent corrective surgery and a third patient has been advised to be so treated also sounds a note of warning concerning the risks, although small, of the management of such patients in this manner. However, dumping, diarrhea, nocturnal aspiration, anastomotic ulcer, or stasis in the Roux-en-Y limb were not as worrisome complications as might have been expected. The chief causes of poor results in this series were gastric stasis or recurrent reflux leading to stricture and dysphagia. Because of these potential hazards of the operative procedure, it should not be undertaken lightly; the fact that in the past 24 years, we have performed only 36 such procedures reflects our conservative approach to its use. Even so, Washer and associates* have advocated its use as a primary procedure in patients with severe esophagitis on the basis of a prospective randomized trial comparing the results of its use with results after the Nissen fundoplication.

It is difficult to establish rigid criteria for the selection of patients with complex esophageal disorders secondary to GERD for vagotomy, antrectomy, and Roux-en-Y diversion. However, some general categories may be useful as guidelines for proper case selection. Certainly, patients with undilatatable strictures that require resections are appropriate candidates, because reconstruction by esophagogastrectomy alone results inevitably in the ultimate development of esophagitis and its complications. A patient with achalasia and true megaesophagus, fortunately rarely seen today, and in whom esophagomyotomy has failed to provide adequate esophageal emptying, constitutes another indication for the procedure. When two previous myotomies for achalasia of less-advanced degree have failed, a more radical procedure is indicated. Similarly, two failed antireflux procedures, such as the Nissen operation, may demand a more radical approach.

In our opinion, the operation also is applicable to patients who have failed to improve after a Collis-Nissen or Collis-Belsey antireflux maneuver. Rarely is the operation indicated as a primary procedure, with the possible exception of the patient with a stricture secondary to scleroderma, a clinical presentation of GERD difficult to treat by conventional techniques.

References


Discussion

DR. LUCIUS D. HILL (Seattle, Washington): I would like to congratulate Dr. Ellis for the pioneering work that he has done in one of the most difficult areas in surgery.

We, too, have been interested in this problem. We have done a fairly large series of these patients. If you put our series together with Dr. Ellis’s and Dr. Skinner’s and others across the country, you find that a lot of these redo operations are being done, which is a reflection on American surgery. All of these patients started out with straightforward gastroesophageal reflux disease, and if we correct the problem the first time we can avoid these large resectional procedures.

We have tried for the most part to reconstruct the GE junction. Remember that your normal gastroesophageal junction is highly competent against reflux. Any one of you could lie down in the aisle and have the guy next to you stand on your abdomen and you don’t reflux. So if we can reconstruct this, we go a long way to curing the disease.

There are those situations where we are confronted, as Dr. Ellis has shown, with a very difficult problem. We, too, have used the Roux-en-Y that he has described. We’ve also used a short segment of jejunum as an interposition. And I would like to ask Dr. Ellis if he has tried this. It work as well I think as the Roux-en-Y procedure.

In redoing these we have probably leaned over backward a little too far. In some of these where we’ve tried to reconstruct the GE junction, a resectional procedure might have given a little better result. Our results with the Roux-en-Y and with these repairs are similar to those of Dr. Ellis.

You will find in some of these that have been operated on several times that when you open the abdomen, there is not 3 inches of large or small bowel for an interposition or a bypass. What we have done in this situation is use a rim of crural diaphragm as a new sphincter.

Remember that the crural diaphragm—as several workers, including McCallum, have shown—has a different innervation from the rest of the diaphragm and behaves more like the esophagus.

We have then brought this rim of diaphragm, down as a sling graft, leaving both sides attached to the crura so it has excellent blood supply, sutured that in place, and it behaves very much like the sphincter.

We have followed these out now for about 3 years and I think when we get a few more patients and a little longer follow-up we can recommend this as an alternative for these very difficult situations.

Again I’d like to congratulate Dr. Ellis for the pioneering work he’s done in this area. But again I’d like to say the best time to repair these is the first time.

DR. PAUL H. JORDAN, JR. (Houston, Texas): Dr. Ellis has reported on 36 patients with complicated gastroesophageal gastric junction problems following previous surgery. He has utilized a procedure that he introduced and which has been adopted by surgeons with great success around the world.

Probably we could all use this operation more often than we do. I know that I am guilty of reoperating on certain patients making an effort to perform a conventional antireflux procedure when the patient would have been better served if I had performed Dr. Ellis’s operation.

With the exception of the patients with dense strictures and the problems of achalasia that he has mentioned, can Dr. Ellis give us any more specific guidelines concerning the selection of patients for his operation who have failed conventional surgery for reflux esophagitis?

While Dr. Ellis rarely uses his operation for a primary procedure, perhaps it should be considered more often. Would he give us his thoughts regarding his operation as a primary procedure?

One final question. And that is, as gastroenterologists become more aggressive with esophageal dilatation and more en- amored with Prilosec, does Dr. Ellis expect to see increased numbers of complex problems of the type that he has described?

DR. J. LYNWOOD HERRINGTON, JR. (Nashville, Tennessee): This paper represents a most important clinical contribution by Dr. Ellis.

A number of years ago at a Southern Surgical Association meeting we had the opportunity to report a small group of six patients subjected to the Roux-en-Y diversion who had failed multiple antireflux procedures and the results were extremely satisfactory.

We have not done it as a primary operation for reflux but we do encounter the situation about once every 2 to 3 years in which we feel that this operation (the Roux-en-Y) is indicated. We do not hesitate with an initial failed antireflux procedure to embark on a second attempt at repair. But, when a second recurrence occurs, we give strong consideration to performing the Roux-en-Y reconstruction.