The Hill Repair

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The Hill repair for correction of hiatal hernia and surgical management of gastroesophageal reflux disease is defined as a cardia calibration plus posterior gastropexy. The repair includes restoration of the gastroesophageal junction (GEJ) with posterior anchoring and reconstruction of the gastroesophageal flap-valve mechanism (GEV). Intraoperative measurement of the lower esophageal sphincter pressure (LESP) is also performed on a routine basis. In laparoscopic cases we routinely perform intraoperative endoscopy to ensure adequate reconstruction of the GEV because of the inability to manually assess the valve.

In 1836, hiatal hernia was first clearly described by Bright[1] in England. Bowditch in the United States was the first who suggested surgery as the treatment of choice for this condition. Surgical treatment developed slowly. In 1952, Ronald Belsey developed his transthoracic repair in England. In 1956, Rudolph Nissen described fundoplication. In 1963, the French surgeon André Toupet described a semifundoplication to be used in hiatus hernia repair and as a complement to Heller myotomy.

In 1967, Hill reported a procedure consisting of calibration of the lower esophageal sphincter and posterior fixation of the gastroesophageal junction to the median arcuate ligament. This procedure became known as the Hill repair. This original report presented an 8-year appraisal of 149 consecutive operations. As stated in that report the Hill repair is primarily aimed "at permanently fixing the gastroesophageal junction in its subdiaphragmatic location to prevent reflux and recurrent herniation."

The ideal antireflux operation should accomplish the following goals: closure of the esophageal hiatus loosely about the esophagus, reduction of the hiatal hernia with firm posterior fixation of the GEJ, calibration of the LESP to a normal range, restoration of the GEV, and prevention of a paraesophageal hernia. The Hill repair accomplishes these five goals.

Closure of the Diaphragm Esophageal Hiatus

To prevent a posterior sliding hernia the hiatus is closed loosely about the esophagus, allowing placement of one finger alongside the esophagus with a nasogastric (NG) tube in place. It is important to stress that a hiatus closed too tightly is a major cause of postoperative dysphagia. It is very difficult to endoscopically dilate the hiatus. In some rare cases of enlarged hiatus, additional anterior closure needs to be performed.

Reduction of the Hiatal Hernia With Firm Posterior Fixation of the GEJ

The secure fixation of the GEJ to its normal intra-abdominal location is a hallmark of the Hill repair and a key to the integrity of the antireflux barrier. This prevents recurrent herniation and is thought to improve length-tension relationships in the lower esophageal musculature, thereby improving abnormal motility in the distal esophagus in a number of patients. To accomplish this secure fixation, the preaortic fascia is used. This stout structure is the lowermost portion of both crura as they come together. It is anterior to the aorta and is anchored to the median arcuate ligament at the level of the celiac axis. Dissecting this ligament can be challenging for the inexperienced surgeon. Use of the ligament or preaortic fascia yields similar results.

Calibration of the LESP to a Normal Range

We have been performing intraoperative manometrics on a routine basis since 1978 and have shown that measuring LESP during surgery can help achieve better results. Objective evaluation of the sphincter pressure after the repair has been accomplished ensures that the quality of the repair will not be based exclusively on the "feeling" or observation of the anatomy by the surgeon. The repair is modified according to the reading of the manometer and anatomic appearance. The Hill repair allows adjustments in suture tension and thus in LESP during surgery. Patients with poor esophageal motility secondary to reflux are at a higher risk of postoperative sever dysphagia. In this group we use a lower intraoperative LESP. Intraoperative manometry is accomplished using a modified NG tube attached to a manometer. This tube has two portions: the standard sump part and an additional segment with an internal diameter of 1.2 mm, the tip closed and a built-in pressure-port constructed by cutting a 1-mm side hole 12 cm from the tip of the tube (Island Scientific, Bainbridge, WA). The manometer is a continuously perfused (0.7 mL/min) water system with a transducer and a digital reading.

Restoration of the GEV

The presence of the GEV and its role as an important component of the antireflux barrier has been under discussion for many years. Recently *Gray's Anatomy* acknowledged the presence of this musculomucosal fold. We have found that grading of the GEV is simple, reproducible, and, in our experience, a better predictor of the presence or absence of reflux than measurement of LESP. We cannot assign relative importance to the LESP or GEV in preventing reflux, but we think that they both are components of the complex barrier to reflux; thus correction of the GEV should also be an aim of antireflux surgery.

In brief, we graded the valve as viewed through the retroflexed endoscope as follows:

Grade I. A musculomucosal fold that adheres closely to the scope trough all phases of respiration and is 3 to 4 cm in length (see Fig I).

Grade II. Slightly less well defined and shorter, opens occasionally but closes promptly and is competent.

Grade III. Opens frequently, is poorly defined, and is frequently accompanied by a hiatal hernia.

Grade IV. Stays open, no well defined fold is appreciated, and is always accompanied by a hiatal hernia.

Grade I and II valves are competent to reflux and grade III and IV valves are not.

During open surgery the recreated valve is palpated through the stomach, thus ensuring that a competent fold has been obtained after the repair. Because this option is not available in laparoscopic surgery we routinely perform endoscopy once the repair has been done but with the trochars still in place. If a grade I valve is not visualized or palpated, further stitches are placed.

Preoperative Workup

This includes history and physical with special emphasis to elucidate other causes of symptoms suggestive of gastroesophageal reflux disease. Achalasia, biliary disease, esophageal spasm, peptic ulcer disease, and cardiac ailments are some of the disorders that can clinically mimic gastroesophageal reflux disease.

Upper flexible endoscopy is essential to evaluate the valve, assess the grade of esophagitis, and obtain biopsy specimens (fundamental in Barrett's esophagus). Ma-

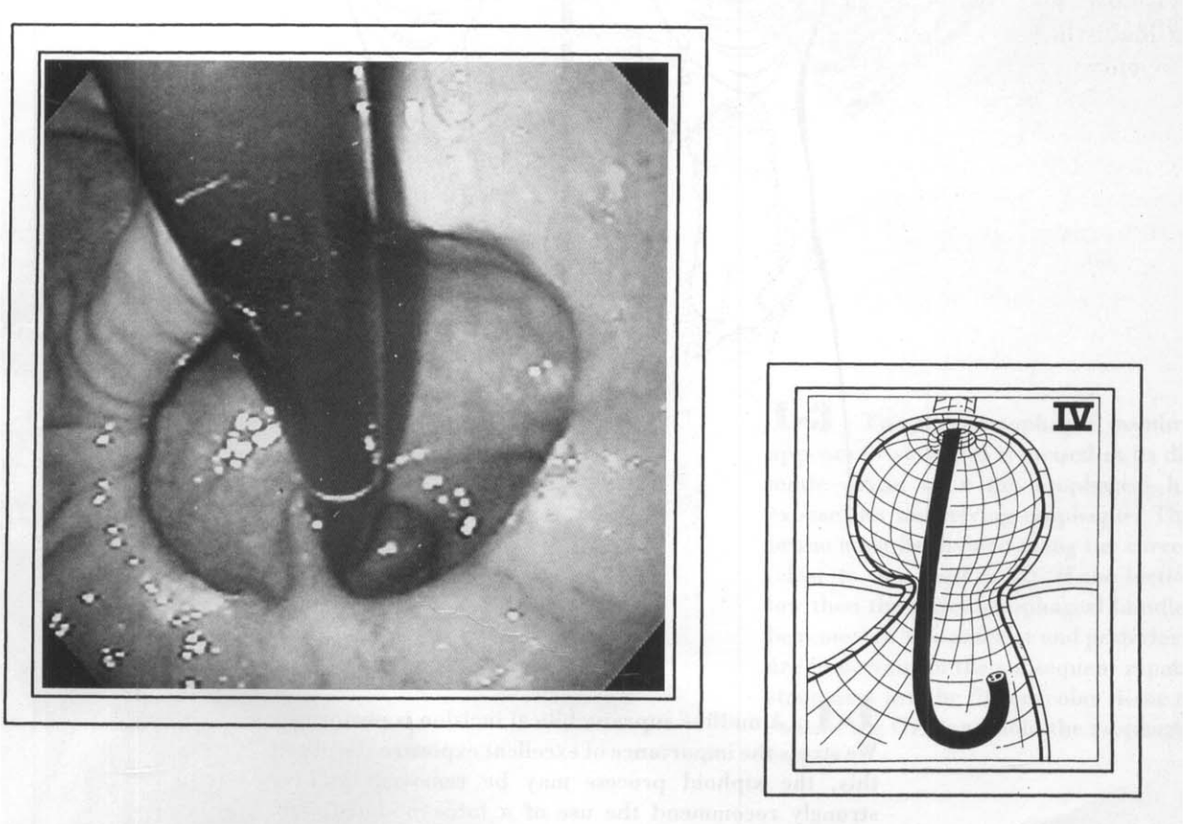
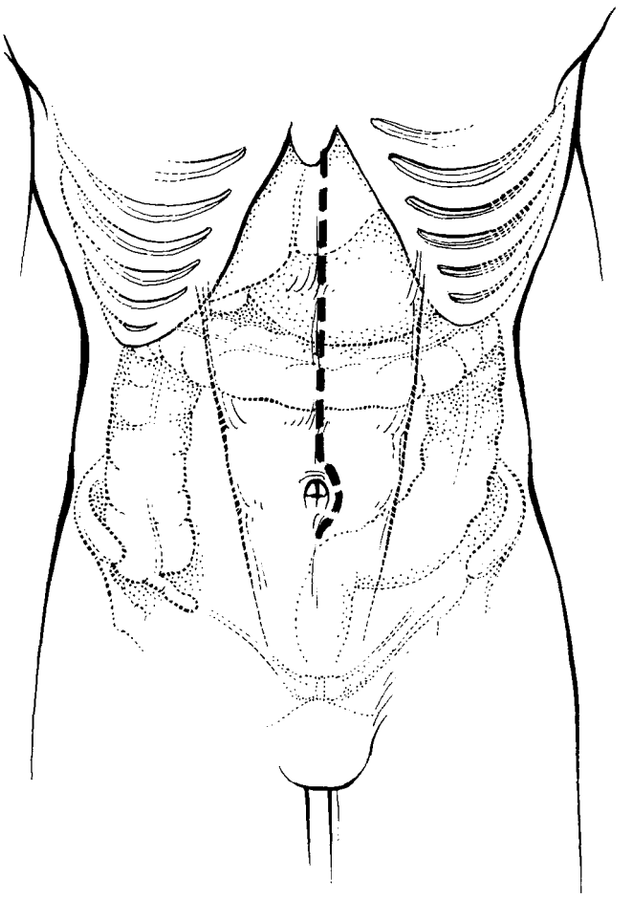


Figure I. Grade IV gastroesophageal valve: No defined musculocosal fold. It stays open, rarely closing, and is always accompanied by a hiatal hernia. (Reprinted with permission).[2]

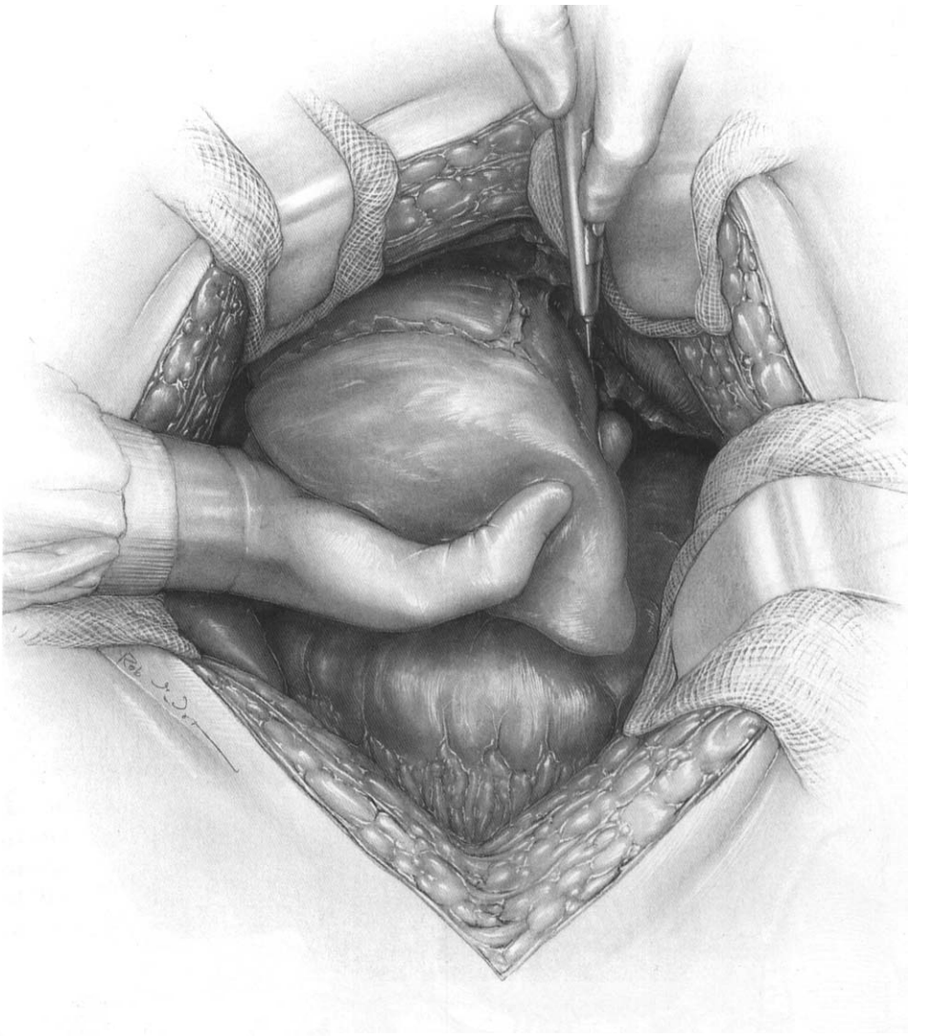
nometry is performed in nearly all cases; the information it provides concerning sphincter pressure and esophageal peristaltic function is very useful when suspicion exists that the symptoms are caused by achalasia or diffuse esophageal spasm. Even though we do not exclude from antireflux surgery patients with decreased esophageal body peristalsis when this is secondary to reflux (in contrast to patients with a primary motor disorder), manometry allows us to identify these patients and to perform a less snug repair aiming for a lower intra-operative LESP than in patients with normal peristalsis.

Upper gastrointestinal series is useful in cases of hiatal hernia and to evaluate stricture. If there is a question about the source of symptomatology, 24-hr pH monitoring confirms the diagnosis of reflux.

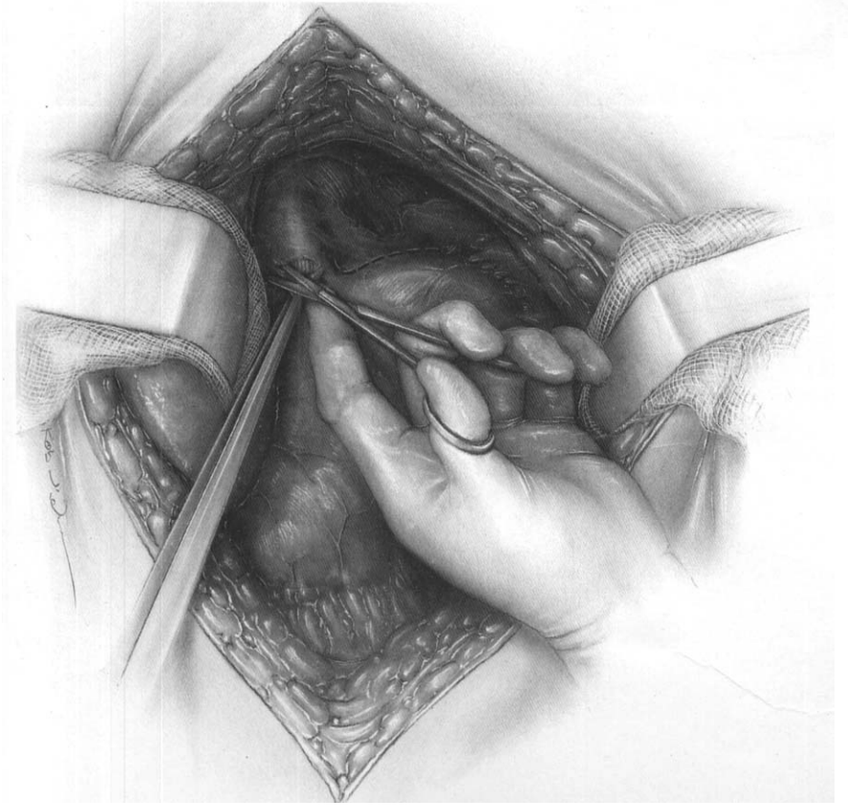
SURGICAL TECHNIQUE: OPEN HILL REPAIR



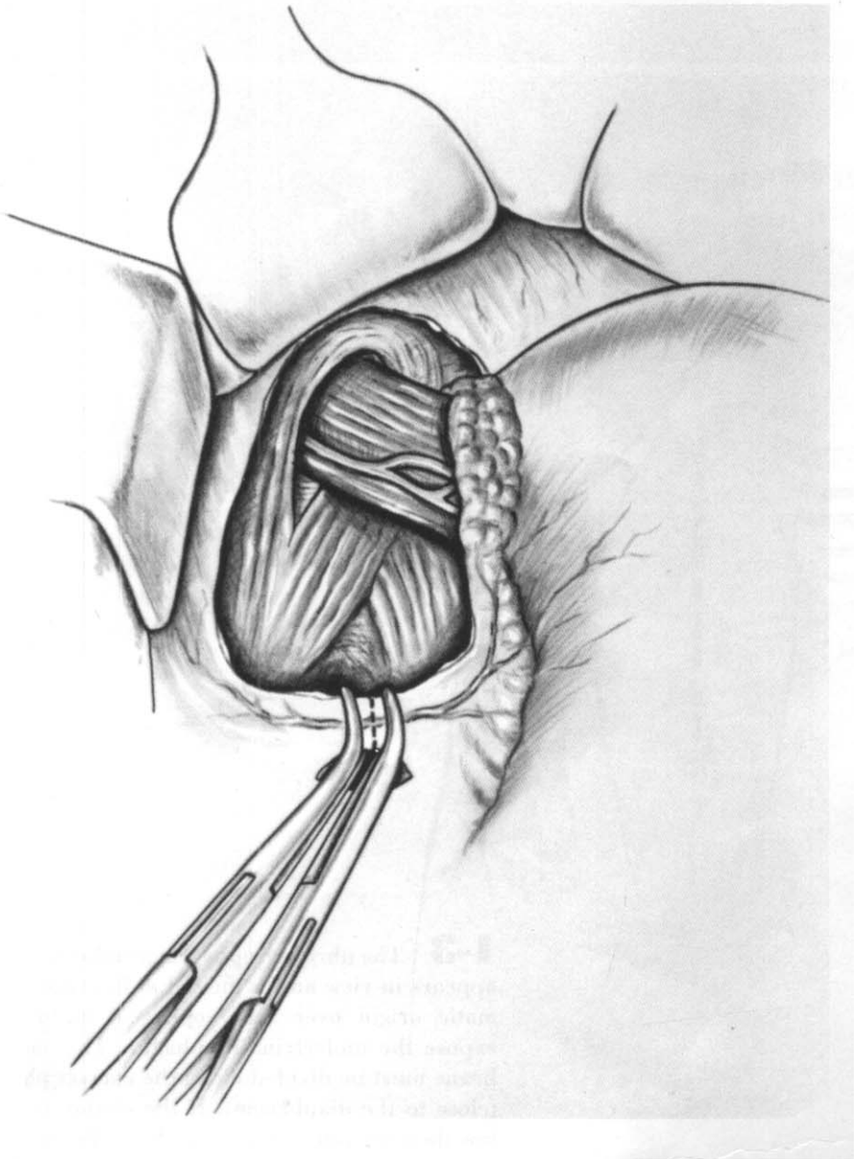
1-1 A midline supraumbilical incision is performed. We stress the importance of excellent exposure. To obtain this, the xiphoid process may be removed, and we strongly recommend the use of a table-mounted, self-retaining "upper-hand" two-bladed retractor or similar retractor. We usually use an additional Balfour retractor to enhance the exposure.



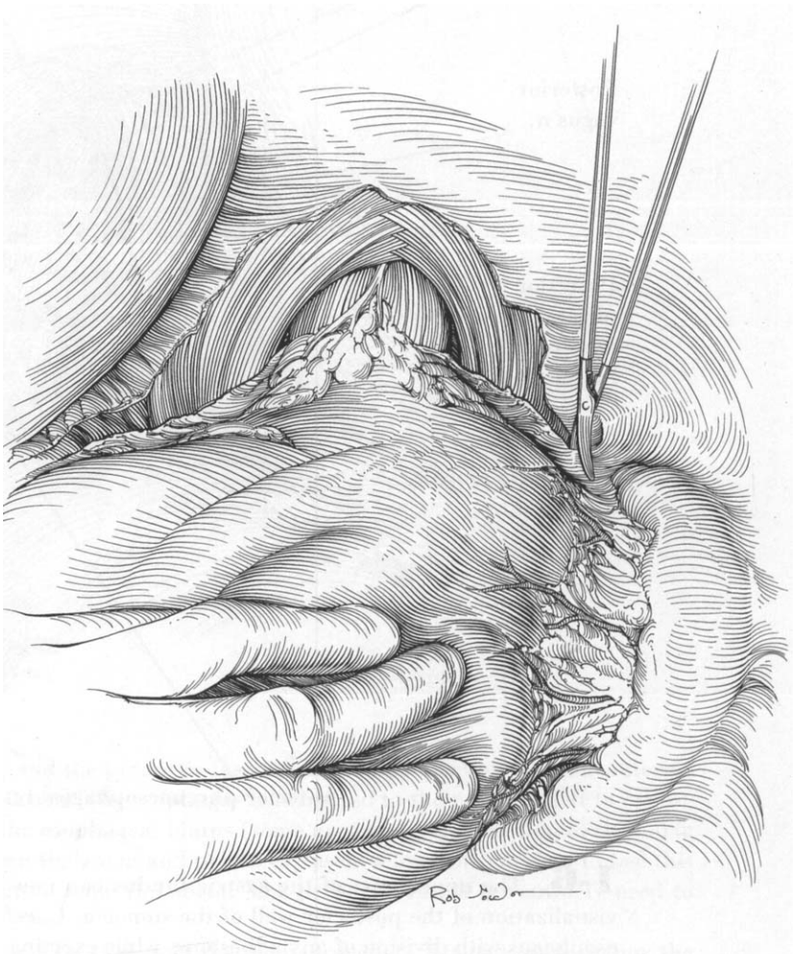
1-2 The abdomen is thoroughly explored with careful attention to the pylorus to exclude pyloric stenosis. Most important, pyloric stenosis should be dealt with properly. The attachment of the left lobe of the liver is released by dividing the anterior and posterior leaves of the triangular ligament parallel to the liver edge. Care should be taken not to injure the phrenic vein. The left lobe of the liver is then retracted downward and to the patient's right. It is important to have an NG tube at the start of the case, because its palpation greatly aids in the dissection of the esophagus and reduces the risk of injury.



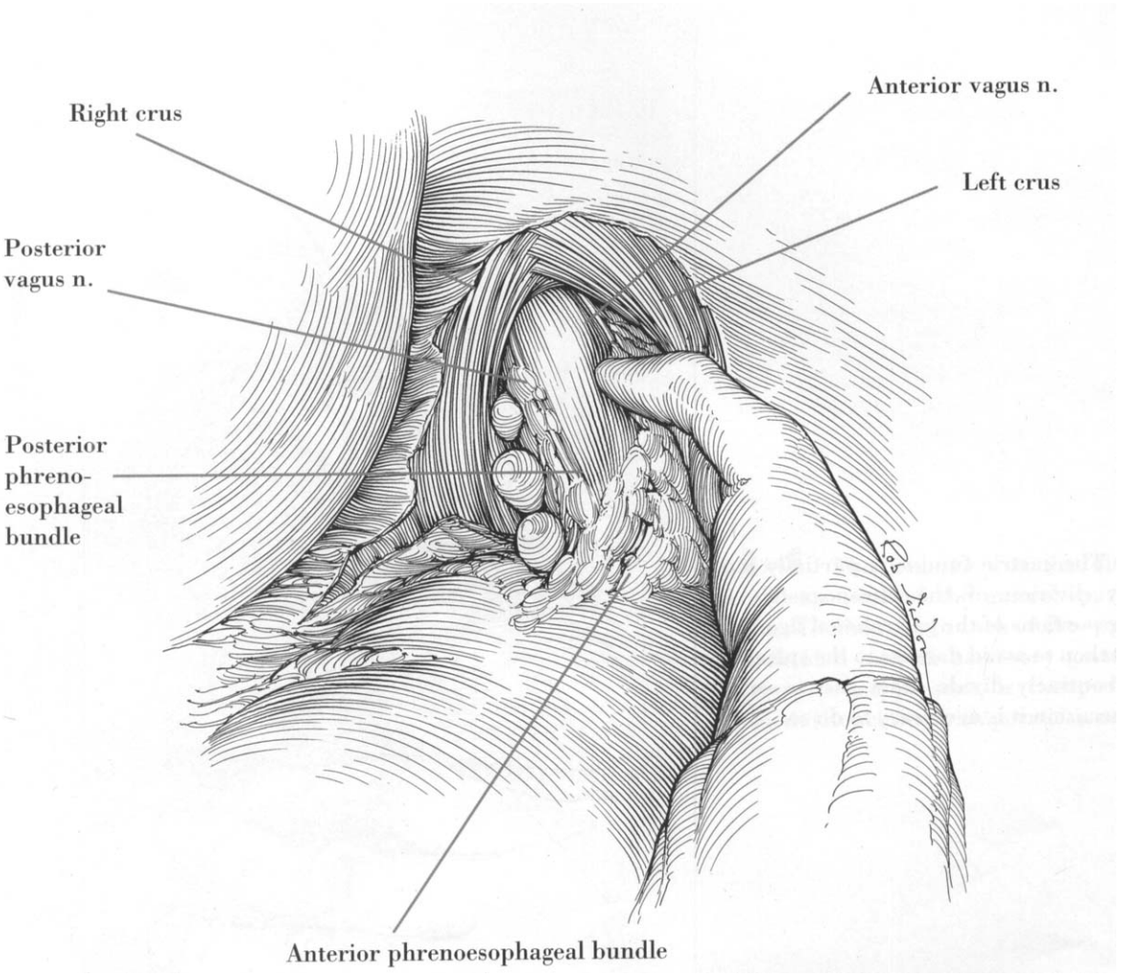
1-3 The phrenoesophageal membrane now appears in view and is incised at its diaphragmatic origin over the esophageal hiatus to expose the underlying esophagus. This membrane must be divided along the correct plane (close to the diaphragm). If the section is too low then the phrenoesophageal bundles would be removed. The anterior and posterior bundles are important in the subsequent repair. These structures are the fibroareolar tissue that surrounds the GEJ and hold the esophagus in the hiatus.



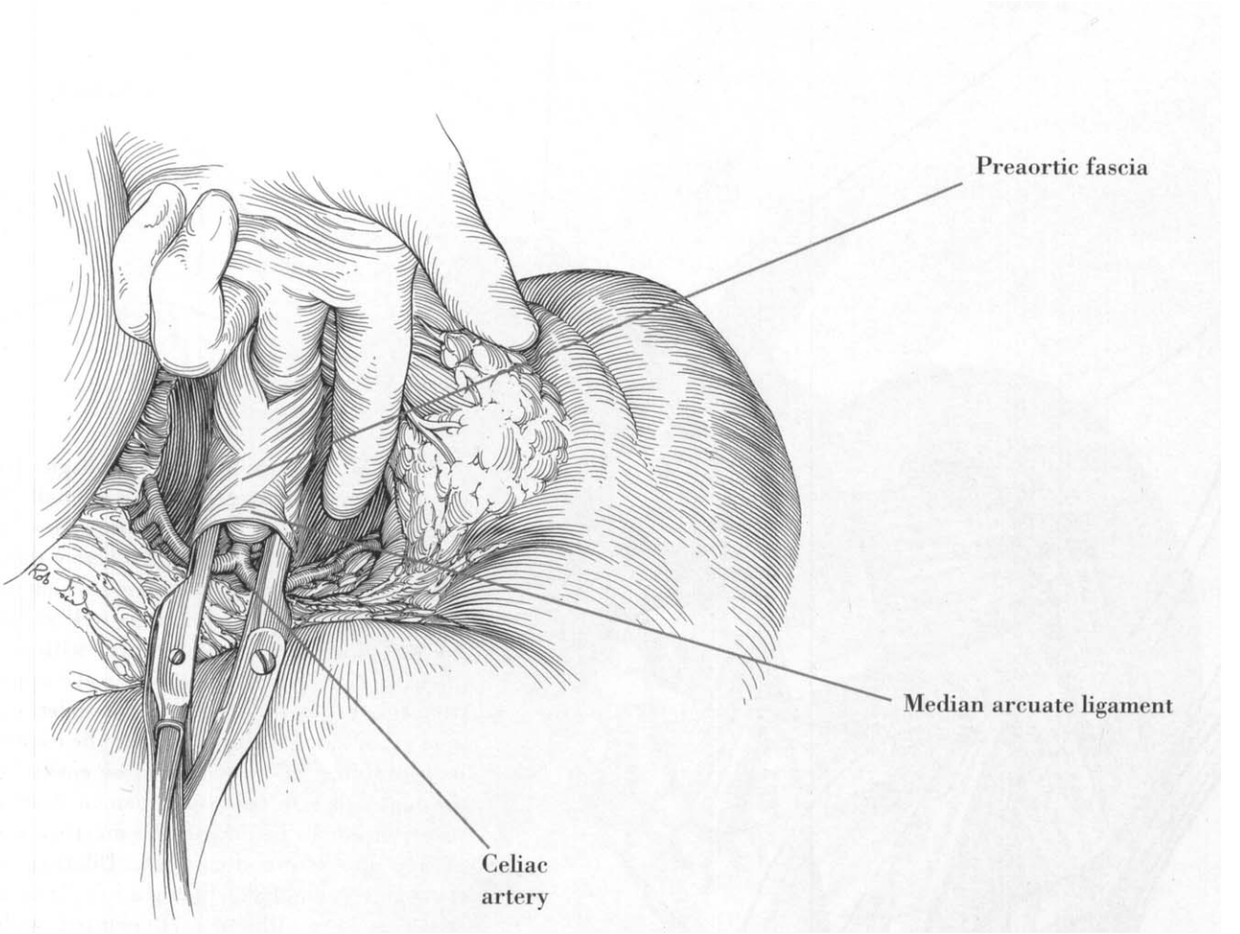
1-4 The next step is the division of superior part of the gastrohepatic omentum. The hepatic branch of the vagus nerve is divided and an accessory gastrohepatic artery, when present, is clamped and divided. (Reprinted with permission.)[16]



1-5 The gastric fundus is partially mobilized by division of the phrenogastric and superior portions of the gastrolienal ligaments. Care is taken to avoid damage to the spleen. We do not routinely divide short gastric vessels, but on occasion it is necessary to do so.

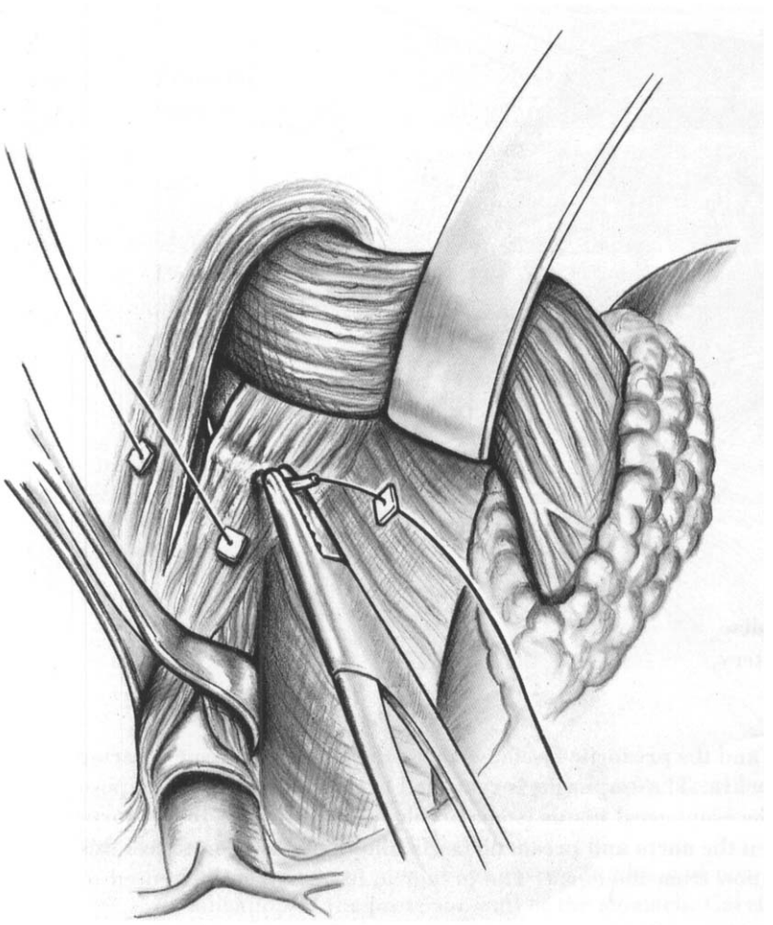


1-6 The upper part of the gastric fundus can now be rotated to the patient's right, allowing visualization of the posterior wall of the stomach. Careful dissection of the posterior aspect of the esophagus with division of any adhesions, while exerting gentle traction on the stomach, will expose both crura and will allow the return of any prolapsed stomach back into the abdominal cavity. In this manner a 3 to 4-cm length of intra-abdominal esophagus is routinely obtained. Both vagus nerves are demonstrated at this moment and carefully preserved. Both phrenoesophageal bundles are also appreciated.

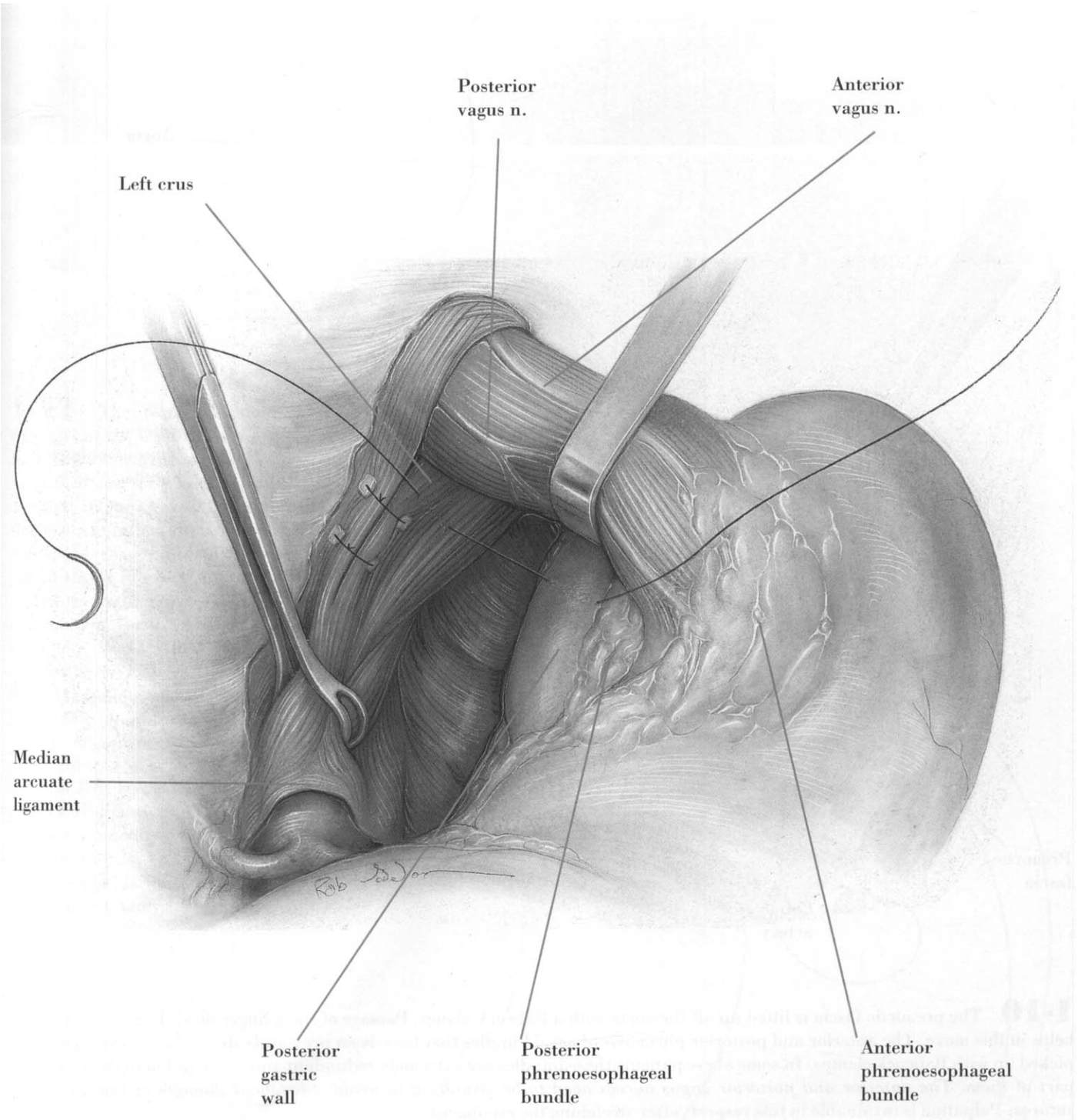


1-7 Attention is now turned to both crura and the preaortic fascia, which is the portion of tissue anterior to the aorta and formed by the origin of both crura. The esophagus is retracted to the patient's left to expose the hiatus. Passing the index finger through the esophageal hiatus (some areolar tissue anterior to the aorta may have to be divided first) and down between the aorta and preaortic fascia allows the surgeon to feel this stout structure and recognize its clear separation from the aorta. The preaortic fascia is routinely used to anchor the repair.

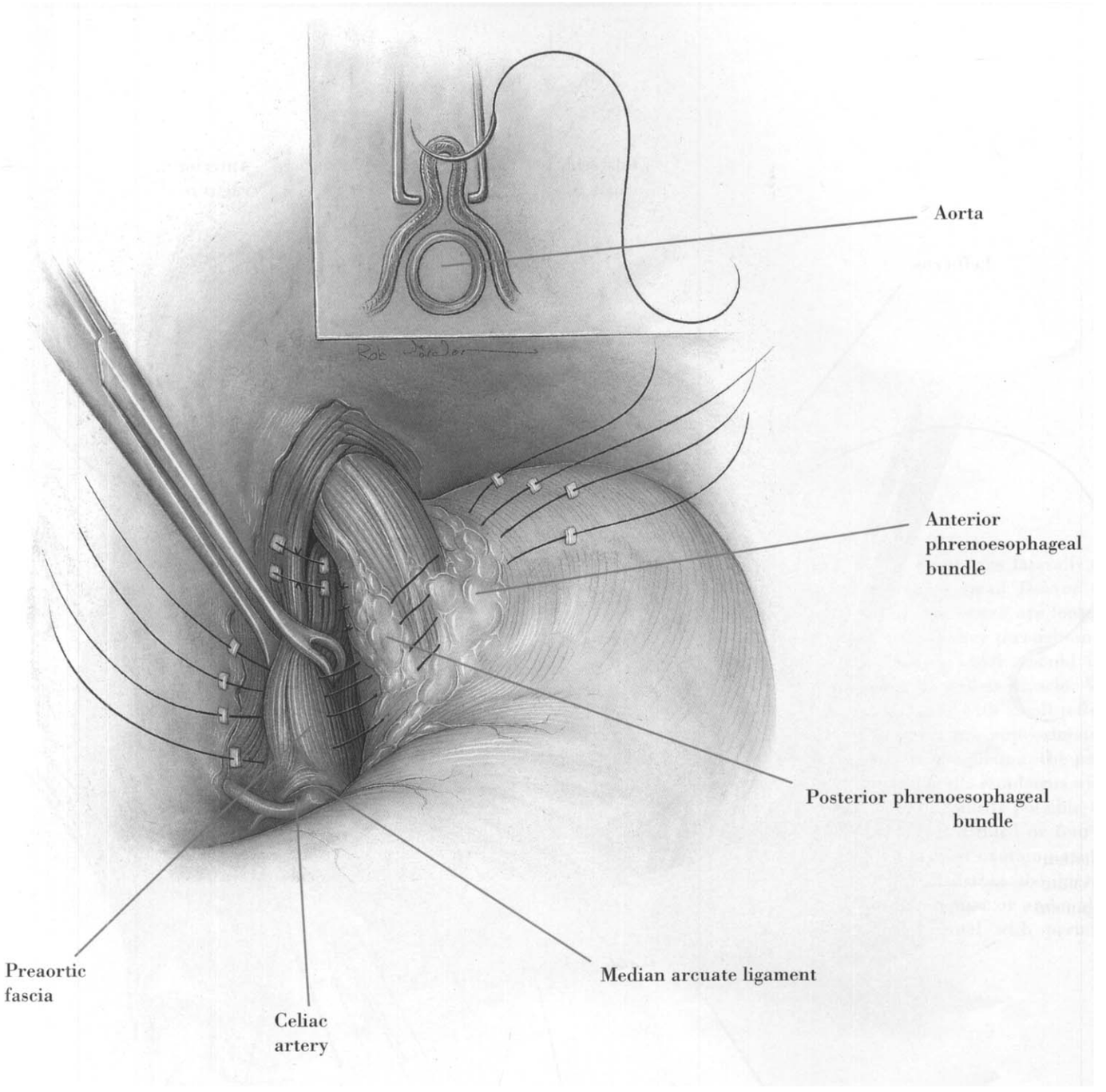
For the experienced surgeon, an option would be to dissect the median arcuate ligament and anchor the repair to it. To do this, careful blunt dissection over the midpoint of the aorta immediately above the celiac trunk will expose the free edge of the ligament. A Goodell cervical dilator is passed underneath this free edge in the cephalad direction. Little or no resistance should be felt with this maneuver if the instrument is in the correct plane. To avoid damage to the aorta or the celiac trunk the instrument should never be forced.



1-8 After retracting the esophagus laterally to expose the esophageal hiatus (a small Deaver or malleable retractor is useful) the crura are loosely approximated with at least two heavy through-and-through nonabsorbable sutures, which should include fascia and peritoneum as well as muscle. We use size 0 nonabsorbable sutures with small teflon pledgets (5 × 5 mm). The crura are approximated posterior to the esophagus. At completion, the passage of an index finger alongside the esophagus with its containing NG tube should be easily possible. If the hiatus is still too wide open, a third or fourth suture needs to be added. We must caution against closing the hiatus too tight. Dilating the hiatus through the esophagus using a bougie or and endoscope is very difficult. (Reprinted with permission.)[16]

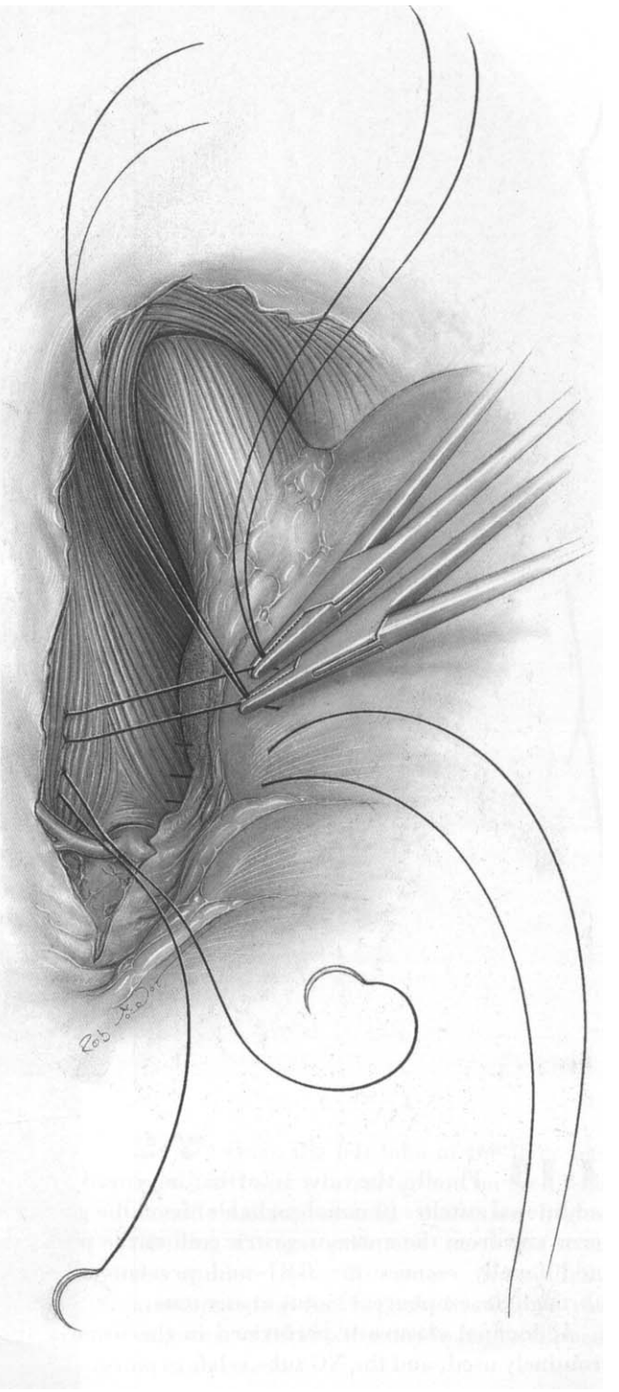


1-9 An additional step may be added to further anchor the repair intra-abdominally. We now place three stitches from the posterior gastric wall (seromuscular layer) to the left crus and left aspect of the preaortic fascia. The posterior vagus nerve is identified again, before placing the stitch and nonabsorbable 0 material is used. The stomach should not be pulled down because this will jeopardize the GEV. Care must be taken because the aorta lies immediately beneath the preaortic fascia.



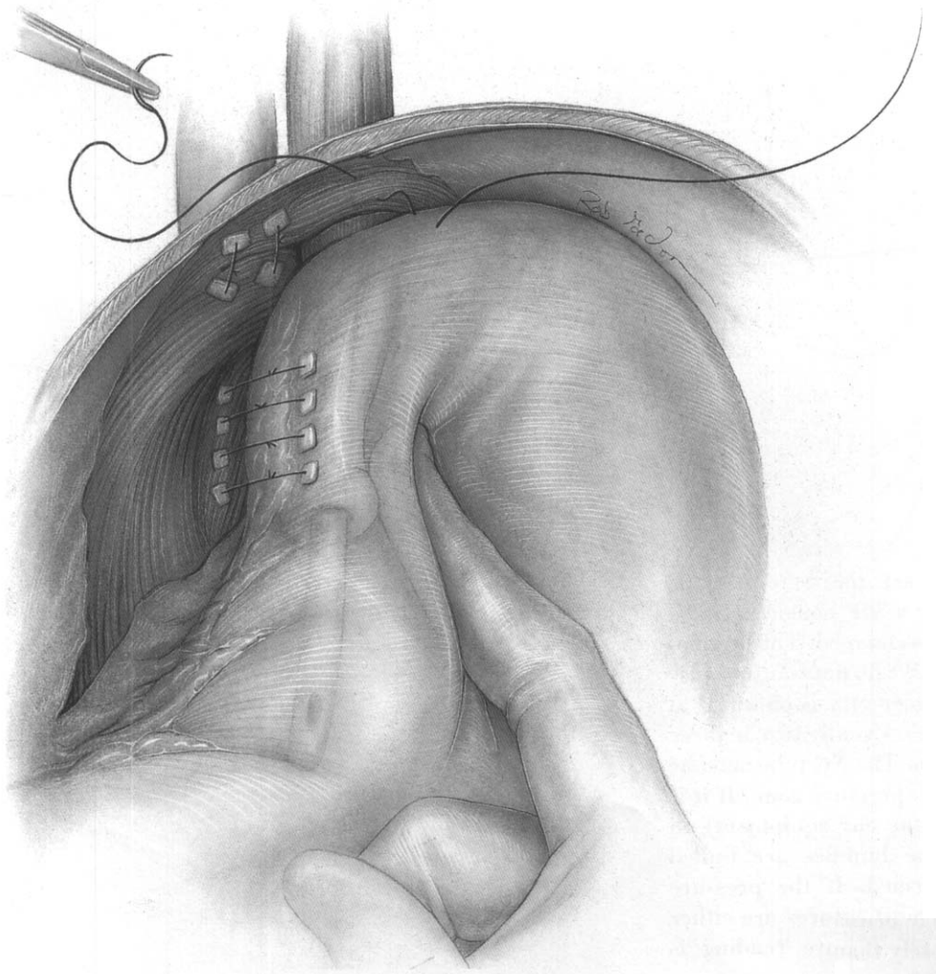
1-10 The preaortic fascia is lifted up off the aorta with a Babcock clamp. Passage of the a finger down behind the fascia helps in this move. The anterior and posterior phrenoesophageal bundles that have been previously dissected are exposed and picked up with Babcock clamps. In some obese patients these bundles are extremely redundant and we do not hesitate to resect part of them. *The anterior and posterior vagus nerves need to be visualized to avoid subsequent damage or inclusion by sutures.* Palpation is invaluable in this respect, after stretching the esophagus.

Starting with the lowermost stitch, the first of four identical 0 nonabsorbable sutures is placed. Teflon pledgets may be used to add stability and avoid the stitches to pull through the tissue, but we have seen some cases of the pledget migrating into the esophageal lumen. Each stitch goes through anterior phrenoesophageal bundle and seromuscular layers of gastric wall (the first suture [lowermost] exits the anterior bundle just lateral to the anterior vagus nerve) and then through the posterior bundle and seromuscular gastric wall with the point of entry being just posterior and to the patient's right of the posterior vagus and finally through the preaortic fascia (which is pulled up off the aorta with a Babcock clamp as shown in the inset). We always suggest passing the needle alongside the clamp. This first suture must include the most caudal portion of the preaortic fascia, close to median arcuate ligament while avoiding the celiac artery. Subsequent sutures (three more) are parallel to this one but in a more cephalad position on the bundles and on the preaortic fascia. Approximately 0.3 cm is the distance between each suture. The higher the sutures on the bundles, the tighter the repair, so large separations between each suture should be avoided. Conversely, inadequate distance between sutures will result in a repair that is too loose. None of these four sutures is tied at this moment; they are tagged with color-coded hemostats. Attention should be given to avoiding entering gastric or esophageal lumen with any suture. (For clarity purposes, sutures are shown placed too cephalid on the anterior bundle.)



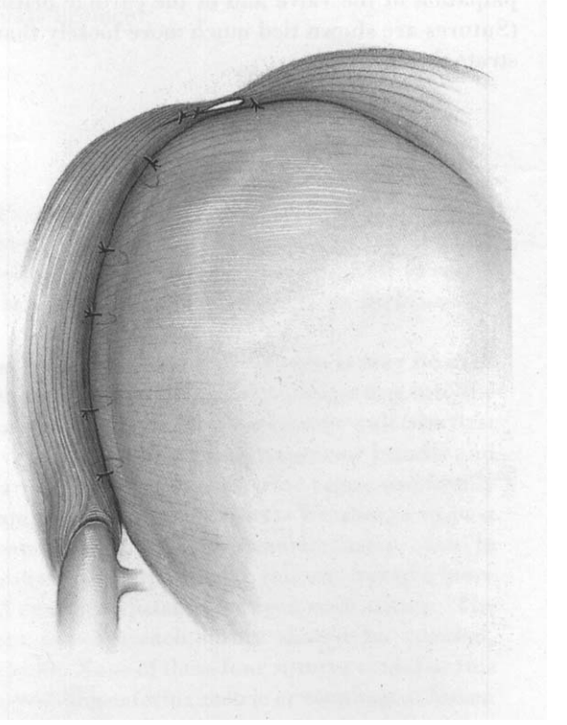
I-11 The two uppermost sutures set the tone for the tightness of the repair. They are tied over a 36F bougie plus NG tube with a single throw in the knot which is clamped. The bundles are pulled inferiorly as each suture is tied. We do not routinely use a bougie in open cases. Intraoperative manometry is obtained at this moment (after withdrawing the dilator). Usually two or three "reads" are made and an average is drawn. The NG tube must be pulled slowly in order not to miss the high pressure zone. If it is within the right range (25 to 35 mm Hg for our equipment) all sutures are finally tied then (again, the bundles are pulled inferiorly) and a final reading is performed. If the pressure reading is too high or low, the two uppermost sutures are either loosened or tightened until the correct pressure reading is obtained.

This maneuver approximates the phrenoesophageal bundles and tightens the collar sling musculature, which accentuates the angle of His, recreates the gastroesophageal valve, and augments the LESP pressure. In addition to the manometry reading, decision to modify the repair is based on its appearance and on palpation of the valve and of the cardiac orifice of the stomach. (Sutures are shown tied much more loosely than usual to demonstrate the anatomy.)



1-12 The completed in situ repair with the accentuated flap valve mechanism in relief is appreciated. The completed repair is firmly anchored in the abdomen and provides at least a 2-cm segment of intra-abdominal esophagus. The restored flap valve can be palpated through the stomach wall against the NG tube.

An additional stitch from the seromuscular layer of the gastric fundus near the angle of His to the diaphragm accentuates this angle and helps prevent a paraesophageal hernia.



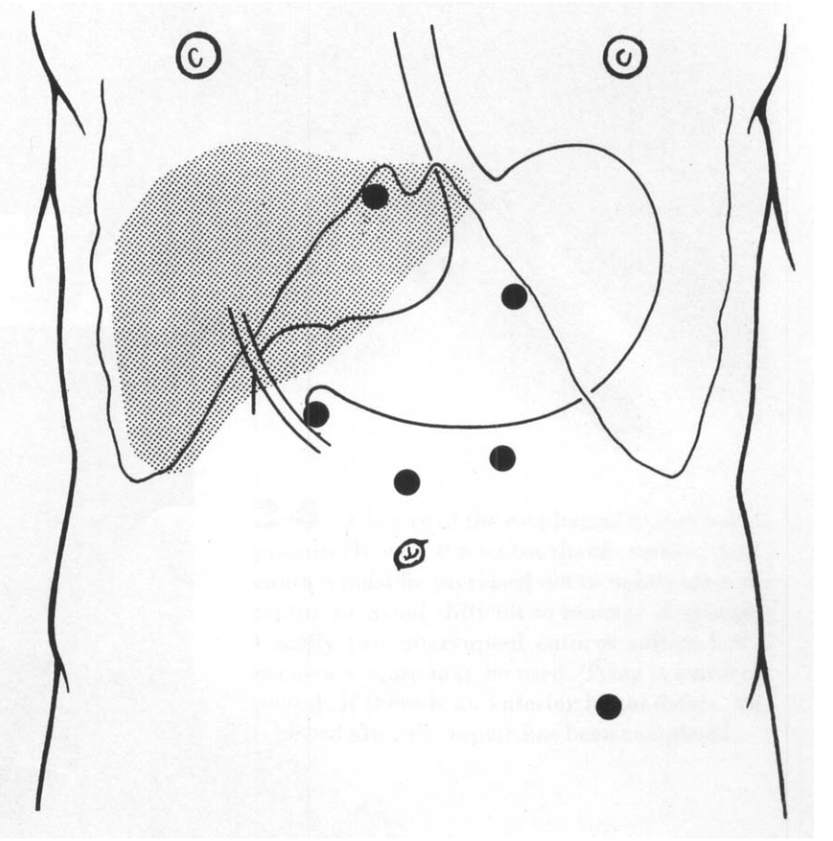
1-13 Finally, the valve is further improved by putting a total of 3 to 5 additional stitches (0 nonabsorbable) from the gastric fundus to the right crus and from the anterior gastric wall to the preaortic fascia. This step additionally secures the GEJ and prevents the repair from slipping through the esophageal hiatus at any time.

Abdominal closure is performed in the usual manner, no drains are routinely used, and the NG tube is left in place.

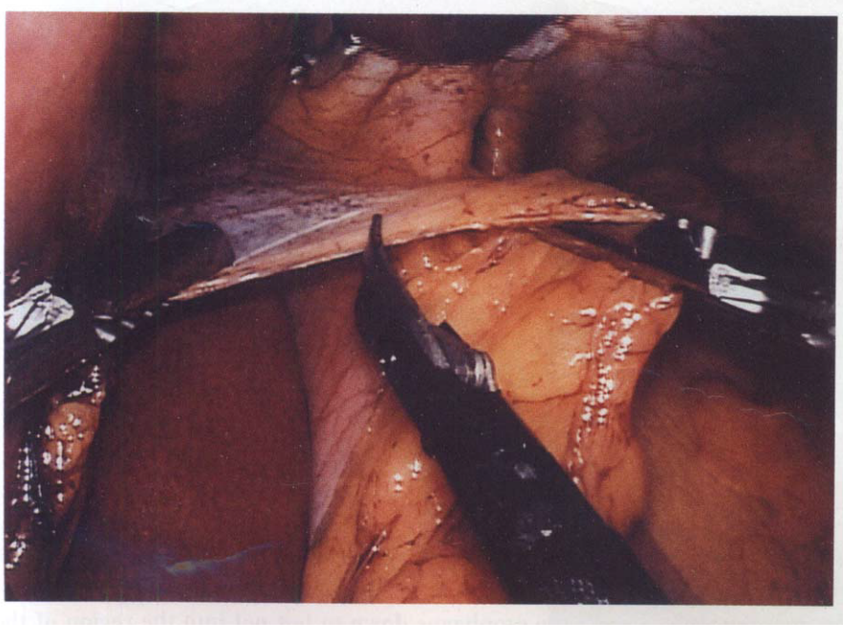
SURGICAL TECHNIQUE: LAPAROSCOPIC HILL REPAIR

Laparoscopic approach has been reserved to primary cases. Reoperative GEJ surgery is very demanding, and we think that in this setting an open repair should be attempted only when important experience has been obtained. Relative contraindications to laparoscopic approach include giant hiatal hernia, massive obesity, and previous upper abdominal surgery.

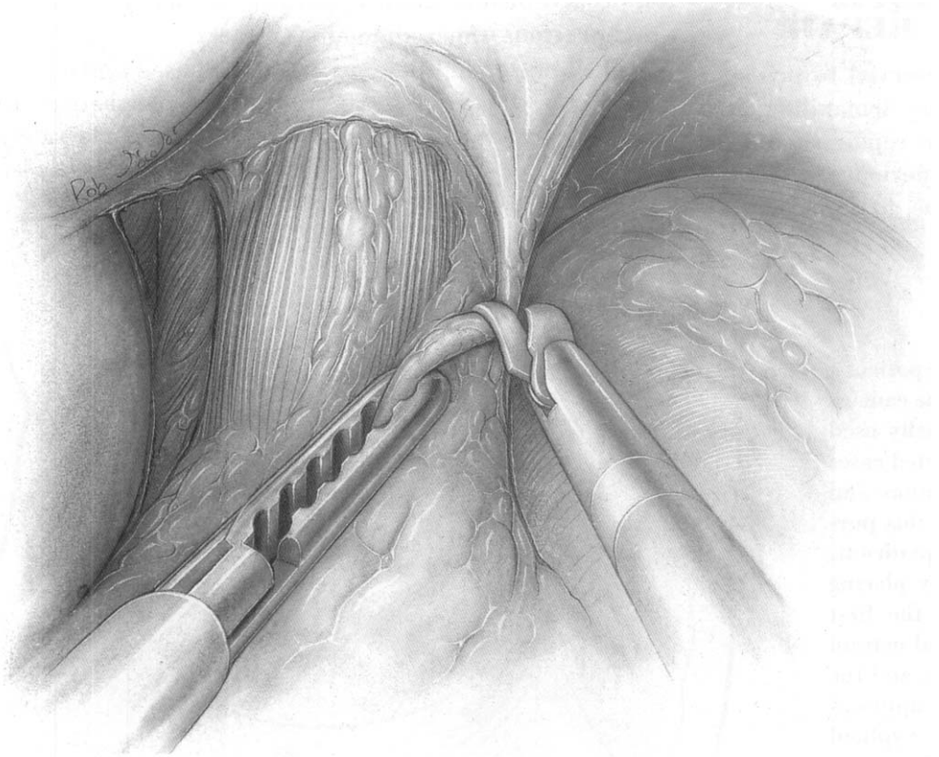
The low dorsal lithotomy position is used and endoscopy is performed once the patient is anesthetized to introduce a guidewire over which a dilator can be safely passed later when needed. The modified NG tube is also passed at this time.



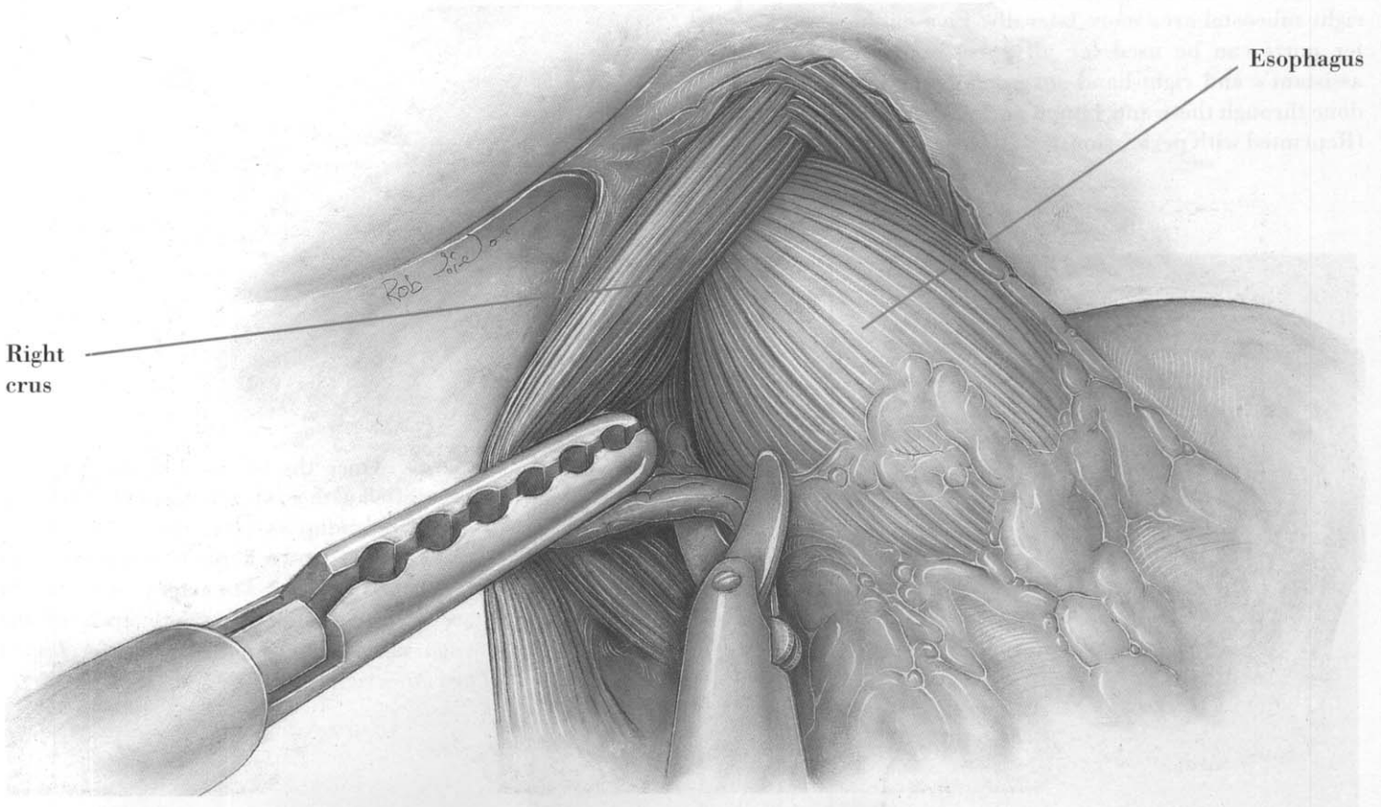
2-1 The surgeon stands between the patient's legs, with the assistant to his right and the camera operator to his left. Five ports are usually used but a sixth port may be required in selected cases to downward retract redundant omentum and stomach. A Babcock clamp is used for this purpose and is placed in the left lower quadrant. Pneumoperitoneum is first instituted by placing the Veress needle in the location for the first assistant's port (just below the left costal margin roughly 5 cm from the xyphoid process), and the camera port is placed in the midline approximately at half the distance from the xyphoid process to the umbilicus. We have found that the 30° lens provides the best visualization. The two surgeon's ports are placed 8 to 9 cm to the right and left of the camera, at the same level. Finally the port used for the liver retractor is placed to the right of the middle line subxyphoid or in the right subcostal area more laterally. Five-millimeter ports can be used for all ports except the assistant's and right-hand surgeon's (suturing is done through these and 11 mm ports are needed). (Reprinted with permission.)[2]



2-2 Once the left lobe of the liver has been lifted with a retractor and secured with a self-retaining system, dissection begins dividing the gastrohepatic omentum over the caudate lobe. An artery occasionally accompanying the hepatic branch of the vagus nerve (that is divided) must be clipped or cauterized.

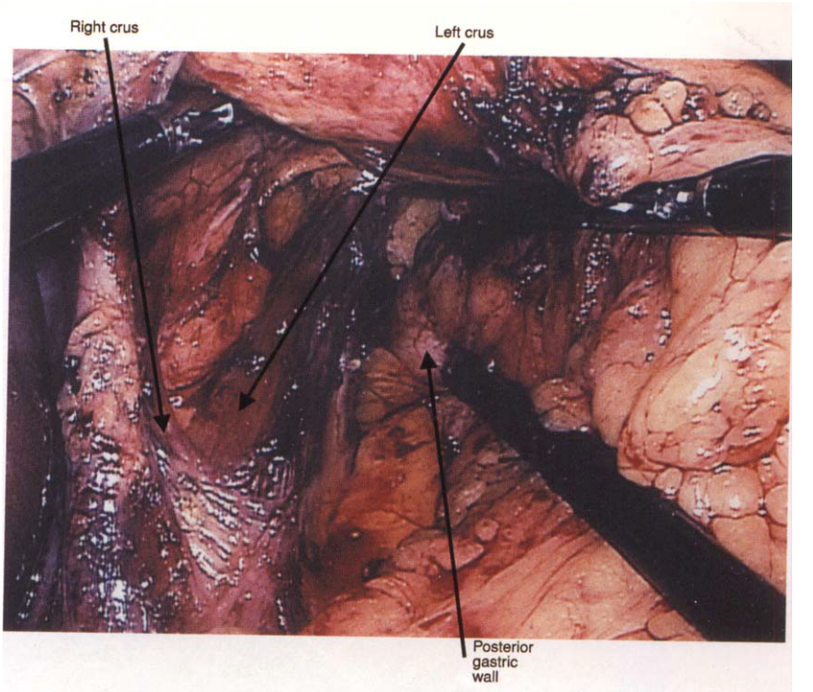


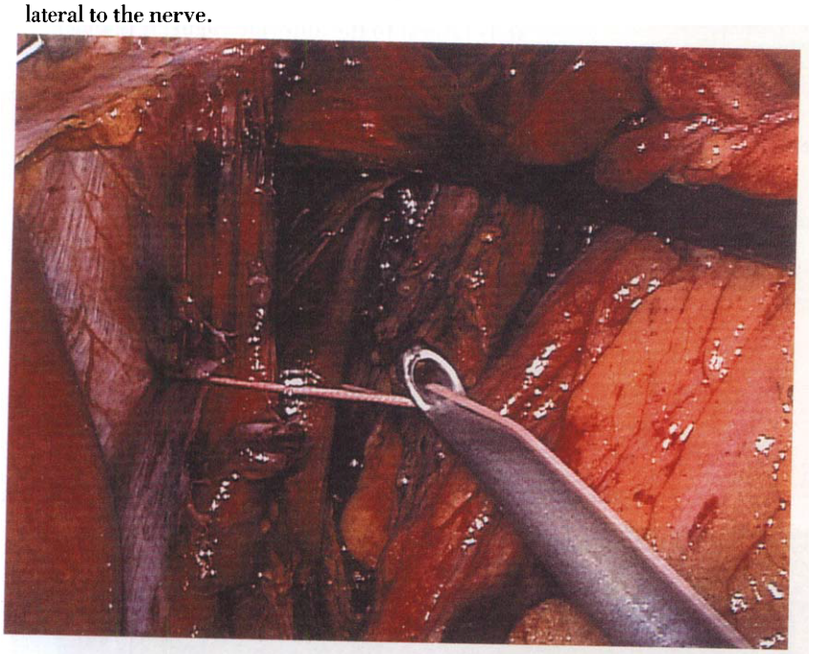
2-3 The phrenoesophageal membrane is dissected from the patient's right to left, exposing the anterior esophageal wall. This dissection is close to the diaphragm to retain the anterior phrenoesophageal bundle. Care must be taken not to injure the anterior vagus nerve or the esophagus. Dissection up into the mediastinum is not necessary and should be avoided to lessen the risk of pneumomediastinum.



2-4 The right crus is now dissected along an avascular plane from the esophagus down to but not into the region of the celiac axis.

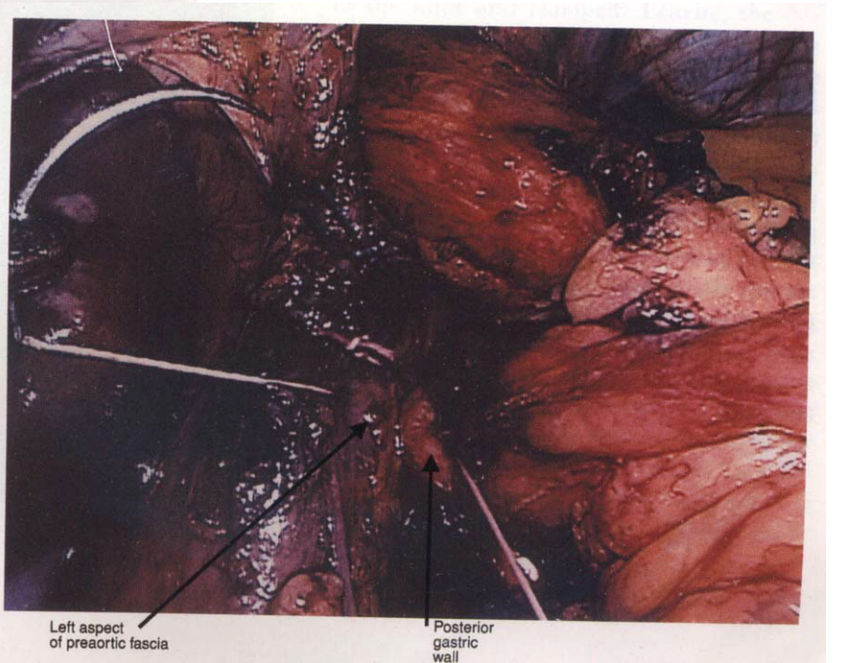
2-5 With blunt dissection the confluence of both crura is then exposed, and following the left crus superiorly opens a retroesophageal space that allows exposure of the posterior aspect of the fundus. To accomplish this it is better to work high on the left crus between it and the esophagus, and it is necessary to separate part of the fibroareolar tissue that overlies the posterior fundus and sometimes to divide a small artery that runs parallel to the left crus. The left gastric pedicle lies at the lowermost part of this dissection, and caution must be exercised not to injure it. The posterior aspect of fundus must be sufficiently dissected out so it can be used later for suturing without tension. The final part of the dissection includes defining the most caudal portion of the preaortic fascia marked at the level of emergence of the celiac axis. Downward traction of the anterior phrenoesophageal bundle permits identification of the anterior vagus nerve and retraction to the patient's left allows visualization of the posterior vagus. The posterior phrenoesophageal bundle lies immediately posterior and lateral to the nerve.

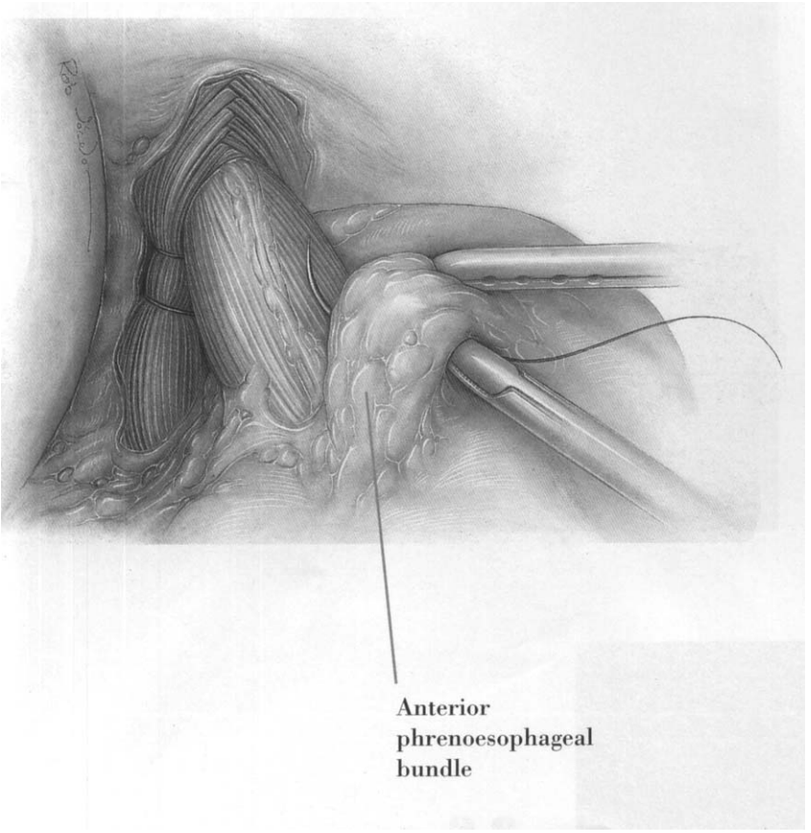




2-6 Closure of the esophageal hiatus is done posteriorly with 0 nonabsorbable suture. Again caution must be exercised not to tightly close the hiatus to avoid difficult-to-manage dysphagia. Usually two interrupted sutures suffice but if necessary more may be used. Tying is extracorporeal. If there is an anterior hiatal defect, this is closed after the repair has been completed.

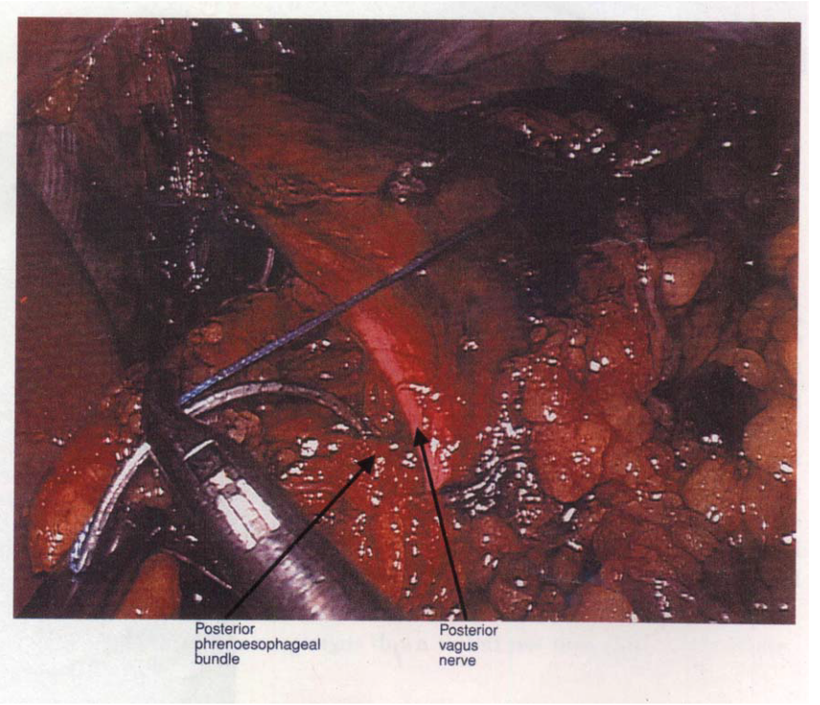
2-7 To add further reinforcement to the repair, two or three stitches are taken from the posterior gastric wall (seromuscular layer) to the left crus and left aspect of the preaortic fascia. The posterior vagus nerve is identified once more before placing the stitch and nonabsorbable 0 material is used. Deep penetration into the preaortic fascia should be avoided because the aorta lies immediately beneath.





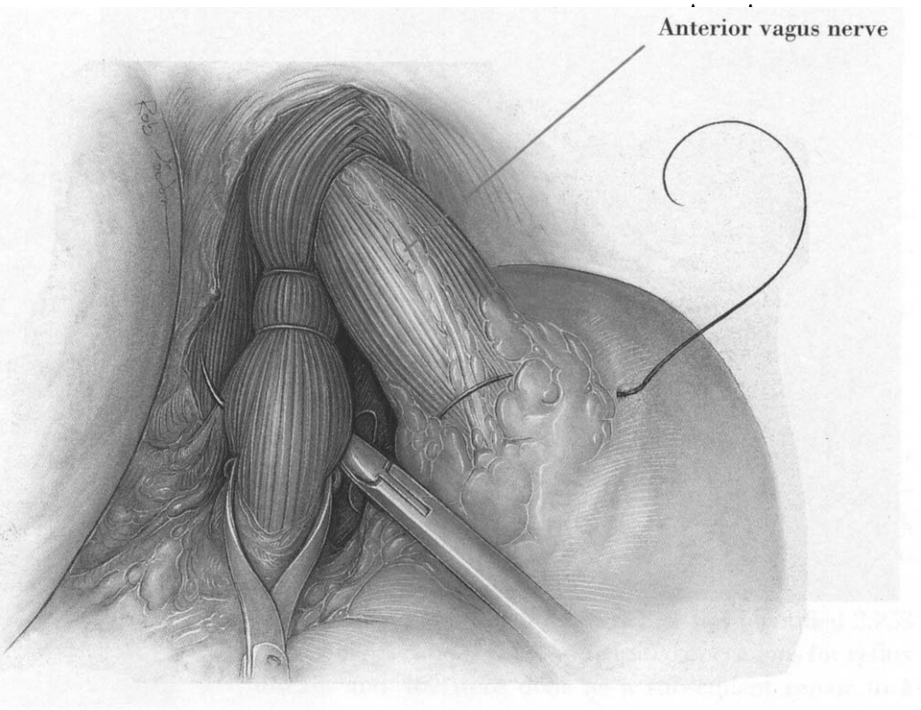
2-8 Placement of the repair sutures is the next step. First two sutures are placed through the surgeon's right hand port, and the third and fourth sutures are introduced through the assistant's port but used by the surgeon once intracorporeal. Two sets of color sutures are used to avoid confusion and with attention to the angle of entry because crossing of the sutures is not common. All sutures are 0 nonabsorbable, and they all include the seromuscular layer of the stomach in addition to the bundle. Attention should be given to avoiding entering the gastric or esophageal lumen.

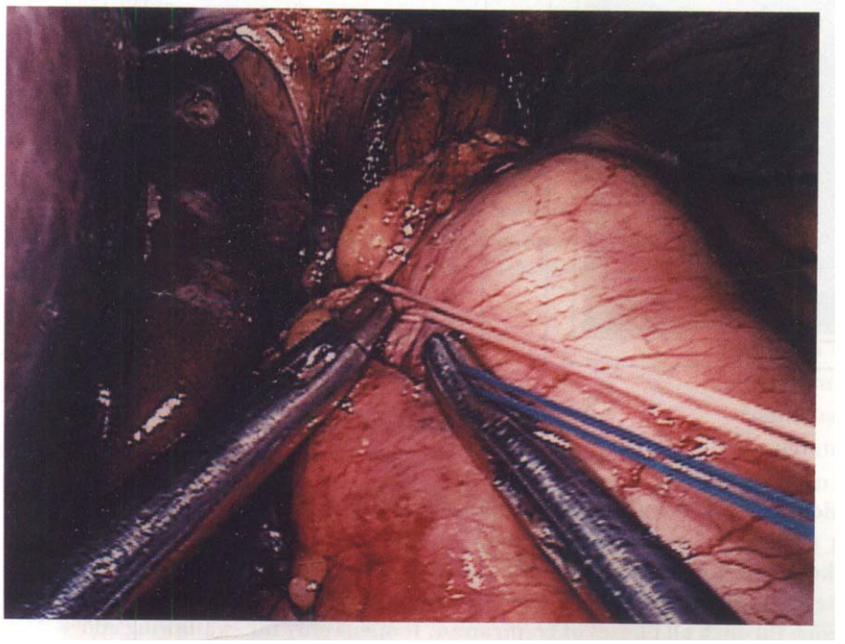
The first suture is the lowermost. It is passed through the anterior bundle and exists immediately lateral to the anterior vagus; it is aimed in vertical direction almost parallel to the vagus nerve.



2-9 This suture crosses in front of the esophagus and then enters the posterior phrenoesophageal bundle immediately lateral to the posterior vagus nerve and exits in the posterior gastric wall. To get deep penetration (avoiding the left gastric pedicle) this suture is placed by aiming the needle towards the back of the patient and cocking it backward. The assistant must pull the tissue between the two bundles anteriorly and to the patient's left for adequate exposure.

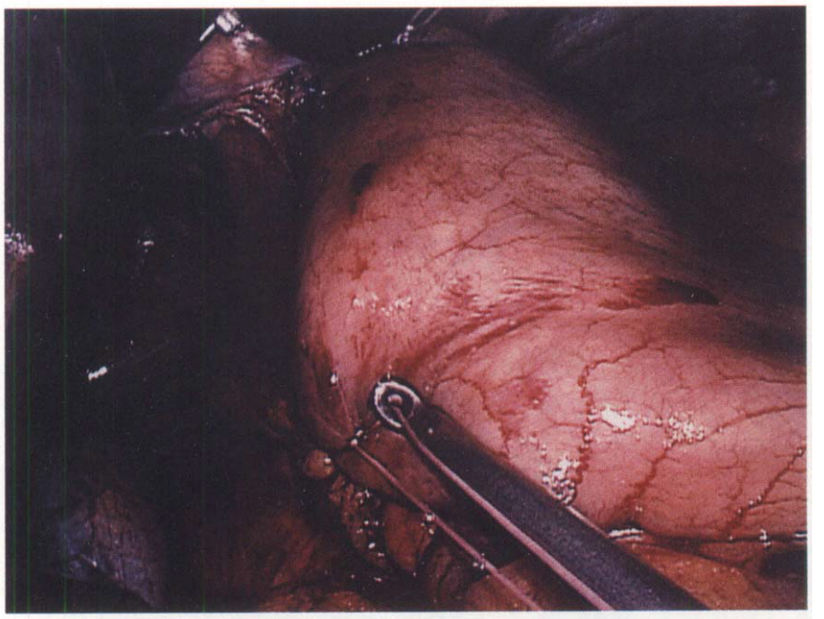
2-10 Finally this suture is passed through the preaortic fascia, which is pulled off the aorta by a grasper or Babcock clamp. Placement of an instrument against the suture while it is pulled back out of the trochar diverts stress from the tissue and avoids sawing through it. The next three repair sutures are placed in a similar fashion, parallel to the first and advancing in a superior direction with a 3- to 4-mm separation between each one. Again caution must be exerted not to place sutures too close together (repair will be loose) or excessively separated (last suture will be excessively high on the bundle and the repair tight). Finally, every suture requires visualization of both vagus nerves to avoid injury by inclusion in the stitch.



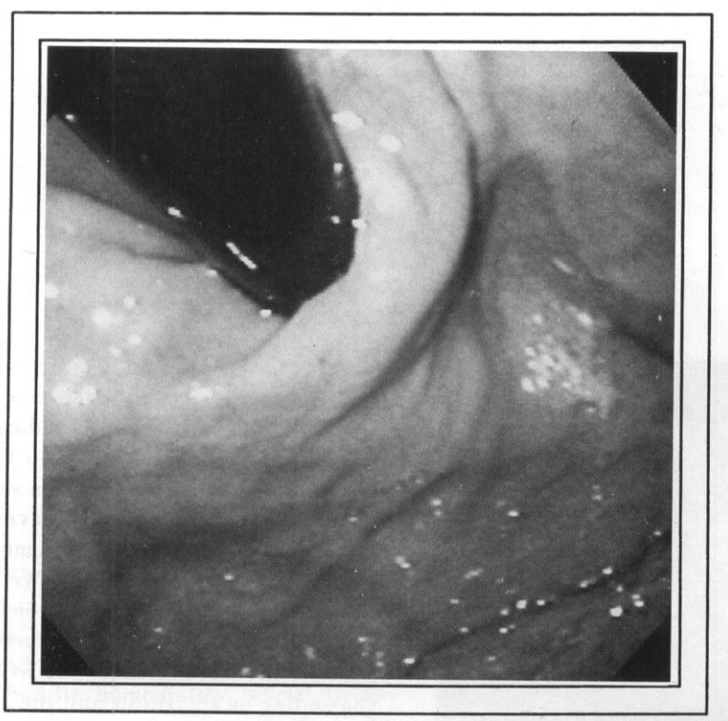


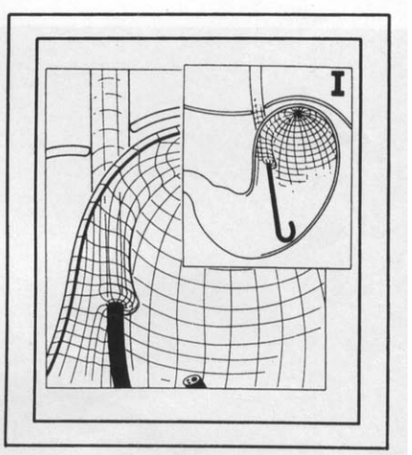
2-11 With the four sutures in place, a 36F dilator is passed over the guidewire alongside the modified NG tube and positioned across the GEJ. The top two sutures (last two placed) are tied with a single throw in the knot and clamped. Leaving the NG tube in place, the dilator is removed and a manometric reading is taken. We usually do two or three pull-throughs which must be slow not to miss the high-pressure zone. For our system ideal pressure is 25 to 35 mm Hg. Depending on the result and the appearance of the repair, sutures are either tightened, loosened (until adequate pressure reading has been obtained), or tied over the dilator (which is reinserted) if the value is within the desired range.

With all four sutures tied a final manometric reading is performed (without the dilator). At this point, if the repair appears too tight (or the pressure is high), it can still be loosened by pulling laterally on the anterior bundle. If the repair still seems too loose (or the pressure is low), additional sutures may be used from the anterior bundle to the preaortic fascia. (For all sutures, the bundles are pulled inferiorly as they are tied.)



2-12 Anterior closure of the hiatus is performed now if necessary. A suture is placed from the anterior fundus wall (0 nonabsorbable, seromuscular) to the diaphragm to prevent a paraesophageal hernia. To accentuate the configuration of the valve a suture is placed between the fundus and the right crus. Finally 2 or 3 sutures are placed from the anterior gastric wall to right side of the preaortic fascia.





2-13 The repair is now viewed endoscopically, the newly recreated valve is assessed (confirming a grade I valve), and evidence of obstruction caused by an excessively tight repair is ruled out. If necessary, modifications to the repair are undertaken (additional sutures placed or some replaced). The grade I valve is well defined, created through the oblique angle in which the esophagus enters the stomach. A musculomucosal fold is opposed to the retroflexed endoscope through all phases of respiration. It opens only for swallowing and closes promptly and extends 3 to 4 cm along the lesser curve.

Trochars are removed under direct vision, all 10-mm sites are closed with a fascia closing device, and subcuticular stitches are used for the skin. (Reprinted with permission.)[2]

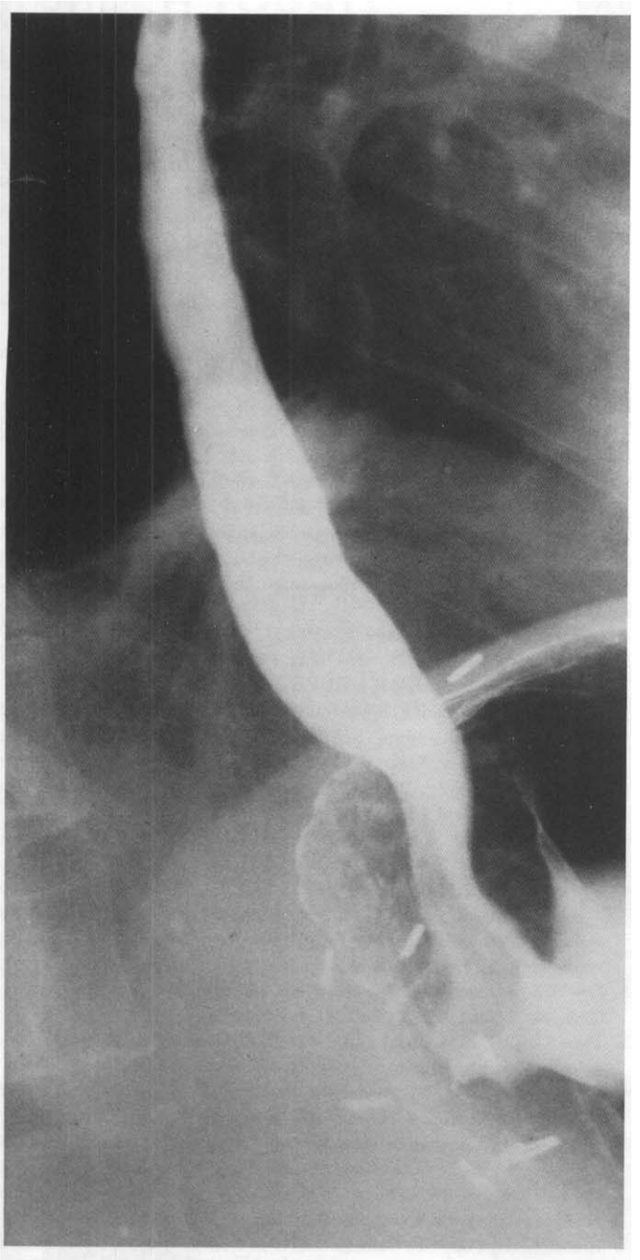


Figure II. Postoperative upper gastrointestinal series: An intra-abdominal segment of esophagus is appreciated. The GEV is clearly defined. (Reprinted with permission.)[17]

COMMENTS

Postoperative Care

Following an open Hill repair, the NG tube is attached to low intermittent suction until the residue obtained after 4 hours with the tube clamped is less than 200 mL. This usually takes 36 to 48 hours. It is important to ensure that the NG tube is patent at all times. Postoperative gastric dilation produces tension on the repair and can have disastrous effects. Once the NG tube has been removed, clear liquids are started (no carbonation) and, if tolerated, diet is progressed to full liquids or pureed foods. If the patient shows signs of gastric distention or vomits, liquids should be resumed. Gastric prokinetic agents can be useful in this setting.

In laparoscopic cases, the NG tube is removed once the procedure is completed, and clear liquids are started the night of the procedure or next morning. Patients are discharged on a soft diet and cautioned that some dysphagia to solids is not uncommon during the first few weeks after surgery. When indicated, postoperative endoscopy (Fig II) allows observation of the reconstructed GEJ.

Results

Our subjective rating of results after surgery is as follows: **Excellent**—no significant symptoms; **Good**—occasional heartburn requiring medication twice per week or less; **Fair**—significant heartburn, requiring medication on a regular basis; **Poor**—unimproved or worse.

An ongoing multi-institution review has identified 2,253 open Hill operations: 1784 were initial operations for reflux disease and 469 were done as a subsequent repair to a previous antireflux surgery (of any kind). These 1784 cases divide as follows: 922 were done by us and have not been previously published, 492 were performed in four institutions by other surgeons, and 370 were done by us and have been previously published. We have analyzed 879 surgeries thus far (from the group of 922). We have found 92.15% good to excellent results, with an average follow-up of 109 months (range, 1 to 386 months).

From the group of 370 patients, 140 were available for follow-up at 15 to 20 years. These were added to 27 patients with the same follow-up and who had any kind of previous antireflux operation, thereby obtaining 167 total cases analyzed and published. At that moment, 88% of these patients evaluated their results as good to excellent. We also personally interviewed these patients applying strict subjective status rating criteria.

In brief: excellent—no recurrent symptoms; good—mild symptoms, no medication; fair—recurrent symptoms, adequate control with medication; poor—daily symptoms, unimproved, patients requiring reoperation.

Using these strict criteria, 78% were deemed to have good to excellent results. Considering that the mean follow-up was 17.8 years, we think that the Hill antireflux operation provides durable long-term results.

Laparoscopic application of the Hill repair was initiated in February 1992 after extensive animal experimentation. To date 338 laparoscopic cases have been

TABLE 1. Percentage of Patients With Objective Evaluations (n = 307) (Laparoscopic Cases)

	Preoperative	Postoperative
Manometry	77.59%	26.7%
24-hr pH	25.08%	19.8%

performed. Our last retrospective review identified 307 patients with sufficient data for analysis. Subjective evaluation using the same evaluation criteria as for the open Hill repair showed 90.8% of patients with good to excellent results. Table 1 shows the percentage of patients with manometry or 24-hour pH monitoring. Average and median values of these objective evaluations after surgery indicate return to normal LESP and 24-hour pH monitoring (Table 2). Twenty-two patients had both preoperative and postoperative 24-hour pH monitoring. The preoperative median value was 11.2% of time with pH $<$ 4 in the distal esophagus. After surgery this value became normal with a median of 2.1% of time pH $<$ 4 in the distal esophagus.

TABLE 2. Objective Evaluations Before and After Surgery in 307 Laparoscopic Cases

	Preoperative	*Postoperative*
Average LESP (mm Hg) (Range)	8.04 (0 to 50)	18.68 (3 to 60)
Median value of % time 24-hr pH $<$ 4 in the distal esophagus	10.9	2.05

Conclusions

Of all the available antireflux procedures the Hill repair is the only one that securely anchors the GEJ to its normal intra-abdominal position. Recurrent hernia is thus rare and slipped repair nonexistent. This restoration of the normal anatomy also accounts for the application of the Hill repair in patients with diminished esophageal body motility secondary to reflux (not primary motility disorders) with good results and recuperation of motility to normal values in many cases. We recognize that patients with diminished motility are at higher risk for postoperative dysphagia but feel confident that the unique ability of the Hill repair to adjust suture tension during surgery allows to obtain a less tight (albeit competent) repair in these patients.

Unlike other groups that avoid surgery in these cases we do apply our technique in patients with abnormal motility secondary to reflux obtaining a rate of long-term dysphagia comparable to the group of patients with normal motility. (Short-term dysphagia is increased in patients with abnormal motility.) Objective feedback of the quality and snugness of the repair through intraoperative manometrics and endoscopic visualization of the GEV is another unique characteristic of the Hill repair and ensures reproducibility.

Another advantage of the Hill repair is that stitches do not enter the esophagus (in contrast with certain modifications of the Nissen) and complications such as long-term fistulas are not seen.

Finally the Hill repair is technically feasible laparoscopically, providing a safe and effective definitive antireflux repair. Our results are comparable to those obtained with the open technique with the obvious and well-known advantages of laparoscopic surgery over the traditional approach.

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