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Laparoscopic Heller Myotomy and Fundoplication for Achalasia

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Objective
The goal of this study was to review the authors' results with laparoscopic cardiomyotomy and partial fundoplication for achalasia.

Summary Background Data
Pneumatic dilatation and botulinum toxin (BOTOX) injection of the lower esophageal sphincter largely have replaced cardiomyotomy for treatment of achalasia. After a brief experience with a thoracoscopic approach, the authors elected to perform cardiomyotomy laparoscopically, in combination with a partial fundoplication (anterior or posterior).

Patients and Methods
Forty patients were treated between July 1992 and November 1996. Thirty patients had previous therapy of achalasia, 21 with pneumatic dilation, 1 with BOTOX, 6 with balloon and BOTOX, and 2 with transthoracic cardiomyotomy. Three patients had previous laparoscopic fundoplication for gastroesophageal reflux. Symptom scores (0 = none to 4 = disabling) were obtained before surgery and after surgery. Barium swallows and esophagogastroduodenoscopy were performed in all patients. Esophageal motility study was performed in 36 patients. Laparoscopic Heller myotomy and fundoplication was performed through five upper abdominal trocars. A 7-cm myotomy extended 6 cm above the GE junction and 1 cm below the GE junction. A posterior fundoplication was performed in 32 patients, anterior fundoplication in 7 patients, and no fundoplication in 1 patient. Statistical inference was performed with a Wilcoxon signed rank test.

Results
Mean operative duration was 199 ± 36.2 minutes. Mean hospital stay was 2.75 days (range, 1–13 days). Dysphagia was alleviated in all but four patients (90%), and regurgitation in all but two patients (95%) ($p < 0.001$). Chest pain and heartburn improved significantly ($p < 0.01$) as well. Intraoperative complications included mucosal laceration in six patients and hypercarbia in one. Postoperative pneumonia developed in two patients, and one patient had moderate hemorrhage from an esophageal ulcer 2 weeks after surgery.

Conclusions
Laparoscopic cardiomyotomy and fundoplication appears to provide definitive treatment of achalasia with rapid rehabilitation and few complications.

Esophageal achalasia is a rare condition of the esophagus, affecting 1 in 100,000 individuals. It is a benign condition manifest by dysphagia, regurgitation, and chest pain and is characterized, manometrically, by a hypertensive nonrelaxing lower esophageal sphincter (LES). Aperistalsis or vigorous uncoordinated contractions of the esophageal body are associated manometric findings. Medical treatment of achalasia usually is unsuccessful, but forceful pneumatic dilation with balloons 3 to 4 cm in diameter usually succeeds.[1] When balloon therapy fails, when the patient wishes not to accept the 3% to 5% perforation risk, and in young patients (in whom balloon dilation is less successful), surgical treatment is indicated.[2]

Cardiomyotomy, introduced by Ernest Heller[3] in 1913, was performed initially through the abdomen. As popularized by Ellis et al.[4] and practiced across North America, cardiomyotomy was performed through the left chest. At the inception of advanced minimally invasive surgery in 1990, cardiomyotomy was performed with a thoracoscope in much the same fashion as through a thoracotomy.[5] After an initial experience with thoracoscopic myotomy and an extensive experience with laparoscopic fundoplication, we chose to approach cardiomyotomy with laparoscopic access. A hemifundoplication (anterior or posterior) was added to cardiomyotomy to prevent postoperative gastroesophageal reflux.

The aim of this study was to review the initial experience with laparoscopic cardiomyotomy and fundoplication at Emory University Hospital. These results show that laparoscopic cardiomyotomy with fundoplication is safe, is equally efficacious to open cardiomyotomy, and provides excellent relief of dysphagia in appropriate patients without the development of symptomatic postoperative reflux (gastroesophageal reflux).

METHODS

Operative Technique

Patient Positioning and Room Setup

The operating room setup was similar to that for laparoscopic fundoplication (Fig. 1). The patient was placed supine, and general anesthesia was induced. The legs then were spread apart on leg boards (the "French" position) using a fracture table. Both arms were tucked at the patient's sides. A urinary catheter and orogastric tube were placed. Sequential pneumatic compression boots were placed. A video monitor was placed at the 12 o'clock position over the patient's head on a cart or on a ceiling-mounted arm. The first assistant's monitor and all the remaining laparoscopic instrumentation were on a cart located in the 10 o'clock position. All tubes and lines were brought onto the field in the right upper quadrant to minimize tangling.

After all trocars were placed, the surgeon stood between the patient's legs, facing the monitors and maintaining coaxial alignment with the gastroesophageal junction, the laparoscope, and the monitor. The camera operator stood on the right side of the patient while the first assistant and scrub nurse stood on the left side of the patient. For the last 18 operations, a robotic camera operator (Computer Motion, Goleta, CA) has replaced the human camera operator.

Instrumentation

Necessary instrumentation included a forward-oblique viewing telescope (30° or 45°), three atraumatic graspers (5-mm Glassman type), a dissecting scissors (5 mm), an expandable liver retractor (5 or 10 mm), a table-mounted arm for retractor fixation, a monopolar dissecting hook, a right angle dissector, a needle holder, a clip applier, and a suction–irrigation device. Five trocars (two 10-mm and three 5-mm trocars) completed basic instrumentation needs. An ultrasonically activated shears (LCS, Ultracision, Smithfield, RI) replaced the disposable multiclip applier to speed mobilization of the greater curvature of the stomach.

Technique

Pneumoperitoneum was established with the Veress needle through an umbilical puncture using carbon dioxide to achieve an intra-abdominal pressure of 15 mmHg. The first 10-mm trocar, for the telescope, was placed through the left rectus sheath medial to the epigastric vessels 15 cm from the xiphoid. The remaining four trocars were inserted under direct vision as shown in Figure 2. A liver retractor was passed through the right subcostal trocar and elevated the left liver lobe to expose the hiatus. The retractor was fixed to the table-mounted retractor arm. The assistant retracted the epiphrenic fat pad caudally with a Glassman-type grasper through the 5-mm port in the left flank.

The hiatal exposure and the mobilization of distal esophagus and cardia were the same as that used for laparoscopic fundoplication. With scissors in the right hand and a Glassman-type grasper in the left hand, dissection began by incising the avascular area of the gastrohepatic omentum above the hepatic branch of the vagus, which exposed the caudate lobe of the liver and the right crus of the diaphragm. The dissection was carried across the hiatus dividing the phrenoesophageal ligament above the epiphrenic fat. The right and left crura of the dia-

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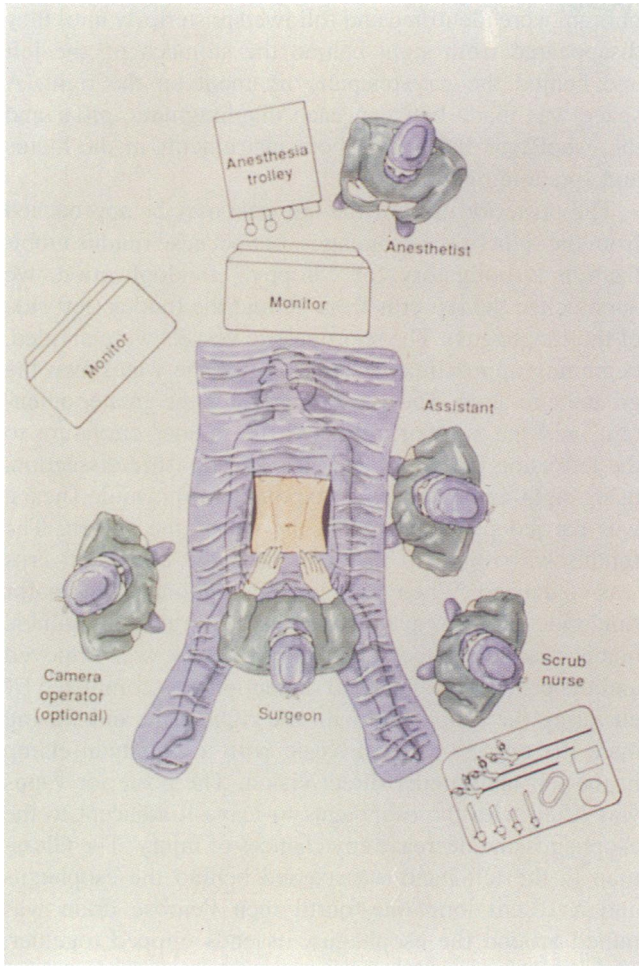

Figure 1. Operating room setup for laparoscopic cardiomyotomy. An identical setup is used for fundoplication.

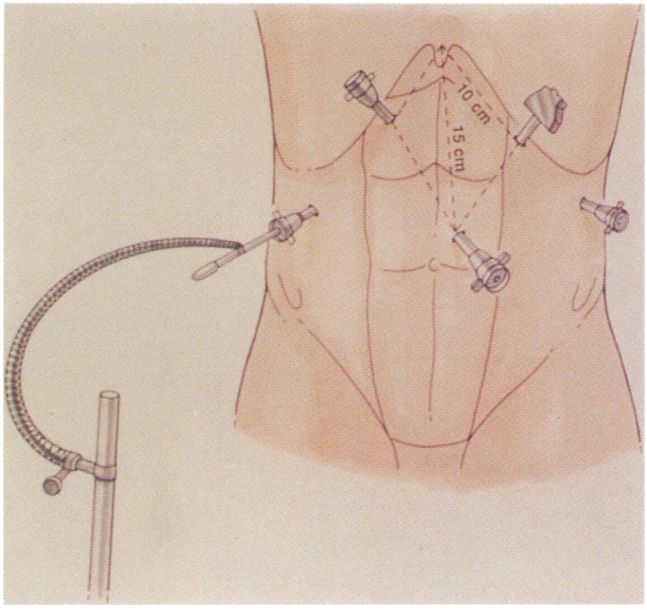

Figure 2. Trocar positions for laparoscopic Heller myotomy. The "diamond of success" is centered on the xiphoid, and measurements are taken to locate the position for telescope, the primary operating trocar, and the liver retractor port.

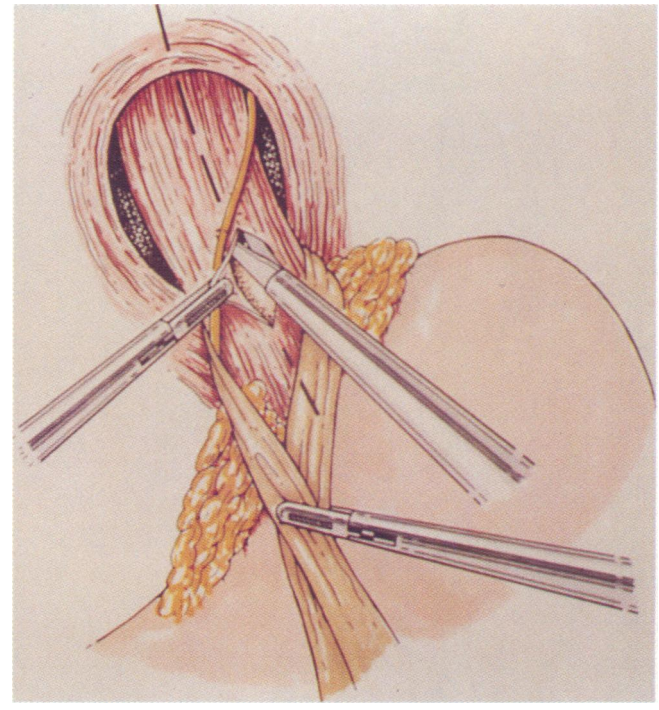

Figure 3. The myotomy is started just above the gastroesophageal junction with a pair of scissors, spreading the longitudinal muscle, hooking one blade beneath the circular muscle, and dividing the muscle.

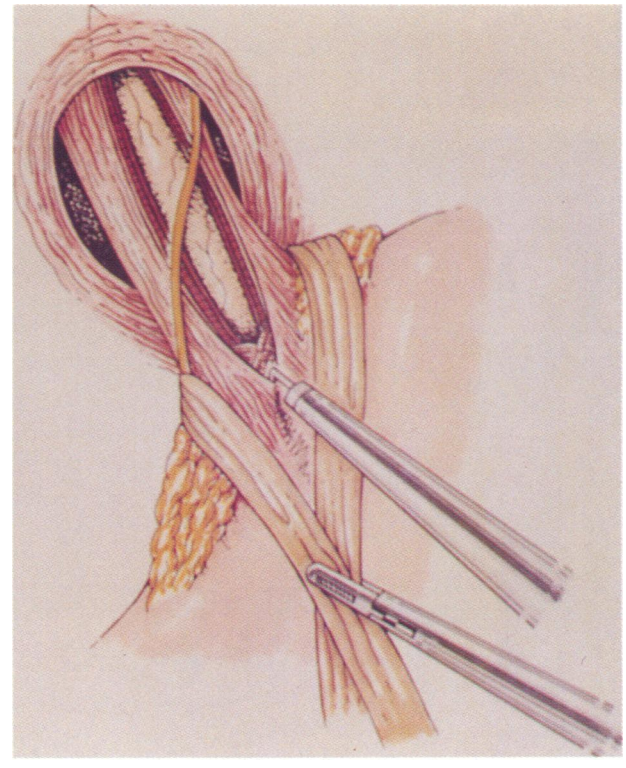

Figure 4. The myotomy is continued 6 cm above the gastroesophageal junction and 1 cm below, sparing the anterior vagus nerve. A monopolar hook with suction and irrigation is used.

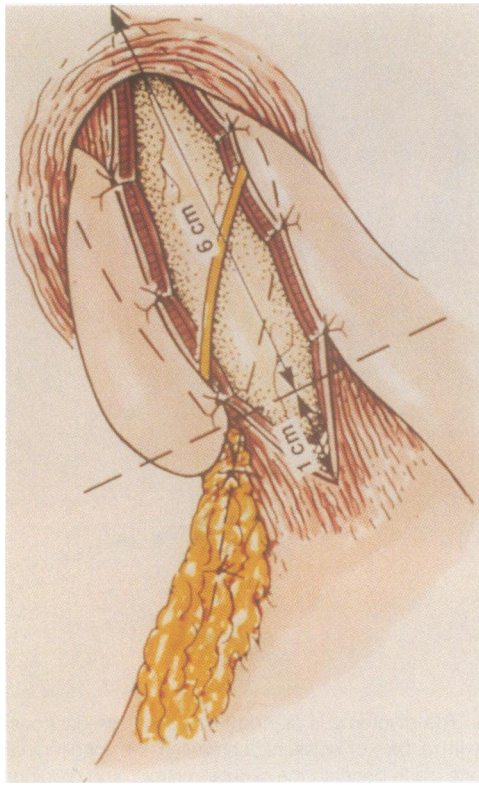

Figure 5. A posterior hemifundoplication anchors the well-mobilized fundus to the cut edges of the myotomy. The fundoplication may be fixed to the loosely closed crura (optional).

phragm were identified and followed posteriorly until they disappeared from sight behind the stomach on the left and behind the gastrohepatic ligament on the right. A space was made between each diaphragmatic pillar and the esophagus by putting both instruments in the hiatus and spreading gently.

The posterior third of the left crus may be approached from the right of the esophagus, but because fundus mobilization is obligatory for "floppy" fundoplication, we approached the left crus from behind the fundus (left side of the esophagus). The short gastric vessels were divided, beginning approximately one third of the way down the greater curvature. The assistant elevated the greater omentum, and the surgeon retracted the greater curvature to the left using the right hand. The short gastric dissection, using right angle and clips, bipolar, or ultrasonic shears, was carried proximally past the tip of the spleen. The fundus was rolled to the right until the entire left crus was visualized. When completed, a redundant fundus for fundoplication was available and the entire diaphragmatic hiatus was delineated. The orogastric tube was removed and the posterior esophageal dissection was completed by elevating the esophagus with the right hand and teasing open the retroesophageal tissue with a Glassman clamp in the left hand under direct vision. The posterior vagus was lifted with the esophagus to leave it adjacent to the esophagus and decrease any chances of injury. The Glassman in the left hand was passed behind the esophagus and a 10-cm long one-fourth inch Penrose drain was pulled around the esophagus, its ends clipped together,

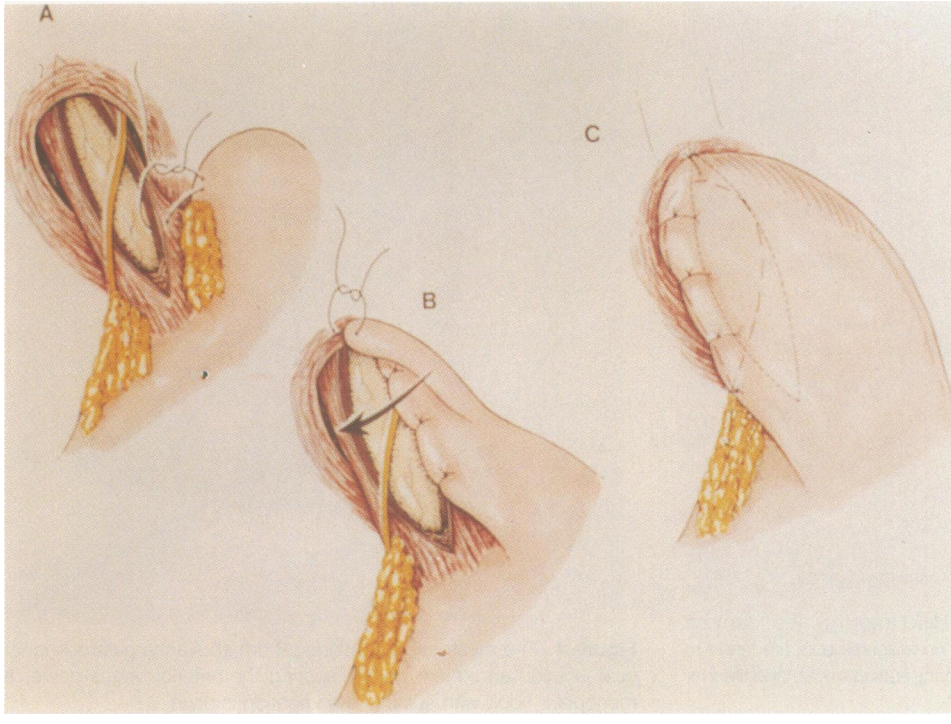

Figure 6. An anterior fundoplication fixes the fundus to the cut edges of the myotomy and the anterior crural arch.

and used for inferior traction by the assistant. The mediastinal mobilization of the esophagus proceeded 8 cm proximal to the gastroesophageal junction anteriorly to ensure an adequately long cardiomyotomy. Monopolar electrosurgery was used extremely sparingly in the region of the vagus nerves. A passage through the anterior epiphrenic fat pad was made to allow the myotomy to extend onto the stomach.

The myotomy was started with scissors just above the gastroesophageal junction on the anterior surface of the esophagus (Fig. 3). The longitudinal fibers were separated bluntly, and the closed scissors were slipped below the circular muscle. The shears were opened, rotated 90°, and the muscle was cut. Once the submucosal plane was reached, a blunt rod was passed cephalad to separate the mucosa from the circular muscle. The monopolar hook then was used to divide the elevated circular muscle. The myotomy was carried proximally for 6 cm above the gastroesophageal junction, passing under the elevated anterior vagus nerve (Fig. 4). Distally, the myotomy was carried across the gastroesophageal junction and onto the stomach for approximately 1 cm (the separation of the muscle layers from the mucosa is more difficult on the stomach, where the muscularis becomes thinner and more firmly attached to the mucosa). No attempt was made to electrocoagulate submucosal bleeding, because this stopped spontaneously and coagulation in this area risks mucosal perforation. Once the myotomy was complete, the muscle edges were separated bluntly from the underlying mucosa for approximately 50% of the esophageal circumference. The orogastric tube was pulled back into the distal esophagus and dilute methylene blue solution (one ampule diluted in approximately 250 mL sodium chloride) was injected down the tube to detect previously unrecognized mucosal perforation. If a perforation was encountered, it was closed with a fine suture (4–0 Vicryl; Ethicon, New Brunswick, NJ) and retested with methylene blue.

An antireflux procedure was performed to prevent postoperative reflux. A posterior (Toupet) hemifundoplication was used in patients with a modestly dilated esophagus. An anterior (Dor) fundoplication was used with the most dilated esophagi, because a posterior fundoplication appeared to cause a relative outlet obstruction by excessively angling the gastroesophageal junction anteriorly. Before the fundoplication was started, the hiatus was examined. If the hiatus was patulous, it was closed loosely with one or two sutures posteriorly. The posterior fundoplication was performed by suturing the fundus on the right side of the esophagus to the cut edge of the muscularis with three sutures. The left side of the fundoplication then was sutured to the cut muscularis on the left side of the esophagus in an identical fashion (Fig. 5). The fundoplication was completed by tacking the fundus of the stomach to the crural closure posteriorly in several places. When an anterior fundoplication was performed, it was done by rolling the fundus over the exposed mucosa. Two to three interrupted sutures were placed between the fundus of the stomach and the cut edge of the muscularis to the left of the esophagus, two to three sutures were placed between the fundus and the anterior crural arch, then three sutures were placed back down the cut muscularis on the right side of the esophagus (Fig. 6).

Postoperative Care

Oral liquids were started on the day of operation after the patient was awake. If a perforation was sutured, liquids were begun the next morning after a gastrografin swallow confirmed that there was no extravasation. Patients were advanced to a special soft diet when liquids were tolerated and discharged 1 to 3 days after surgery. A regular diet was started 3 weeks after surgery.

Patients

Forty patients underwent laparoscopic Heller myotomy with fundoplication for achalasia between August 1992 and November 1996. There were 20 females and 20 males, and mean age was 40.8 years (range, 10–84 years). Included in this group were five adolescents between the ages of 10 and 18. Five patients were older than 70 years of age. Follow-up is current in 37 patients, and 3 patients could not be reached. The mean follow-up is 12.5 months, and for 23 patients, it has been longer than 1 year since operation. Typical findings of achalasia after laparoscopic fundoplication developed in three patients. In two of these patients, preoperative manometry was not performed, and in the third patient, preoperative manometry results were normal.

Upper digestive symptoms were scored by the patient before and after operation using a five-point scale (0 = symptom absent, 1 = symptom rare, 2 = symptom occasional, 3 = symptom frequent, and 4 = symptom disabling). Routine preoperative patient-initiated symptom scoring was started after eight patients had undergone laparoscopic Heller myotomy. Thus, symptom scores were available in 32 patients before surgery and in 37 patients after surgery (6 months and 1 year, respectively). The most recent symptom scores were used for postoperative assessment in which two sets of symptom scores were available in the same patient.

For this study, we analyzed four symptoms: dysphagia, regurgitation, heartburn, and chest pain. Before surgery, dysphagia was scored as 2 to 4 in 25 (78%) of 32 patients, regurgitation was scored as 2 to 4 in 25 (81%) of 31 patients, heartburn was scored as 2 to 4 in 17 (55%) of 31 patients, and chest pain was scored as 2 to 4 in 15 (48%) of 31 patients. Preoperative weight loss >4.5 kg occurred in 31 (77%) of patients. A barium swallow was performed in all patients and was available for review in

38 patients. Ten patients had a normal or mildly dilated esophagus (<3 cm), 20 patients had moderate esophageal dilation (3–7 cm), 5 patients had dilation >7 cm, and 3 patients had a sigmoid esophagus. Esophagogastroduodenoscopy was performed in all patients to rule out a peptic or malignant cause for dysphagia.

Esophageal manometry was performed before surgery in 36 (90%) of patients and omitted in 4 patients because of megaesophagus. In 9 of the remaining 36 patients (25%), motility was incomplete because of an inability to pass the catheter through the gastroesophageal junction, despite the use of fluoroscopy. Incomplete or absent sphincter relaxation was present in all patients. Four patients had repetitive high pressure contractions and were given the diagnosis of vigorous achalasia. In all patients treated previously, resting lower esophageal sphincter pressure (LESP) was >10 mmHg. Although the diagnosis of achalasia usually was secure before the motility study, in four patients (including the three patients treated previously for gastroesophageal reflux with laparoscopic fundoplication) achalasia was an unsuspected manometric finding.

Previous treatment for achalasia was present in three fourths of our population. Twenty-one patients had previous pneumatic dilation (12 patients had multiple treatments), 6 patients had been treated previously with botulinum toxin (BOTOX) and pneumatic dilation, 1 patient was treated with BOTOX alone, and 2 patients had previous transthoracic cardiomyotomy. Only one of the adolescents had been treated previously, an 18-year-old boy who had been treated with both balloon dilation and BOTOX. Patients with favorable response to balloon dilation but who ultimately required operation were asked to compare the initial results of balloon dilation with the initial results of laparoscopic cardiomyotomy.

Statistical Methods

Symptom scores before surgery were compared with symptom scores after surgery in the same patient. A Wilcoxon signed rank test was used for statistical inference.

RESULTS

Forty patients underwent laparoscopic cardiomyotomy. All operations started laparoscopically were finished laparoscopically, including the five patients who had undergone operation previously about the GE junction. After completion of cardiomyotomy, 32 patients underwent posterior fundoplication, and 7 underwent anterior fundoplication. The mean (± standard deviation) operating time was 199 ± 36.2 minutes. In the last ten patients, operating time ranged from 135 to 180 minutes. Water-soluble barium swallows showed no leak after surgery in 39 patients and was equivocal in 1 patient (see below).

Figure 7. Barium trapping behind a mucosal fold creates the illusion of perforation (A) but delayed films showed esophageal emptying, and a computed tomographic scan shows the source of the fever, LLL consolidation (B).

Thirty-seven patients left the hospital in <72 hours. Only three patients stayed beyond 3 days, two because of generalized frailty and one for antibiotic therapy of a possible microperforation (Fig. 7).

Preoperative symptom scores were compared to postoperative symptom scores. Dysphagia was eliminated or rare (score, 0–1) in 36 (90%) of 40 patients and regurgitation was eliminated in all but 2 patients (Fig. 8). Statistically significant, but lesser, changes were noted in heartburn and chest pain scores. Preoperative weight loss was reversed in all patients. In four patients, dysphagia is present but was improved by operation in two of the four. Included in this group are both patients who had previous transthoracic cardiomyotomy, 1 of 3 patients with sigmoid esophagus, and 1 of 20 patients with moderate esophageal dilation. One of the two patients who had previous transthoracic cardiomyotomy and a megaesophagus underwent esophagectomy 1 year after laparoscopic Heller myotomy.

Most patients treated previously with balloon dilation or BOTOX injection reported improvement in swallowing with these techniques, but 18 (64%) of 28 said the results of cardiomyotomy offered greater improvement in swallowing, and 10 (36%) of 64 said the initial results of balloon or BOTOX were equivalent to those of surgery, but dysphagia had not recurred after operation in all but one of these 28 patients.

Complications

Intraoperative mucosal perforation occurred in six patients (15%) and usually was the result of electrosurgical injury to the mucosa during myotomy. It occurred on the gastric end of the myotomy in two of these patients and in the region of previous BOTOX injection at the LES in two patients. Simple repair was sufficient in all patients. In one patient, without

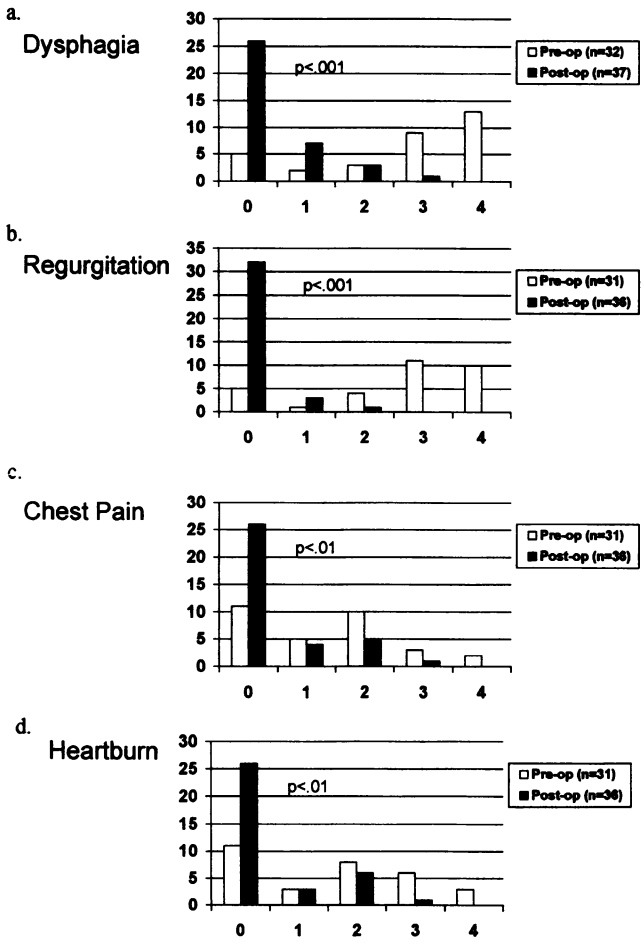

Figure 8. (a–d) Symptom scores for dysphagia, regurgitation, chest pain, and heartburn were compared before surgery and after surgery.

intraoperative perforation, a fever on postoperative day 2 was investigated with a barium swallow. This initially was thought to represent a mucosal perforation, but a computed tomographic scan showed lower left lobe pneumonia, and delayed esophageal images showed complete emptying of the esophagus (Fig. 7). Pneumothorax occurred in one patient, was identified, and was evacuated out a trocar site with a red rubber catheter placed across the pleural laceration at the completion of the case. Intraoperative hypercarbia, refractory to intra-abdominal pressure reduction, was treated by changing insufflation gas to nitrous oxide in one patient.

Postoperative complications occurred in three patients (7.5%). Pneumonia occurred in two patients, and a postoperative upper gastrointestinal bleeding occurred in one patient 2 weeks after laparoscopic Heller myotomy and anterior fundoplication. Esophagogastroduodenoscopy in this patient showed an ulcer immediately above the gastroesophageal junction. Transfusion was unnecessary, and healing has occurred on H_2 receptor antagonists. There were no postoperative deaths, but two patients are now dead of other causes.

DISCUSSION

The diagnosis of typical and vigorous achalasia is rarely difficult. Symptoms of dysphagia and regurgitation, coupled with a barium swallow finding of a "bird's beak" esophagus suggested the diagnosis in 90% of our patients. Endoscopy was critical in removing all doubt about the benign nature of the esophageal narrowing. Esophageal motility study performed in 36 patients confirmed the diagnosis of achalasia in 32 and provided an unsuspected diagnosis of achalasia in 4 patients (1 patient with an esophageal diverticulum, 1 patient with a normal barium swallow, but typical achalasia symptoms, and 2 patients after laparoscopic fundoplication). Esophageal motility study also was helpful showing elevated resting LESPs in patients who did not respond to balloon or BOTOX treatment.

Achalasia may be difficult to diagnose after fundoplication but should be considered in all patients with postoperative dysphagia, even if preoperative esophageal motility study was normal. In a cohort of approximately 40 patients referred to the Swallowing Center for evaluation of post-Nissen dysphagia, 5 patients had the symptoms and manometric findings of achalasia. All have responded well to cardiomyotomy and partial fundoplication. Two of these operations were performed via laparotomy because of previous laparotomy. The three patients of these treated with laparoscopic access had undergone laparoscopic Nissen fundoplication within the past year, two without preoperative manometry and one with normal preoperative manometry. Achalasia probably was overlooked in one of these five patients based on review of the preoperative barium swallow, but it is more likely that it was acquired after surgery ("iatrogenic" achalasia) in the other four patients.[6] When we have performed a cardiomyotomy on individuals with dysphagia after fundoplication who possess the manometric profile of achalasia and are refractory to standard dilation techniques, our results were superior to those of treatment with pneumatic dilation or "redo" hemifundoplication alone.

Historically, the most popular treatment for achalasia is dilation. Dilation with rigid instruments (initially a whale bone) has been performed since the 17th century but was supplanted in the 20th century by dilation with various nylon, silk, and latex bags and balloons. Modern therapy involves the rapid inflation of a 30- to 35-mm polyethylene balloon in the distal esophagus under fluoroscopic observation.[7] A water-soluble contrast study is performed immediately to prove that esophageal perforation has not occurred (range, 2%–12%). The success rate of this procedure is 55% to 70% with a single dilation but can be increased to nearly 90% with multiple dilations.[2,7,8–10] The best results may be attained (albeit with a slightly higher risk of perforation) by increasing balloon size in a stepwise fashion over several months from 3 to 4 cm. For

balloon therapy to be effective in alleviating dysphagia, it should lower the resting LESP to <10 mmHg,[1] but in none of our patients dilated previously was resting LESP <10 mmHg. In patients with dysphagia, esophageal dilation and low-resting LESP (<10 mmHg) cardiomyotomy is less likely to improve swallowing. In the only prospective, randomized trial performed comparing balloon dilation with surgery, cardiomyotomy outperformed balloon dilation 95% to 65%.[11] When patients are stratified by age, balloon dilation is <50% effective in patients younger than 40 years of age and is rarely effective in adolescents.[8,12] Although initially there was great fear that previous balloon dilation would make laparoscopic myotomy more difficult, this was not our experience. Frequently, when performing cardiomyotomy, it was possible to observe the disrupted LES in patients who had undergone balloon dilation previously, but this did not impede cardiomyotomy significantly.

Other nonoperative therapies, such as calcium channel antagonists or BOTOX injection, generally are less effective than is balloon dilation. The only role for calcium channel antagonists is as a temporary measure while awaiting definitive therapy. Initially, BOTOX is as effective as balloon therapy but requires frequent retreatment to maintain an efficacy rate of 65%.[13] Although it is tempting to use BOTOX as a temporizing maneuver, it may scar the submucosal plane at injection points. In this series, esophageal mucosal perforation occurred during cardiomyotomy in two (29%) of the seven patients who previously had been treated with BOTOX. It is our belief that BOTOX should be reserved for the treatment of achalasia in patients who are poor candidates for surgery (*e.g.*, high anesthesia risk), and poor candidates for balloon dilation (*e.g.*, patients with sigmoid esophagus).

The most common surgical treatment for achalasia practiced in North America for the past 40 years has been transthoracic Heller myotomy,[2,4] but transabdominal cardiomyotomy remained popular in South America and Europe during this period.[11,14–16] The success rate at relieving dysphagia was 89% to 95% whether cardiomyotomy was performed through a thoracotomy or laparotomy.[2,8,9,11,14–16] At the same time, postoperative esophageal perforation was <1%. Despite these excellent results, 75% of patients opted for balloon dilation as primary therapy when both options were presented fairly to the patient.[9] Laparoscopic surgery, by reducing the pain, the scar, and the postoperative disability, has made surgical therapy more attractive to patients.

The first published series of minimally invasive cardiomyotomy mimicked the transthoracic approach to LES.[5] Although this operation was quite successful, it has been abandoned largely by its originators in favor of the laparoscopic approach. Problems with the thoracoscopic approach included the following:

1. A perpendicular approach to the esophagus is less favorable for attaining and maintaining the submucosal plane than is the horizontal approach afforded by laparoscopic access.
2. It is difficult to judge the appropriate end to the myotomy to completely divide the LES but not allow postoperative reflux. The use of an endoscope in the esophagus with thoracoscopic access helped in making the myotomy long enough, but did not prevent reflux. An endoscope is unnecessary for the laparoscopic approach.
3. Postoperative pain and length of hospitalization generally are greater after operation using a thoracoscopic approach than after a laparoscopic cardiomyotomy.[17]

Laparoscopic Heller myotomy was first described in 1991.[18] Two recent series confirmed equivalent efficacy and safety of the laparoscopic approach when compared with those of open Heller myotomy.[19,20] Careful follow-up manometry showed that the LES resting pressure and residual pressure (pressure remaining during swallowing) were equivalent when open and laparoscopic operations were performed. After performing thoracoscopic cardiomyotomy, we found the laparoscopic approach was decidedly simpler, and it allowed us to perform a hemifundoplication, obviating the guessing game of how much sphincter division was enough, yet not too much.

The greatest "lesson learned" during this study was the importance of careful patient selection for laparoscopic Heller myotomy. Of the four patients who reported occasional or frequent dysphagia, two of them had previous transthoracic cardiomyotomy after surgery and one of the patients had a sigmoid esophagus. A preoperative predictor of postoperative dysphagia was absent in the last patient. One of the patients with a megaesophagus after transthoracic cardiomyotomy was advised to have esophagectomy at initial evaluation, but wished a laparoscopic attempt first. The second patient who had a previous cardiomyotomy had a resting LESP of 10 mmHg and was advised to undergo esophagectomy but desired an attempt at laparoscopic Heller myotomy. Esophagectomy has been performed subsequently in the first patient and is scheduled to be performed in the second patient. In patients without a sigmoid esophagus before surgery and who have not undergone previous surgery for achalasia, there have been no failures of therapy and only one patient reported occasional dysphagia, chest pain, and regurgitation. Currently, we would not offer a laparoscopic cardiomyotomy to a patient with a previous achalasia operation if the patient's resting LESP was ≤10 mmHg pressure.

The technique of laparoscopic cardiomyotomy evolved as experience progressed (generally to greater simplicity). Initially, we tried to avoid posterior dissection of the esophagus but learned that encircling the esophagus added

little additional operating time, allowed better inferior traction, and allowed easier dissection of the mediastinal esophagus. Such dissection is, of course, critical to the performance of posterior fundoplication but not always necessary for anterior fundoplication. Routine dissection of the greater curvature, although not adding simplicity, does allow a tension-free hemifundoplication and should be performed even if an anterior fundoplication (Dor) is chosen. Mucosal holes, although intimidating initially, are handled adequately with simple suture with 4–0 Vicryl (Ethicon, New Brunswick, NJ). It is unnecessary to buttress the repair with the fundoplication. Mucosal burn marks from accidental contact with the monopolar hook are best handled by oversewing the burn site. Esophageal dilators and endoscopes generally are unnecessary, and dilators should not be used during the cardiomyotomy. The dilator will thin out the mucosa and not allow adequate separation between mucosa and muscularis. Attempts at using the ultrasonic scalpel for myotomy also resulted in more frequent mucosal perforation and was abandoned.

Previous studies of cardiomyotomy showed little symptomatic reflux if fundoplication was not performed,[14] but abnormal pH studies were discovered in six of ten patients after thoracoscopic cardiomyotomy.[21] Based on these data, we thought it beneficial to perform a fundoplication in conjunction with Heller myotomy. Although there is some debate as to the best antireflux procedure to perform, we were unable to show any symptomatic difference between the anterior and posterior fundoplication. The posterior fundoplication (Toupet) has been our favorite because it holds the myotomy open and in the supine position, it theoretically should be a better reflux valve. In the recumbent position, the fundus fills with intragastric fluid, closing off the gastroesophageal junction. This benefit is lost if the fundus is brought anterior to the esophagus. Conversely, the posterior fundoplication appears to create a posterior "bar" impeding esophageal emptying in patients with a markedly dilated esophagus, so we favor an anterior fundoplication in this group. No 24-hour pH data are available comparing anterior and posterior fundoplication when performed in conjunction with a Heller myotomy, but esophageal pH seems to be well controlled with anterior fundoplication in >90% of patients undergoing laparoscopic cardiomyotomy (Way, personal communication, 1996).

Laparoscopic cardiomyotomy is a safe, effective procedure for the treatment of achalasia. The greatest challenge in the next decade will not be deciding who should be offered laparoscopic cardiomyotomy, but deciding who would best be served with nonoperative therapy. Although some believe that surgery should be the primary therapy in all patients with achalasia, there are ample data to suggest that a single balloon dilation will be effective in the majority of patients older than 40 years of age, and it is our observation that balloon dilation does little to harm subsequent cardiomyotomy. For this reason, we recommend laparoscopic cardiomyotomy as primary therapy in the young and reserve cardiomyotomy therapy for a failure of balloon dilation in individuals older than 40 years of age.

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Discussion

DR. HIRAM C. POLK, JR. (Louisville, Kentucky): Dr. Cameron, Dr. Copeland, Ladies, and Gentlemen. I think this paper represents a rare coming of age of laparoscopic papers. You can compliment the presentation, you can compliment the work, but this is distinctly different from the reports we have heard from the laparoscopic community over the last year and many meetings prior to this in which hundreds of patients who have at least belched once have had laparoscopic Nissen fundoplication.

We have been told this morning that 10% of the American population have reflux esophagitis. The good news is they will all soon be postoperative, so we will not have to hear about them anymore.

I think you need to contrast this paper, though, because John did not dwell on some things that make this paper extremely good. Number one, there is a precise discussion of technical detail about how to do this operation.

There also is an honest discussion of patients that he wished he had not operated on. I think those are the things that let you know someone is approaching this with real objective care.

Let me stress again that he had 21 patients who failed after pneumatic dilatation. There were six more who failed after balloon dilatation. There were two patients who failed after transthoracic myotomy, and there was one patient with a failed botulinum toxin.

Furthermore, there were three patients who had onset of swallowing disorders after fundoplication. Almost all of those people have had achalasia all along; it has just been missed.

I think this is a remarkable report that is a coming of age of the new generation of laparoscopic procedures. I probably would only challenge one point. They have not stressed the importance of crural repair. It probably is as important as a loose repair as a part of the Heller myotomy operation.

I think this is a wonderful paper that has been very well presented. More and more of our laparoscopic papers should try to emulate this standard for reporting results in patients who need operations.

Thank you very much.

DR. WILLIAM O. RICHARDS (Nashville, Tennessee): Thank you, Dr. Cameron, Dr. Copeland, Members, and Guests. It is a great privilege to be able to discuss this paper. John and his colleagues have presented extraordinary results with their approach.

First, I'd like to amplify that their approach is the best approach available now. We started out doing this transthoracically and found that the approach makes it very difficult to reach the lower esophageal sphincter (LES), which is the critical point of this operative procedure. The transabdominal approach allows you to divide the LES, and it provides much better results.

Moreover, it is simpler because you do not have to insert a double lumen endotracheal tube or a chest tube.

My question and comment is related to whether or not you need to add the antireflux procedure to this procedure. My colleague, Ken Sharp, and I have performed laparoscopic Heller myotomies in 21 patients, and only two of those patients, 10% of our population, are symptomatic with reflux at this time. Moreover, we have had the opportunity to do 24-hour pH studies in many of these patients, and we have not found significant gastroesophageal reflux in these patients.

Perhaps one thing we are doing is a routine intraoperative endoscopy to grade the amount of LES sphincter division intraoperatively. That may be one difference.

Finally, I'd like to say that I question the routine use of the antireflux procedure in these patients because of the question that you addressed, John. The dilated sigmoid esophagus has poor propulsion. What is going to happen to these patients long term if you add more LES resistance? Are we going to see these patients 15 years down the road with a dilated esophagus unable to propulse food bolus past the LES?

I'd like to thank the Association for the privilege of the floor.

DR. WILLIAM C. MEYERS (Worcester, Massachusetts): Dr. Hunter, Dr. Branum, and colleagues continue to lead the way in some of the newer, minimally invasive procedures. Thank you for this superb study.

The Heller myotomy does appear to be a good operation to be performed laparoscopically. It satisfied the criteria that it is the safe, simple, and efficient operation, and one can perform exactly the same operation as one would with an open operation.

I have two questions. First, what do you think of those two criteria for defining whether or not an operation in general should be performed laparoscopically? We have also performed five Heller myotomies in children, as Dr. Richards has, without fundoplication.

There has also been an excellent relief of symptoms with no evidence of reflux on short-term follow-up.

We also use esophagogastroscopy intraoperatively to help guide our cut. Do you think we should still be adding a fundoplication?

I thank the Association and Dr. Hunter for the privilege of the floor.

DR. JOHN G. HUNTER (Closing Discussion): Dr. Polk, Dr. Meyers, and Dr. Richards, thank you very much for your kind comments and questions.

Addressing Dr. Polk's question about the crural repair, I think this is a very interesting phenomenon because it generally is reported that patients with achalasia don't have hiatal hernias. As the esophagus dilates in these patients, frequently they develop hiatal hernias, not from the stomach transgressing the diaphragm, but from the large esophagus dilating the hiatal ring. We routinely add loose crural approximation to our repair when we do the Heller myotomy. Again, on the very large esophagus, we are a bit ginger about this because we do not want to create outflow obstruction by doing so.

I think the questions of Dr. Richards and Dr. Meyers about the need for an antireflux procedure are very germane. The question is do you cut too much or do you cut not enough? I think this is the problem. How much is enough?

An endoscope has been used as a guide in the University of California at San Francisco experience, but this has really been