Hypothesis: Laparoscopic Heller myotomy with anterior hemifundoplication is the surgical procedure of choice for the treatment of esophageal achalasia. Specific factors, eg, severity of esophageal body deformity, might affect postoperative outcome.

Design: Prospective case-control study.

Setting: Academic referral center for gastrointestinal tract motility disorders.

Patients: Twenty-nine patients with esophageal achalasia who underwent 1 to 3 sessions of failed pneumatic dilation each.

Intervention: Laparoscopic Heller myotomy with anterior (Dor) hemifundoplication.

Main Outcome Measures: Preoperative and postoperative symptomatic evaluation, esophagoscopy, esophagography, stationary and ambulatory esophageal manometry, and pH monitoring.

Results: Three patients had stage I disease, 10 had stage II, 12 had stage III, and 4 had stage IV at preoperative radiologic examination. At surgery, there were no conversions to open procedures, and 2 mucosal perforations were immediately identified and sutured. Good or excellent results were seen in 26 patients. All patients with stage I or II disease had excellent functional results. Of patients with stage III disease, results were excellent in 7, good in 4, and bad in 1. Of patients with stage IV disease, 2 had good results and 2 had bad results. After surgery, lower esophageal sphincter pressure was reduced significantly (from 46.1±12.1 to 5.4±1.8 mm Hg; P < .001), as was esophageal diameter (from 61±17 to 35±19 mm; P < .001) (data are given as mean±SD). However, an excellent result occurred only in patients with a postoperative esophageal diameter less than 40 mm.

Conclusion: Functional outcome of laparoscopic Heller-Dor procedure for achalasia is related to the preoperative stage of the disease on the esophagogram and to the extent of reduction in esophageal width after surgery.

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When pneumatic dilation of the lower esophageal sphincter (LES) is contraindicated or poor results are anticipated or the procedure fails to relieve the patient's symptoms, surgery should be considered for the treatment of esophageal achalasia. Transabdominal cardiomyotomy, first described by Heller in 1914, offers satisfactory results in approximately 95% of patients with achalasia. More recently, minimally invasive esophagomyotomy by laparoscopy is replacing open surgery for achalasia, but data comparing these 2 different approaches are sparse. Data from small series show similar results concerning relief of dysphagia and satisfaction of the patient with the outcome after either approach. The laparoscopic approach is associated with significantly less blood loss, parenteral narcotic use, hospitalization time, and time off work. However, little has been reported about any predictors of outcome after surgery. It has been suggested that a significant reduction in esophageal body diameter on an esophagogram after surgery is associated with good postoperative functional results, whereas the patient with a dilated and tortuous esophagus is unlikely to respond to cardiomyotomy.

In the present study, we analyzed data from 29 patients who underwent laparoscopic Heller myotomy and anterior hemifundoplication for achalasia and who completed 1-year follow-up. Emphasis was given to documentation of the results and to definition of any predictors of outcome.
PATIENTS AND METHODS

Between January 1, 1995, and June 30, 1998, 29 patients underwent laparoscopic treatment for esophageal achalasia. Preoperative workup included clinical assessment, esophagography, upper alimentary endoscopy, esophageal manometry, 24-hour ambulatory esophageal manometry, and pH monitoring. Severity of dysphagia, regurgitation, and heartburn was assessed separately according to a scoring system similar to that described by Johnson and DeMeester10 (0 indicates absence; 1, occasional episodes; 2, frequent episodes; and 3, daily episodes). On the esophagogram, the diameter of the esophagus 8 cm proximal to the gastroesophageal junction was measured and the disease was graded as follows: stage I, diameter less than 40 mm; stage II, diameter of 40 to 60 mm; stage III, diameter greater than 60 mm; and stage IV, diameter of any size with sigmoid configuration of the distal esophagus. Ambulatory esophageal manometric and pH monitoring data were assessed according to standard definitions.11

OPERATIVE TECHNIQUE AND POSTOPERATIVE MANAGEMENT

Dissection was limited to the anterior aspect of the abdominal esophagus and the diaphragmatic crura. The anterior vagal trunk was dissected and preserved, as was the hepatic branch of the anterior vagus. After dissecting and excising the fatty pad of the gastroesophageal junction, the myotomy was started from the junction and was extended proximally on the esophagus up to 5 cm by dividing the circular muscular layer and distally on the stomach up to 1.0 to 1.5 cm by dividing the oblique muscular fibers. Division of the muscular fibers was achieved using a hook device and minimal electrocautery. The cut muscular edges were dissected laterally to fully expose the anterior aspect of the submucosa. The integrity of the submucosal layer was tested by instilling 30 mL of diluted methylene blue through a nasal tube into the esophageal lumen. The operation was completed with an anterior hemifundoplication of the Dor type, which was accomplished by suturing the anterior gastric fundus first to the left cut edge of the myotomy and the left pillar of the crus and then to the right cut edge of the myotomy and the right pillar of the crus.12

The nasogastric tube was left in place for 24 to 48 hours and was removed after a meglumine diatrizoate (Gastrografin) swallow showed easy passage through the lumen of the gastroesophageal junction and no leaks. A liquid diet was then resumed. On the second postoperative day and continuing for 6 to 8 weeks, a soft diet was recommended. Unless other complications occurred, patients were discharged from the hospital on the second to third postoperative day.

POSTOPERATIVE ASSESSMENT

Patients were clinically assessed 2 weeks, 3 months, and 1 year after surgery. Clinical outcome was classified as excellent (symptomatic score of 0-1), good/satisfactory (symptomatic score of 2-4), or bad (symptomatic score of ≥5). Nine months to 1 year after surgery, all patients underwent esophagography, standard stationary manometry, and 24-hour ambulatory esophageal pH monitoring.

STATISTICAL ANALYSIS

Unless otherwise stated, all values are expressed as mean±SD. Comparisons between preoperative and postoperative values of the various variables were made by applying the Mann-Whitney test for paired values and the χ² test with the Yates correction, as appropriate. Regression analysis was also used to identify any correlation between the preoperative stage of the disease and the clinical and laboratory outcomes after surgery. P<.05 was considered statistically significant.

RESULTS

PREOPERATIVE ASSESSMENT

There were 12 men and 17 women aged 47.5±18.9 years (range, 18-74 years). Duration of symptoms was 5.2±4.5 years (range, 1-19 years). Twelve patients underwent 1 session, 10 underwent 2 sessions, and 4 underwent 3 sessions of LES pneumatic dilation before surgery, with temporary or no relief of dysphagia. In only 3 patients with stage IV disease on esophagography (dilated sigmoid shape of the distal esophagus) was pneumatic dilation not attempted immediately before surgery, although they had 1 to 2 attempts at earlier stages of disease. All patients had constant dysphagia and regurgitation. Twelve patients reported weight loss, 10 experienced recurrent respiratory tract symptoms, and 7 had heartburn. Two young patients reported spontaneous or postdeglutition chest pain.

According to the preoperative esophagogram, patients were classified as follows: stage I, 3 patients; stage II, 10; stage III, 12; and stage IV, 4. Mean esophageal diameter was 61±17 mm. Mean LES pressure was 46.1±12.1 mm Hg (range, 29-69 mm Hg). Lower esophageal sphincter relaxation was absent in 23 patients and incomplete in 6. At standard esophageal manometry, esophageal peristalsis was absent in all patients. Ambulatory manometry showed aperistalsis in 26 patients, failed peristalsis in 2, and dropped peristalsis in 1. An abnormal DeMeester score (51±22) on esophageal pH monitoring was found in 9 patients, 7 of whom reported heartburn. In these 9 patients, the pattern of reflux was characterized by a few long-duration reflux episodes (total reflux time, 18%±7%), with a pH just less than 4.

OPERATIVE AND POSTOPERATIVE COURSE

Operative time was 73±18 minutes (range, 45-105 minutes). Blood loss was minimal. The location of the gastroesophageal junction with use of the endoscope as the Z-line was usually 0.5 to 1.0 cm more proximal than that found using the laparoscope as the proximal border of the oblique muscle fibers of the stomach. In most patients, there was considerable difficulty in detaching the cut edges of the circular muscle fibers away from the underlying esophageal submucosa. Two intraoperative mucosal perforations occurred, both at the level of the gastroesophageal junction: one using the transesophageal endoscope and the other using the hook device dur-
Clinical Presentation and Radiological, Manometric, and Esophageal pH Monitoring Findings Before and After Myotomy and Anterior Hemifundoplication*

<table>
<thead>
<tr>
<th></th>
<th>Before Surgery</th>
<th>After Surgery</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dysphagia scoring</td>
<td>2.62 ± 0.49</td>
<td>0.48 ± 0.91</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Regurgitation scoring</td>
<td>2.52 ± 0.78</td>
<td>0.41 ± 0.78</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Esophageal diameter, mm</td>
<td>61 ± 17</td>
<td>35 ± 19</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Lower esophageal sphincter</td>
<td>46.1 ± 12.1</td>
<td>5.4 ± 1.8</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>pH monitoring, DeMeester score</td>
<td>25 ± 21</td>
<td>16 ± 11</td>
<td>.02</td>
</tr>
</tbody>
</table>

*Data are given as mean ± SD.

After myotomy, there was an overall decrease in esophageal width. Patients with postoperative esophageal diameters of less than 40 mm had excellent functional results. The 8 patients with postoperative esophageal diameters of greater than 40 mm had either partial symptomatic improvement (n=5) or no improvement at all (n=3).

No leaks were evident on the immediate postoperative esophagogram, and the nasogastric tube was removed and an oral diet was resumed by all patients. Four patients developed atelectasis that was promptly resolved with chest physiotherapy and antibiotic treatment. Postoperative hospital stay was 2.2 ± 0.9 days (range, 1-8 days). The third patient in succession in the series was readmitted because of epigastric pain on the fifth postoperative day. He developed an esophageal leak and a small collection of fluid below the left hepatic lobe that was treated with percutaneous drainage. He was discharged from the hospital 6 days later. The late leak was attributed to desloughing of an esophageal mucosal burn at the upper site of myotomy. That particular patient had had esophageal pneumatic dilation on 3 occasions before surgery.

LONG-TERM FOLLOW-UP

At 1-year follow-up, excellent or good results were reported by 26 patients (90%). Twenty-one patients (72%) reported total relief of dysphagia and absence of regurgitation events (score of 0 for both symptoms in all patients), and another 5 patients (17%) were satisfied with the final outcome, reporting considerable improvement of dysphagia (a score of 1 in 4 patients and a score of 2 in 1 patient) and occasional episodes of regurgitation (a score of 1 in all patients). The remaining 3 patients (10%) did not show any improvement in dysphagia (a score of 2 in 1 patient and a score of 3 in 2 patients) and complained of frequent episodes of regurgitation (a score of 2 in 1 patient and a score of 3 in 2 patients). In addition, 3 patients had severe heartburn (a score of 2 in 1 patient and a score of 3 in 2 patients), and they all had stage IV disease at preoperative classification. All patients with stage I or II disease at preoperative assessment reported excellent results. Of 12 patients with stage III disease, 7 had excellent results, 4 had good results, and 1 reported a bad outcome. Of 4 patients with stage IV disease, the procedure failed to relieve the symptoms in 2 and the remaining 2 showed improvement but not complete dissolution of dysphagia. Conceivably, postoperative outcome was significantly related to the preoperative radiologic stage of the disease (r = 0.66; P < .001). An advanced radiologic stage at preoperative assessment was usually associated with a nonsatisfactory clinical outcome.

The esophagogram showed a significant overall decrease in the diameter of the lower esophagus after myotomy (Table and Figure). However, an excellent result (total relief of symptoms) occurred only when the postoperative esophageal diameter was less than 40 mm. Furthermore, the 5 patients with fair or satisfactory clinical outcomes had a significantly narrower esophagus after surgery than did the 3 patients with bad outcomes (P = .03).

The increased preoperative LES pressure was lowered significantly after myotomy (Table). The fact that postoperative LES resting pressure decreased invariably below 10 mm Hg signified a complete myotomy. There was no correlation between preoperative LES pressure or the extent of the postoperative decline in LES pressure and the clinical results. Ambulatory esophageal manometry did not reveal evidence of even partial restoration of esophageal peristalsis in any patient.

There was an overall significant decrease in DeMeester reflux scores to almost normal levels (Table). In particular, reflux scores were overall significantly decreased in the 9 patients with increased preoperative reflux (DeMeester score, 26 ± 21; P = .01, and total reflux time of pH < 4, 10% ± 10%; P = .03). However, 2 of these 9 patients continued to present with abnormal scores after surgery. Only 1 patient without reflux before surgery showed abnormally increased reflux scores after surgery.

Although the number of series reported in the literature and the overall number of patients included is rather small,
Because all patients had stage IV disease. The pattern of pathological findings on esophageal pH monitoring oc-
equate factor for good outcome. Therefore, a complete myotomy is a necessary but not ad-
 Adequate myotomy. However, not all patients were satisfied with the results. In the present series, in which 4 patients had stage IV disease on the preoperative esophagogram, excellent or good results were obtained in 26 patients with laparoscopic myo-
 Cancer. However, 2 of 4 patients in the present se-
 rious with a very dilated and tortuous distal esophagus re-
 ported satisfactory functional results, with occasional dysphagia or regurgitation. Furthermore, 83% of patients with a dilated and straight distal esophagus and all patients with a dilated and sigmoid-shaped esophagus had a satisfac-
 tory functional outcome in a series reported by Patti et al.10 Taking into account the minimal morbidity of the laparo-
 scopic approach, we believe that all patients with stage IV disease should be offered laparoscopic myotomy first, re-
 serving esophagectomy for patients who were not relieved of their symptoms.

In any case, the functional outcome of myotomy is strongly related to the preoperative stage of the disease on the esophagogram. All patients with stage I or II disease in the present series had excellent results, whereas less sat-
 isfactory or bad results were seen only in some patients with stage III and all with stage IV disease. Furthermore, the results of the present series showed that good or ex-
 ceellent functional results are obtained only in patients with a postoperative esophageal diameter of less than 40 mm on the esophagogram. Patients with less satisfactory or even bad outcomes demonstrated a more dilated esophagus after surgery.

After pneumatic dilation of the esophagus, a reduc-
 tion of LES resting pressure to less than 10 mm Hg is con-
 sidered a prerequisite for satisfactory results.17 This seems to be the case in patients treated with myotomy, using ei-
 ther the open or closed approach.1,9,12,16,18,19 All patients in the present series invariably had resting LES pressure of less than 9 mm Hg at postoperative esophageal manom-
 etry, signifying an adequate myotomy. However, not all these patients had satisfactory functional results. There-
 fore, a complete myotomy is a necessary but not ade-
 quate factor for good outcome.

The addition of Dor fundoplication in the present series prevented gastroesophageal reflux. Heartburn and pathological findings on esophageal pH monitoring oc-
 curred in 5 patients after surgery and were attributed to delayed esophageal emptying rather than to true reflux because all patients had stage IV disease. The pattern of esophageal acidity, as detected on pH monitoring, is dif-
 ferent in the case of true esophageal reflux than in that caused by delayed esophageal emptying. In the latter case, there is usually a constant decrease in esophageal pH to just less than 4. In the former case, sharp declines to pH less than 2 are observed.

In conclusion, laparoscopic Heller myotomy with Dor fundoplication is effective in relieving dysphagia in most patients with achalasia, preventing simultaneous gastro-
 esophageal reflux. A good postoperative result is ex-
 pected when the length of myotomy is adequate, LES pres-
 sure declines substantially, preoperative esophageal dilation is not excessive, and distortion of the distal esophagus is absent. Patients with stage IV disease can be treated with myotomy provided that the postoperative width of the esophagus decreases to less than 40 mm. Increased esoph-
 ageal acidity and heartburn in patients after myotomy is attributed to delayed esophageal emptying.

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