Hypothyroid: Laparoscopic Heller esophageal myotomy improves esophageal clearance and symptoms of achalasia in the early and late postoperative periods.

Design: We followed up 98 consecutive patients attending a referral center between February 1, 1994, and July 1, 2000, who underwent laparoscopic myotomy. Operative time, complications, and length of stay were recorded. Postoperative outcomes were assessed using Van Trappen symptom scores (1 indicates no symptoms; 2, symptoms occurring less than once a week; 3, symptoms occurring more than once weekly; and 4, persistent symptoms) and scintigraphic esophageal transit studies.

Results: Of 98 patients, 91 underwent anterior fundoplication. There were no open conversions and 1 mucosal perforation, which was closed laparoscopically without complications. Mean operative times and postoperative days were 3.2 hours and 4.3 days, respectively, in the first 32 patients and 1.7 hours and 2.3 days, respectively, in the last 32 patients (P<.001). Postoperative complications included pneumothorax (4% of patients), atelectasis (5%), and delayed gastric emptying (1%). Seventy-five percent of patients gained weight after surgery. At longest follow-up, 91% of patients were satisfied with the outcome of the procedure. Mean Van Trappen scores for dysphagia improved from 4.0 in the preoperative period to 1.2 at early and late follow-up (P<.001). Fluid retention at 10 minutes in the upright position was 47% in the preoperative period and improved at early and late follow-up to 21% and 20%, respectively (P<.001).

Conclusions: Laparoscopic Heller myotomy can safely reverse the symptoms of achalasia and improve esophageal transit. These benefits, realized during the early postoperative period, were maintained at longest follow-up.


DIOPATHIC ESOPHAGEAL achalasia is a primary motility disorder of the esophagus of unknown etiology. The underlying pathophysiologic features seem to be loss of ganglion cells in the esophagus, resulting in the absence of peristalsis of the esophageal body; failure of the lower esophageal sphincter (LES) to relax with swallowing; and normal or elevated resting LES pressures. A functional obstruction at the level of the LES results in progressive dysphagia to liquids and solids. Without adequate treatment, regurgitation and weight loss develop. Presently, all forms of treatment are directed at relieving the functional obstruction at the level of the LES by disrupting or poisoning the muscles contributing to the high-pressure zone. Because the LES is the primary barrier to gastroesophageal reflux, disruption places the patient at risk for pathological gastroesophageal reflux. Treatment of patients with achalasia must strike a balance between the relief of dysphagia and the potential creation of pathological gastroesophageal reflux.

Nonsurgical treatments consist of calcium channel blocker use, passive and pneumatic dilation of the gastroesophageal junction, and botulinum toxin injection into the LES. Pneumatic dilation improves symptoms in approximately 70% of patients who undergo this form of treatment. Proponents of pneumatic dilation argue that it is safer and less costly than surgical therapy. Critics point out the risk of perforation; the need for repeated dilations, especially in younger patients; and the high incidence of subsequent gastroesophageal reflux. Results of a randomized controlled study of Heller myotomy vs pneumatic dilation suggest that myotomy leads to a superior result. Analysis of the use of botulinum toxin shows that 45% (14/31) of patients did not respond or relapsed within 2 to 3 months. Of those who responded, 68% remained in remission at 1 year.

Esophageal myotomy has been the surgical procedure of choice for the treat-
PATIENTS AND METHODS

STUDY DESIGN

From February 1, 1994, to July 1, 2000, ninety-eight consecutive patients, 51 females and 47 males, aged 16 to 83 years (mean age, 45 years) underwent laparoscopic esophageal myotomy at the Vancouver Hospital and Health Sciences Center, Vancouver, British Columbia. The diagnosis was made on the basis of clinical history and results of barium swallow, upper gastrointestinal tract endoscopy, and manometry. Fifty-nine patients had undergone preoperative pneumatic dilation, and 8 patients had received at least 1 botulinum injection into the LES muscle.

Operative time, complications, and length of hospital stay were recorded for each patient. Postoperative outcomes were assessed by esophageal transit studies and a standardized patient questionnaire for symptoms. The standardized questionnaire was administered by telephone interview or at follow-up clinic visits. Patients’ symptoms were subdivided into 4 classes as proposed by Van Trappen and Hellemans:1 class 1, no symptoms; class 2, symptoms occurring less than once a week; class 3, symptoms occurring more than once weekly; and class 4, persistent symptoms. Patients were also asked to classify their satisfaction with the procedure as very satisfied, somewhat satisfied, or not at all satisfied. The symptoms analyzed include dysphagia, heartburn, and regurgitation.

Esophageal transit studies were performed with 100 mL of water labeled with technetium Tc 99m sulfur colloid using multiple swallowing techniques.14 Imaging was performed for 10 minutes in the supine position and then for 10 minutes in the upright position. Standard esophageal manometry was performed using a solid-state pressure catheter in the manner described by Castell and Castell.15

SURGICAL TECHNIQUE

The objectives of this procedure are (1) to carry out myotomy of the longitudinal and circular muscles of the lower 6 cm of the esophagus, the esophagogastric junction, and the proximal 2 cm of the stomach obliterating the dysfunctional LES and (2) to augment the antireflux barrier by fixing the lower 6 cm of myotomized esophagus below the diaphragm under the influence of positive intra-abdominal pressure and wrapping it with a partial anterior gastric fundoplication to compress the esophagus during increases in intragastric pressure, at which time reflux usually occurs.

Patients are given clear fluids for 48 hours before surgery. All procedures are done under general anesthesia, taking care to avoid aspiration during induction. A flexible endoscope is used to visualize the esophagus, stomach, and duodenum. All foreign materials in the esophagus and stomach are removed, and the tip of the esophagoscope is drawn back into the middle of the esophagus.

The patient is placed in the lithotomy position, with calf compressors in place. Pneumoperitoneum is produced using a Veress needle in the left upper quadrant. Five ports are used for this procedure. The left lobe of the liver is retracted, exposing the diaphragmatic hiatus. A Babcock retractor placed on the upper stomach is used to retract the esophagogastric junction caudally. The gastrohepatic ligament is divided, exposing the right crus of the diaphragm. The phrenoesophageal ligament is divided, avoiding injury to the vagus nerves. The left crus of the diaphragm is exposed completely. The retroesophageal space is opened from the right side of the esophagus, and the esophagus is encircled with a vascular tape. Six to 8 cm of esophagus is mobilized into the abdominal cavity, with careful attention to hemostasis.

The flexible esophageal is placed into the stomach using direct visualization. The phrenoesophageal ligament is divided along the line of the myotomy, avoiding injury to the anterior vagus nerve. The esophageal myotomy is started in the thickened esophagus, 6 to 8 cm proximal to the phrenoesophageal ligament. The myotomy is carried under the anterior vagus nerve, through the esophagogastric junction, and onto the stomach for at least 2 cm. The esophageal muscle is swept off the mucosa for 180°. The endoscope is removed, checking the esophagogastric junction for patency and the mucosa for perforations.

Six centimeters of esophagus is anchored in the abdomen by placing two 2-0 nonabsorbable sutures between the fundus, the left crus of the diaphragm, and the left myotomized esophageal muscle. The vascular tape is removed. The fundus of the stomach is then rolled loosely over the lower esophagus and anchored in place with 3 sutures between the fundus, the right myotomized muscle, and the right crus of the diaphragm, making sure that all of the myotomized esophagus is covered with the fundoplication. Patients receive a Gastrografin swallow the night of surgery, followed by clear fluids, and are discharged from the hospital 24 to 48 hours after surgery, with a dental soft diet for 3 weeks.

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Mean Van Trappen Symptom Scores for 89 Patients

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Preoperative (Mean, 4 mo)</th>
<th>Early Postoperative (Mean, 22 mo)</th>
<th>Late Postoperative (Mean, 22 mo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dysphagia</td>
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<td>1.2*</td>
<td>1.2*</td>
</tr>
<tr>
<td>Heartburn</td>
<td>...</td>
<td>1.6</td>
<td>1.4</td>
</tr>
<tr>
<td>Regurgitation</td>
<td>...</td>
<td>1.1</td>
<td>1.1</td>
</tr>
</tbody>
</table>

*P < .001 compared with preoperative data.

despite having better esophageal transit after surgery. This patient’s condition has improved with balloon dilation of the esophagogastric junction. A second patient required laparoscopic takedown of the fundoplication because of stricture at the site of the myotomy. This patient’s dysphagia has improved, but she now experiences heartburn.

Fifty-seven patients had preoperative heartburn at least once per week. Only 2 of these patients had weekly heartburn after surgery. Thirty-six patients had no heartburn before surgery. Of these, 2 developed heartburn at longest follow-up. Overall, 4% of patients had at least weekly heartburn in the postoperative period. Early and late Van Trappen scores for heartburn remained stable (Table). Ninety patients experienced preoperative regurgitation. Only 1 patient complained of regurgitation occurring more than once a week after surgery. Seventy-four percent of patients gained weight and 25% did not; 1 patient lost weight after surgery. Eight-seven patients were very satisfied with the operation, 1 was somewhat satisfied, and 1 was not at all satisfied at their last follow-up visit.

Preoperative and postoperative esophageal transit studies were performed in 67 patients. Early postoperative studies were done a mean of 1.7 months after surgery. The latest postoperative transit study was done a mean of 8 months after surgery. Mean esophageal retention of fluid after 10 minutes in the supine position improved from 70% in the preoperative period to 49% in the early postoperative period (P < .001) and 48% in the late postoperative period. Mean retention of fluid after an additional 10 minutes in the upright position improved from 47% in the preoperative period to 21% in the early postoperative period (P < .001) and 20% in the late postoperative period. Of the 67 patients, 1 had greater retention in the upright position at longest follow-up and 3 remained the same after surgery. Results of transit studies did not correlate with changes in symptom scores. Operative time, complications, symptom scores, and esophageal transit were not effected by the preoperative use of pneumatic dilation or botulinum toxin injection.

## Comment

During the past 6 years, laparoscopic esophageal myotomy and anterior fundoplication has been performed faster, with fewer complications, and with shorter hospital stays. If complications occur, they are minor, such as atelectasis, subcutaneous emphysema, and small pneumothoraces that resolve with supportive therapy. The most dangerous complication of not only esophageal myotomy but also pneumatic dilation is esophageal perforation. This complication, if not recognized and treated urgently, can result in mediastinitis, systemic sepsis, and sometimes death. The patient who survives the esophageal perforation will require multiple interventions, often with poor results. The incidence of esophageal perforation might be up to 12% with pneumatic dilation depending on operator experience.1,2 Esophageal mucosal perforations have been reported in up to 9% of patients undergoing esophageal myotomies through the abdomen2,3 or chest.4,5 The single instance of esophageal

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**RESULTS**

The following preoperative symptoms were recorded: dysphagia in 96% of patients, regurgitation in 92%, and heartburn in 58%. Weight loss of at least 2.2 kg was observed in 68% of patients. All patients had a bird’s beak deformity at the esophagogastric junction and aperistalsis in the body of the esophagus recorded by barium swallow. Esophageal manometry showed a mean (SD) preoperative LES pressure of 28.0 (17.2) mm Hg, with aperistalsis in all patients studied.

Of 98 patients, 91 underwent anterior fundoplication. No conversions to open procedures were required. One intraoperative complication occurred in the eighth patient, who sustained a perforation of the esophageal mucosa. This perforation occurred during repeated passage of the endoscope to assess the patency of the esophagogastric junction after myotomy. The perforation was repaired laparoscopically and covered by the fundoplication. The patient had no further complications. Mean operative time for all patients was 2.3 hours (range, 1.0-6.5 hours). Mean operative time was 3.2 hours in the first 32 patients vs 1.7 hours in the last 32 patients (P < .001). Mean overall postoperative stay was 3.1 days. Postoperative days declined from a mean of 4.3 in the first 32 patients to a mean of 2.3 in the last 32 patients (P < .001). Postoperative complications included pneumothorax (n = 4), subcutaneous emphysema (n = 5), atelectasis (n = 5), delayed gastric emptying (n = 1), pleural effusion (n = 1), pneumonia (n = 1), and wound infection (n = 1).

The follow-up questionnaire was completed for 89 patients. Median follow-up was 18 months (range, 2-70 months). Mean symptom scores using the Van Trappen technique are shown in the Table. Dysphagia scores improved from 4.0 in the preoperative period to 1.2 in the early and late postoperative periods. The improvement in dysphagia scores persisted throughout follow-up. Although laparoscopic esophageal myotomy significantly improved the dysphagia score, 2 patients continued to have significant dysphagia. One patient had dysphagia

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**COMMENT**

During the past 6 years, laparoscopic esophageal myotomy and anterior fundoplication has been performed faster, with fewer complications, and with shorter hospital stays. If complications occur, they are minor, such as atelectasis, subcutaneous emphysema, and small pneumothoraces that resolve with supportive therapy. The most dangerous complication of not only esophageal myotomy but also pneumatic dilation is esophageal perforation. This complication, if not recognized and treated urgently, can result in mediastinitis, systemic sepsis, and sometimes death. The patient who survives the esophageal perforation will require multiple interventions, often with poor results. The incidence of esophageal perforation might be up to 12% with pneumatic dilation depending on operator experience. Esophageal mucosal perforations have been reported in up to 9% of patients undergoing esophageal myotomies through the abdomen or chest. The single instance of esophageal
mucosal perforation occurred early in our study, during repeated insertion of the endoscope to examine the extent of the myotomy. The mucosal perforation was closed laparoscopically and covered with a fundoplication without any long-term complications. Because of that adverse event, the endoscope was not reinserted after initial examination of the myotomy. Preoperative use of pneumatic dilation and botulinum injection made the myotomy more difficult but has not resulted in an increase in perforations or a decrease in the efficacy of the operation, as opposed to other reports. Careful dissection of the longitudinal and circular muscles away from the mucosa during myotomy have resulted in no mucosal perforations in the last 90 patients. The lack of open conversions and the low mucosal perforation rate have contributed to the high satisfaction rate of our patients.

Laparoscopic esophageal myotomy and anterior fundoplication resulted in improvement of dysphagia, regurgitation, and heartburn in most patients. The results were immediate and were sustained to the longest follow-up period. Regurgitation disappeared in all but 1 patient, which also contributes to the high satisfaction rate with the procedure. The improvement in dysphagia scores was better than for thoracoscopic esophageal myotomy reported by Patti and Stewart and their colleagues. Rosati and colleagues, using a laparoscopic myotomy and anterior fundoplication, also report that 96% of their patients had either absent or mild dysphagia after surgery. Ellis reported that 74% of his patients had no or minimal dysphagia 9 years after left-sided thoracotomy and myotomy without an antireflux procedure. Malthaner and colleagues reported that 67% of their patients had minimal dysphagia 19 years after a transthoracic myotomy with a partial fundoplication. Both Ellis and Malthaner and colleagues believed that the deterioration in functional results was probably due to an increase in gastroesophageal reflux. Heartburn occurs in at least 25% of patients undergoing pneumatic dilation, thoracoscopic myotomy, or transabdominal myotomy without fundoplication. Aguilar-Paiz et al reported no abnormal 24-hour pH results in patients with laparoscopic myotomy and fundoplication. In our study, 55 of 57 patients had improvement of their preoperative heartburn. Only 2 patients developed new heartburn after surgery. These findings suggest improved esophageal clearance after surgery.

Scintigraphic esophageal transit studies previously have been reported to provide a quantitative assessment of the response to therapy for achalasia. Liquid meals are superior to solid meals in assessing esophageal clearance because of variable mixing rates. We use a liquid meal in the supine position because it eliminates the assistance of gravity in clearing the esophagus, providing an assessment of esophageal body function. Upright swallowing of a liquid meal is a better measure of physiologic swallowing. Although supine and upright clearance improved significantly with myotomy, neither returned to within the normal range. Holloway and associates demonstrated that patients undergoing dilation or myotomy do not regain normal esophageal emptying. The significant improvement seen in esophageal emptying objectively confirms patients’ subjective impression and reaffirms that the treatment of this disorder is palliative rather than curative. This improvement seems to be sustained to the latest follow-up of our patients.

Our patients who did not have an anterior fundoplication had similar improvement in symptom relief and esophageal transit compared with those who had an anterior fundoplication. The ideal choice of type of fundoplication, including the necessity of dividing the short gastric vessels, remains unclear. Further study, preferably in a randomized clinical trial, is needed. Results of our medium-term follow-up of patients undergoing laparoscopic esophageal myotomy for the treatment of achalasia suggest that the technique can be performed effectively and safely; that outcomes are good, as assessed by symptom scores and esophageal emptying; and that symptom relief is sustained during follow-up of up to 6 years. The results, however, must be interpreted with caution because the work of Di Simone and colleagues suggests that up to 10 years of follow-up is required to detect the development of gastroesophageal reflux and recurrent dysphagia.

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REFERENCES

Cedric Bremner, MD, Los Angeles, Calif: The minimally invasive approach to esophageal myotomy was first described by Alfred Cuschieri in 1991 and spearheaded in the United States by Dr Pellegrini, who also abandoned thorascopic myotomy in favor of the laparoscopic approach. The laparoscopic approach has gained better acceptance than the open technique and offers a shorter hospital stay and less postoperative pain. Yesterday, Dr Patti's group presented their results with 102 patients who had undergone laparoscopic myotomy and the Dor fundoplication. Today, Dr Finley and his associates present a similar series treated by the same method in Canada.

Three large series such as these have also been reported by Drs Costantini and Bonavina in Italy and by Drs Hunt and Wills in Australia. Several similar series approaching these numbers have also been reported from laparoscopic centers in the United States. The unified results have been excellent, making this obviously the preferred treatment for achalasia today. However, there is still debate about the need for an antireflux procedure, the type of antireflux procedure, and the best methods of evaluating the results.

Those contesting the need for an antireflux procedure, including Dr Cuschieri himself, have done so largely on the basis of symptomatic assessment of reflux. Symptomatic evaluation of reflux does not equate well with 24-hour pH testing, which is the gold standard and preferred method of evaluating reflux.

Drs Costantini and Zaninotta used pH monitoring in both of their follow-up studies and reported reflux in only 6.3% and 6.9%, respectively. Furthermore, Dr Patti's group showed that reflux was reduced from 60% to 17% by adding a partial fundoplication. These results substantiate the use of the Dor as an acceptable procedure. It has the other advantage of not necessarily requiring division of the short gastric vessels, and this was discussed yesterday. This leads to my first question. Dr Finley, you dissected the retroesophageal space, which is not the practice in all centers. It would certainly be necessary if a hiatal hernia was also present, as occurs in about 5% of patients with achalasia. Is it necessary to include this maneuver in all cases and, if so, why?

Assessment of the adequacy of the myotomy and possible restrictive effects of esophageal emptying was done in Dr Finley's study using radioisotope techniques. Previous studies of smaller series using the same technique suggest that the supine assessment in achalasia is of no value, and this is understandable because of the inherent motility disorder. Fluid transit at 10 minutes in this study was 80% complete. Marshall's patients in another series had 85% to 98% emptying after pneumatic dilation alone, but of course methodology at different centers is likely to give conflicting results. That brings up another question.

Dr Finley, is the technetium method of assessing esophageal emptying an acceptable one, and is it standardized? Could it be better standardized for comparison of results in different centers, or would an alternative method, such as a timed swallow study, as described by de Oliveira, be one to look at?

My final comment relates to the risk of the procedure and the effect of prior pneumatic dilation or botulinum toxin injection. Dr Finley's group is to be congratulated on only one intraoperative mucosal transgression and no conversions to the open procedure, despite pneumatic dilation and botulinum injection in many patients. Others have also experienced this difficulty. Would Dr Finley comment on any particular tricks he may use when dissecting the adherent mucosa?

Lawrence W. Way, MD, San Francisco, Calif: It is interesting to see so many cases done by a single surgeon. I have two questions. First, what was the correlation between the symptomatic results and the scintigraphic results? Are there clinical inferences that can be made from the scintigraphic studies?

Second, when the term "heartburn" is used, for the reader it inevitably implies gastroesophageal reflux. Experiments have shown, however, that the substernal discomfort caused by reflux cannot always be distinguished from that resulting from other conditions. A judgment that reflux is either present or absent based on symptoms is fairly inaccurate. In another word, what is called heartburn is neither sensitive nor specific in the diagnosis of reflux. Further, we know that in achalasia, heartburn can result from esophageal stasis of food as well as from gastroesophageal reflux. Thus, the cause of heartburn cannot be assumed; it requires verification by pH monitoring.

Therefore, what did you mean to convey when using the word "heartburn" in describing postoperative symptoms? And why not perform pH monitoring to check?

John K. MacFarlane, MD, Vancouver, British Columbia: If I may, I was wondering whether Dr Finley might enlighten us as to whether or not reflux could be seen with scintigraphic studies. I know that some of these are done dynamically and perhaps he could comment on that for us.

Dr Finley: To address Dr Bremner's questions, is it necessary to dissect the retroesophageal space? The purpose of this maneuver is to mobilize 6 cm of tubular esophagus into the abdomen in order to facilitate a complete 6-cm myotomy of the esophagus. This mytomized esophagus is anchored in the abdomen and wrapped with an anterior fundoplication to prevent gastroesophageal reflux.

The techniques used to evaluate liquid transit through the esophagus are standardized and validated. After a 12-hour fast the patient is given 100 cc of water labeled with technetium 99. We showed increased esophageal clearance both in the supine and upright positions using this technique. The timed barium swallow technique is another measure of liquid esophageal transit. We have not been able to find a reproducible method of measuring solid transit through the esophagus.

Preoperative pneumatic dilation and especially botulimum injection lead to severe panesophageal fibrosis in some patients. We have avoided mucosal perforation by having a scope in the esophagus and carefully dissecting the circular muscle away from the mucosa using a hook. The muscle is cut using a low level of cautery.

Dr Way, are there correlations between the emptying and symptoms? The one patient who did poorly in our study had had preoperative transit, which got worse after surgery. On analyzing all of the patients, there was not a good correlation between the average esophageal transit and the change in symptoms. I think it is because our symptom score is too crude a measurement tool.

What are the inferences of heartburn? I agree with you completely. Heartburn may be due to gastroesophageal reflux, fermentation of esophageal contents, or esophageal dysmotility. The most objective measurement of esophageal acid exposure is a 24-hour pH study. The complications of reflux disease in treated achalasia do not appear to be a problem until at least 5 years after the operation. Since invasive esophageal physiology testing is not well tolerated by patients, I plan to study them with 24-hour pH studies and esophageal manometry 5 years after the operation.

Dr MacFarlane, sometimes we can see reflux with the transit studies, but again it doesn't appear to correlate very well with the 24-hour pH studies.