Laparoscopic versus Open Repair of Paraesophageal Hernia: The Second Decade

Jörg Zehetner, MD, Steven R DeMeester, MD, FACS, Shahin Ayazi, MD, Patrick Kilday, Florian Augustin, MD, Jeffrey A Hagen, MD, FACS, John C Lipham, MD, FACS, Helen J Sohn, MD, FACS, Tom R DeMeester, MD, FACS

BACKGROUND: A decade ago we reported that laparoscopic repair of paraesophageal hernia (PEH) had an objective recurrence rate of 42% compared with 15% after open repair. Since that report we have modified our laparoscopic technique. The aim of this study was to determine if these modifications have reduced the rate of objective hernia recurrence.

STUDY DESIGN: We retrospectively identified all patients that had primary repair of a PEH with ≥50% of the stomach in the chest from May 1998 to January 2010 with objective follow-up by videoesophagram. The finding of any size of hernia was considered to be recurrence.

RESULTS: There were 73 laparoscopic and 73 open PEH repairs that met the study criteria. There were no significant differences in gender, body mass index, or prevalence of a comorbid condition between groups. The median follow-up was similar (12 months laparoscopic versus 16 months open; p = 0.11). In the laparoscopic group, 84% of patients had absorbable mesh reinforcement of the crural closure and 40% had a Collis gastroplasty, compared with 32% and 26%, respectively, in the open group. A recurrent hernia was identified in 27 patients (18%), 9 after laparoscopic repair and 18 after open repair (p = 0.09). The median size of a recurrent hernia was 3 cm, and the incidence of recurrence increased yearly in those with serial follow-up with no early peak or late plateau.

CONCLUSIONS: In our first decade of laparoscopic PEH repair, no mesh crural reinforcement was used, and no patient had a Collis gastroplasty. Evolution in the technique of laparoscopic PEH repair during the subsequent decade has reduced the hernia recurrence rate to that seen with an open approach. Reduced morbidity and shorter hospital stay make laparoscopy the preferred approach, but continued efforts to reduce hernia recurrence are warranted. (J Am Coll Surg 2011;212:813–820. © 2011 by the American College of Surgeons)

The term giant paraesophageal hernia (PEH) is typically used to describe a hiatal hernia in which one-half or more of the stomach is in the thorax. These hernias, labeled types III and IV, are associated with gastric volvulus and life-threatening complications, and when symptomatic, surgical repair is indicated. Traditionally, repair consisted of either an open transthoracic or transabdominal procedure with reduction of the hernia, crural closure, and creation of a fundoplication, with or without gastropexy or gastrostomy tube placement. Development of the laparoscopic Nissen procedure prompted application of minimally invasive techniques to the repair of these large PEHs, and good symptomatic results were initially reported. However, using objective assessment with barium videoesophagrams, we found that most recurrent hernias were asymptomatic, and that purely symptomatic follow-up led to an underappreciation of the prevalence of recurrence. In that report from 10 years ago we showed that the objective hernia recurrence rate with a laparoscopic approach was significantly higher (42%) compared with an open approach (15%).

After confirmation of our findings at other centers, efforts were made to modify the laparoscopic procedure and reduce the recurrence rate. One area of focus was the use of mesh to reinforce the crural closure. A randomized trial showed that crural reinforcement with a biologic mesh re-
duced recurrences at 6 months from 24% to 9% with no mesh erosion.7 Another area of focus was on esophageal length and the development of techniques to perform a laparoscopic Collis gastroplasty. Over the past decade we have incorporated these concepts and have modified our approach to laparoscopic PEH repair. The aim of this study was to determine if these modifications have resulted in a reduction in the objective hernia recurrence rate with laparoscopic PEH repair down to the rate seen with an open repair.

METHODS
We retrospectively reviewed the records of all patients that had primary surgical repair of a large PEH (defined as ≥50% of the stomach in the chest on videosophagram) from May 1998 to January 2010. The date May 1998 was selected because patients that had operative repair of a large PEH before that date have previously been reported (first-decade experience).7 Preoperative evaluation consisted of a videosophagram, upper endoscopy, and esophageal motility (with endoscopic catheter placement) as previously described.9 Selected patients underwent preoperative 24-hour pH monitoring, cardiac stress test, or other studies as deemed to be appropriate by the faculty surgeon. We excluded patients from this analysis who had earlier antireflux surgery or PEH repair, along with those that had concomitant abnormalities, such as achalasia (1 patient).

Postoperatively, patients had a routine follow-up office visit at 2 to 4 weeks after discharge from the hospital and then were seen between 3 and 6 months and again at 12 months for a videosophagram. Annual follow-up with a videosophagram was able to be obtained in a subgroup of patients. Patients who had a Collis gastroplasty had an upper endoscopy to evaluate for the presence of erosive esophagitis secondary to acid production by the gastroplasty tube, and patients with Barrett esophagus had annual surveillance upper endoscopy. Follow-up was calculated from the date of surgery to the date of the most recent videosophagram or upper endoscopy. Recurrence was defined as a hiatal hernia of any size seen on videosophagram or upper endoscopy. This study was approved by the University of the Southern California Keck School of Medicine Institutional Review Board.

Surgical techniques
Patients underwent a laparoscopic or open repair of PEH based on surgeon and patient preference. There was a steady increase in the use of the laparoscopic approach and a decline particularly in the open transthoracic approach over the years of the study. All operations included a complete dissection of the hernia sac, primary crural closure, and either a complete (Nissen) or partial (Belsey or Toupet) fundoplication. The choice of a complete Nissen or a partial fundoplication was based on the patient’s preoperative motility study and videosophagram. All Nissen fundoplications were performed over a 58-60 French bougie, except Collis-Nissen fundoplications, which were constructed around a 48-52 French bougie.

The crura were closed in all patients with nonabsorbable suture (most commonly 0-Ethibond [Ethicon]), either as figure-of-eight sutures or pledgeted horizontal mattress sutures in most circumstances. After primary closure a nonpermanent mesh (Surgisis [Cook Medical Inc.], Vicryl [Ethicon], or Bio-A [WL Gore and Associates]) was often used to reinforce the crural closure. The mesh was secured using one or a combination of sutures, tacks, or BioGlue (CryoLife) based on surgeon preference. The technique for Vicryl mesh and Bioglue has been previously reported.10 In all cases the mesh was placed over the posterior crural closure ± on each side of the esophagus, but was not placed circumferentially around the esophagus. In patients where the esophagus was judged to be foreshortened, a Collis gastroplasty was performed transthoracically as described by Collis,11 laparoscopically or transabdominally using the circular-stapled technique,12 or with a wedge fundectomy.13 Gastropexy or gastrostomy tubes were not used.

Statistical analyses
Data are expressed as medians and interquartile range (IQR). Comparisons of proportions were performed by using chi square or Fisher exact test. Continuous variables were compared by using Mann-Whitney or Kruskal-Wallis test. Freedom from recurrence was calculated by using Kaplan-Meier method and compared by using log-rank test. A p value of <0.05 was considered to be significant.

RESULTS
During the years of the study we performed 2,355 antireflux procedures. We retrospectively identified 203 patients (8.6%) that had primary repair of a PEH with ≥50% of the stomach in the chest, and all 146 patients (72%) that had objective follow-up at our center form the study group. There were 73 laparoscopic and 73 open repairs, including 7 conversions from laparoscopic to open transabdominal which were analyzed with the open group. The clinical

<table>
<thead>
<tr>
<th>Abbreviations and Acronyms</th>
</tr>
</thead>
<tbody>
<tr>
<td>IQR = interquartile range</td>
</tr>
<tr>
<td>PEH = paraesophageal hernia</td>
</tr>
</tbody>
</table>
characteristics of these 146 patients are presented in Table 1. There were no significant differences, except the median American Society of Anesthesiologists score was higher in the open group. The prevalences of comorbid conditions were similar. The approach for PEH repair, type of fundoplication, use of a Collis gastroplasty, and details of crural closure are presented in Table 2. Mesh reinforcement of the crural closure was significantly more common in the laparoscopic group. The median operative time was significantly shorter in the laparoscopic group (160 min [IQR 132 to 188 min]) compared with the open group (177 min [IQR 137 to 212 min]; \( p = 0.0368 \)). Freedom from recurrence of any hernia for the laparoscopic and open approaches with objective follow-up is shown in Fig 1. The median size of a recurrent hernia was 3 cm (range 1–5 cm; Fig 2). Most recurrences were detected by videoesophagram, but in 8 patients an endoscopy detected a small hernia that was not seen on videoesophagram. An endoscopy was done in 11 of the 19 patients that had a hernia identified on videoesophagram, and the endoscopy showed a hernia in each patient (no missed hernias by endoscopy). A reoperation was performed in 5 patients (3.4%) with a recurrent hernia for symptoms of dysphagia, regurgitation, or chest pain. We analyzed factors that were potentially associated with hernia recurrence, including the use of a Collis gastroplasty, mesh reinforcement of the crural closure, pledged sutures in the crura, and a Nissen as opposed to a partial fundoplication, and did not find any individual factor that was associated with a significant reduction in the rate of recurrent hernia (Table 4).

Annual videoesophagrams for a minimum of 3 years were obtained in 41 patients (20 after laparoscopic repair and 21 after open repair). These serially followed patients allowed us to determine the timing of recurrence, and as shown in Fig 3 the prevalence of recurrence continued to increase with each year of follow-up out to 3 years. There were 9 patients that had ≥1 additional videoesophagram performed a year or more after a recurrent hernia was detected, and of these, 7 had no change in the size of the hernia at a median follow-up of 12 months after recurrence (maximum 36 months). In 2 patients, the hernia increased in size with follow-up, in one patient going from 2 to 4 cm

### Table 1. Patient Characteristics (n = 146)

<table>
<thead>
<tr>
<th></th>
<th>Laparoscopic (n = 73)</th>
<th>Open (n = 73)</th>
<th>( p ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median age, y [IQR]</td>
<td>69 [60–76]</td>
<td>65 [57–75]</td>
<td>0.17</td>
</tr>
<tr>
<td>Sex, male/female</td>
<td>22/51</td>
<td>26/47</td>
<td>0.60</td>
</tr>
<tr>
<td>Median BMI, kg/m² [IQR]</td>
<td>27.4 [25.5–31.1]</td>
<td>28.3 [25.1–33.0]</td>
<td>0.45</td>
</tr>
<tr>
<td>Median ASA score [IQR]</td>
<td>2 [2–3]</td>
<td>3 [2–3]</td>
<td>0.0146</td>
</tr>
<tr>
<td>Prevalence of comorbidities, n (%)</td>
<td>43 (59)</td>
<td>43 (59)</td>
<td>1.00</td>
</tr>
<tr>
<td>Cardiac</td>
<td>8 (11)</td>
<td>10 (14)</td>
<td>0.80</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>6 (8)</td>
<td>16 (22)</td>
<td>0.0356</td>
</tr>
<tr>
<td>Hypertension</td>
<td>31 (42)</td>
<td>31 (42)</td>
<td>1.00</td>
</tr>
<tr>
<td>Diabetes</td>
<td>3 (4)</td>
<td>3 (4)</td>
<td>1.00</td>
</tr>
<tr>
<td>Smoking</td>
<td>9 (12)</td>
<td>9 (12)</td>
<td>1.00</td>
</tr>
<tr>
<td>Alcohol</td>
<td>12 (16)</td>
<td>8 (11)</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Lap, laparoscopic.

### Table 2. Operative Techniques (n = 146)

<table>
<thead>
<tr>
<th></th>
<th>Laparoscopic (n = 73)</th>
<th>Open A (n = 33)</th>
<th>Open TT (n = 40)</th>
<th>( p ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundoplication</td>
<td>73 (100%)</td>
<td>33 (100%)</td>
<td>40 (100%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Nissen</td>
<td>52 (71%)</td>
<td>27 (82%)</td>
<td>32 (80%)</td>
<td>0.39</td>
</tr>
<tr>
<td>Partial</td>
<td>21 (29%)</td>
<td>6 (18%)</td>
<td>8 (20%)</td>
<td>0.39</td>
</tr>
<tr>
<td>Collis gastroplasty</td>
<td>29 (40%)</td>
<td>9 (27%)</td>
<td>10 (25%)</td>
<td>0.21</td>
</tr>
<tr>
<td>Crural closure</td>
<td>73 (100%)</td>
<td>33 (100%)</td>
<td>40 (100%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Figure of eight sutures</td>
<td>34 (47%)</td>
<td>25 (76%)</td>
<td>21 (53%)</td>
<td>0.0190</td>
</tr>
<tr>
<td>Pledged</td>
<td>39 (53%)</td>
<td>8 (24%)</td>
<td>19 (47%)</td>
<td>0.0190</td>
</tr>
<tr>
<td>Mesh reinforcement</td>
<td>61 (84%)</td>
<td>20 (61%)</td>
<td>3 (8%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>BioA/Surgisis</td>
<td>33</td>
<td>14</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Vicryl</td>
<td>28</td>
<td>6</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Lap, laparoscopic; Open A, open transabdominal; Open TT, open transthoracic.
in 12 months, and in the other going from 2 to 3 cm after 24 months.

**DISCUSSION**

Surgical repair of a PEH is conceptually simple: reduce the stomach back into the abdomen, reapproximate the crura, and perform a fundoplication. For decades the outcome of PEH repair was based on a postoperative assessment of symptoms. However, many of these patients had relatively few significant symptoms before surgery and underwent correction of the intrathoracic stomach to prevent the catastrophic consequences of incarceration, perforation, or necrosis associated with a volvulized intrathoracic stomach. In 2000, we compared our initial series of patients that had laparoscopic repair of a PEH with patients that had a traditional open transabdominal or transthoracic approach. This prompted an analysis of the factors that might be contributing to recurrent hernias and modification of the laparoscopic technique at our and other centers.

The first area of focus and modification was on crural closure and reinforcement. It was recognized that in many patients with a PEH, the crura were widely splayed and atretic and held sutures poorly. In 2002, Frantzides et al reported that the hernia recurrence rate after laparoscopic repair of a hiatal hernia with an 8 cm crural defect was...
significantly reduced when the crural closure was reinforced with polytetrafluoroethylene mesh. In that randomized trial, the recurrence rate at a median follow-up of 2.5 years was 0/36 with polytetrafluoroethylene reinforcement compared with 8/36 (22%) in the nonreinforced group, with no mesh erosions. As more compliant mesh products became available, there was an increased use of synthetic mesh around the hiatus.\textsuperscript{17-20} Furthermore, some surgeons applied concepts developed from the repair of hernias at other sites, such as the tension-free repair of inguinal hernias, to the repair of paraesophageal hiatal hernias. In 2005, Granderath et al\textsuperscript{21} suggested that the hiatal closure be tailored depending on the size of the defect and promoted a tension-free polytetrafluoroethylene mesh bridge across the crura for very large defects. With that approach, the crura were not approximated, but the mesh was secured on each side to the crura, bridging the crural defect. This left mesh immediately under the esophagus, in an area of constant movement, creating the potential for mesh erosion into the esophagus. Although these early reports were either silent about mesh erosion or unaware of any, a subsequent multiauthored collection of 28 cases of erosion of permanent mesh into the esophagus or stomach was published, and highlighted the problems and complexity of reoperation in these patients.\textsuperscript{22}

Although reports describing the use of permanent mesh were encouraging for the low recurrence rate, the potential for mesh erosion into the esophagus has largely led to the abandonment of permanent mesh at the hiatus. In most surgeons’ and patients’ minds, a recurrent hernia is a lot less difficult problem than mesh erosion which might necessitate esophagectomy. Consequently, with the hope of preserving the benefits of mesh reinforcement while minimizing or eliminating the potential for erosion, interest has focused on the use of absorbable or biologic mesh material.\textsuperscript{8,23-25} In 2006, a randomized multicenter trial showed a significant reduction in hernia recurrence after PEH repair using Surgisis (porcine intestinal submucosa) reinforcement of the crural closure.\textsuperscript{8} However, the follow-up was only 6 months, but at the 2010 meeting of the American College of Surgeons in Washington, DC, the authors presented follow-up to 5 years and showed that the hernia recurrence rate was approximately 50% in both groups. Consequently, the ability of nonpermanent mesh to prevent late hernia recurrence is unclear, and long-term results from studies using other types of absorbable mesh materials will be important to clarify this issue.

A second area of focus and modification of the technique for laparoscopic PEH repair was to more carefully assess for tension on the repair as a consequence of a shortened esophagus. It was recognized that laparoscopic pneumoperitoneum elevated the diaphragms and could give surgeons the impression that there was more intra-abdominal esophagus than what was actually present, or would be present once the diaphragm returned to a normal position with deflation of the pneumoperitoneum. In addition, the assessment of intra-abdominal esophageal length was sometimes complicated by the complexity of precisely determining the true gastroesophageal junction in patients where the proximal stomach had become tubularized from chronic herniation. Although the debate about the existence of a shortened esophagus continues to this day, the literature would suggest that if it does exist, the condition it is most commonly associated with is a giant PEH.\textsuperscript{26} Attention to esophageal length led to the recognition that many patients had less than 2 cm to 3 cm of intra-abdominal esophagus after mediastinal mobilization, prompting the development of techniques to perform a laparoscopic Collis gastroplasty.

The technique for lengthening the esophagus was first described in 1957 by Dr Leigh Collis for use during a transthoracic procedure, and it was not readily adaptable to patients undergoing a laparoscopic PEH repair.\textsuperscript{11} However, creative esophageal surgeons subsequently described several methods to recreate the Collis gastroplasty in a minimally invasive fashion.\textsuperscript{12,13} Currently, the most popular technique creates the gastroplasty tube by excising a wedge of fundus (wedge fundectomy technique).\textsuperscript{12} In a report describing laparoscopic repair of 662 PEHs, Luketich and colleagues\textsuperscript{27} used a Collis gastroplasty in 63% of patients and considered it to be an important part of the repairs and one of the factors associated with their low (15.7%) rate of recurrent hernia. Some of the lowest reported recurrence rates come from series of open transthoracic repairs where a Collis gastroplasty was either performed routinely or used in the majority of patients.\textsuperscript{28,29}

Like others, we modified our laparoscopic PEH repair technique over the past decade, and compared with the

---

**Figure 3.** Cumulative prevalence of a recurrent hernia in the 41 patients (21 open and 20 laparoscopic) that had annual esophagrams for a minimum of 3 years.
42% hernia recurrence rate we reported for our first decade we now report that we have reduced our objective hernia recurrence rate down to that seen with open repair: 12%. The major differences between then and now are the almost routine use of absorbable mesh reinforcement of the primary crural closure and a more liberal use of the Collis gastroplasty. In the first decade of laparoscopic PEH repair at our center, no patients had mesh reinforcement of the crura, compared with 84% in the past decade. Likewise, in the first decade no patient had a laparoscopic Collis gastroplasty, compared with 40% of the laparoscopic patients in the recent decade. We also changed from simple sutures to either figure-of-eight or pledgeted horizontal mattress sutures for primary crural closure. Finally, laparoscopic equipment has improved, and high-definition cameras now provide outstanding visualization of the operative field. These modifications have resulted in improved results with laparoscopic repair. The present study was unable to pinpoint any specific factor that significantly reduced recurrence, but instead it is likely that a combination of all of the above factors led to the observed improvement over this past decade. It is interesting that even though some of the modifications, such as mesh reinforcement of the crural closure, were incorporated into our open technique, the results for open repair in the past decade did not change substantially from the preceding decade. This is not likely to be related solely to a selection bias, where an open approach was used only in the most difficult patients, because several faculty surgeons were late adopters of the laparoscopic approach and preferred the open approach in most patients. It is possible that routine use of mesh in the open group would be beneficial in an effort to continue to refine the procedure and further reduce hernia recurrence rates.

Most recurrent hernias were 2 cm to 3 cm in size, asymptomatic, and detected on routine follow-up videoesophagraphy. We found that endoscopy was the most sensitive test to detect a recurrent hernia. On upper endoscopy, we found several hernias smaller than 2 cm in patients where no hernia had been seen on the videoesophagram, and endoscopy confirmed the presence of a hernia in every patient known to have a hernia by videoesophagraphy. Therefore, if there is uncertainty based on videoesophagraphy about the presence of a recurrent hernia, endoscopy can be used to clarify the issue. In the present series, there were no large paraesophageal recurrences, and only 5 patients (3%) had a reoperation, all for symptoms associated with a recurrent hernia. Although we had thought that perhaps most recurrences would occur early, instead we found that the prevalence of a recurrent hernia increased annually in the subgroup of patients with serial videoesophagrams. We only had a sufficient number of patients with serial follow-up to assess the annual recurrence rate out to 3 years, and it is unclear if this trend will continue indefinitely or plateau at some point in time. It has also been unclear what the natural history is for a recurrent hernia. In this study, we provide some insight into this issue, because we had a group of 9 patients with follow-up videoesophagrams after an asymptomatic recurrent hernia was identified. The size of the recurrent hernia did not change out to a maximum of 36 months of follow-up in most (7/9) patients. Considering this, we think it is likely that most recurrent hernias after repair of a large PEH do not require subsequent surgical reintervention. Furthermore, none of the 27 patients with a recurrent hernia had a serious or catastrophic complication related to the recurrence, suggesting that the natural history of a small recurrent hernia is different than that of the original intrathoracic stomach. Additional support for this concept comes from White and associates,15 who reported that with symptomatic follow-up out to a mean of 11.3 years after laparoscopic PEH repair, there were 10 recurrences in 31 patients, but 80% were sliding hernias and only 2 patients had a reoperation. Heartburn was the only symptom that was greater in the patients with a recurrent hernia. They concluded that most hernia recurrences after PEH repair are minimally symptomatic and follow a benign course over the long term.15 This is not to imply that early recurrence of a complete or nearly complete intrathoracic stomach can be followed. We did not have this type of recurrence in the present series, but anecdotally we have had patients transferred to us or know of patients with complications related to an early complete or near-complete recurrence of the PEH. In our opinion, these patients should be considered for prompt reoperation. However, careful attention to sac excision, crural closure, and esophageal length during the original procedure should make this an uncommon situation.

In this series, primary closure of the crura was always accomplished. Reports describe the inability to close the crura primarily and the use of mesh to bridge the defect.21 In our experience, the only crural defects that could not be closed primarily were in reoperations, and in those patients we use a relaxing incision in the left hemidiaphragm to allow primary crural closure and then use a Gore-Tex patch to close the diaphragmatic defect. The use of mesh as a bridge across the unopposed crura is strongly discouraged, because in our experience this has led to erosions with permanent material and very complex reoperations when biologic material was used. In some patients with a very large hiatus, an anterior stitch was necessary to adequately close the hiatus around the esophagus, but our preference is always to place the crural sutures posterior to the esophagus.
and avoid anterior sutures if possible. Likewise, we prefer not to encircle the esophagus with mesh, even absorbable mesh, but use the mesh purely as reinforcement for the posterior crural closure. There is no consensus within our group on the best absorbable mesh, and there are advantages and disadvantages for each type. Further experience and follow-up may provide some insight into hernia recurrence rates based on the type of absorbable mesh used for crural reinforcement. Such an analysis was not possible in the present series, because of the small numbers in each group. Fixation techniques for the mesh also varied within our group. Some used glue whereas others preferred sutures and absorbable tacks placed carefully to avoid aortic or cardiac penetration. An advantage of the permanent tacks used initially was that they clearly outline the crural repair and make recognition of the anatomy after repair and the presence of a recurrent hernia readily apparent. These types of tacks or clips to mark the crural closure may be useful early in the experience of surgeons taking on PEH repairs to help visualize the anatomy postoperatively on radiographic examinations.

This study was limited by the numbers of patients, lack of a randomized comparison, and relatively short-term follow-up, particularly in the laparoscopic group. However, the careful objective follow-up with videosophragrams and endoscopies are a strength and provide insight beyond symptoms into the prevalence and natural history of a recurrent hernia after PEH repair. Additional strengths are that the control group of open PEH repair patients was concurrent rather than historic, and that this single-center experience permitted a direct comparison of the results from the initial and subsequent decade of experience with laparoscopic PEH repair. In conclusion, giant PEHs, with more than 50% of the stomach in the chest, remain a challenging surgical problem. Although repair can seem deceptively simple, keeping the stomach securely below the diaphragm has proven to be difficult. Every detail of the operation, including sac excision, esophageal mobilization, crural closure techniques, mesh reinforcement of the crural repair, and esophageal lengthening when necessary, is likely to be important to minimize hernia recurrence. Fortunately, with attention to these details most hernia recurrences are small, asymptomatic, and unlikely to increase significantly in size over the short term. Furthermore, these small recurrent hernias do not seem to be associated with the same risk for severe complications as the original intrathoracic stomach. Nonetheless, continued efforts to refine and modify the techniques of repair, including the type of mesh material used, are warranted in an effort to further reduce the rate of recurrent hernia after laparoscopic PEH repair. Considering that the prevalence of a recurrent hernia is now similar for laparoscopic and open approaches, the reduced morbidity and shorter hospital stay associated with the laparoscopic procedure make it the preferred technique for the surgical correction of a giant paraesophageal hiatal hernia.

REFERENCES