Hypothesis: Perioperative complications of laparoscopic antireflux operations are infrequent and treatable and do not cause permanent disability.

Results: Ninety-two complications occurred in 538 operations (17.1%). Sixty-eight patients (12.6%) experienced minor complications. Postoperative ileus was the most common complication (n=37 [6.9%]), followed by pneumothorax (n=13 [2.4%]) and urinary retention (n=10 [1.9%]). Major complications were present in only 24 patients (4.5%) and occurred significantly more frequently after reoperations. Of these, dysphagia was the most frequent complication observed (n=11 [2.0%]), followed by perforated viscus (n=4 [0.7%]). Two patients (0.4%) died. All but 4 major complications resulted in full recovery.

Conclusions: Major complications in laparoscopic antireflux surgery are rare, their treatment is straightforward, and permanent disability is uncommon. Complications occur twice as often during reoperations, highlighting the difficulty in performing these procedures. Although primary laparoscopic antireflux operations are performed by many general surgeons routinely, reoperations should be performed by a team experienced in laparoscopic esophageal surgery.

Arch Surg. 2001;136:399-404
MATERIALS AND METHODS

The medical records of all patients who had undergone a laparoscopic antireflux operation for GERD from January 20, 1993, until December 28, 1999, were reviewed through our prospectively designed and maintained database. Included were patients who had not previously undergone any antireflux operations and those who had been referred with failed antireflux procedures. Excluded were patients with achalasia, epiphrenic diverticula, leiomyoma, or paraesophageal hernia.

For the purposes of this study, we defined a complication as a deviation from the normal postoperative course as delineated in our clinical pathway. For example, we do not routinely use a nasogastric tube (NGT); thus, someone who required it for distention, bloating, or vomiting was considered to have had a minor complication. We allow patients to receive full-liquid diet the night of surgery or the following morning, and we discharge home on the second or third postoperative day. Patients who could not progress on their diet as expected were considered to have an ileus.

We also divided the complications into minor and major. Minor complications were those that required no treatment other than intravenous fluids, NGT, bladder catheterization, or antibiotics and might be considered simple deviations of the expected recovery course. Major complications were defined as those that had the potential for death, a reoperation, or permanent disability and that required repeated or more invasive treatment. We explicitly excluded recurrent GERD symptoms.

The Mann-Whitney test was used for statistical comparison of nonparametric data, with the statistical significance accepted for P < .05.

MINOR COMPLICATIONS

As shown in Table 1, minor complications developed in 68 patients (12.6%). In 59 patients (11.8%), these occurred after primary operations and in 9 (23.7%), after reoperations.

Ileus

Ileus was the most common complication in this study (37 patients [6.9%]) and occurred significantly more frequently after reoperations (18.4%) than after primary operations (6.0%) (P = .002). Thirty of these patients required insertion of an NGT in the immediate postoperative course to treat the problem. Their mean length of stay was 3.4 days (range, 2-14 days). Seven patients were re-admitted after a mean of 1.6 days after discharge because of distention, nausea, and abdominal pain. An ileus was diagnosed by means of abdominal x-ray and treated with NGT suction. Total mean length of stay for these patients, including the primary stay after the operation and that caused by the readmission, was 6.7 days (range, 3-14 days). All patients recovered without further operative intervention.

Pneumothorax

The second most common minor complication was intraoperative pneumothorax (13 patients [2.4%]), which was diagnosed by means of observation of the paradoxical motion of the diaphragm or an obvious defect in the pleura. This complication occurred in 5.3% of patients undergoing reoperation and in 2.2% of patients undergoing first operation (P = .12). Clinical manifestations of pneumothorax did not develop in most of these patients, with the exception of 1 patient who became hemodynamically unstable for a short time. After the pneumoperitoneum was released and the patient was resuscitated with intravenous fluids, the operation was finished uneventfully at a lower insufflation pressure (10 mm Hg). Postoperative chest x-ray was performed in 11 patients, mainly for documentation. One of these patients had a complete collapse of 1 lung and was treated with a chest tube. The other patients had partial pneumothoraces that were treated with supplemental oxygen therapy alone. All patients recovered fully, with a mean length of stay of 3.4 days (range, 2-8 days).

Urinary Retention

Urinary retention necessitating reinsertion of a bladder catheter occurred in 10 patients (1.9%). These included 5 men and 5 women with a mean age of 49 years (range, 21-73 years). Three men were discharged with a catheter in place and underwent evaluation by a urologist. The mean length of stay was 3.2 days (range, 2-8 days).

Other

Other minor complications were pneumonia (2 patients), atelectasis (2 patients), temporary atrial fibrillation (3 patients), and wound infection (1 patient). All resolved with noninvasive treatment.

MAJOR COMPLICATIONS

As shown in Table 2, we identified 24 major complications (4.5%). Major complications occurred signific-

Table 1. Frequency of Minor Complications Stratified by Primary Operations and Reoperations

<table>
<thead>
<tr>
<th></th>
<th>Primary Operations (n = 500)</th>
<th>Reoperations (n = 38)</th>
<th>Total (n = 538)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ileus</td>
<td>30 (6.0)*</td>
<td>7 (18.4)</td>
<td>37 (6.9)</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>11 (2.2)</td>
<td>2 (5.3)</td>
<td>13 (2.4)</td>
</tr>
<tr>
<td>Urinary retention</td>
<td>10 (2.0)</td>
<td>0</td>
<td>10 (1.9)</td>
</tr>
<tr>
<td>Other</td>
<td>8 (1.6)</td>
<td>0</td>
<td>8 (1.5)</td>
</tr>
<tr>
<td>Total</td>
<td>59 (11.8)</td>
<td>9 (23.7)</td>
<td>68 (12.6)</td>
</tr>
</tbody>
</table>

*P < .002.
Dysphagia

Dysphagia was present more than 2 months postoperatively in 11 patients (2.0%). No diagnostic test was performed in the first 8 weeks postoperatively. Contrast esophagography was the initial study in all patients. This was performed in 10 patients; results were normal in 5 patients, showed a tight fundoplication in 3 patients, and showed a stricture and a herniation in 1 patient each. One patient underwent esophagogastroduodenoscopy only without an upper gastrointestinal series.

The treatment consisted of dilation alone in 10 of those 11 patients. All 10 patients were asymptomatic after a mean of 2.4 dilations. The patient with the herniation had undergone 3 failed previous fundoplications in other hospitals and had an elective esophagostomy.

Acute Herniation

Acute herniation occurred in 1 patient who lifted his 4-year-old son on postoperative day 4. He underwent immediate reoperation and recovered uneventfully.

Perforation

Perforation of the esophagus (3 patients) or stomach (1 patient) was significantly more frequent after a reoperation than after primary operations (P < .001). During a primary operation, 1 perforation of the esophagus that we presume occurred during passage of a 52F bougie was detected 1 week later. The patient underwent reexploration, the area was drained, and the Nissen fundoplication was performed again. He recovered uneventfully and has had no signs of recurrent reflux 1 year after his reoperation.

Three perforations occurred during reoperations. One esophageal perforation was oversewn. One patient who had a short esophagus and had a perforation was treated by means of esophagectomy during the same operative procedure, as we believed it was the best treatment option for the GERD and the perforation. The third patient, with failure of 3 previous antireflux operations, sustained several small gastric perforations during the takedown of a tightly adhesional Toupet fundoplication. This was successfully treated with laparoscopic resection of the perforated fundus and a Dor fundoplication. All patients recovered uneventfully.

Liver Hematoma

Small lacerations or contusions of the left lobe of the liver are usually uneventful and self-limited and thus were not counted as complications in this study. Two patients, however, required treatment or hospitalization for a liver laceration, which in these cases were included as major complications. In 1 of these patients, a right-sided subcapsular liver hematoma developed that ruptured. The patient needed blood transfusion, an angiogram, and embolization of a bleeding vessel. This patient had undergone a cholecystectomy years before her antireflux operation. In retrospect, we believe that adhesions to the right lobe of the liver fixed it in position, and when we exercised our routine lateral retraction of the left lobe (toward the anterior aspect of the abdomen and toward the right side), the fixed right lobe of the liver may have sustained shear forces leading to the bleeding. The other patient had an unexplained prolonged postoperative fever that was thought to be secondary to a small left intraparenchymal hematoma found on computed tomographic study of the abdomen. This patient was observed and discharged on postoperative day 6. Both patients eventually had full recovery.

Mortality

Two patients died perioperatively (0.4%). One patient underwent operation for GERD as the underlying cause for her severe idiopathic pulmonary fibrosis. Adult respiratory distress syndrome developed postoperatively and she died. The other patient was admitted 4 days postoperatively with shock and a new-onset cerebrovascular accident. He was found to have gastric necrosis and underwent immediate operation, but he eventually died. This patient was also in end-stage pulmonary disease caused by chronic aspiration and required high doses of steroids and home oxygen therapy.

Reoperation

Reoperation for reasons other than failed primary antireflux operation occurred in 4 patients. These were described in detail in the respective paragraphs and consisted of the patient with dysphagia due to herniation, the patient with acute herniation, the patient with the esophageal perforation during a primary operation, and the patient with gastric necrosis and stroke who eventually died.

Table 2. Frequency of Major Complications Stratified by Primary Operations and Reoperations

<table>
<thead>
<tr>
<th>Complication</th>
<th>Primary Operations (N = 500)</th>
<th>Reoperations (N = 38)</th>
<th>Total (N = 538)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dysphagia</td>
<td>9 (1.8)</td>
<td>2 (5.3)</td>
<td>11 (2.0)</td>
</tr>
<tr>
<td>Liver trauma</td>
<td>2 (0.4)</td>
<td>0</td>
<td>2 (0.4)</td>
</tr>
<tr>
<td>Acute herniation</td>
<td>1 (0.2)</td>
<td>0</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>Perforated viscus</td>
<td>1 (0.2)*</td>
<td>3 (7.9)*</td>
<td>4 (0.7)</td>
</tr>
<tr>
<td>Reoperation</td>
<td>3 (0.6)*</td>
<td>1 (2.6)</td>
<td>4 (0.7)</td>
</tr>
<tr>
<td>Death</td>
<td>2 (0.4)</td>
<td>0</td>
<td>2 (0.4)</td>
</tr>
<tr>
<td>Total</td>
<td>18 (3.6)*</td>
<td>6 (15.8)*</td>
<td>24 (4.5)</td>
</tr>
</tbody>
</table>

*P < .05.
number of surgeons who perform this technically demanding operation is increasing, it is equally important to evaluate the spectrum of intraoperative and immediate postoperative complications in a center with a large volume of laparoscopic antireflux operations. We thought that a careful analysis of each and every deviation from the clinical care pathway that we had designed would be the most appropriate way to define complications. Using this method, we would be able to identify the true postoperative course of our patients, to change our clinical pathways, and to give the patients realistic expectations for their recovery. We would also be able to gain knowledge of causes and management of complications and design ways to prevent them, thus lowering the cost—human and financial—of complications.

The total number of perioperative complications reported in this study (17.1%) is higher than in other reports (7% and 12%). In part this is because we included any deviation from the previously defined course and in part because we deliberately acted very liberally to include every possible complication, no matter how small. Another cause is probably related to the fact that we included patients undergoing reoperations, in whom complications are known to develop with much higher frequency than after primary operation. Minor complications, particularly ileus, and major complications, particularly perforation, were significantly more frequent after reoperations. We therefore recommend that reoperations be performed by an experienced team only.

Minor complications constituted most complications. Surprisingly, we found ileus to be the primary cause of prolonged hospitalization, whereas this complication is not mentioned in other reports. This is explained by the fact that we included patients with bloating, nausea, and acute gastric distention in this category, whereas they are listed separately in other studies. Nasogastric tube decompression is the only treatment necessary. We speculate that ileus may be related to the known ill effects of opiate derivatives on gut motility and recommend today that their use be minimized and that they be replaced whenever possible with other pharmaceuticals that, while providing comfort, have less effect on bowel function.

Urinary retention that required catheterization is another complication that may be related to opiate use and that may be less prominent if morphine is not used.

The rate of pneumothorax ranges from 0% to 2% and depends on the extent of the dissection in the mediastinum and the presence of adhesions. Therefore, patients who have a short esophagus, severe esophagitis, or long-segment Barrett esophagus and patients with previous antireflux operations are at higher risk. The treatment differs from that of pneumothorax due to other causes. The entrance of carbon dioxide (CO_2) from the abdomen into the pleural space causes compression of the lung, depending on the insufflation pressure. Reduction of the insufflation pressure and hyperventilation with positive pressure from the ventilator are usually all that is necessary. Closure of the pleural injury can be attempted but is of no demonstrable benefit. Once the operation is finished and the CO_2 is evacuated from the abdomen, the remaining CO_2 in the pleural space will be reabsorbed quickly. Consequently, we had only 1 patient in whom we had to stop the operation briefly because of hemodynamic effects. Therefore, for the occurrence of a symptomatic pneumothorax, we recommend complete decompression of the abdomen, allowing the anesthesiologist to stabilize the patient, and then continuation of the operation with less insufflation pressure. Postoperative chest x-ray is not required if the patient is in no respiratory or hemodynamic distress and has good blood oxygenation levels measured by means of pulse oximetry. We no longer recommend the use of chest tube decompression, which prolongs postoperative recovery and hospital stay.

Other typical complications that are mentioned in the literature, such as splenic injury requiring splenectomy and vagus nerve injury, were not seen in this study. This is perhaps a tribute to the exposure afforded by the laparoscope, which has definitely reduced the incidence of splenectomy during the performance of antireflux operations. The short gastric vessels are always transected. Whenever possible, this is accomplished with an ultrasonic scalpel. Care must be taken particularly at the most proximal short gastric vessel, as the spleen can be very close to the fundus of the stomach. Both vagus nerves were always clearly seen and preserved during the dissection.

Major complications were uncommon, and the frequency with which we found them in our patients was similar to that reported by others. Dysphagia was included here because it required esophagogastroduodenoscopy or reoperation for treatment. Early postoperative dysphagia is caused by edema from the operative trauma and subsides within 4 to 6 weeks. To prevent food from obstructing the esophagus during this time, with subsequent retching and possible rupture of the repair, we designed a booklet that instructs our patients to adhere to a certain diet for the first 4 weeks postoperatively. This diet consists of a progressive move from liquids and mechanically soft food (advised for the first few days) to a more liberal use of solid food, gradually incorporating elements that are harder to move through the gastroesophageal junction.

Dysphagia may also be related to technical problems. The closure of the crura and the fundoplication may be too tight, which can be avoided by using an esophageal bougie or intraoperative endoscopy. The position and geometry of the fundoplication may be wrong, resulting in a twist of the esophagus or an obstruction. This can be avoided by meticulous adherence to the technique, transection of the short gastric vessels, and orientation of the fundoplication slightly to the right. The objective is to have the posterior aspect of the stomach displaced to the same extent as the anterior aspect, thereby decreasing the tendency to produce a torsion of the esophagus. If dysphagia persists after 8 weeks postoperatively, a workup should be started with a contrast esophagogram. The esophagogram will show whether herniation of the wrap or another anatomic malformation is present. If a gross anatomic defect is present on esophagogram, the best treatment is reoperation with complete takedown of the wrap and subsequent reconstruction. If the esophagographic findings are normal, an endoscopy may add useful information with respect to the wrap. Examination of the fundoplication from within the stomach will occasionally show the twists on the rugae that
are characteristic of a geometrically incorrect fundoplication. If the endoscopy findings appear normal, dilation is indicated for the patient with severe and disabling symptoms. This helped 5 of our patients in whom no anatomic or physiological abnormality could be identified. Patients who have persistent symptoms despite adequate dilation may require a reoperation. In these cases, it is important to be prepared to undertake an esophagotomy if an appropriate dissection and reconstruction are not feasible.

Perforations of the stomach or the esophagus occur mainly during reoperations or as bougie injuries. An anesthesiologist or nurse anesthetist usually performs the insertion of the bougie. The gastroesophageal junction should not be pulled in any direction, to prevent angulation. The insertion should be performed slowly, and the surgeon should constantly observe the gastroesophageal junction and the stomach to ascertain that the bougie is progressing as expected. The perforation of the esophagus in this study occurred in the thoracic esophagus. Symptoms developed 1 week after discharge and we chose to reoperate. At operation, a clear-cut perforation was no longer visible, so after a complete dissection of the area, the wrap (which had been taken down) was reconstructed. The patient experienced no problems postoperatively and has remained asymptomatic.

Reoperations pose a significantly higher risk for perforation because of the existing adhesions. Some small perforations can be treated with suture alone, depending on the location and size. Devitalized tissue should be resected and covered with a fundoplication. In one of our patients with a short esophagus, esophagectomy was the safest and most effective treatment. Therefore, preoperative evaluation of these patients using barium esophagogram and discussion of this treatment possibility with the patient are important.

Acute herniation has been reported to occur in as many as 7% of patients, but only happened once in this study after a patient lifted his 4-year-old son. The low rate of acute herniation in most studies and in our series probably results from emphasis on the closure of the crura and the fixation of the fundoplication to the diaphragm.

Mortality is low in all series (0%-1%). All patients who died in our series had significant aspiration-related and perforation of a viscus. Study of the development and management of these complications has shown that the most common can probably be prevented by simple changes in the intraoperative and postoperative care plan.

Ileus and urinary retention can be prevented by the use of analgesic medication other than opiate-based drugs. Pneumothorax can be prevented by careful dissection, can be handled with lower insufflation pressure, and does not require postoperative chest x-ray or chest tube.

Dysphagia can be prevented by the transsection of the short gastric vessels, use of a bougie or intraoperative endoscopy, orientation of the fundoplication to the right, and a gradual diet increase postoperatively.

Esophageal perforations caused by bougie can be prevented by careful insertion by the anesthesia staff, no angulation of the esophagus, and complete intraabdominal observation of the bougie course.

In reoperations, patients must be informed about the possibility of a perforation and the possibility of an esophagectomy. The surgeon has to be prepared to close small perforations with simple sutures.

We therefore conclude that major complications in laparoscopic antireflux surgery are rare and that the treatment is straightforward and resolves the problem in most cases without permanent disability. Nevertheless, because complications occur twice as often during reoperations, surgery for failed previous antireflux operations is difficult and should be undertaken by an experienced team with advanced laparoscopic skills.


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REFERENCES

David Rattner, MD, Boston, Mass: Dr Pohl and his colleagues from Seattle present a series of 538 patients who were operated upon over a 6-year period. They retrospectively analyzed the group in regard to their postoperative complications. It is important to note that what they are talking about are the traditional M & M [mortality and morbidity] type of complications, not quality of life, not failed antireflux operation, and also that all patients with parasophageal hernias, a much more difficult group of patients, were excluded from this series. This is important because what they show is that traditional complications are much more common in the patients undergoing reoperations. If one looks at the data in this series, only 6 of the reoperations out of 538 patients originated in Dr Pellegrini's group, whereas 32 of them were referred from the outside. Now we do not know the total number of cases that are being done outside of the University of Washington practice, so we cannot really develop a rate. This is very important because new developments in technology—such as the harmonic scalpel, such as the suturing devices—bring this operation to a level where every general surgeon can perform the operation technically, but clearly there are nuances that lead to differing results. What we are seeing is that the people who have a large experience, just as in Whipples, are getting very good results, and the occasional surgeons may not be quite hitting the benchmark. For example, at MGH [Massachusetts General Hospital] right now, one third of all the laparoscopic antireflux operations are re-dos and only 15% of the re-dos are originating in-house. The rest are being referred in. So I think the message here is that the first operation is very important in that it needs to be carried out in the best possible way, because the results of the reoperation, as Dr Pohl has pointed out, are not as good and the redo operation is not as safe as the first go-around.

The most common complication that has been reported here has been ileus, and it is more common in reoperations than in the primary procedures. This has been attributed to the use of narcotics and that narcotics are the culprit when someone has ileus after a lap Nissen, but I would suggest to you that it is probably vagal nerve trauma or vagal nerve injury, and this is why it is more common in the reoperative setting.

This study is important for what it does not say. It does not talk about the incidence of diarrhea, bloating, nausea, the typical post-Nissen syndromes. Likewise, dysphagia is very liberally defined here. It is difficult to keep a patient on clear liquids for 2½ months before you finally take them to the endoscopy suite and dilate them.

I would like to conclude my comments by asking a couple of questions of Dr Pohl. What was the average length of stay for the series as a whole? We only have the length of stay for patients sustaining complications. Likewise, other traditional numbers like the conversion rate are not mentioned. Was there in fact a learning curve? Did your length of stay decline to 23 hours during your last 50 or 100 patients, as it has in most other parts of the country? Could you share with us the clinical pathway that you used? Did you provide this to the patients in their preoperative visit so they knew what to expect?