Laparoscopic Nissen Fundoplication With Prosthetic Hiatal Closure Reduces Postoperative Intrathoracic Wrap Herniation

Preliminary Results of a Prospective Randomized Functional and Clinical Study

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Background: Postoperative intrathoracic wrap migration is the most frequent morphological complication after laparoscopic antireflux surgery. Previous authors have studied the use of prosthetic materials for hiatal closure to prevent recurrence of hiatal hernia and/or postoperative intrathoracic wrap herniation.

Hypothesis: Patients with prosthetic hiatal closure have a higher rate of short-term dysphagia but a significantly lower rate of postoperative intrathoracic wrap herniation at follow-up.

Design: Prospective randomized trial. We compared patients who underwent laparoscopic Nissen fundoplication with simple sutured hiatalplasty with those who underwent laparoscopic Nissen fundoplication with prosthetic hiatal closure.

Setting: University-affiliated community hospital.

Patients: One hundred consecutive patients undergoing laparoscopic Nissen fundoplication for gastroesophageal reflux disease and hiatal hernia repair.

Intervention: Laparoscopic Nissen fundoplication with simple sutured crural closure (n = 50 [group 1]) vs laparoscopic Nissen fundoplication with simple sutured cruroplasty and onlay of a polypropylene mesh (n = 50 [group 2]).

Main Outcome Measures: Recurrences; complications; results of esophageal manometry, 24-hour pH monitoring, esophagogastroduodenoscopy, and barium swallow test; and symptomatic outcome.

Results: Patients in both groups had similar preoperative values in esophageal manometry, 24-hour pH monitoring, and symptom scoring. At the 3-month and 1-year follow-ups, functional outcome variables (lower esophageal sphincter pressure and DeMeester score) improved significantly compared with the preoperative values. A higher postoperative dysphagia rate could be evaluated in group 2. An intrathoracic wrap migration occurred in 13 patients (26%) in group 1 vs 4 (8%) in group 2 (P < .001).

Conclusion: Laparoscopic Nissen fundoplication with prosthetic cruroplasty is an effective procedure to reduce the incidence of postoperative hiatal hernia recurrence and intrathoracic wrap herniation.

Arch Surg. 2005;140:40-48

Since the first laparoscopic fundoplication was described in 1991, laparoscopic antireflux surgery (LARS) has become an effective alternative to lifelong antireflux medication therapy and the standard approach to hiatal hernia repair and surgical treatment of gastroesophageal reflux disease (GERD).1-3 Numerous studies have shown that LARS is a safe and effective treatment option with excellent midterm and long-term functional outcomes, that it results in a high patient satisfaction, and that it significantly improves patients’ long-term quality of life.4-5 Despite these data, some large studies have shown that LARS fails in a few patients who have recurrent or persistent GERD symptoms.6-8 Morphological reasons for failure include too tight a wrap, a telescope phenomenon (slippage of a part of the stomach through the fundic wrap), a malformed or twisted wrap, a wrap disruption, and the intrathoracic migration of the wrap.9-10 Reasons for postoperative intrathoracic wrap migration are an inadequate crural closure and postoperative hiatal rupture. Typical symptoms of an intrathoracic wrap herniation are persistent or recurrent reflux, dysphagia, or the combination of both. The combination of these symptoms and this anatomic morphological complication leads to reoperation in most of these patients.11
Investigations of reoperation after primary failed antireflux surgery demonstrated that breakdown of the hiatal closure with consequent intrathoracic wrap herniation was the most common morphological reason for reoperation.8,12,13 Therefore, some authors have described the use of prosthetic materials for hiatal closure in patients with GERD, with or without large hiatal hernia, and have shown that prosthetic hiatal closure can be an effective procedure to prevent postoperative reherniation.14-16 Previous nonrandomized reports also have proved the effectiveness of prosthetic crural closure compared with simple cruroplasty by showing that prosthetic cruroplasty reduces the incidence of postoperative intrathoracic wrap herniation significantly with good to excellent functional results and a significant improvement in the patient’s quality of life.17,18 However, fewer data are available concerning prospective randomized trials about prosthetic hiatal closure during LARS.19 Thus, we undertook this prospective randomized trial to compare the use of prosthetic hiatal closure with simple hiatal closure in laparoscopic Nissen fundoplication and its influence on postoperative wrap herniation occurrence, functional results, and symptomatic outcome.

METHODS

Of 143 consecutive patients with symptomatic GERD who underwent LARS in our surgical unit between May 1, 2001, and May 30, 2002, a group of 100 patients were prospectively randomized to laparoscopic 360° Nissen fundoplication with crural closure using simple nonabsorbable sutures and a 1 × 3-cm polypropylene mesh (n = 50 [group 2]) or laparoscopic 360° Nissen fundoplication with crural closure with simple nonabsorbable sutures alone (n = 50 [group 1]). The remaining patients were excluded from study randomization owing to impaired esophageal body motility. All patients had a lengthy history of GERD symptoms (mean 5.9 years) and had been treated with proton pump inhibitors (20-60 mg/d) for a minimum of 6 months. The complete demographic data of both groups are shown in Table 1.

Basic requirements before surgery included an exact evaluation of GERD symptoms and results of esophagogastroduodenoscopy (EGD) with biopsy of the gastroesophageal junction, esophageal manometry, and 24-hour pH monitoring in all patients and results of a barium swallow test in selected patients with endoscopically proved large hiatal hernia. Indications for surgery in our patients were recurrent or persistent GERD-related symptoms, persistent or recurrent complications of GERD, decreased quality of life, and a pathologic lower esophageal sphincter (LES) pressure (<6 mm Hg) in combination with pathologic pH values (indicated by DeMeester score). All operative procedures were performed by 2 laparoscopically experienced surgeons (F.A.G. and R.P.) in a standardized manner. Randomization to simple sutured hiatal closure or to prosthetic hiatal closure was performed via random sampling numbers immediately before surgery by an independent member of the team. Preoperative and postoperative assessment of symptomatic and functional outcome was performed by 2 physicians who were not involved in the running trial to ensure blind assessment of outcome. The study protocol is shown in Figure 1.

PREOPERATIVE EVALUATION

Before surgery, all patients underwent a detailed interview regarding GERD symptoms such as heartburn, regurgitation, and dysphagia. Each of these symptoms was quantified using a standardized score system. The severity of GERD symptoms was subdivided as none, mild to moderate, and severe.

Preoperative EGD with biopsy and histological examination of the gastroesophageal junction was performed routinely in every patient. Preoperative esophageal manometry and 24-hour pH monitoring were performed in all patients to determine LES pressure and length, esophageal body motility, and esophageal acid exposure. Patients with poor esophageal motility (<30 mm Hg in the lower esophageal segments in response to wet swallows) or severely disordered peristalsis (>40% simultaneous contractions in wet swallows) were excluded from this study and underwent laparoscopic 270° Toupet fundoplication.

OPERATIVE PROCEDURES

In all 100 patients, a laparoscopic 360° floppy Nissen fundoplication was performed. Every step of the procedure is standardized and has been performed equally in every patient.

The technique of laparoscopic fundoplication has been described previously.6 The operative steps in this study follow.

In group 1, the crura were brought together using one to four 2-0 nonabsorbable sutures for posterior cruroplasty depending on the size of the hiatal defect. In group 2, the hiatus

Table 1. Patient Demographics*  

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group 1 (Nonmesh) (n = 50)</th>
<th>Group 2 (Mesh) (n = 50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>20 (40)</td>
<td>18 (36)</td>
</tr>
<tr>
<td>Men</td>
<td>30 (60)</td>
<td>32 (64)</td>
</tr>
<tr>
<td>Age, mean, y (range)</td>
<td>48.7 (24-73)</td>
<td>48.3 (22-71)</td>
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<tr>
<td>Height, mean, cm (range)</td>
<td>170.8 (149-190)</td>
<td>174.5 (157-194)</td>
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<tr>
<td>Weight, mean, kg (range)</td>
<td>82.6 (59-110)</td>
<td>84.2 (53-104)</td>
</tr>
<tr>
<td>Presence of Barrett esophagus</td>
<td>9 (18)</td>
<td>10 (20)</td>
</tr>
<tr>
<td>Size of hiatal hernia, cm</td>
<td>4 (90)</td>
<td>4 (90)</td>
</tr>
<tr>
<td>≤5</td>
<td>18 (40)</td>
<td>19 (42)</td>
</tr>
<tr>
<td>&gt;5</td>
<td>27 (60)</td>
<td>26 (58)</td>
</tr>
</tbody>
</table>

*Unless otherwise indicated, data are expressed as number (percentage) of patients.

Figure 1. Study protocol. EGD indicates esophagogastroduodenoscopy; GERD, gastroesophageal reflux disease; LES, lower esophageal sphincter.
was closed with the use of a 1 × 3-cm polypropylene mesh in addition to 1 to 4 simple sutures, depending on the size of the hiatal hernia. The mesh was cut from a 10 × 15-cm polypropylene mesh that is routinely used for laparoscopic transabdominal inguinal hernia repair in our unit. After hiatal dissection (Figure 2) and exact identification of the left and right crura (Figure 3), the posterior vagal nerve was dissected from the posterior portion of the esophagus (Figure 4). Usually, a first suture was affixed above the vagal nerve (Figure 5 and Figure 6). In group 1, additional sutures were brought in, depending on the hiatal hernia size (Figures 7, 8, and 9). In group 2, the mesh was brought intra-abdominally, fixed on the hiatal crura as a posterior onlay prosthesis, and secured with 1 stitch on the lateral sides of the left and right crura (Figure 10 and Figure 11). After hiatal closure, the 360° floppy Nissen fundoplication was performed as described previously (Figures 12, 13, and 14).

FOLLOW-UP

One week after surgery, GERD symptoms (heartburn, regurgitation, and dysphagia) were evaluated using the scoring system as described. At 6 weeks after surgery, all patients underwent routine EGD at our surgical unit or by a local gastroenterologist. At 3 months and 1 year after surgery, a standard postoperative examination was performed in our surgical unit, including esophageal manometry, 24-hour pH monitoring, cinematographic x-ray (barium swallow test), and evaluation of GERD symptoms. In all patients who were referred to our unit in the meantime with any kind of persistent or recurrent signs of GERD symptoms during follow-up, routine EGD and cinematographic x-ray were performed.

STATISTICAL ANALYSIS

We used the SPSS software program (SPSS Inc, Chicago, Ill) for statistical analysis comparing baseline differences between surgical groups and treatment results using tests as appropriate. A P value of less than .05 was considered statistically significant. Data are reported as mean ± SD, range, or percentage.

RESULTS

There were no significant differences between groups regarding demographic data such as age, sex, weight, or height (Table 1). Preoperative and postoperative evaluations of symptomatic outcome, upper gastrointestinal tract endoscopy, esophageal manometry, and 24-hour pH monitoring were performed in all patients.
PREOPERATIVE ASSESSMENT

In preoperative upper gastrointestinal tract endoscopy, we found no significant differences between the surgical groups. In both groups, 45 patients (90%) had a hiatal hernia. Nineteen (42%) of the 45 patients in group 2 had a hiatal hernia of 5 cm or smaller; 26 (58%), larger than 5 cm. In group 1, 18 (40%) of the 45 patients had a hiatal hernia of 5 cm or smaller; 27 (60%), larger than 5 cm. All patients in both groups showed endoscopic signs of gastroesophageal reflux, and in 19 patients, results of the histological examination detected Barrett esophagus (group 2, n=10 [20%]; group 1, n=9 [18%]).

The incidence of preoperatively reported severity and frequency of the leading symptom, heartburn, did not differ significantly between groups. Forty-eight patients (96%) in group 2 and 47 patients (94%) in group 1 reported mild to moderate or severe preoperative heartburn.

There were no significant differences regarding the preoperative incidence of regurgitation. Preoperative regurgitation was present in 24 patients (48%) in group 2 and in 22 (44%) in group 1.

In contrast, the preoperative incidence of dysphagia was higher in group 1, with 3 patients (6%) vs 1 patient (4%) in group 2. The difference was not significant.

Preoperative results of esophageal manometry and 24-hour pH monitoring also showed no significant differences between groups. The mean LES resting pressure was 4.13 mm Hg in group 2 vs 4.68 mm Hg in group 1. No patient in either group had esophageal motility disorders, and no significant differences could be detected in amplitude of contractions in wet swallows or esophageal peristalsis (simultaneous or interrupted waves). As expressed by the various values measured by 24-hour pH monitoring, the preoperative extent of esophageal acid exposure also was similar in both groups (mean DeMeester scores, 55.71 [group 2] vs 54.43 [group 1]).

OPERATIVE INFORMATION

There was no significant difference in mean operating time between groups (56 minutes [group 1] vs 58 minutes [group 2]). There were no intraoperative complications in either group, so all procedures were completed laparoscopically.

Intraoperatively, the size of the hiatal defect was measured in the anterior-posterior plane and verified to be
smaller or larger than 5 cm by using an endoscopic ruler. The amount of applied hiatal sutures, as previously described, depended on the size of the hiatal defect and was chosen empirically. In all patients, the intrathoracic hernia sac had been removed as completely as possible. The mean number of hiatal sutures in group 2 was 2.3 (range, 1-4); in group 1, 2.2 (range, 1-4). In group 2, the hiatal sutures were placed in addition to the 1×3-cm polypropylene mesh. In 19 group 2 patients (42%) with a hiatal hernia larger than 5 cm, 3 to 4 sutures were used in addition to the mesh. In the remaining 26 patients (58%) in group 2 with a hiatal hernia of 5 cm or smaller, 1 to 2 sutures were placed to approximate the crura. In the 18 patients (40%) in group 1 with a hiatal hernia larger than 5 cm, 3 to 4 sutures were placed for crural closure. The 27 patients (60%) in group 1 with a hiatal hernia of 5 cm or smaller had 1 to 2 sutures for crural approximation.

SYMPTOMATIC OUTCOME

At 1 week after surgery, a significant improvement regarding the symptoms of heartburn and regurgitation could be evaluated. In both surgical groups, none of the patients reported any kind of heartburn or regurgitation (P<.001). At the 6-week and 3-month follow-up, 1 patient (2%) in group 1 reported mild episodes of recur-
rent heatburn, whereas in group 2, none of the patients had persistent or recurrent postoperative heartburn at the 6-week and 3-month follow-up ($P = \text{NS}$ [not significant]). At the postoperative 1-year follow-up, 1 patient (2%) in each group reported mild episodes of heartburn (Figure 15).

The extent of postoperative regurgitation at the 6-week and 3-month follow-ups was equal in both surgical groups. Two patients (4%) in each group reported mild episodes of regurgitation at the 3-month follow-up. One year after surgery, 2 patients (4%) in group 1 reported regurgitation, in contrast to 1 patient (2%) in group 2 ($P = \text{NS}$) (Figure 16).

A significant difference in the postoperative occurrence of dysphagia could be evaluated at follow-up. Eight patients (16%) in group 2 reported mild dysphagia for solid food 1 week after surgery in contrast to 2 patients (4%) in group 1 who also reported mild episodes of dysphagia for solid food ($P < .05$). At the 6-week and 3-month follow-ups, we also found a significant difference in dysphagia rates of both groups, including 6 patients (12%) in group 2 vs 2 (4%) in group 1 ($P < .05$). At the 1-year follow-up, the dysphagia rate was equal in both surgical groups (2 patients [4%]) and was comparable with the preoperative data (Figure 17).

**EGD CONTROL**

At the upper gastrointestinal tract endoscopy performed 6 weeks after surgery, an intrathoracic wrap migration was suspected in 1 patient (2%) in group 1 and 1 patient (2%) in group 2. Both patients underwent a cinematographic x-ray (barium swallow test). Results of the barium swallow test showed a partial intrathoracic wrap migration in both patients. The remaining 98 patients showed no endoscopic signs of intrathoracic wrap migration (82 patients referred to our unit, and 16 treated by the local gastroenterologist).

**ESOPHAGEAL MANOMETRY**

At postoperative esophageal manometry, the LES resting pressure increased significantly compared with preoperative values. In group 2, the LES pressure increased from $4.13 \pm 2.53$ to $12.87 \pm 5.71$ mm Hg at 3 months and to $12.12 \pm 6.91$ mm Hg at 1 year ($P < .01$). In group 1 patients, LES pressure increased from a preoperative level of $4.68 \pm 2.11$ to $11.55 \pm 6.23$ mm Hg at 3 months and $10.05 \pm 4.15$ mm Hg at 1 year ($P < .01$). No pathologic values regarding amplitude of esophageal contractions or esophageal peristalsis developed in any of the patients.
During the complete follow-up, a significant difference in the occurrence of postoperative intrathoracic wrap migration could be evaluated. In group 2, an intrathoracic wrap migration developed in 4 patients (8%) compared with 13 (26%) in group 1 (P<.01) (Figure 19).

**CINEMATOGRAPHIC X-RAY (INTRATHORACIC WRAP MIGRATION)**

During the complete follow-up, a significant difference in the occurrence of postoperative intrathoracic wrap migration could be evaluated. In group 2, an intrathoracic wrap migration developed in 4 patients (8%) compared with 13 (26%) in group 1 (P<.01).

In the group 2 patients, the intrathoracic wrap migration was diagnosed between 4 weeks and 9 months postoperatively. All 4 patients in group 2 had a high body mass index (calculated as weight in kilograms divided by the square of height in meters; mean, 27.5). Two of these 4 patients had a hiatal hernia larger than 5 cm; 2 of them, of 5 cm or smaller (Table 2). All 4 patients underwent barium swallow testing, symptom interview, and laparoscopic refundoplication. The indications for laparoscopic refundoplication in these patients were epigastric pain and/or dysphagia. The 2 patients with a hiatal hernia larger than 5 cm underwent laparoscopic refundoplication with circular hiatal mesh prosthesis. All 4 patients were free of symptoms at follow-up.

**COMMENT**

During the past decade, laparoscopic fundoplication has emerged as the most effective alternative to lifelong medical treatment of GERD. Many authors have shown that LARS is a safe and effective treatment option and leads to excellent functional results, relief of GERD symptoms, and a significant improvement in patient quality of life. Success rates ranging from 85% to 95% have established this procedure in centers worldwide.

Despite good to excellent results in a large patient population undergoing midterm and long-term follow-up, some groups have shown that a small percentage of patients have recurrent or persistent GERD symptoms after LARS. The most frequent symptoms after failed antireflux surgery have proved to be recurrent or persistent reflux, dysphagia, or a combination of both. The most frequent morphological complications leading to these symptoms are too tight a wrap, wrap disruption, telescope phenomenon (slippage of a part of the stomach through the fundic wrap), and, in particular, intrathoracic wrap migration. The intrathoracic wrap migration has been shown to be the most frequent morphological anatomic reason for failure of a LARS. In a recently published series from Hashemi et al, the laparoscopic repair of type 3 hiatal hernia was associated with a prevalence of recurrent hiatal hernia of 42%. In most patients, the intrathoracic wrap migration is the result of an inadequate closure of the hiatal crura or a breakdown of the crural closure.

Therefore, some experienced foregut surgeons have proposed the hiatal closure as one of the common problems in LARS. To reduce the postoperative incidence of this complication, a number of groups have advocated the use of prosthetic materials for hiatal reinforcement.

In the present study, we present, to our knowledge, the first short-term results of a prospective randomized trial comparing the postoperative results of 50 patients who underwent LARS with simple sutured crural closure with 50 patients who underwent LARS with crural closure in addition to a 1 × 3-cm polypropylene prosthesis. Main outcome measurements were symptomatic and functional results and the postoperative frequency of an intrathoracic wrap migration.

In a recently published, nonrandomized series from our own group with a large patient sample, the authors compared 361 patients who underwent LARS with crural closure using simple nonabsorbable sutures with 170 patients who underwent LARS with 1 × 3-cm polypropylene mesh hiataloplasty. Findings included a significant difference in postoperative intrathoracic wrap migration occurrence. An intrathoracic wrap migration developed in 6.1% of the nonmesh group within the first postoperative 12 months, whereas that condition developed in only 0.6% of patients with a mesh hiataloplasty. This experience has led us to perform a prospective randomized trial to prove this situation.

When comparing the results of both studies, we found that there is no significant difference in the functional variables of esophageal manometry and 24-hour pH monitoring between the surgical groups. In the present study, we also could not find any significant difference in typical GERD symptoms like heartburn or regurgitation. However, a significant difference in postoperative short-term dysphagia could be evaluated. The patients who underwent prosthetic hiatal closure presented a significantly higher dysphagia rate up to 3 months after surgery, but...
1 year after surgery, the dysphagia rate was equal in both groups and comparable with preoperative values. Postoperative dysphagia has been estimated to be one of the main problems after antireflux surgery, with a reported incidence ranging from 3% to 24% after laparoscopic Nissen fundoplication. Usually, dysphagia as a common complication after Nissen fundoplication is mild and improves within the first postoperative months. In our previously nonrandomized study, we also saw a significantly higher rate of postoperative dysphagia in patients with prosthetic crural closure, but 1 year after surgery, both surgical groups no longer showed a significant difference, and the dysphagia rates of both groups were equal to preoperative values. Some other experienced groups have proved prosthetic hiatal closure to be a protective factor regarding recurrent hiatal hernia or intrathoracic wrap migration. In a prospective randomized controlled trial by Frantzides et al, 72 patients with a hiatal defect of 8 cm or larger were treated by means of either laparoscopic Nissen fundoplication with simple sutured posterior cruroplasty or laparoscopic Nissen fundoplication with an onlay polytetrafluoroethylene cruroplasty. Those authors also found a significant difference in postoperative hernia recurrence. Hiatal hernia recurrence developed in 22% of the primary repair group in contrast to no recurrence in the polytet group for a mean follow-up period of 2.5 years.

Champion and McKernan have reported the impact of hiatal hernia size on recurrence after laparoscopic fundoplication. They found a recurrence rate of 10.6% in 144 patients who underwent laparoscopic primary repair with a hiatal defect larger than 5 cm, which led the authors to begin crural closure using prosthetic materials. In a later published series of the same group, 52 patients with evidence of a large paraesophageal hernia underwent laparoscopic fundoplication with prosthetic crural closure using a 3 × 5-cm polypropylene onlay mesh. During an average postoperative follow-up of 25 months, a recurrent hiatal hernia developed in only 1 patient (1.9%), and no prosthetic erosion has been found. The potential for erosion or transmural migration of a foreign body or surgical material into the esophagus, especially in this anatomic area, might be a drawback, however, and must be a matter of discussion. In our surgical unit, we have used prosthetic materials for hiatal closure since December 1998, and more than 300 patients have undergone LARS with mesh hiatalplasty since then. With a follow-up of more than 90% of our patients, we did not see a single patient with any signs of esophageal erosion until now. In fact, when placed correctly, the mesh does not come into contact with the posterior portion of the esophagus but rather with the posterior fundic wrap. Edelman has reported that possible adherence of the fundic wrap to the mesh anchors the wrap in its subdiaphragmatic position and therefore prevents migration by itself.

As a foreign body or surgical material into the esophagus, the incidence of erosion or transmural migration of a foreign body or surgical material into the esophagus has been estimated to be one of the main problems after antireflux surgery, with a reported incidence ranging from 3% to 24% after laparoscopic Nissen fundoplication. Usually, dysphagia as a common complication after Nissen fundoplication is mild and improves within the first postoperative months. In our previously nonrandomized study, we also saw a significantly higher rate of postoperative dysphagia in patients with prosthetic crural closure, but 1 year after surgery, both surgical groups no longer showed a significant difference, and the dysphagia rates of both groups were equal to preoperative values.

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In a prospective nonrandomized trial by our own group, 24 patients underwent laparoscopic refundoplication after primary failed antireflux surgery because of intrathoracic wrap migration. In these patients, the hiatal crura were reinforced with an oval sheet of 10 × 15-cm polypropylene mesh, with a 3 × 4-cm keyhole in the center of the mesh for the esophageal body. During the complete minimum follow-up period of 1 year, we saw no patients with a recurrence or with mesh erosion.

Overall, fewer data are available regarding foreign body erosion after LARS with prosthetic hiatal closure. In a study by Carlson et al, a group of 44 patients was followed up for 52 months. An erosion developed in 1 patient who had no hiatal hernia recurrence during follow-up.

In the present study, we found a significant improvement in the functional variables of esophageal manometry and 24-hour pH monitoring after surgery, with no significant differences between surgical groups. A significant difference in the postoperative occurrence of intrathoracic wrap migration could be evaluated for this follow-up period. A postoperative intrathoracic wrap migration developed in 13 (26%) of the patients who underwent LARS with simple suture cruroplasty compared with 4 (8%) of the prosthetic hiatal closure patients. However, we saw a significantly higher rate of postoperative dysphagia in these patients as long as 3 months after surgery. Most of the patients with a postoperative intrathoracic wrap migration had a hiatal hernia larger than 5 cm. Two patients of the mesh group had a large hiatal hernia in combination with a high body mass index, which also has been described to be a prognostic factor for postoperative complications after LARS.

Consistent with the results of other authors, our results suggest that laparoscopic Nissen fundoplication with prosthetic crural closure is an effective procedure in patients with GERD, with good functional results and symptom relief in most of the patients. The procedure has proved to be effective in reducing the rate of postoperative intrathoracic wrap migration. However, longer follow-up of this prospective randomized study is necessary.

Accepted for Publication: April 14, 2004.
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References


