Necessity of fundoplication and mesh in the repair of the different types of paraesophageal hernia

V. Dara, A. Croo, A. Peirsman, P. Pattyn

Department of Gastrointestinal Surgery, University Hospital and Medical School Ghent, Ghent, Belgium

Abstract

Background : **The management of paraesophageal hernia (PEH) has changed significantly since the introduction of laparoscopic surgery in the 1990's. This study aims to explore the need of a Nissen fundoplication or a posterior gastropexy and the use of mesh reinforcement in the surgical repair of PEH.**

Patients and methods : **Seventy-three patients with a symptomatic and documented PEH type II, III or IV were included in this retrospective study. The following data were collected: type of PEH, surgical procedure, complications, length of hospital stay, recurrences, time to recurrence, type of PEH recurrence and treatment of recurrent PEH.**

Results : **All 73 patients underwent laparoscopic surgery without any conversion to open surgery. In 80% a posterior gastropexy was performed, while the remaining 20% suffered from GERD-symptoms and were treated with a Nissen fundoplication. In 18% of the patients a mesh was used as reinforcement of the repair. The surgical repair differed significantly according to the type of PEH. Fourteen percent of the patients suffered from a postoperative complication, pneumothorax and dysphagia being the most frequent. There were no perioperative deaths. The recurrence rate was 22% with a median time to recurrence of 12 months.**

Conclusion : **Laparoscopic PEH repair is a safe and efficacious procedure with no mortality and minimal early morbidity. The surgical repair of PEH should be adjusted to the type of PEH. However, up until now the literature fails to produce clear guidelines on when to perform a gastropexy or Nissen fundoplication and which patients might benefit from a mesh reinforcement.** (Acta gastroenterol. belg., **2019**, 82, **251-256**).

Key words : Paraesophageal hernia, Nissen fundoplication, posterior gastropexy, mesh

Introduction

Hiatal hernias are characterized by a widening of the space between the diaphragmatic crura and a weakening of the phrenoesophageal membrane, resulting in a protrusion of the stomach into the thoracic cavity. Ake Akerlund (1) first used the term "hiatus hernia" in 1926 and described 3 subtypes, which have been subsequently modified to the current classification that includes 4 subtypes (2). A type I or "sliding hernia" in which only the esophagogastric junction migrates into the thorax is the most common type of hiatal hernia, good for 95% of all hiatal hernias. The other 3 types are together classified as paraesophageal hernias (PEH) and combined they make up the remaining 5% of hiatal hernias. Type II represents a true paraesophageal hernia with herniation of the gastric fundus through a localized weakness in phrenoesophageal membrane, typically lateral and anterior to a normally positioned, infradiaphragmatic esophagogastric junction. Type III hiatal hernia is a combination of types I and II with herniation of both the esophagogastric junction and stomach into the chest cavity. These tend to be large and the term of large or giant paraesophageal hernia is commonly used when more than respectively 30% or 50% of the stomach is displaced above the diaphragm (3). In type IV hiatal hernias, another intra-abdominal organ such as the colon, small bowel, omentum or spleen additionally migrates into the hernia sac along with the stomach.

The management of paraesophageal hernia has undergone significant evolution, particularly since the introduction of minimally invasive laparoscopic techniques in the 1990's. The laparoscopic repair of PEH has been shown to result in reduced pain, hospitalization and convalescence (4). Historically, all paraesophageal hernias were surgically repaired. Nevertheless, patients with asymptomatic PEH are often identified by routine chest X-ray showing the air-fluid level of the stomach in the chest. It is questionable to plan surgery for all these patients. A surgical intervention is now reserved for symptomatic patients. This study aims to explore the controversies in PEH repair. The necessity of performing a Nissen fundoplication or posterior gastropexy and mesh reinforcement was correlated with the possibility of a recurrent PEH.

Materials and methods

Study design

We retrospectively reviewed all laparoscopic para-esophageal hernia repairs in the department of gastro-intestinal and colorectal surgery at the University Hospital of Ghent, Belgium by a single team of surgeons between 2005 and 2015. In total we identified 168 cases. Diagnosis was made as stated in the preoperative workup. Only patients with complaints of gastro-esophageal reflux or dysphagia and a type II, III or IV PEH were included in the study. Exclusion criteria were previous operations

Correspondence to : Pattyn Piet, MD, PhD., Department of Gastrointestinal Surgery, University Hospital and Medical School Ghent, De Pintelaan 185, 9000 Ghent, Belgium.
Tel: +32(0)9.332.55.62. Fax: +32(0)9.332.15.03
E-mail : piet.pattyn@ugent.be

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of the esophagus or stomach and/or associated diseases of the stomach or esophagus that required extensive medical treatment (e.g. malignant tumors of the stomach or esophagus). Seventy-three patients were included in the study.

All statistical analyses were performed using SPSS Statistics 23 (SPSS, Chicago, IL, USA) in cooperation with the biostatistical unit of Ghent University. Since the data were not normally distributed non-parametric descriptors median and range were calculated. For continuous variables Kruskal-Wallis test was used, whereas Pearson Chi square test was used for categorical variables. A two-sided value of $p<0.05$ was considered statistically significant.

Preoperative workup

The operating surgeon reviewed all patients preoperatively. Plain chest X-ray, gastroscopy, CT scan or contrast swallow were routinely conducted to define anatomy and exclude other pathologies. Since esophageal manometry and pH testing are often unreliable in the setting of PEH, they were not regularly obtained. If there were any concerns regarding surgical fitness, patients were reviewed by the relevant specialist and if needed echocardiography or pulmonary function tests were conducted.

Surgical technique

The surgical technique was standardized for all patients and comprised of a laparoscopic four-ports approach in lithotomy with fixed Nathanson liver retractor. The procedure ordinarily starts at the pars flaccidus with opening of the lesser sac. The right crus is then dissected, continuing anteriorly to the left crus. The anterior hernia sac is mobilized into the mediastinum with careful identification and preservation of the esophagus, vagal structures and pleura. The right crus is then dissected downward to completely encircle the esophagus. Next, the esophagus is dissected to fully reduce the hernia sac. The upper one to two short gastric vessels are divided continuing upward until the angle of His. In case the hernia sac is voluminous, it is partly removed to avoid injury of the vagal nerve. Next, circumferential dissection of the esophagus is completed. It is our experience that this could be mostly achieved without the requirement of Collis's gastroplasty. The crural ligaments are then closed from posterior to anterior in an interrupted fashion using polytetrafluoroethylene pledgets for a reinforcement repair without tension by utilizing Ethibond 1 sutures on CT needles with intracorporeal knot tying.

In case of a large hiatal defect with a thin quality of the crura, mostly seen in type IV hiatal hernias, a heart-shaped polytetrafluoroethylene mesh (Gore-tex Dual Mesh) in an onlay fashion is used to close the defect. Nissen fundoplication is selectively indicated for patients with preoperative gastro-esophageal reflux disease (GERD) symptoms. The fundoplication is calibrated with a 34Fr bougie and constructed with three stitches of 2.0 silk incorporated with a bite of esophagus. The critical point is to ensure that the fundus is wrapped around the esophagus snugly but not overly. Then 2 stitches are placed bilaterally between the tops of fundoplication and the esophagus. We do not place sutures to anchor the fundoplication to the crura or anterior abdominal wall, as the bulk of the fundoplication itself is enough to maintain its infradiaphragmatic position. In the absence of GERD symptoms a posterior gastropexy is performed. In this case, the fundus of the stomach is fixed to the diaphragm using at least 3 sutures Surgilon 2.0.

Postoperative care

A nasogastric tube is kept until the patient is completely awake. Fluids are allowed from the first postoperative day and advance gradually with an early mobilization. Nausea was managed aggressively to minimize vomiting, because our experience suggests that this might be responsible for early recurrence. If there was any clinical or intraoperative suspicion of potential complications, patients were kept fasted until a contrast swallow was performed.

Postoperative follow-up

All patients are seen postoperatively at 6 weeks, 3 months, and 12 months in our outpatient department, with some patients having additional or delayed follow up. The patients are only assessed clinically during follow-up, only if there is anything abnormal an upper gastrointestinal endoscopy or CT-scan is performed.

Results

Seventy-three patients met inclusion criteria. The median age of the study population was 67 years (IQ-range 61-76 years). Male-to-female ratio was 17/56. Table 1 shows the basic demographics of the study patients according to the type of PEH. There were no significant differences in the distribution of age or sex ($p= 0.402$, $p= 0.478$).

All patients were treated laparoscopically without conversion to open surgery. In general 80% of PEH were treated with a posterior gastropexy, while the remaining

Table 1. — **Basic demographics**

	n (%)		**median age (IQ range)**		**male : female**
PEH type II	38	52,1%	66	(61 - 74)	7:31
PEH type III	30	41,1%	71	(61 - 77)	8:22
PEH type IV	5	6,8%	72	(48 - 75)	2:03

Kruskal-Wallis test for age distribution : p = 0.402. Pearson Chi-Square test for sex distribution : p = 0.478

Table 2 — **Surgical treatment of PEH**

			PEH type II			PEH type III			PEH type IV		
	73	100%		38	52,1%		30	41,1%		5	6,8%
Nissen	11	15,1%	10	26,3%	90,9%	1	3,3%	9,1%	0	0%	0%
Nissen + mesh	4	5,5%	1	2,6%	25,0%	1	3,3%	25,0%	2	40%	50%
Gastropexy	49	67,1%	27	71,1%	55,1%	21	70%	42,9%	1	20%	2%
Gastropexy + mesh	9	12,3%	0	0%	0,0%	7	23,3%	77,8%	2	40%	22%

Pearson Chi-Square test for Nissen : $p < 0,05$. Pearson Chi-Square test for Nissen + mesh : $p < 0,005$. Pearson Chi-Square test for Gastropexy : $p = 0,067$. Pearson Chi-Square test for Gastropexy + mesh : $p < 0,005$.

Table 3 — **Complications classified by Clavien-Dindo with corresponding treatment**

Grade 1: Any deviation from the normal postoperative course	
1x subobstruction	conservative
1x late incisional hernia	conservative
2x dysphagia	conservative
Grade 2: Complications requiring pharmacological treatment	
None	
Grade 3a: Surgical, endoscopic or radiological intervention not under general anesthesia	
4x pneumothorax	4x chest tube insertion
Grade 3b: Surgical, endoscopic or radiological intervention under general anesthesia	
1x dysphagia	revision
1x dysphagia + pylorospasm	revision
Grade 4a: Life-threatening complication with ICU-care, single organ dysfunction	
None	
Grade 4b: Life-threatening complication with ICU-care, multi organ dysfunction	
None	
Grade 5: Death of patient	
None	

20% suffered from GERD-symptoms and were treated with a Nissen fundoplication. In 18% mesh reinforcement was deemed necessary. The surgical treatment options that were used in this study are listed in table 2. Significant differences according to the type of PEH were found when comparing these surgical procedures ($p< 0.001$). In approximately 70% of both a type II or III PEH repair a posterior gastropexy was favored, whereas a mesh reinforcement with either Nissen fundoplication or posterior gastropexy was preferred in 80% of the type IV PEH cases. Of all the patients treated with a Nissen fundoplication 91% had a type II PEH ($p<0.05$). Nissen fundoplication with mesh reinforcement was most commonly used in case of a type IV PEH ($p<0.005$). Of all the patients treated with posterior gastropexy with mesh reinforcement 78% had a type III PEH ($p<0.005$).

Postoperative complications, both during hospitalization and follow up (Table 3) occurred in 13,7% of the patients (n=10). Sixty percent of the complications occurred after a type III PEH-repair. The complication rate in type II and IV PEH were respectively 30% and 10%. All the complications are listed in table 3 according to the Clavien-Dindo classification. The most common complications were pneumothorax and postoperative dysphagia, occurring both in 4 patients. The 4 patients with a pneumothorax required a chest tube. Two out of the 4 patients with postoperative dysphagia had a second operation to resolve the dysphagia. One of these two patients with dysphagia also suffered from pylorospasm due to vagal nerve injury for which pyloroplasty was recommended. One patient had an abdominal subobstruction, while another suffered from a late incisional hernia, both were treated conservatively. There were no observations of mesh-related complication such as erosions, strictures or infection. There were no perioperative deaths. There were no significant differences in the distribution of complications according to the type of PEH ($p = 0.323$). The median hospital stay was 4 days (IQ-range 3-6). There was a significant difference in total hospital stay according to type of PEH

Table 4 — **Recurrence rate according to the initial treatment and the initial type of PEH**

			PEH type II		PEH type III		PEH type IV	
			n= 38		n = 30		n = 5	
	16	100%	8*	21,1%	8**	26,7%	0	0%
Nissen	0	0%	0	0%	0	0%	0	0%
Nissen + mesh	1	6,2%	0	0%	1	3,3%	0	0%
Gastropexy	13	81,3%	8	21,1%	5	16,7%	0	0%
Gastropexy + mesh	2	12,5%	0	0%	2	6,7%	0	0%

* recurrent type of PEH : 2x type II, 2x type III, 4x type IV. ** recurrent type of PEH : 3x type II, 3x type III, 2x type IV.
Pearson Chi-Square test for recurrence according to PEH type : p = 0,403. Pearson Chi-Square test for recurrent type of PEH according to the initial type of PEH : p = 0,569. Pearson Chi-Square test for recurrence according to surgical treatment : p = 0,293. Pearson Chi-Square test for recurrence after Nissen + mesh : p = 0,302. Pearson Chi-Square test for recurrence after Gastropexy : p = 0,055. Pearson Chi-Square test for recurrence after Gastropexy + mesh : p = 0,131.

(p< 0.05). The median hospital stay was respectively 3.5 (IQ-range 3-5), 5 (IQ-range 4-6) and 6 days (IQ-range 5-6) for a type II, III and IV PEH.

During follow-up there was a recurrence rate of 21,9% (n=16) (Table 4). All recurrences were symptomatic as stated earlier. Although no recurrences occurred after repair of a type IV PEH, there was no significant difference in recurrence rate according to the initial type of PEH (p = 0.403). Eight recurrences occurred after repair of a type II PEH: 2 patients had a type II recurrence, another 2 had a type III recurrence and the remaining 4 patients had a type IV recurrent PEH. The remaining 8 recurrences occurred after repair of a type III PEH. Three patients had a type II recurrence, another 3 had a type III recurrence and the remaining 2 had a type IV recurrence. There was no significant association between the type of recurrent PEH according to the initial type of PEH (p= 0.569). Although 81,3% of recurrent PEH occurred after surgical treatment with posterior gastropexy, no significant differences were found when comparing recurrences according to the surgical treatment options (p= 0.293). When comparing the initial type of PEH with the surgical treatment options, no significant differences were found in recurrence rate (nissen + mesh p= 0.302, gastropexy p= 0.055, gastropexy + mesh p= 0.131). Three out of the 13 the patients (23%) that were treated with mesh reinforcement had a recurrent PEH. Comparing recurrence rates to surgical treatment options with or without mesh reinforcement did not show a significant difference (p= 0.911). The median time to diagnosis of a recurrent PEH was 12 months. There was no significant difference in the time interval to recurrence according to the type of PEH (p = 0.474).

The surgical treatment of recurrent PEH according to the initial surgical treatment are shown in table 5. All of the 16 patients with a recurrent, symptomatic PEH had a second surgical procedure: 50% had a second, open surgical procedure and the remaining 50% was treated laparoscopically. Twelve patients were treated with a mesh reinforcement, 1 patient received a Nissen fundoplication and 3 patients were treated with a posterior gastropexy. In contrast to the primary surgical procedures no combinations of Nissen or gastropexy with mesh reinforcement was used in treating recurrent PEH. No significant association was found between the surgical treatment of recurrent PEH according to the treatment of the initial PEH (p= 0.873).

In order to identify possible risk factors for recurrent PEH a logistic regression analysis was performed. Type of PEH, use of mesh, Nissen fundoplication or gastropexy during surgical repair were included as possible risk factors. None of these factors were able to predict a recurrent PEH.

Discussion

The primary finding of this study is that laparoscopic PEH repair is a safe and efficacious procedure with no mortality and minimal early morbidity. Moreover, all operations were completed without conversion to open surgery. These findings are in agreement with recent reviews of the published literature on laparoscopic PEH

Table 5 — **Treatment of recurrent PEH according to the initial treatment**

		recurrent type II PEH			recurrent type III PEH			recurrent type IV PEH		
		n = 5			n = 5			n = 6		
		mesh	nissen	gastropexy	mesh	nissen	gastropexy	mesh	nissen	gastropexy
	16	5	0	0	3	1	1	4	0	2
Nissen	0	0	0	0	0	0	0	0	0	0
Nissen + mesh	1	1	0	0	0	0	0	0	0	0
Gastropexy	13	4	0	0	2	1	1	3	0	2
Gastropexy + mesh	2	0	0	0	1	0	0	1	0	0

Pearson Chi-Square test for treatment of recurrent PEH according to the initial treatment : p = 0,873.

repair in which the median mortality rate was 0.3% and the complication rates varied between 0 and 14% (5).

The observation in literature that a proportion of patients develop reflux postoperatively raises the question as to whether all patient undergoing laparoscopic surgery for PEH should undergo 24h-pH testing and manometry studies prior to their operation. Lebenthal et al. (6) reported that pH monitoring should be performed in the presence of GERD symptoms to document the presence of abnormal esophageal acid exposure. Manometry is used to assess esophageal motility, which influences selection of the type of fundoplication (partial or total). Other authors believe that such tests are not necessary as the presence of a hiatal hernia often makes the examination difficult or unreliable. In addition, it is hard to quantify the relative importance of reflux because of a defective lower esophageal sphincter and mechanical obstruction of the stomach due to the presence of a PEH (7). The usefulness of both 24h-Ph testing and manometry remain unclear.

The decision to surgically repair a PEH is based on 3 factors: the patient's overall medical status, symptomatic complaints and the chance of incarceration and strangulation (8). Traditionally, surgical repair has been recommended to all patients with PEH if medically operable regardless of the presence of symptoms (4). This was based on the perceived likelihood of an acute incarceration or volvulus. A study by Stylopoulos changed many of these perceptions by pooling all available data regarding patients with asymptomatic or minimally symptomatic PEH managed with a watchful waiting approach (8). The frequency of acute complications requiring emergency surgery was only 1.1% per year. In addition, an examination of national hospital outcomes databases showed a relatively low mortality rate of 5% in patients undergoing such acute operations to reduce an incarcerated hernia (8). This suggests that a selective approach to surgery is reserved for symptomatic patients. Nevertheless, an emergent evaluation is required for patients with known or suspected PEH who present with Borchardt's triad (epigastric or chest pain, inability to vomit and failure to pass a nasogastric tube) (9).

There has been debate over the necessity of complete hernia sac excision. Some authors suggest that partial excision is sufficient (10)**.** If the hernia sac is thick or densely adherent to mediastinal structures attempt to resect the entire sac should be abandoned. However, it appears that complete sac excision leads to decreased (early) recurrence (10). As suggested by Horgan and colleagues (11), sac excision should start at approximately the 2 o'clock position, then proceed more laterally and out toward the left crus until the fibers of the left crus are visible. Next, the dissection should be extended toward 11 o'clock and down to 3 or 4 o'clock position. This "left crus approach" reduces the risk of injuring a relapsed or accessory left hepatic artery or left gastric vessel. More importantly, it is crucial not to disrupt the fascia overlying the crus, as it will provide strength for sutures. Surgeons should divide and resect the sac and all of its attachments circumferentially. By leaving a portion of the sac in place, especially if it is in continuity with the intra-abdominal peritoneum, a possible path may be left for development of a recurrent hernia (12).

Esophageal shortening has long been a major issue of controversy in the diagnosis and management of hiatal hernia. Despite having been described over 50 years, questions remain as to the existence and management of a shortened esophagus (13). Those who do not believe that a shortened esophagus exists claim that, in most patients, the esophagus appears shortened because the stomach is pushing it up into the chest cavity and if the hernia is corrected no lengthening procedure is necessary (14). Moreover, the requirement of a Collis gastroplasty in case of a short esophagus is gradually decreasing in number over the years and it is likely that short esophagus is overdiagnosed. In our series Collis gastroplasty was not required and we feel that with adequate esophageal dissection and mobilization sufficient intra-abdominal length can be achieved. However, other recent studies (16) state that a short esophagus might well be a contributing factor to the high recurrence rate following fundoplications or repair of large hiatal hernias. A recent Italian study where 56% of the patients were treated with Collis gastroplasty showed a recurrence rate of 4% studies (15).

The necessity of a fundoplication procedure during PEH repair is not clearly elucidated in the literature. Recent studies have shown that postoperative dysphagia is much more common in patients who have undergone a concomitant fundoplication procedure and that reflux is more common in those who have not (16). In most cases however reflux is easily controllable with medication. Endoscopy was routinely used to evaluate the tightness of the fundoplication in patients who we suspected might have dysphagia. Despite these additional efforts, dysphagia was the most common postoperative complaint. Although we do not advocate abandonment of a concomitant fundoplication procedure, it is possible that a more intensive preoperative screening may minimize the need for reoperation because of dysphagia.

Generally, there has always been a debate if the hiatal defect should be primary closed versus mesh closure. Certainly, size as defined by the number of sutures used to close a defect is somewhat imprecise and no official standard of care has been established. We find it interesting that many surgeons use the size of the hiatal defect in deciding whether to use a mesh, yet there is no method for measuring defect size. In 2007, Granderath (17) described the calculation of the hiatal surface area that takes into account the crural length and the distance between the right and left crura. The number of sutures used to reapproximate the crura usually correlates with hiatal defect size and can be used as an indirect gauge of defect size. According to a 2010 survey of members of the Society of American Gastrointestinal and Endoscopic Surgeons only 8% of surgeons routinely used a mesh

(18). For those who used a mesh selectively, 46% cited size of the defect as indication to use a mesh. In the largest series to date, Luketich et al. reviewed 662 patients who underwent laparoscopic hiatal hernia repair (19). Surgeons used a mesh only when the peritoneum overlying the crura was compromised or if the hiatal opening could not be closed without tension. A mesh was used in 13% of the cases and recurrence rate was 16%. They found no differences in rates of symptoms between patients with or without mesh. Parker et al. noted that most prior research shows a very low rate of symptoms in patients with non-mesh repair, even if radiologic recurrence exists (20). The data suggests that the quality of fundoplication plays a greater role in postoperative symptoms than the presence of recurrence of herniation. Quality of fundoplication includes the right place, not too tight or loose and of appropriate length. Furthermore, it has been shown that a non-absorbable mesh seems to reduce recurrence, but is prone to several complications such as mesh extrusion, bowel erosion, fistulization to gastrointestinal organs and wound sepsis (21). These complications arise from the fact that a non-absorbable mesh creates substantial visceral adhesions to adjacent organs. Because of these pitfalls some authors discourage the use of prosthetic materials at the hiatus (22). Nevertheless, it is shown that the addition of a biologic mesh to a primary repair does not significantly affect recurrence at all up to 5 years, so it seems that the use of biological mesh may delay rather than prevent recurrence (23).

Our study has several limitations due to its retrospective nature of a single team of surgeons at a single institution and lack of control group. For example, we were unable to assess symptom-free interval in our population. Our follow-up duration is limited to 12 months. Finally, the accuracy of our long-term recurrence rate would change if all patients received postoperative radiologic studies. However, these studies were only performed if patients were symptomatic.

Conclusion

In summary, laparoscopic repair of PEH has evolved to include careful awareness of a combination of factors rather than individual variables, most importantly complete excision of the hernia sac, extensive mobilization of the esophagus, and crural reinforcement. Meticulous attention to these factors reduces hernia recurrence. In regard to using a mesh in PEH repair, the potential benefit of lowering the recurrence of herniation is not necessarily outweighed by the risk of mesh complication.

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