

## Controversies in paraesophageal hernia repair

### A review of literature

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#### Abstract

**Background:** The surgical repair of paraesophageal hiatal hernias (PHH) can be performed by endoscopic means, but the procedure is not standardized and results have not been evaluated systematically so far. The aim of this review article was to clarify controversial subjects on the surgical approach and technique, i.e., recurrence rate after conventional versus laparoscopic PHH treatment, results of mesh reinforcement of the cruroplasty, the necessity for additional antireflux surgery, and indications for an esophageal lengthening procedure.

**Methods:** An electronic Medline search was performed to identify all publications reporting on laparoscopic and conventional PHH surgery. The computer search was followed by additional hand searches in books, journals, and related articles. All types of publications were evaluated because of a lack of high-level evidence studies such as randomized controlled trials. Critical analysis followed for all articles describing a study population of >10 patients and those reporting postoperative outcome.

**Results:** A total of 32 publications were reviewed. Randomized controlled trials comparing laparoscopic and open techniques could not be identified. Nineteen of the publications described the results of retrospective series. Therefore, most of the studies retrieved were low in hierarchy of evidence (level II-c or lower). The overall median hospital time as published was 3 days for patients operated laparoscopically and 10 days in the conventional group. Postoperative complications, such as pneumonia, thrombosis, hemorrhage, and urinary and wound tract infections, appeared to be more frequent after conventional surgery. Follow-up was longer for conventional surgery (median 45 months versus 17.5 months after the laparoscopic technique). Recurrence rates reported were higher in patients operated conventionally (median 9.1% versus 7.0% for patients operated laparoscopically). Recurrences after PHH re-

pair may decrease with usage of mesh in the hiatus, although uniform criteria for this procedure are lacking. No conclusions could be drawn regarding the necessity for an additional antireflux procedure. Furthermore, uniform specific indications for the need of an esophageal lengthening procedure or preoperative assessment methods for shortened esophagus could not be detected. **Conclusion:** Treatment based on standardized protocols for preoperative assessment and postoperative follow-up is required to clarify the current controversies.

**Key words:** Laparoscopy — Paraesophageal hernia — Hiatal hernia — Diaphragm hernia

Diaphragmatic herniation is a common disorder of the digestive tract [1, 2]. It is characterized by a protrusion of the stomach into the thoracic cavity through a widening of the right crus of the diaphragm. Four anatomic patterns of hiatal hernia can be recognised. Sliding or type I hernia, in which the gastroesophageal junction migrates into the thorax, is the most common type of hiatal hernia (95%) and may predispose to gastroesophageal reflux [4, 8]. Type II represents a true paraesophageal hernia with herniation of the gastric fundus anterior to a normally positioned esophagogastric junction. Type III, with both elements of types I and II hiatal hernia, tend to be large with more than 50% of the stomach within the mediastinal sac. In type IV hernias the stomach, sometimes with other viscera such as the colon or spleen, migrates completely in the hernia sac, which may result in an “upside-down stomach” [20].

Although paraesophageal hernias (PHH) account for only 5% of all hiatal hernias [9], they are important to detect because of the potentially life-threatening complications such as obstruction, acute dilatation, perforation, or bleeding of the stomach mucosa [13, 48]. In essence, no conventional options are available for the treatment of paraesophageal hernia, so surgical repair is recommended for relief of symptoms. Surgery with the

objective of preventing complications in asymptomatic patients has been recommended, but scientific studies that compare peroperative morbidity to natural history are scarce [20, 41, 42, 46, 47].

The principles of PHH treatment are complete excision of the peritoneal sac from the mediastinum and reduction of herniated stomach and the most distal esophagus into the abdominal cavity, followed by repair of the diaphragm hiatus [12, 35, 49].

PHH repair by laparoscopic techniques was introduced in 1992 by Cuschieri et al. [8] and is currently practiced worldwide. The approach has demonstrated to be feasible and safe in several recent series [10, 11, 14, 16, 19, 21, 23, 26–30, 36–40, 43, 50–53]. Nevertheless, controversy continues regarding four main subjects in the field of surgical treatment of PHH. Regarding the surgical approach, many authors suggest that the laparoscopic approach for PHH repair may result in a higher recurrence rate than in conventional surgery (laparotomy or thoracotomy) [11, 19, 53]. With regard to the surgical technique, there are three issues to be clarified. First, the need to add an antireflux procedure to PHH repair is a topic of discussion. Most of the paraesophageal hernia are type III, which implies that the gastroesophageal junction has migrated above the diaphragm. This may result in an insufficiency of the lower esophageal sphincter with concomitant GERD symptoms, such as heartburn, regurgitation, and cough. In many institutions an antireflux procedure is therefore routinely applied. Some authors state that esophageal dissection during surgery induces gastroesophageal reflux disease (GERD), whereas others advocate that restoration of the anatomical disorder resolves reflux. At present, however, there is little evidence regarding these assumptions, as randomized controlled trials have not been performed up to now [6, 18, 31, 32, 51].

The second controversy is related to the issue of performing an esophageal lengthening procedure in case of a recognized or suspected esophageal shortening as another factor that may influence the recurrence rate after PHH repair [17, 22, 24, 34, 44].

Last, the indications and results of prosthetic crural repair for large PHH remain uncertain with regard to the prevention of recurrences [5, 15, 25, 45].

The aim of this study is to summarize published data and to analyze the current status of laparoscopic and conventional PHH repair, with special emphasis on morbidity and mortality, recurrence rate, the need for an antireflux procedure and indications for esophageal lengthening techniques and reinforcement of the crural repair.

## Materials and methods

### Literature search

An electronic search of Medline using the PubMed database was carried out to identify all publications on laparoscopic and conventional PHH surgery. The search strategy was restricted to studies on human subjects and reported in English. The terms *laparoscopic*, *laparoscopic*, *open*, *conventional*, *paraesophageal hernia*, *hiatal hernia*, and

*diaphragm hernia* were used in various combinations. The computer search was followed by hand searches in journals, books, and reference lists of obtained articles to identify further studies of relevance for the review. Search results were gathered in a bibliographic database.

### Acquisition of results

In order to generate as many publications as possible in the separate areas of interest, all publication types published between 1993 and 2004 were evaluated. Because of a complete lack of studies with a high level of evidence, such as randomized controlled trials, cohort studies and case-controlled studies and meta-analyses, only population size and time to follow-up were used as criteria to include publications. Publications with a population of >10 patients were critically analyzed. Case reports and studies not reporting postoperative outcome were excluded. To access eligibility, all abstracts presenting results and complications of PHH repair were reviewed by two authors (WD and ET) and rediscussed (WD and IB).

After the initial assessment for eligibility, two authors independently extracted the following data: number and demographic data of patients, type of study, length of study and follow-up, preoperative evaluation, indication for surgical repair, surgical technique, postoperative (anatomical) recurrence, mortality, morbidity and hospital stay. In case of disagreement between the two readers, consensus was reached by joint review of the study.

Data analysis was limited to basic manipulation because of a lack of statistically relevant data, resulting from large trials. When needed, statistics to facilitate descriptive objectives were performed in order to compare the different subgroups. Results are presented as median (range) or mean if parametric.

## Results

Thirty-two publications that met the inclusion criteria were found over a time period of 10 years (1993–2004). Nineteen studies were retrospective and 13 were prospective. The size of the patient population ranged from 10 to 240 patients. For the papers that reported length of follow-up, the median follow-up period was 21 months (range 6–94).

According to the Oxford Centre for Evidence-based Medicine Levels of Evidence, the studies retrieved were classified to grade the level of evidence for each article [3, 7, 33]. In Table 1 the hierarchical approach to study design is shown. The highest grade is reserved for research involving randomized controlled trials and the lowest grades are applied to descriptive studies (e.g., case series) and expert opinion. Observational studies, cohort studies, and case-control studies fall at intermediate levels.

In Table 2 the authors, year of publication, number of patients included, number of patients followed, length of follow-up, and conversion rate are presented.

### Surgery and postoperative period

A total number of 1,525 laparoscopic and 766 conventional PHH repairs were retrieved from 32 studies. The overall reported median operative time in the laparoscopic group was 196 min (range 90–320). With growing experience in the laparoscopic approach the mean operating time decreased considerably. To exemplify, in the study described by Diaz et al. [10], an average operative time of 258 min was seen during the

**Table 1.** Grades of evidence according to the Oxford Centre for Evidence-based Medicine Levels of Evidence

I	Evidence obtained from systematic reviews with homogeneity of randomized controlled trials
I-b	Evidence obtained from individual randomized controlled trials with narrow confidence interval
II-a	Evidence obtained from systematic reviews with homogeneity of well-designed cohort studies
II-b	Evidence obtained from individual cohort studies (including low-quality RCT; e.g., < 80% follow-up)
II-c	Evidence obtained from "outcomes" research; ecological studies
III-a	Evidence obtained from systematic reviews with homogeneity of case-control studies
III-b	Evidence obtained from individual case-control studies
IV	Evidence obtained from case-series and poor-quality cohort and case-control studies
V	Expert opinion without explicit critical appraisal, or based on physiology, bench research, or "first principles"

RCT, Randomized controlled trials

**Table 2.** Conventional versus laparoscopic approach

Reference	Year	Level of evidence	No. of operations		No. of patients followed	Mean follow-up (months)	Conversion (%)
			Lap	Conv			
Casabella	1996	IV	15		15	12	2 (13.3)
Wiechmann	2001	IV	60		44	6	6 (10)
Willekes	1997	IV	30		n.r.	n.r.	0 (0)
Pierre	2002	IV	203		152	18	3 (1.5)
Khaitan	2002	IV	31		15	25	6 (19.4)
Luketich	2000	IV	100		90	12	3 (3)
Trus	1997	IV	76		76	n.r.	1 (1.3)
Van de Peet	2000	IV	22		22	24	0 (0)
Perdikis	1997	IV	65		49	18	2 (3.1)
Krähenbühl	1998	IV	12		12	21	1 (8)
Andujar	2004	IV	166		120	15	2 (1.2)
Swanstrom	1999	IV	52		50	18	0 (0)
Mattar	2002	II-c	125		83	40	3 (2.4)
Huntington	1997	II-c	58		58	12	1 (1.7)
Horgan	1999	II-c	41		n.r.	36	2 (4.9)
Edye	1998	II-c	49		49	29	n.r.
Dahlberg	2001	II-c	37		31	15	2 (5.4)
Diaz	2003	II-c	119		96	30	3 (2.5)
Wu	1999	II-c	38		35	6	1 (3)
Targarona	2004	II-c	46		37	30	0 (0)
Gantert	1997	II-c	55		55	11	5 (9.1)
Athanasakis	2001	II-c	10		10	12	0 (0)
Ponsky	2003	II-c	28		28	21	0 (0)
Hashemi	2000	II-c	27	27	51	17 and 34 resp.	2 (7.4)
Ferri	2004	II-c	35	25	57	4 and 45 resp.	1 (2.9)
Schauer	1998	IV	25	70	92	13 and 48 resp.	3 (4.3)
Patel	2004	IV		240	222	42	
Geha	2000	IV		100	n.r.	n.r.	
Altorki	1998	IV		47	42	45	
Williamson	1993	IV		126	115	61.5	
Myers	1995	IV		37	24	67	
Maziak	1998	IV		94	90	94	

Lap, laparoscopic approach; Conv, conventional "open" approach; n.r., not reported

first 20 procedures, which progressively came down to the average of 169 min with growing experience. Only three studies reported on operating time after conventional surgery (medians of 123, 176, and 208 min, respectively).

When comparing results of the individual studies, the overall reported median hospital stay of the laparoscopically operated patients was shorter (3 days, range 2–6) compared to the conventional group (10 days, range 7–10). This reduced hospitalization after laparoscopic PHH repair was noticed in all studies on lapa-

roscopic PHH repair. The overall median conversion rate was 2.4% (range 0–19.4%).

### Complications

Accurate assessment of the complication rate after PHH repair appeared to be complex, as a standard index to score postoperative complications was lacking in all articles. Some authors distinguish between minor and major complications after surgical intervention, whereas

**Table 3.** Mortality and morbidity following laparoscopic and conventional PHH repair

Reference (year)	Laparoscopic		Conventional	
	Mortality (%)	Morbidity (%)	Mortality (%)	Morbidity (%)
Casabella (1996)	0 (0)	0 (0)		
Gantert (1997)	1 (1.8)	3 (5.5)		
Athanasakis (2001)	0 (0)	1 (10)		
Wiechmann (2001)	1 (1.6)	0 (0)		
Willekes (1997)	0 (0)	1 (3.3)		
Pierre (2002)	1 (0.5)	12 (5.9)		
Mattar (2002)	3 (2.2)	2 (1.5)		
Khaitan (2002)	0 (0)	1 (3.2)		
Luketich (2000)	1 (1)	7 (7)		
Huntington (1997)	0 (0)	1 (1.7)		
Horgan (1999)	1 (2.4)	0 (0)		
Edye (1998)	n.r.	n.r.		
Dahlberg (2001)	2 (5.4)	2 (5.4)		
Diaz (2003)	2 (1.7)	5 (4.2)		
Swanstrom (1999)	0 (0)	1 (1.9)		
Trus (1997)	2 (3)	n.r.*		
Wu (1999)	2 (5)	n.r.*		
Van de Peet (2000)	0 (0)	n.r.*		
Perdikis (1997)	0 (0)	5 (7.7)		
Krähenbühl (1998)	0 (0)	3 (8.3)		
Targarona (2004)	1 (2.2)	2 (4.3)		
Ponsky (2003)	0 (0)	0 (0)		
Andujar (2004)	0 (0)	4 (2.4)		
Hashemi (2000)	0 (0)	3 (11)	1 (3.7)	5 (18.5)
Schauer (1998)	1 (1.4)	6 (8.6)	0 (0)	5 of 23 (21.7)
Ferri (2004)	0 (0)	5 (14)	0 (0)	8 (25)
Altorki (1998)			1 (2)	n.r.
Williamson (1993)			2 (1.7)	8 (6.7)
Maziak (1998)			2 (2.1)	5 (5.3)
Myers (1995)			0 (0)	6 (16.2)
Patel (2004)			4 (1.7)	16 (6.7)

PHH, paraesophageal hiatal hernia; n.r., not reported, \*, only major complications described in paper

others report detailed information on postoperative morbidity.

In order to compare postoperative morbidity after laparoscopic and conventional PHH repair, all studies were reviewed for wound infection, urinary tract infection, thrombosis, pneumonia and hemorrhage.

The overall postoperative complication rate ranged from zero to 14% for laparoscopic PHH repair, and between 5.3% and 25% in the conventional group (Table 3). The most frequent postoperative complications following laparoscopic PHH repair were of respiratory origin (i.e. pneumonia) which ranged from 0 to 10%. Other common postoperative complications, such as wound infection (mean 0.2%), urinary tract infection (mean 0.6%), and hemorrhage (mean 0.6%), occurred infrequently. Although series reporting morbidity following open PHH repair were limited, median incidence rates of 2.6% (range 2.1–8.7%) were found for respiratory complications and 5.8% (range 0.8–8.7%) for wound infection.

The median mortality rate in the laparoscopic group was 0.3% (range 0–5.4%), and it was 1.7% (range 0–3.7%) in the conventional PHH repair group.

### Recurrence

Protocols to assess postoperative recurrence were not standardized in any of the studies, except in four where nearly all patients had postoperative barium swallow studies [4, 19, 27, 53].

A discrepancy between anatomic and symptomatic recurrence of the PHH was noticed. We defined anatomic recurrence as a recurrent PHH with or without related symptoms, objectified by barium swallow series. This inconsistency made it difficult to report on true recurrence rate. Recurrence rates for patients treated laparoscopically or conventionally for the individual studies are presented in Table 4. Whether or not a barium esophagram was carried out after PHH repair is also shown in this table. Of the 32 studies extracted, postoperative esophagram series were not performed at all or only in case of persisting symptoms in 16 studies. Of the remaining 16 studies reporting radiologic follow-up, most incorporated no barium swallow studies directly after surgery (i.e., within 6 weeks) and therefore could not be compared with long-term results. Consequently, no correlation could be observed between short- and long-term results of the anatomical outcome after PHH repair.

The overall reported median recurrence rate was 9.1% (range 0–44%) in the conventional group versus 7% (range 0–42%) in the laparoscopic group. Median follow-up interval for patients operated conventionally was 45 (34–94) months versus 17.5 (4–36) months after laparoscopic PHH repair. Recurrence rates were notably higher in studies that included radiologic follow-up in a large percentage of their patients. The median anatomical recurrence rate in studies with barium esophagram series at a minimum of 3 months after PHH repair in >75% of total patients was 20% (range 0–

**Table 4.** Recurrence rate following laparoscopic and conventional PHH repair

Reference (year)	Recurrence		Postoperative esophagram	
	Laparoscopic (%)	Conventional (%)	Yes (%)	Not reported
Athanasakis (2001)	0 (0)		100	
Krähenbühl (1998)	0 (0)		100	
Ponsky (2003)	0 (0)		100	
Wu (1999)	8 of 35 (22.9)		92	
Ferri (2004)	7 of 31 (23)	8 of 18 (44)	86	
Targarona (2004)	6 (20)		81	
Hashemi (2000)	9 of 21 (42)	3 of 20 (15)	75	
Wiechmann (2001)	3 (5)		73	
Andujar (2004)	34 of 120 (28)		72	
Perdikis (1997)	7 of 46 (15.2)		71	
Diaz (2003)	21 of 96 (22)		69	
Patel (2004)		19 of 153 (12)	64	
Khaitan (2002)	6 of 25 (24)		60	
Dahlberg (2001)	3 of 22 (13.6)		60	
Mattar (2002)	14 (11.2)		26	
Horgan (1999)	2 (4.9)		20	
Casabella (1996)	0 (0)			x
Gantert (1997)	3 (5.5)			x
Willekes (1997)	0 (0)			x
Pierre (2002)	5 (2.5)			x
Luketich (2000)	1 (1)			x
Huntington (1997)	0 (0)			x
Edye (1998)	7 (14.3)			x
Swanstrom (1999)	4 (8)			x
Trus (1997)	4 of 76 (5.3)			x
Van de Peet (2000)	5 of 22 (22.7)			x
Schauer (1998)	10 of 67 (16)	4 of 25 (16)		x
Altorki (1998)		3 (7.1)		x
Williamson (1993)		13 (11)		x
Geha (2000)		0 (0)		x
Myers (1995)		1 (2.7)		x
Maziak (1998)		2 of 90 (2.2)		x

PHH, paraesophageal hiatal hernia

42%). Studies in which barium esophagram series were performed in case of symptoms demonstrate a lower recurrence rate, ranging from 0% to 22.7%. These percentages account for the laparoscopic group; objective data for patients treated by laparotomy or thoracotomy could not be retrieved.

#### *Prosthetic crural reinforcement*

Recently, a systematic review was published presenting 23 studies on PHH repair with or without the use of mesh in the hiatus [45]. Most of the clinical results of crural reinforcement techniques are derived from limited series of patients, and long-term follow-up is lacking. More than 10 variations of mesh repair in the hiatus are described, and no consensus has been reached on the appropriate reinforcement procedure after PHH repair, if necessary. Only three comparative studies have been published, of which one was a prospective randomized trial. In addition, two of the comparative studies included patients with all types of hiatal hernia, and only one focused on PHH repair. Basso et al. compared simple and tension-free closures using an onlay piece of polypropylene [5]. Kamolz et al. compared simple closure with a reinforcement procedure that put the stitches over a piece

**Table 5.** Antireflux procedures

Type of fundoplication	Number of patients
Nissen	997
Toupet	143
Dor	14
Belsey Mark IV	46
Collis-Nissen	380
Unknown	229
Other	37

of polypropylene covering the hiatal closure [25]. Neither study was randomized; they were merely comparisons of initial experiences without mesh with more recent experiences with mesh. They demonstrated a reduction in incidence of recurrence after mesh placement, without specific morbidity (9% versus 0%,  $n = 65$  versus 67, resp.). Frantzides et al. published their results of a prospective randomized trial comparing simple closure with polytetrafluoroethylene crural reinforcement after PHH repair in cases with a hiatus wider than 8 cm [15]. Recurrences were significantly reduced in this series of 72 patients after mesh placement (20% versus 0%) with a mean follow-up of 40 months.

### *Antireflux procedure*

In Table 5 the type antireflux fundoplication and related number of patients of all 32 studies are presented. An antireflux procedure was performed in 1,846 of a total of 2,291 patients (80.6%). The most common fundoplication was the Nissen 360° wrap, performed in 54% ( $n = 997$ ) of patients. The Collis-Nissen fundoplication was carried out in 20.6% ( $n = 380$ ) of patients.

The majority of all studies were of a retrospective character and therefore, information on pre- and postoperative GERD symptoms and objective assessment by 24-hr pH monitoring was scarce. As part of the preoperative workup, 24-hr pH-metry was performed regularly in 10 of the 32 studies. A total of 355 patients with GERD-related symptoms, scored with validated standard questionnaires, had 24-hr pH-metry in these 10 studies. Abnormal acid exposure was reported in 118 (52%) patients (>9% of total reflux time pH <4). Postoperative results on 24-hr pH monitoring were reported in two studies after laparoscopic PHH repair. In both studies all patients had an antireflux procedure after repair of the hiatus. In the study by Athanasakis et al., all 10 patients had standard pre- and postoperative 24-hr pH-metry that revealed a mean preoperative DeMeester score of 70 versus 10 after laparoscopic PHH repair [4]. In the next study by Swanstrom et al., selectively obtained ambulatory preoperative 24-hr pH-metry proved to be abnormal in 80% (18 of 22 in a population of 52) of patients [43]. Postoperatively, 31 patients (61%) were examined for acid exposure at a mean of 8 months. Abnormal results from 24-hr pH testing were detected in four (13%), although it is unclear whether these patients also were tested preoperatively.

### *Esophageal lengthening procedure*

Indications to perform a Collis procedure after repair of PHH remain controversial in most papers, and many authors seem to base their decision to perform an additional Collis gastroplasty on peroperative findings. Uniform preoperative assessment protocols for shortened esophagus with esophagram and manometry studies in patients with PHH were unavailable in the articles evaluated. Esophageal lengthening procedures were performed in eight of the 32 studies. Pierre et al. report on 113 of 203 patients with a Collis gastroplasty as part of their repair [38]. Conclusions on the effect of an esophageal lengthening procedure with regard to recurrence and complication rates could not be drawn. Thus, information on a preoperative strategy to unequivocally detect esophageal shortening remains unclear in the literature.

## **Discussion**

Operative management of PHH is associated with significant morbidity through laparotomy or thoracotomy

[20, 31, 41]. This accounts in particular for the elderly population in which this disorder is most common. The average patient diagnosed with PHH is aged between 60 and 70 years [52]. The natural history of this type of hernia is progressive enlargement of the hiatus and herniation of the stomach, which potentially can develop into a large or giant paraesophageal hernia. Despite the fact that patients may be asymptomatic, the development of potentially life-threatening complications without surgical intervention is well known and has proven to be fatal in 27% of cases [41, 47, 48]. Surgical repair has therefore been recommended, regardless of symptoms in the individual patient [20]. It has been advocated, however, by Stylopoulos et al. that asymptomatic or minimally symptomatic PHH can also be monitored by “watchful waiting” in stead of prophylactic surgery with a mortality rate of 5.4% of acute operated patients [42]. Additionally, they state that patients with asymptomatic PHH are likely to develop symptoms needing emergency surgery in 1.16% of cases. These authors therefore advise surgery only in case of progression of symptoms or when complications occur.

A greater part of the authors of the studies reviewed report that the laparoscopic procedures remain technically demanding and generally require long operations because of the size and distorted anatomy of the PHH. No explicit difference, however, in operating time between the two approaches could be detected. In our opinion, conventional surgery for large PHH often is as demanding as the laparoscopic technique, mostly due to impaired sight or reach in the upper abdomen. For years, large PHH were considered as a contraindication for laparoscopic surgery but, up to now, no evidence is available to support this contraindication. The morbidity reported in patients treated by laparotomy or thoracotomy exceeded morbidity reported in laparoscopically operated patients. It has to be taken into consideration that figures on morbidity only give an indication since uniformity in describing postoperative complications is lacking. Overall, we found a median morbidity rate of 4.3% in the laparoscopic group (22 studies) and 16.2% in the conventional group (seven studies). In addition, the median hospital stay after laparoscopic repair of PHH was shorter than after conventional surgery. Nevertheless, these data should be interpreted in the perspective of historical changes in hospital stay, since articles on open PHH repair were published between 1993 and 2004, whereas articles on laparoscopic PHH repair were published between 1997 and 2004.

A well-known complication after PHH repair is recurrent herniation. Because recurrence does not necessarily implicate return of complaints, objective information on the anatomic recurrence rate requires standardized work-up and follow-up with regular routine barium swallow series up to at least 2 years. No such detailed studies are available as yet. In the present study, follow-up was considerably longer for conventional surgery (median 45 months versus 17.5 months after the laparoscopic technique). Only seven studies assessed long-term outcome by means of a barium esophagram in a high percentage of patients

studied at 3 to 48 months. Hashemi et al. performed a barium esophagram in 74% of patients undergoing conventional PHH repair at a median of 35 months and in 77% of patients with laparoscopic repair at a median of 17 months [19]. The remaining patients did not agree to radiographic follow-up examination. They showed an *anatomical* PHH recurrence in 15% of the open repairs ( $n = 20$ ) and 42% of the endoscopically operated patients ( $n = 21$ ). Similarly, Andujar et al. showed anatomical recurrences in six patients (5%), sliding hernia in 24 (20%), and wrap failures in an additional four patients (3.3%) in 120 laparoscopically operated patients with routine x-ray series (Table 4). In this review, conversely, we found a higher median recurrence rate in studies reporting outcome after conventional PHH repair (9.1% compared to 7.0% following laparoscopic surgery). In general, diversity in describing recurrence rates between individual studies may lead to a discrepancy between studies that mention anatomical recurrence and those that describe symptomatic recurrence. In addition, the number of studies describing recurrence after conventional PHH repair is much smaller, so no precise data regarding the recurrence rate are available.

One prospective randomized trial on the use of mesh reinforcement techniques after PHH repair has been published [15]. Although a significant reduction in recurrent PHH is noted, only two other comparative studies are available as yet. Uniformity in the type of reinforcement technique is lacking as several variations in the application of mesh for crural repair have been described. The use of prosthetic reinforcement of cruroplasty in PHH seems promising and may prevent recurrences, but this remains a controversial issue as unequivocal evidence is scarce. At present, the decision to perform a mesh cruroplasty after repair of the PHH is based on clinical experience, and further randomized studies on these techniques with standardized use of reinforcement techniques are needed to elucidate the value of these methods.

With regard to the additional value of an antireflux procedure, no randomized controlled trials have been undertaken as yet. An antireflux procedure is applied routinely by many authors, but frequently without documentation on reflux and reflux symptoms before and after surgery. In a recent published expert opinion on PHH repair by Lal et al., it is stated that a Nissen fundoplication should routinely be performed in case of normal esophageal motility [28]. They advocate that, in experienced hands, prolonged operating time and postoperative dysphagia after routine fundoplication are of minimal consequence to postoperative outcome. Furthermore, they believe that a fundoplication is an effective method to prevent postoperative reflux and affix the stomach intra-abdominally. Swanstrom et al. also advocate routine addition of a fundoplication, because, in their perspective, preoperative testing is unreliable for a selective approach because of the altered anatomy [43]. Casabella et al. promote that the addition of a fundoplication prevents postoperative gastroesophageal reflux symptoms caused by extensive dissection of the esophagus,

resulting in damage to the natural lower sphincter mechanism [6]. Though theoretically sound, there is currently no clear objective proof for these assumptions or for the benefits of a routinely performed antireflux procedure after PHH repair. Additionally, it has been questioned whether a fundoplication has to be performed to decrease the recurrence rate, rather than whether an antireflux procedure is indicated to treat or prevent reflux [6, 27]. The efficacy of an antireflux procedure in preventing recurrent PHH, however, seems to be based on experts' opinion and has not been studied prospectively.

Criteria for performing a Collis esophageal lengthening gastroplasty also remain controversial, not the least because the existence of short esophagus has extensively been debated. Altorki et al. evaluated 52 patients with PHH and reported that in 77% the gastroesophageal junction was positioned in the mediastinum, but extensive mobilization of the esophagus without an additional Collis lengthening gastroplasty resulted in good clinical results in 90% of patients [1]. Maziak et al. reported the gastroesophageal junction had migrated in the mediastinum in 91 of 94 patients with PHH, objectified by esophagogastrosopy [31]. Reflux esophagitis was found in 34 patients (36%). These results, however, were not objectified with x-ray series and 24-hr pH-metry before surgery. Recurrent PHH with severe symptoms of recurrent reflux occurred in 2.2% of patients. In contrast, Ellis et al. identified only two patients with shortened esophagus during 55 PHH repairs [13]. In a review by Horvath et al. on the current insights of shortened esophagus, extensive mediastinal mobilization of the esophagus (type II dissection) before attempting a Collis procedure is advised [22]. When a tension-free intraabdominal esophageal length of  $\sim 2.5\text{--}3$  cm has been accomplished, no additional esophageal lengthening procedure needs to be performed. In general, no uniform absolute criteria have been developed that could be retrieved from the literature that in time can be applied prospectively to identify patients with shortened esophagus. In that perspective, many surgeons will use their personal experience to determine whether a Collis gastroplasty has to be performed, often during the surgical procedure. This cannot, however, be based on evident proof in the literature of a decrease of anatomic recurrence after PHH repair accompanied with a Collis procedure.

In conclusion, none of the assigned controversies could be adequately answered by reviewing the literature. This might indicate that the incidence of patients with PHH is too low, that the anatomical basis of the disease remains complex with regard to different surgical techniques, or that outcome measures are well defined but underexposed. For this reason, prospective studies including pre- and postoperative assessment of reflux-related symptoms, i.e., barium swallow series, upper gastrointestinal endoscopy, esophageal manometry, and 24-hr pH-metry at standard points in time, should be performed. Therefore, we recently started a pilot study on laparoscopic PHH repair with selective use of an antireflux procedure, according to well-defined sub-

jective and objective criteria including standardized pre- and postoperative work-up and follow-up. Ultimately, this will have to be followed by multicenter randomized controlled trials to further elucidate the aforementioned controversies in PHH repair.

## References

- Altorki NK, Yankelevitz D, Skinner DB (1998) Massive hiatal hernias: the anatomic basis of repair. *J Thorac Cardiovasc Surg* 115: 828–835
- Andujar JJ, Papisavas PK, Birdas T, Robke J, Raftopoulos Y, Gagne DJ, Caushaj PF, Landreneau RJ, Keenan RJ (2004) Laparoscopic repair of large paraesophageal hernia is associated with a low incidence of recurrence and reoperation. *Surg Endosc* 18: 444–447
- Assendelft WJ, van Tulder MW, Scholten RJ, Bouter LM (1999) The practice of systematic reviews. II. Searching and selection of studies. *Ned Tijdschr Geneesk* 143: 656–661
- Athanasakis H, Tzortzinis A, Tsiaoussis J, Vassilakis JS, Xynos E (2001) Laparoscopic repair of paraesophageal hernia. *Endoscopy* 33: 590–594
- Basso N, DeLeo A, Genco A, et al. (2000) 360 Degrees laparoscopic fundoplication with tension free hiatoplasty in the treatment of symptomatic gastroesophageal reflux disease. *Surg Endosc* 14: 164–169
- Casabella F, Sinanan M, Horgan S, Pellegrini CA (1996) Systematic use of gastric fundoplication in laparoscopic repair of paraesophageal hernias. *Am J Surg* 171: 485–489
- Cook DJ, Guyatt GH, Laupacis A, Sackett DL, Goldberg RJ (1995) Clinical recommendations using levels of evidence for antithrombotic agents. *Chest* 108 Suppl: 227S–230S
- Cuschieri A, Shimi S, Nathanson LK (1992) Laparoscopic reduction, crural repair, and fundoplication of large hiatal hernia. *Am J Surg* 163: 425–430
- Dahlberg PS, Deschamps C, Miller DC, Allen MS, Nichols FC, Pairolero PC (2001) Laparoscopic repair of large paraesophageal hiatal hernia. *Ann Thorac Surg* 72: 1125–1129
- Diaz S, Brunt LM, Klingensmith ME, Frisella PM, Soper NJ (2003) Laparoscopic paraesophageal hernia repair, a challenging operation: medium-term outcome of 116 patients. *J Gastrointest Surg* 7: 59–66
- Edye MB, Canin-Endres J, Gattorno F, Salky BA (1998) Durability of laparoscopic repair of paraesophageal hernia. *Ann Surg* 228: 528–535
- Edye M, Salky B, Posner A, Fierer A (1998) Sac excision is essential to adequate laparoscopic repair of paraesophageal hernia. *Surg Endosc* 12: 1259–1263
- Ellis FH Jr, Crozier RE, Shea JA (1986) Paraesophageal hiatus hernia. *Arch Surg* 121: 416–420
- Ferri LE, Feldman LS, Stanbridge D, Mayrand S, Stein L, Fried GM (2005) Should laparoscopic paraesophageal hernia repair be abandoned in favor of the open approach? *Surg Endosc* 19: 4–8
- Frantzides CT, Madan AK, Carlson MA, Stavropoulos GP (2002) A prospective, randomized trial of laparoscopic polytetrafluoroethylene (PTFE) patch repair vs simple cruroplasty for large hiatal hernia. *Arch Surg* 137: 649–652
- Gantert WA, Patti MG, Arcerito M, Feo C, Stewart L, DePinto M, Bhojyul S, Rangel S, Tyrrell D, Fujino Y, Mulvihill SJ, Way LW (1998) Laparoscopic repair of paraesophageal hiatal hernias. *J Am Coll Surg* 186: 428–432
- Gastal OL, Hagen JA, Peters JH, Campos GMR, Heshemi M, Theisen J, Bremner CG, DeMeester TR (1999) Short esophagus: analysis of predictors and clinical implications. *Arch Surg* 134: 633–636
- Geha AS, Massad MG, Snow NJ, Baue AE (2000) A 32-year experience in 100 patients with giant paraesophageal hernia: the case for abdominal approach and selective antireflux repair. *Surgery* 128: 623–630
- Hashemi M, Peters JH, DeMeester TR, Huprich JE, Quek M, Hagen JA, Crookes PF, Theisen J, DeMeester SR, Sillin LF, Bremner CG (2000) Laparoscopic repair of large type III hiatal hernia: objective followup reveals high recurrence rate. *J Am Coll Surg* 190: 553–560
- Hill LD, Tobias JA (1968) Paraesophageal hernia. *Arch Surg* 96: 735–744
- Horgan S, Eubanks TR, Jacobsen G, Omelanczuk P, Pellegrini CA (1999) Repair of paraesophageal hernias. *Am J Surg* 177: 354–358
- Horvath KD, Swanstrom LL, Jobe BA (2000) The short esophagus: pathophysiology, incidence, presentation, and treatment in the era of laparoscopic antireflux surgery. *Ann Surg* 232: 630–640
- Huntington TR (1997) Short-term outcome of laparoscopic paraesophageal hernia repair. A case series of 58 consecutive patients. *Surg Endosc* 11: 894–898
- Jobe BA, Horvath KD, Swanstrom LL (1998) Postoperative function following laparoscopic collis gastroplasty for shortened esophagus. *Arch Surg* 133: 867–874
- Kamolz T, Granderath FA, Basmmmer T, Pasiut M, Pointer R (2002) Dysphagia and quality of life after laparoscopic Nissen fundoplication in patients with and without prosthetic reinforcement of the hiatal crura. *Surg Endosc* 16: 572–577
- Khaitan L, Houston H, Sharp K, Holzman M, Richards W (2002) Laparoscopic paraesophageal hernia repair has an acceptable recurrence rate. *Am Surg* 68: 546–551
- Krahenbuhl L, Schafer M, Farhadi J, Renzulli P, Seiler CA, Buchler MW (1998) Laparoscopic treatment of large paraesophageal hernia with totally intrathoracic stomach. *J Am Coll Surg* 187: 231–237
- Lal DR, Pellegrini CA, Oelschlager BK (2005) Laparoscopic repair of paraesophageal hernia. *Surg Clin North Am* 85: 105–118
- Luketich JD, Raja S, Fernando HC, Campbell W, Christie NA, Buenaventura PO, Weigel TL, Keenan RJ, Schauer PR (2000) Laparoscopic repair of giant paraesophageal hernia: 100 consecutive cases. *Ann Surg* 232: 608–618
- Mattar SG, Bowers SP, Galloway KD, Hunter JG, Smith CD (2002) Long-term outcome of laparoscopic repair of paraesophageal hernia. *Surg Endosc* 16: 745–749
- Maziak DE, Todd TR, Pearson FG (1998) Massive hiatus hernia: evaluation and surgical management. *J Thorac Cardiovasc Surg* 115: 53–60
- Myers GA, Harms BA, Starling JR (1995) Management of paraesophageal hernia with a selective approach to antireflux surgery. *Am J Surg* 170: 375–380
- Offringa M, de Craen AJ (1999) The practice of systematic reviews. I. Introduction. *Ned Tijdschr Geneesk* 143: 653–656
- O'Rourke RW, Khajanchee YS, Urbach DR, Lee NN, Lockhart B, Hansen PD, Swanstrom LL (2003) Extended transmediastinal dissection: an alternative to gastroplasty for short esophagus. *Arch Surg* 138: 735–740
- Patel HJ, Tan BB, Yee J, Orringer MB, Iannettoni MD (2004) A 25-year experience with open primary transthoracic repair of paraesophageal hiatal hernia. *J Thorac Cardiovasc Surg* 127: 843–849
- van der Peet DL, Klinkenberg-Knol EC, Alonzo Poza A, Sietses C, Eijbsbouts QAJ, Cuesta MA (2000) Laparoscopic treatment of large paraesophageal hernias: both excision of the sac and gastroplexy are imperative for adequate surgical treatment. *Surg Endosc* 14: 1015–1018
- Perdikis G, Hinder RA, Filipi CJ, Walenz T, McBride PJ, Smith SL, Katada N, Klingler PJ (1997) Laparoscopic paraesophageal hernia repair. *Arch Surg* 132: 586–589
- Pierre AF, Luketich JD, Fernando HC, Christie NA, Buenaventura PO, Little VR, Schauer PR (2002) Results of laparoscopic repair of giant paraesophageal hernias: 200 consecutive patients. *Ann Thorac Surg* 74: 1909–1915
- Ponsky J, Rosen M, Fanning A, Malm J (2003) Anterior gastroplexy may reduce the recurrence rate after laparoscopic paraesophageal hernia repair. *Surg Endosc* 17: 1029–1035
- Schauer PR, Ikramuddin S, McLaughlin RH, Graham TO, Slivka A, Lee KKW, Schraut WH, Luketich JD (1998) Comparison of laparoscopic versus open repair of paraesophageal hernia. *Am J Surg* 176: 659–665
- Skinner DB, Belsey RH (1967) Surgical management of esophageal reflux and hiatus hernia. Long-term results with 1,030 patients. *J Thorac Cardiovasc Surg* 53: 33–54



42. Stylopoulos N, Gazelle GS, Rattner DW (2002) Paraesophageal hernias: operation or observation? *Ann Surg* 236: 492–500
43. Swanstrom LL, Jobe BA, Kinzie LR, Horvath KD (1999) Esophageal motility and outcomes following laparoscopic paraesophageal hernia repair and fundoplication. *Am J Surg* 177: 359–363
44. Swanstrom LL, Marcus DR, Galloway GQ (1996) Laparoscopic Collis gastroplasty is the treatment of choice for the shortened esophagus. *Am J Surg* 171: 477–481
45. Targarona EM, Bendahan G, Balague C, Garriga J, Trias M (2004) Mesh in the hiatus: A controversial issue. *Arch Surg* 139: 1286–1296
46. Targarona EM, Novell J, Vela S, Cerdan G, Bendahan G, Torrubia S, Kobus C, Rebaso P, Balague C, Garriga J, Trias M (2004) Mid term analysis of safety and quality of life after the laparoscopic repair of paraesophageal hiatal hernia. *Surg Endosc* 18: 1045–1050
47. Trus TL, Bax T, Richardson WS, Branum GD, Mauren SJ, Swanstrom LL, Hunter JG (1997) Complications of laparoscopic paraesophageal hernia repair. *J Gastrointest Surg* 1: 221–228
48. Tsuboi K, Tsukada K, Nakabayashi T, Kato H, Miyazaki T, Masuda N, Kuwano H (2002) Paraesophageal hiatus hernia, which has progressed for 8 years: report of a case. *Hepatogastroenterology* 49: 992–994
49. Watson DJ, Davies N, Devitt PG, Jamieson GG (1999) Importance of dissection of the hernial sac in laparoscopic surgery for large hiatal hernias. *Arch Surg* 134: 1069–1073
50. Wiechmann RJ, Ferguson MK, Naunheim KS, McKesey P, Hazelrigg SJ, Santucci TS, Macherey RS, Landreneau RJ (2001) Laparoscopic management of giant paraesophageal herniation. *Ann Thorac Surg* 71: 1080–1086
51. Williamson WA, Ellis FH Jr, Streitz JM Jr, Shahian DM (1993) Paraesophageal hiatal hernia: is an antireflux procedure necessary? *Ann Thorac Surg* 56: 447–451
52. Willekes CL, Edoga JK, Frezza EE (1997) Laparoscopic repair of paraesophageal hernia. *Ann Surg* 225: 31–38
53. Wu JS, Dunnegan DL, Soper NJ (1999) Clinical and radiologic assessment of laparoscopic paraesophageal hernia repair. *Surg Endosc* 13: 497–502