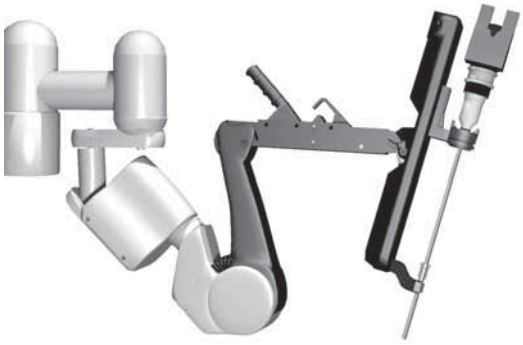
## Chapter 6

# Controversies in large hiatal hernia repair; a review of the literature



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# Abstract

## Background

The surgical repair of large types II-IV hiatal hernia (HH) can be performed by endoscopic means, but the procedure is not standardised and results have not been evaluated systematically so far. The aim of this review article was to clarify controversial subjects on surgical approach and technique, i.e. recurrence rate after conventional versus laparoscopic large HH 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 large HH 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 randomised controlled trials. Critical analysis followed for all articles describing a study population of more than ten patients and those reporting postoperative outcome.

## Results

A total of 32 publications were reviewed. 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 three days for patients operated laparoscopically and ten days in the conventional group. Postoperative complications, 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 HH repair 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 standardised protocols for preoperative assessment and postoperative follow-up is required to clarify the current controversies.

# Introduction

Diaphragmatic herniation is a common disorder of the digestive tract[1-8]. It is characterised 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 hiatal 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[9,10]. 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 type I and II hiatal hernia, tend to be large with more than 50% of the stomach within the mediastinal sac. In type IV hernia 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"[11].

Although large hiatal hernia, i.e. types II-IV (HH), account for only 5% of all hiatal hernia[12], they are important to detect because of the potentially life-threatening complications such as obstruction, acute dilatation, perforation or bleeding of the stomach mucosa[13,14]. In essence, no conventional options are available for the treatment of large HH, so surgical repair is recommended for relief of symptoms. Surgery with the objective to prevent complications in asymptomatic patients has been recommended, but scientific studies that compare intra-operative morbidity to natural history are scarce[7,11,14-17].

The principles of large HH treatment are complete excision of the peritoneal sac from the mediastinum, reduction of herniated stomach and the most distal esophagus into the abdominal cavity, followed by repair of the diaphragm hiatus[4,18-20].

Large HH repair by laparoscopic techniques was introduced in 1992 by Cuschieri et al.[10] and is currently practised worldwide. The approach has demonstrated to be feasible and safe in several recent series[3,5,6,8,9,21-37]. Nevertheless, controversy continues regarding four main subjects in the field of surgical treatment of large HH. Regarding the surgical approach, many authors suggest that the laparoscopic approach for HH repair may result in a higher recurrence rate than in conventional surgery (laparotomy or thoracotomy)[22,24,36]. With regard to the surgical technique, there are three issues to be clarified. First, the need to add an antireflux procedure to HH repair is a topic of discussion. Most of the hiatal hernia are type III which implicates 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 GERD whereas others advocate that restoration of the anatomical disorder resolves reflux. At present, however, there is little evidence regarding these assumptions, as randomised controlled trials have not been performed up to now[35,38-40].
The second controversy is related to the issue of performing an esophageal lengthening procedure in case of a recognised or suspected esophageal shortening as another factor that may influence the recurrence rate after large HH repair[39,41-45].
Last, the indications and results of prosthetic crural repair for large HH remain uncertain with regard to the prevention of recurrences[7,46,47].
The aim of this study is to summarise published data and to analyse the current status of laparoscopic and conventional large HH 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.

## Methods

### Literature search

An electronic search of Medline using the PubMed database was carried out to identify all publications on laparoscopic and conventional large HH surgery. The search strategy was restricted to studies on human subjects and reported in English. The terms 'laparoscopic', 'laparoscopy', '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 much 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, like randomised 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 more than ten patients were critically analysed. Case reports and studies not reporting postoperative outcome were excluded. To access eligibility, all abstracts presenting results and complications of large HH repair were reviewed by two authors (WD and ET) and re-discussed (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 ten years (1993 – 2004). Nineteen studies were retrospective and thirteen were prospective. The size of the patient population ranged from 10 to 240 patients. 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[48-51]. In table 1 the hierarchical approach to study design is shown. The highest grade is reserved for research involving randomised 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.

**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 randomised controlled trials |
| I-b | Evidence obtained from individual randomised 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 randomised controlled trials; 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" |

## Surgery and postoperative period

A total number of 1525 laparoscopic and 766 conventional large HH repairs were retrieved from thirty-two studies. The overall reported median operative time in the laparoscopic group was 196 minutes (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.[21], an average operative time of 258 minutes was seen during the first twenty procedures, which progressively came down to the average of 169 minutes with growing experience. Only three studies reported on operating time after conventional surgery (medians of 123, 176 and 208 minutes 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 hospitalisation was noticed in all studies on laparoscopic large HH repair. The overall median conversion rate was 2.4% (range 0-19.4%).

**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

## Complications

Accurate assessment of the complication rate after large HH 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 others report detailed information on postoperative morbidity. In order to compare postoperative morbidity after laparoscopic and conventional large HH repair, all studies were reviewed for wound infection, urinary tract infection, thrombosis, pneumonia and haemorrhage.

The overall postoperative complication rate ranged from zero to 14% for laparoscopic large HH repair, and between 5.3% and 25% in the conventional group (table 3). The most frequent postoperative complications following laparoscopic large HH repair were of respiratory origin (i.e. pneumonia) which ranged from zero to 10%. Other common postoperative complications, such as wound infection (mean 0.2%), urinary tract infection (mean 0.6%) and haemorrhage (mean 0.6%), occurred infrequently. Although series reporting morbidity following open large HH 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 1.7% (range 0-3.7%) in the conventional large HH repair group.

## Recurrence

Protocols to assess postoperative recurrence were not standardised in any of the studies, except in four where nearly all patients had postoperative barium swallow studies[8,9,24,36].

A discrepancy between anatomic and symptomatic recurrence of large HH was noticed. We defined anatomic recurrence as a recurrent HH 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 HH 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 sixteen studies. Of the remaining sixteen studies reporting radiologic follow-up, most incorporated no barium swallow studies directly after surgery (i.e. within six 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 large HH repair.

**Table 3**
Mortality and morbidity following laparoscopic and conventional large HH 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) |

n.r.: not reported *: only major complications described in article

**Table 4**

Recurrence rate following laparoscopic and conventional large HH 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) | | 9 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 |

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 large HH repair. Recurrence rates were notably higher in studies that included radiological follow-up in a large percentage of their patients. The median anatomical recurrence rate in studies with barium esophagram series at a minimum of three months after large HH repair in more than 75% of total patients was 20% (range 0–42%). Studies in which barium esophagram series were performed in case of symptoms demonstrated 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 twenty-three studies on large HH repair with or without the use of mesh in the hiatus[52]. 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 ten variations of mesh repair in the hiatus are described and no consensus has been reached on the appropriate reinforcement procedure after HH repair, if necessary. Only three comparative studies have been published of which one was a prospective randomised trial. In addition, two of the comparative studies included patients with all types of hiatal hernia, and only one focused on large HH repair. Basso et al. compared simple and tension-free closures using an onlay piece of polypropylene[47]. Kamolz et al. compared simple closure with a reinforcement procedure that put the stitches over a piece of polypropylene covering the hiatal closure[53]. Neither study was randomised; 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 randomised trial comparing simple closure with poly-tetrafluoroethylene crural reinforcement after large HH repair in cases with a hiatus wider than 8 cm[46]. 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 thirty-two studies are presented. An antireflux procedure was performed in 1846 of a total of 2291 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 hours pH monitoring was scarce. As part of the preoperative work-up, 24-hr pH-metry was performed regularly in ten 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 ten 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 large HH repair. In both studies all patients had an antireflux procedure after repair of the hiatus. In the study by Athanasakis et al., all ten patients had standard pre- and postoperative 24 hours pH-metry which revealed a mean preoperative DeMeester score of 70 versus 10 after laparoscopic large HH repair[9]. 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[33]. 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 4 (13%), although it is unclear whether these patients also were tested preoperatively.

## Esophageal lengthening procedure

Indications to perform a Collis procedure after repair of large HH remain controversial in most papers, and many authors seem to base their decision to perform an additional Collis gastroplasty on intra-operative findings. Uniform preoperative assessment protocols for shortened esophagus with esophagram and manometry studies in patients with large HH 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[31]. 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.

**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 |

## Discussion

Operative management of large HH is associated with significant morbidity through laparotomy or thoracotomy[11,15,39]. This accounts in particular for the elderly population in which this disorder is most common. The average patient diagnosed with large HH is aged between 60 and 70 years[34]. The natural history of this type of hernia is progressive enlargement of the hiatus and herniation of the stomach, which potentially can develop in a large or giant diaphragmatic 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[14,15,17]. Surgical repair has therefore been recommended, regardless of symptoms in the individual patient[11]. It has been advocated, however, by Stylopoulous et al. that asymptomatic or minimally symptomatic large HH can also be monitored by 'watchful waiting' in stead of prophylactic surgery with a mortality rate of 5.4% of acute operated patients[16]. Additionally, they state that patients with asymptomatic large HH 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 HH. No explicit difference,

however, in operating time between the two approaches could be detected. In our opinion, conventional surgery for large HH often is as demanding as the laparoscopic technique, mostly due to impaired sight or reach in the upper abdomen. For years, large HH were considered as a contra-indication for laparoscopic surgery but, up to now, no evidence is available to support this contra-indication. 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 large HH 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 HH repair were published between 1993 and 2004, while articles on laparoscopic HH repair were published between 1997 and 2004.

A well-known complication after large HH repair is recurrent herniation. Due to the fact that recurrence does not necessarily implicate return of complaints, objective information on the anatomic recurrence rate requires standardised work-up and follow-up with regular routine barium swallow series up to at least two 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 three to 48 months. Hashemi et al. performed a barium esophagram in 74% of patients undergoing conventional large HH repair at a median of 35 months and in 77% of patients with laparoscopic repair at a median of 17 months[24]. The remaining patients disagreed to radiographic follow-up examination. They showed an anatomical HH 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)[2]. In this review, conversely, we found a higher median recurrence rate in studies reporting outcome after conventional large HH 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 who mention anatomical recurrence and those who describe symptomatic recurrence. In addition, the number of studies describing

recurrence after conventional large HH repair is much smaller, so no precise data regarding the recurrence rate are available.
One prospective randomised trial on the use of mesh reinforcement techniques after large HH repair has been published[46]. Although a significant reduction in recurrent HH 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 large HH 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 large HH is based on clinical experience and further randomised studies on these techniques with standardised use of reinforcement techniques are needed to elucidate the value of these methods.
With regard to the additional value of an antireflux procedure, no randomised 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 large HH repair by Lal et al., it is stated that a Nissen fundoplication should routinely be performed in case of normal esophageal motility[54]. 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 due to the altered anatomy [33]. Casabella et al. promote that the addition of a fundoplication prevents the postoperative gastroesophageal reflux symptoms caused by extensive dissection of the esophagus, resulting in damage of the natural lower sphincter mechanism[38]. Though theoretically sound, there is currently no clear objective proof for these assumptions and the benefits of a routinely performed antireflux procedure after large HH 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[8,38]. The efficacy of an antireflux procedure in preventing recurrent HH, 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 large HH and

reported that in 77% the gastroesophageal junction was positioned in the mediastinum, but extensive mobilisation 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 large HH, objectified by esophagogastroscopy[39]. 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 HH 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 large HH repairs[13]. In a review by Horvath et al. on the current insights of shortened esophagus, extensive mediastinal mobilisation of the esophagus (type II dissection) before attempting a Collis procedure is advised[42]. When a tension-free intra abdominal esophageal length of approximately 2.5 to 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 if 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 large HH 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 either the incidence of patients with large HH 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 monitoring at standard points in time, should be performed. Therefore, we recently started a pilot study on laparoscopic large HH repair with selective use of an antireflux procedure according to well-defined subjective and objective criteria including standardised pre- and postoperative work- and follow-up. Ultimately, multicentre randomised controlled trials are probably needed to further elucidate the aforementioned controversies in large HH repair.

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