Overview and Management of Paraesophageal Hernias

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Introduction and Classifications

At present, controversy exists regarding the management of hiatal hernia and its associated conditions, such as gastroesophageal reflux disease (GERD) and chronic anemia [1–6]. The majority of the controversy stems from the variable definitions of hernia types based on anatomical changes at the hiatus and the accuracy of diagnostic tests in differentiating these anatomical abnormalities [1, 2, 5]. In general, hiatal hernia can be defined as migration of either the stomach or esophagogastric junction and occasionally other visceral organs into the mediastinum, in the setting of deterioration of the phreno-esophageal ligament and widening of the hiatus.

The history of hiatal hernia surgery was best summarized by Stylopoulos and Rattner in 2005 [7]. The original definition and classification of hiatal hernias, in association with the most frequently associated disease, GERD, can be traced to 1948, when Allison published his fundamental paper on *Peptic Ulcers of the Esophagus* [8]. The first descriptions of post-traumatic and congenital diaphragmatic hernias date back to the sixteenth century [7]. In the first half of the twentieth century, several authors published their clinical experiences with hiatal hernias [7].

In 1948, Philip Allison described his clinical experience with several types of hiatal hernia, supported by radiographic studies [8]. He classified his experience into four different morphologic types (Fig. 13.1). In the first figure, he shows a true paraesophageal hernia, which he names as such (Fig. 13.1a). In the second figure, he demonstrates a sliding hiatal hernia with esophageal shortening (Fig. 13.1b). In the third figure, a sliding hiatal hernia is described, complicated by a paraesophageal pouch (Fig. 13.1c). The fourth figure demonstrates a "bulging hernia"

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S. Horgan, K.-H. Fuchs (eds.), *Management of Gastroesophageal Reflux Disease*,
https://doi.org/10.1007/978-3-030-48009-7_13

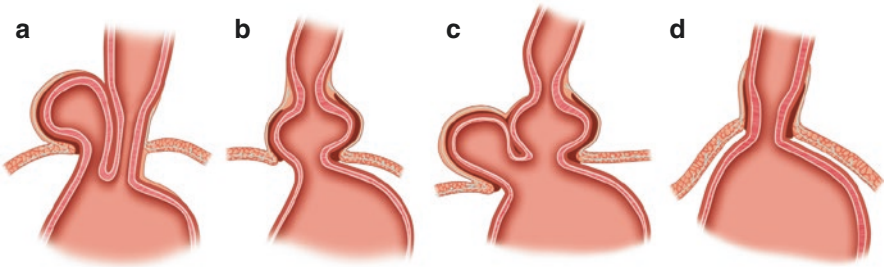

Fig. 13.1 The types of hiatal hernias as described by Allison 1948. His first drawing showed a true paraesophageal hernia (**a**), followed by a sliding hernia (**b**). The third was a mixed hernia (**c**) with both cardia and fundus migrated. The forth type (**d**) was a bulging of the diaphragm without migration of the stomach

(Fig. 13.1d). Of note, this image demonstrates a "bulging diaphragm" with an intact cardia at the hiatal opening. The topographic migration of the cardia and proximal stomach does not cause a true hernia, nor does the cardia protrude through the hiatus. Weakening of the diaphragm around the hiatus allows for cephalad movement of the center portion of the diaphragm along with the cardia, with preservation of the adhesive structures at the cardia.

Allison's early classification system, together with his pexy operation, was popularized in the 1950s by many surgeons. The subsequent experience with GERD patients with hiatal hernia led to a more thorough understanding of these two entities and their association [8–12]. Allison's fundophrenicopexy and Nissen's early experience with fundoplication stimulated a more scientific focus on these conditions [11, 12].

After another decade of clinical experience, Skinner and Belsey, who published a number of papers in the 1950s and 1960s, summarized their comprehensive experience in 1967 with a report encompassing over 1000 patients with hiatal hernia [9, 10, 13, 14]. In this publication, they documented the hiatal hernia classification that remains in use internationally [15]. Figure 13.2 demonstrates this classification with four types of hiatal hernia (Fig. 13.2a). Type I, a sliding hernia, accounts for approximately 85 to 90% of all hiatal hernias in the vast majority of subsequent publications [13–15]. Type II is a true paraesophageal hernia with intact position of the cardia at the hiatal level (Fig. 13.2b). Type II is further characterized by a small defect or weakening in the phreno-esophageal ligament, causing herniation of the fundic flap into the paraesophageal mediastinal area through the hiatus. Type III is a complete dislocation of the proximal stomach, with movement of both the cardia and fundus into the lower mediastinum (Fig. 13.2c). Type IV is defined as a large Type III hernia combined with cranial migration of other organs such as the colon, small bowel, or even the spleen into the mediastinum (Fig. 13.2d). Types II, III, and IV combined occur only in 5–15% of patients with hiatal hernia. Skinner and his group have propagated this classification, which many surgeons now follow [1–3, 5, 6].

In a subsequent publication on massive hiatal hernia, Skinner again reiterated that he reserves the term "paraesophageal hernia" to apply strictly to a true Type

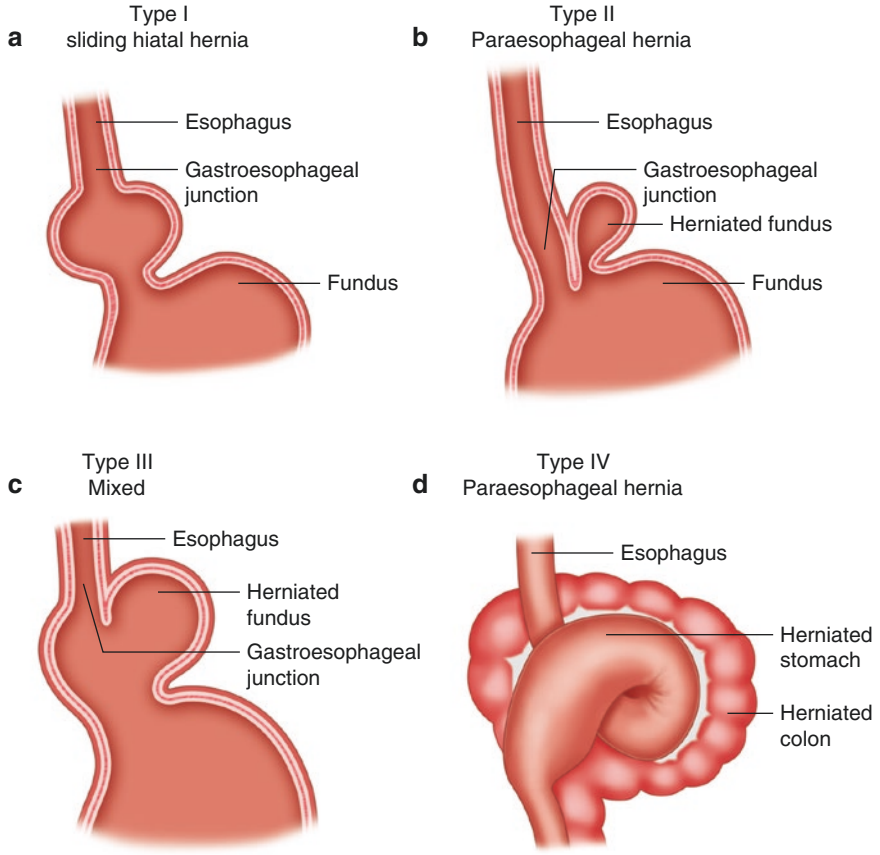

Fig. 13.2 Skinner's and Belsey's classification of hiatal hernias, as it is used still today by many physicians: Type I, sliding hernia (**a**); Type II, true paraesophageal hernia (**b**); Type III, mixed hernia with both cardia and fundus migrated (**c**); Type IV, upside-down stomach with accompanying viscera (**d**)

II paraesophageal hernia. Despite this, many surgeons broadly apply the term "paraesophageal hernia" to Types II, III, and IV [13, 15]. Skinner believed Type II hernia to be "an uncommon situation with the esophagogastric junction remaining securely anchored in the abdomen" [13, 15]. In contrast, the term paraesophageal hernia is currently used for all hernias with the exception of small- to midsize sliding Type I hernias. Particularly in the United States, all large hiatal hernias are described as paraesophageal hernias, if the fundus has migrated into the chest [1–3, 5, 6].

At some institutions in Europe, Skinner's classification was modified in daily practice based on anatomical and clinical observations [16, 17]. Some European gastroenterologists and surgeons differentiated between (Fig. 13.3a–d) first, a sliding hernia hiatal hernia; second, a mixed hiatal hernia with migration of both the

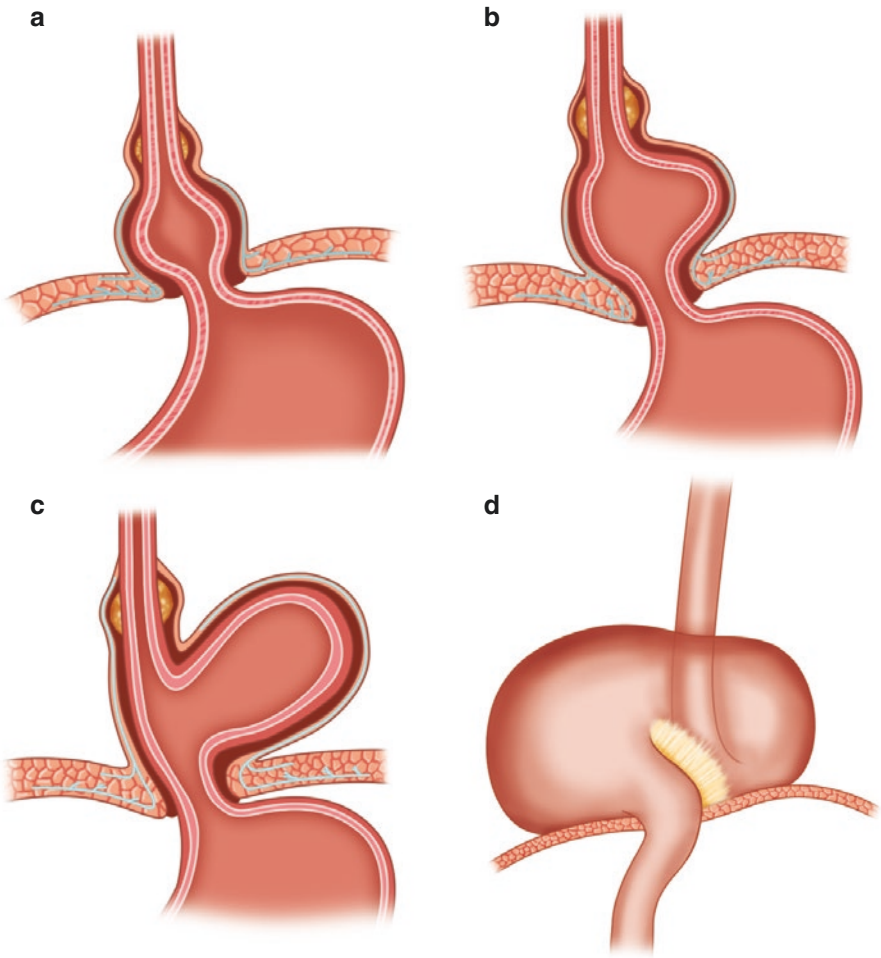

Fig. 13.3 Endoscopic classification mainly used in Europe: First, axial sliding hernia (**a**); second, mixed hernia with both cardia and fundus migrated (**b**); third, true paraesophageal hernia (**c**); forth, upside-down stomach with or without other viscera (**d**)

cardia and fundus; third, a true paraesophageal hernia with stable cardia and migration of a paraesophageal fundic flap alone (true paraesophageal hernia); and fourth, an upside-down stomach with possible migration of other viscera. This classification represented more the development of a hiatal hernia associated with GERD in Type 1 and Type 2, separated from rarely occurring true paraesophageal hernias and upside-down stomach (Type 3 and Type 4).

Another classification, based on endoscopic findings, was created and published by Lucius Hill in 1995, describing the findings of the hiatus and cardia in endoscopic retroflexion (Fig. 13.4) [18, 19]. Hill differentiated the following:

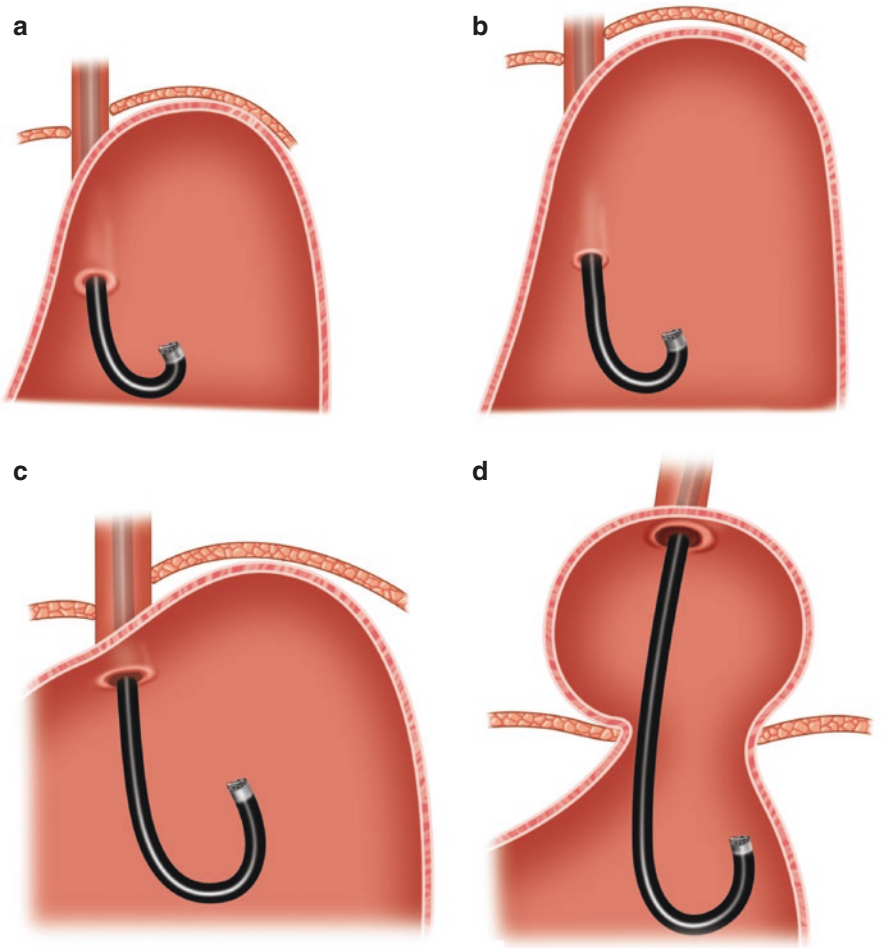

Fig. 13.4 The endoscopic Hill classification for describing the flap valve in endoscopic retroflexion: grade 1, muscular tissue of the cardia is tight around the endoscope (**a**); grade 2, ridge of muscular tissue at the cardia is less well defined, and there is some oral displacement of the cardia as well as a certain opening of the angle of His (**b**); grade 3, the ridge of the muscular structure at the gastric entrance is barely present anymore, and the cardia is widened, allowing a view into the esophageal lumen next to the scope (**c**); grade 4, the normal muscular ridge is completely gone, and the entrance of the stomach stays always open (**d**). The endoscopist can look into the esophagus, and there is always a hiatal hernia present

- A grade 1 flap valve (Fig. 13.4a): the ridge of the tissue at the cardia is preserved and closely approximated to the shaft of the retroflexed scope, extending 3–4 cm along the lesser curvature.
- A grade 2 flap valve (Fig. 13.4b): the ridge at the cardia is less pronounced and may open with respiration.
- A grade 3 flap valve (Fig. 13.4c): a diminished ridge of the cardia is noted, along with failure to close around the endoscope, often accompanied by a hiatal hernia.

- A grade 4 flap valve (Fig. 13.4d): the muscular ridge at the cardia is absent; the esophagogastric junction stays open, and the endoscopist may easily view the esophageal lumen in retroflexion. A hiatal hernia is always present.

This description, based on detailed endoscopic observations, expands the description of features of a sliding hiatal hernia. Thus far, it has not been integrated into the current classifications. The importance of the Hill classification is shown in subsequent publications, since it correlates with reflux activity and may even predict the size of the hiatus [2, 20]. In a recent publication, the Hill classification was shown to be superior to measurement of the vertical length of a hiatal hernia, with respect to the mechanical assessment of the antireflux barrier [20].

With the advent of high-resolution manometry (HRM), an increasingly accurate assessment of the mechanical features and dynamic status of the esophagogastric junction, as well as functional assessment of the esophagus, cardia, lower esophageal sphincter (LES), and diaphragm, is possible [2]. Kahrilas et al. have demonstrated the manometric characteristics of both the LES and the diaphragm (Fig. 13.5) [2, 21]. Their study indicates that radiographic assessment of a sliding hernia may be inaccurate, similar to endoscopic assessment of sliding hiatal hernias, when the

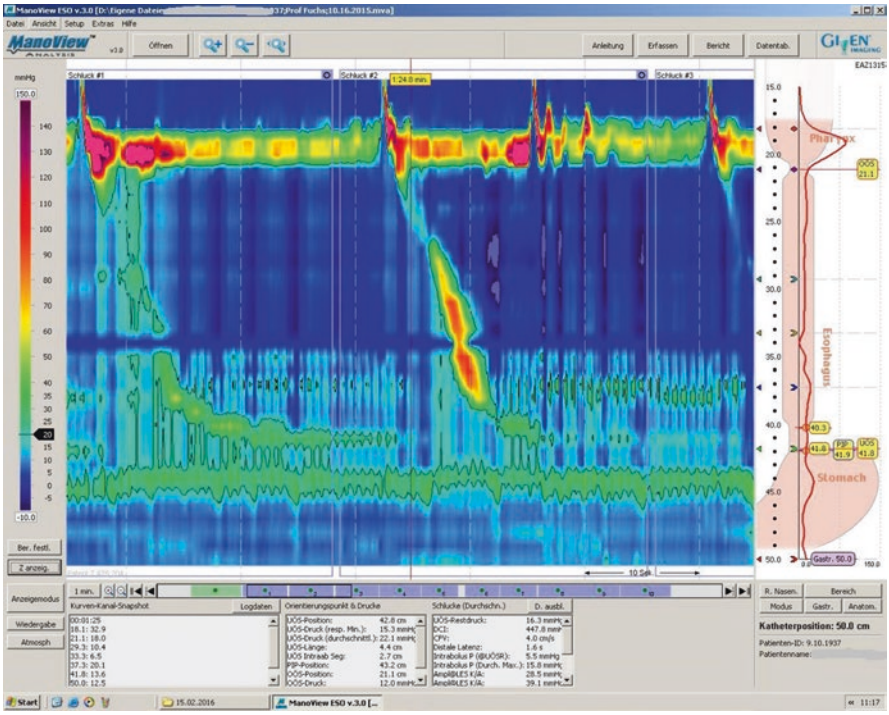

Fig. 13.5 Demonstration of the high-resolution manometry profile of a patient with a hiatal hernia as measured with multiple pressure sensors, which allows for a precise assessment. Note the separated pressure level of the LES and the diaphragm due to the hernia

endoscopic protocol does not account for physiologic movement of the esophagus due to longitudinal tension, and vertical movements of the LES during swallowing [2, 21]. Furthermore, he emphasizes that "unless a strict protocol for endoscopic measurement of the esophagogastric junction is tightly adhered to, the identification of Type I hernias less than 3 cm in size with endoscopy is unreliable."

It can be challenging to identify the exact position of the esophagogastric junction, as the beginning of the gastric mucosal folds is used as a visual landmark during endoscopy. This identification may be particularly difficult in the cardia of a patient with long-term GERD and Barrett's esophagus. In these patients, the distal esophageal segment within the deteriorated sphincter may carry columnar lined epithelium and folds due to effacement of the LES. As a result, the distal esophageal segment with the LES may be widened and appear to be part of the gastric wall. The improved accuracy of HRM in assessing hiatal hernia size has been confirmed by other authors [2, 21–23].

Granderath and Pointner introduced the term hiatal surface area (HSA) as another classification of hiatal size measurement and assessment of the severity of hiatal deterioration during GERD [24]. Based on the clinical dilemma of hiatal closure in larger hernias, the authors began calculating HSA as a criterion for decision-making regarding mesh use. HSA is an intraoperative measurement, quantifying the crural length (in cm), as well as the semicircle between both ventral crural edges representing the hiatal arch. With these values, the crural angle can be calculated and subsequently the HSA between the crurae. The authors use the HSA to differentiate between hiatal closure with versus without mesh [24]. Others have used this method to stratify their patients with different sizes of hiatal hernia [24–26]. Smaller hernias are classified as <10 cm^2; large hiatal hernias 10–20 cm^2, and a third group, patients with >20 cm^2 as giant hernias.

Special Issues Regarding Paraesophageal Hernias

In this manuscript, we will use the term "paraesophageal hernia" for all larger hiatal hernias including true paraesophageal hernias, mixed hernias, and upside-down stomach, as most authors especially in North America do [2, 6, 15, 22, 23]. It must be emphasized that in patients with a true paraesophageal hernia and concomitant upside-down stomach, the cardia and LES remain at the level of the hiatus, permitting reasonable function of the antireflux barrier. These patients usually do not have associated GERD symptoms [4–6].

Patients with large mixed hiatal hernias, with migration of the fundus and the cardia into the chest, usually have severe GERD [4, 5]. Additionally, these patients may develop short esophagus over time due to inflammation and scarring of the esophagus, which may lead to further surgical challenges [5] (see Chap. 12).

Patients with massive hernias may develop severe respiratory sequelae over time, as pulmonary capacity may be reduced due to the size and mass effect of the hernia. These patients are frequently elderly, increasing their risk for pulmonary complications at baseline [27]. Thus, the assessment, diagnosis, and surgical decision-making

process should be managed expeditiously in these particular patients, prior to loss of pulmonary reserve.

The diagnostic management of these patients entails assessment of anatomical changes, as well as an extensive functional workup via GI function studies to evaluate all possible pathophysiologic causes. This includes a precise diagnosis according to the previously described classifications [4, 5, 23]. Patients must also be evaluated for presence of insufficient esophageal motility and involvement of delayed gastric emptying, which may initially be confounding factors in the diagnosis. Precise endoscopic evaluation of the esophagus and stomach is imperative. The presence of Barrett's esophagus must be verified or excluded. In the stomach, the presence of gastric ulcers and/or Cameron lesions must be verified [6]. Other causes of chronic anemia must be worked up and excluded as well.

As mentioned above, paraesophageal hernias occur infrequently and represent approximately 5–15% of all hiatal hernias [13, 23]. Since the hernia sac can be large, with significant intramediastinal involvement, the operative management of these patients should be undertaken by skilled surgeons, experienced in both abdominal and thoracic surgery. These patients should be treated in centers with a comprehensive knowledge of esophageal disorders and sufficiently high surgical volume. The management of an error in diagnostic workup, or technical problems during surgery, is best managed at a facility with appropriate resources and experienced staff. It is not surprising that some of the best results regarding surgical treatment of paraesophageal hernias were published via open transthoracic approach within an experienced group [28].

Two decades ago, the surgical management of patients with giant hernias remained associated with a certain level of mortality, which had to be taken into consideration when establishing indications for hiatal hernia surgery in elderly patients [7, 13, 15, 29]. Watchful waiting was considered an acceptable option, particularly in high-risk patients, as the mortality rate with surgery for paraesophageal hernia repair could be substantial [29].

With the advent and advancement of minimally invasive surgical techniques, impact of operative intervention on these patients has changed, access trauma has been reduced, and overall likelihood of mortality has been reduced [29–35]. Several publications show favorable outcomes with laparoscopic reduction of hernia and fundoplication for treatment of paraesophageal hernias [35].

Emergency Procedures for Paraesophageal Hernias

With respect to large hiatal hernias, both upward migration of the hernia and the paraesophageal extent of intramediastinal dislocation are based on the degree of stomach mobility. With sufficient mobility, patients are at increased risk for development of gastric volvulus within the mediastinum, resulting in strangulation of the stomach and potentially other organs following the stomach into the chest. Since paraesophageal hernias are a rare phenomena, such surgical emergencies are also rather infrequent [29, 35]. However, in certain centers, they may represent a

substantial percentage of cases due to referral patterns [36, 37]. It must be emphasized that the relationship between the percentage of emergency cases and elective operations is variably reported in the literature, raising the question of whether cases are accurately reported as emergent, since the percentage of patients ranges from 3% to 15% [35–37].

In practice, these emergent cases are frequently managed by the on-call general or thoracic surgeons. Indications for emergency surgery include ischemia, gastrointestinal bleeding from a Cameron ulcer, gastric outlet obstruction, cardiopulmonary decompensation due to intrathoracic pressure increase, and aspiration events [36].

The literature shows that these patients have an elevated risk of both postoperative complications and mortality, as they are often decompensated from baseline due to the acute pathophysiologic process occurring [35–37]. The technical principles of the paraesophageal hernia repair remain the same during emergent surgery. Due to strangulation and occasional perforation, the need for gastric resection and more complex procedures is elevated in comparison to elective cases [36].

The morbidity rate in the setting of emergent paraesophageal hernia repair is reported to be between 20% and 45% [35–37]. The mortality rate may be as high as 5–16.4% [34–36]. In emergent cases, the necessity of open operation is increased, and longer hospital stays are documented as well [35, 36].

The Technique of Surgical Treatment of Paraesophageal Hernias

True Paraesophageal Hernias

The majority of patients with true paraesophageal hernia suffer from postprandial pain. It is uncommon for these patients to have massive gastroesophageal reflux. The diagnosis of a true paraesophageal hernia is generally established by radiography and/or upper GI endoscopy. Attention to detail is mandatory during endoscopic retroflexion to accurately observe fundic movements during respiration. A less experienced endoscopist is liable to miss the endoscopic subtleties of a paraesophageal herniation. Therefore, it is critical to spend time in retroflexion, observing the respiratory movements of the gastric wall and diaphragm. One may be able to observe migration of a small portion of fundic flap above the diaphragm through a small defect in the phreno-esophageal ligament.

After a few steps of laparoscopic exploration and dissection of the hiatus, the migration of the fundus will be readily apparent. It is infrequent that the localized defect in the phreno-esophageal ligament is appropriately managed without further dissection of the hiatus. Once the hiatal region is dissected and the hernia visualized, weakening of the hiatal structure, particularly the phreno-esophageal ligament, can be noted. A formal hiatal dissection is necessary to delineate the anatomical landmarks of both the crurae and the hiatal arch.

In general, a full hiatal dissection is completed in these cases. With the esophagus is mobilized from all attachments at the hiatus, there is concern for elevated risk

of secondary reflux postoperatively; thus, fundoplication after formal hiatal approximation via posterior cruroplasty should be performed, in our opinion.

Upside-down Stomach

Patients with upside-down stomach with or without additional migration of other viscera often present with a chief complaint of retrosternal and thoracic pain. Prior to referral to an esophageal center, they have, for the most part, undergone either upper GI swallow study or cross-sectional imaging, and the diagnosis is established beforehand. Functional assessment of esophageal and gastric function should be performed to assess for the presence of motility disorders.

Laparoscopic exploration frequently demonstrates complete rotation of the stomach into the chest, with or without other viscera. If the colon has migrated into the thorax, it can be easily reduced into the abdominal cavity by gently pulling it caudad. The stomach should then be pulled down into the abdomen, and a thorough inspection should be performed of the hiatus and the hernia sac, with evaluation of the position and length of intra-abdominal esophagus. In each case, one can confirm an adhesive strand from the left crus to the fundus, which represents the axis of rotation of the stomach into the chest.

The dissection of the hiatus is started at the left crus after division of the short gastric vessels (Fig. 13.6). Full mobilization of the hernia out of the mediastinum is critical, since it needs to be reduced completely. The hernia sac can be grasped at the left crus, proceeding with full mediastinal mobilization of the hernia sac via gentle blunt dissection, resulting in minimal to no blood loss. The sac is then pulled down in the abdominal cavity to be resected. With reduction of the hernia, the esophagus along with the vagal trunks can be fully appreciated in the mediastinum. These structures must be preserved, and lesions to the esophagus must be avoided. We advocate against leaving any hernia sac in the mediastinum, since it may hinder the

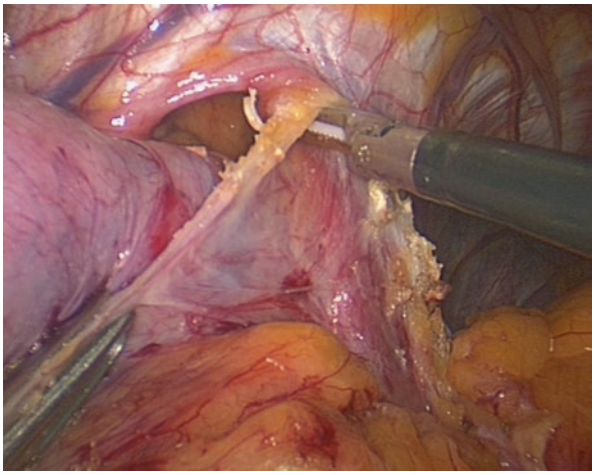

Fig. 13.6 The start of the dissection of a massive hiatal hernia at the left crus to divide the hernia sac for further mobilization in the mediastinum and complete hernia sac resection

full anatomical assessment of the intramediastinal structures. Furthermore, it may disturb mobilization of the esophagus and distort the shaping of the fundoplication. Additionally, residual hernia sac left within the mediastinum may make a future dissection even more challenging should a revision surgery be necessary.

In patients with upside-down stomach, there is usually no risk for a shortened esophagus, since the cardia is at the level of the hiatus. It is often difficult to handle the weakened hiatal diaphragm, which may be widened and attenuated over the years. Hiatal approximation is important, and we usually perform this with two figure-of-8-stitches posteriorly and an additional one to two stitches anteriorly. This combined anterior and posterior hiatoplasty provides a sufficient hiatal approximation; in the majority of cases, mesh reinforcement is not needed. However, in some cases, a crural gap remains and tension is high. In these cases, we use mesh to bridge the hiatal gap.

We are aware of the current controversial discussion about the arguments both in favor of and against the use of mesh reinforcement at the hiatus. As a center for referrals of redo surgery, we have seen many complications after mesh implantation and therefore use mesh reinforcement at the hiatus only selectively (see Chap. 10).

Management of (Paraesophageal) Mixed Hernias

These types of hernias are likely the most frequent paraesophageal hernias [4, 5, 35]. Involved patients usually suffer from prolonged symptoms of GERD and require a full gastrointestinal functional assessment regarding their reflux disease and possible Barrett's esophagus. In paraesophageal mixed hernias, the hernia develops due to a circular defect of the phreno-esophageal ligament. With the ongoing process of strain in this region, in conjunction with increasing weakening of the supportive connective tissue structures of the cardia, the LES moves higher up into the mediastinum (Fig. 13.7). These patients have a large vertical extension of their

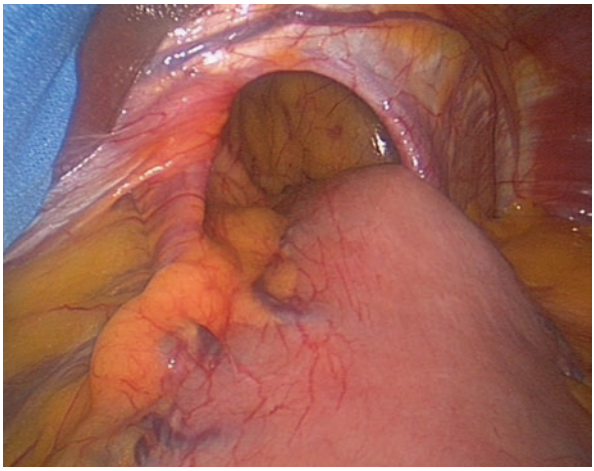

Fig. 13.7 Laparoscopic view in a large mixed hiatal hernia with possible shortening of the esophagus

Table 13.1 Overview on the application of technical details among specialized surgeons to treat paraesophageal hernias

Technical details	Arafat FO, 2012	DeMeester SR, 2013	Cohn TD, Soper NJ, 2017	Dallemagne B, 2018	Sorial RK, 2019
Dissection + identification vagus	+	+	+	+	+
Hernia sac excision	+	+	+	+	+
High esophageal mobilization	+	+	+	+	+
Crural approximation suture	+	+	+	+	+
Crural absorbable mesh enforcement always Selective	– –	+	+	+	+
Right-side release selective	–	+	+	–	–
Esophageal lengthening Collis	+	+	+	+	+
Fundoplication always	+	+	+	+	+
Partial fundoplication in esophageal motility disorders	+	+	+	+	

hernia, along with a particularly elevated risk of developing short esophagus (see Chap. 12).

Prior to hernia surgery, patients deemed to potentially require intraoperative esophageal lengthening should be evaluated by surgeons in esophageal centers, as such complex anatomical situations are managed most efficaciously during primary surgery. The technique of laparoscopic hiatal hernia reduction, closure of the hiatus, and laparoscopic fundoplication is described in detail in other chapters. The procedure in patients with large/giant hernias follows the same technical principles.

There are a few particular issues that are important for the success of these techniques in patients with large paraesophageal mixed hernias. Table 13.1 demonstrates some important surgical concepts that most experts follow to manage patients with paraesophageal hernias based on both clinical experience and evidence from the literature [32–37]. The following list of technical steps describes these details:

1. The surgeon should be experienced in a variety of esophageal procedures, which may range from simple, straightforward, laparoscopic fundoplication to the necessity for a Collis gastroplasty or resection.
2. It is important to have sufficient liver retraction to gain an optimal view of the hiatus and subsequently the mediastinum.
3. The first step is the dissection of the hiatal sac and its resection as mentioned above. This can be best done via constant downward tension applied to the cardia

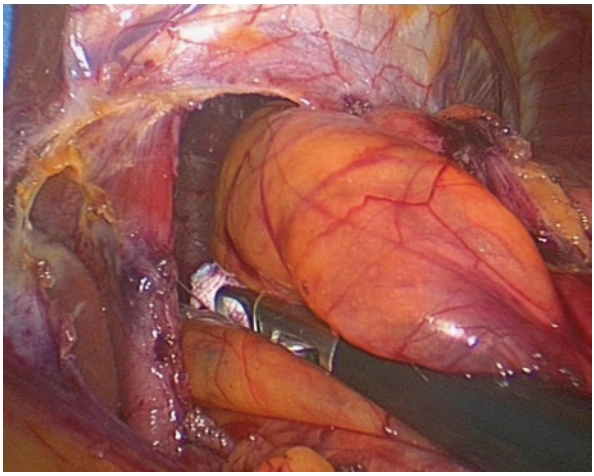

Fig. 13.8 Blunt mobilization of the hernia sac of a large mixed hernia in the mediastinum, which will allow for an optimal view on the esophagus and the vagal trunks

in order to achieve adequate exposure of the esophagus and mediastinum (Fig. 13.8).

4. Careful dissection of the cardia with resection of all fatty tissue and elements of the hernia sac is important for the definition of all anatomical structures, especially the anterior and posterior vagus.
5. The identification and preservation of the vagal trunks are critical in preventing postoperative gastroparesis.
6. A loop around the LES facilitates the atraumatic pull-down of the esophagus while exerting adequate strength. This will facilitate esophageal mobilization to the level of the pulmonary vessels in the mediastinum. Tension-free positioning of the LES in the abdominal cavity is a key element contributing to the future function of the fundoplication as an antireflux barrier. This step is of utmost importance, because mesh reinforcement of the hiatus will never compensate for insufficient mobilization of the esophagus to create a tension-free position of the LES.
7. The narrowing of the hiatus can be performed with figure-of-8-stitches of braided suture material. Usually two to three stitches posteriorly are enough to create sufficient reapproximation. It is important to avoid any tenting of the esophagus by the posterior cruroplasty, since this can lead to postoperative "hiatal dysphagia." An anterior hiatoplasty should be added to complete the narrowing of the hiatus in these cases. The use of mesh reinforcement should be used selectively in those cases in which it is deemed necessary (see Chap. 10).

In cases of short esophagus, one should not hesitate to perform an esophageal lengthening procedure (see Chap. 12). A gastropexy may be added to the fundoplication, if there is a slight tension that does not appear significant enough to warrant performance of a Collis gastroplasty [38, 39].

Results of Surgical Therapy for Paraesophageal Hernia

Table 13.2 demonstrates an overview on the outcomes following surgical intervention for paraesophageal mixed hernias in the literature [31, 36, 40–45]. Early data from the laparoscopic era show the overall promise of this technique, given that length of hospital stay, postoperative complication rates, and mortality (0.3 versus 1.7%) were improved [30]. However, the debate regarding the role of minimally invasive techniques for this difficult surgical entity continued for several years. No randomized trials are currently available.

Reflecting on the available literature regarding these patients, it is critical to clearly delineate the difference between a good outcome and a bad outcome. Radiologic hernia recurrence, frequently used as a marker for assessment of outcomes, is easily measured. However, symptomatic and functional outcomes are likely to be more relevant. Quality of life is influenced by symptom patterns, i.e., reflux or dysphagia, while simple migration of the wrap into the chest may not alter quality of life for the patient [35]. Dallemagne et al. performed a review demonstrating that the average radiologic recurrence rate of hiatal hernia is between 16 and 66%, while the rate of redo operations was lower, ranging from 2% to 9% [35]. Table 13.2 shows a similar analysis based on Dallemagne's review [35]. The data show that the selected reports have a radiologic recurrence rate with a median of 32%, persistent and/or new onset of symptoms at 18%, and necessity for redo operation reported as 4% (2–9%) [31, 36, 40–45]. This is interesting, since the need for redo surgery is 4%, which is lower than the frequency of redo operations in regular antireflux procedures [46, 47]. In conjunction with evidence suggestive of reduced

Table 13.2 Overview on results after paraesophageal hernia surgery (based on Dallemagne [35])

Authors Year	*n*	Follow-up symptoms/ radiography months	Persist./ new-onset symptoms %	Radiolog. recurrence %	Redo surgery done %
Jobe 2002	52	39/37	19	32	4
Aly 2005	100	47	–	23	4
Zaninotto 2007	54	71/32	22	20	9
Luketich 2010	662	30/25	11	16	3
Dallemagne 2011	85	118/99	16	66	2
Oelschlager 2012	78	58	29	57	3
Targarona 2013	77	108	22	46	4
Shea 2019	199	–	11	32	7

mortality associated with the laparoscopic approach, one can conclude that this approach is likely advantageous.

Some surgical groups were initially critical about shifting approaches but with increasing experience reported favorable results with minimally invasive techniques [48]. The report of Dallemagne et al. was noteworthy, with a reoperation rate of only 2%, despite an objective hernia radiologic recurrence rate of 66% [35]. Luketich et al. reported a reoperation rate of 3.2% in 662 patients, with a reported radiologic recurrence rate of 16% [43].

In summary, patients with large or massive hiatal hernias do carry the infrequent but increased risk of presenting as a surgical emergency. Additionally, these patients may suffer long term from sequelae of aspiration and other respiratory problems. Thus, a critical assessment and diagnostic workup should be performed and elective laparoscopic repair undertaken when appropriate, following the aforementioned technical details.

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