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REVIEW ARTICLE

Mesh-reinforced hiatal hernia repair: a review on the effect on postoperative dysphagia and recurrence

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Abstract
Purpose The objective of the present study was to review the pertinent literature and analyze the evidence for and against the use of mesh for hiatal hernia repair, with a focus on the effects on recurrence and postoperative dysphagia.
Methods A literature search was performed between January 1990 and March 2010. Studies were considered for inclusion, provided (1) they comprised a series of at least 20 patients, (2) they documented a follow-up period of at least 6 months, (3) they reported on the outcome as expressed by hernia recurrence rates, and (4) they reported on type of mesh material, hiatal closure, and antireflux surgery.
Results Twenty-three articles enrolling a cumulative number of 1,446 patients fulfilled the inclusion criteria. Polypropylene meshes seem to be associated with low recurrence rates (0–22.7%, median 1.9%) and acceptable dysphagia rates (0–21.7%, median 3.9%). Higher dysphagia rates after polytetrafluoroethylene (PTFE) and expanded PTFE (ePTFE) mesh hiatoplasty have been recorded (15.5–34.3%). Even though the use of novel biologic implants for hiatal repair is still in its infancy, the existing results from clinical research are promising.
Conclusions Polypropylene meshes seem to provide durable results with low dysphagia rates. Unacceptably high recurrence rates for PTFE/ePTFE meshes have been reported. Biologic implant engineering represents a promising field in hiatal hernia surgery.

Keywords Hiatal hernia · Mesh · Polypropylene · Polytetrafluoroethylene · Biologic implant

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Introduction

Laparoscopic techniques have allowed a minimally invasive approach for hiatal hernias and gastroesophageal reflux disease (GERD). In effect, laparoscopy provides the advantage of enhanced access to the mediastinum and precise dissection of the periesophageal and mediastinal tissue. The initial enthusiasm for laparoscopic antireflux procedures and their satisfactory outcomes was counterbalanced by high recurrence rates complicating laparoscopic primary suture hiatoplasty [1]. The application of mesh-reinforced hiatal closure has resulted in a significant reduction in recurrence rates and was, therefore, embraced by the surgical community.

However, concerns exist regarding mesh-related complications, including intraluminal erosion, fibrosis, and esophageal stenosis, which are thought to be the cause of higher dysphagia rates and are the main drawbacks discouraging wide application of mesh hiatoplasty [2]. In order to minimize these adverse effects, a variety of materials have evolved, and biologic implants derived from human cadaveric dermis and small intestine submucosa (SIS) have been recently

introduced in hiatal hernia repair. Different mesh shapes have also been appraised with regard to dysphagia and recurrence rates. Furthermore, mesh application without primary hiatorrhaphy, referred to as tension-free hiatoplasty, has been postulated to be associated with lower recurrence rates as a result of the theoretically decreased tension and muscular fiber disruption of the crural pillars. The choice between fundoplication and gastropexy following hiatal repair is of great importance for reflux control and prevention of hernia recurrence and perhaps for dysphagia; however, the efficacy of each individual technique has not been adequately investigated.

The objective of the present study was to provide an overview of current trends in laparoscopic mesh-reinforced hiatal closure and evaluate the outcome of different materials and techniques with a special concern to hernia recurrence and postoperative dysphagia.

Material and methods

Data sources and study selection

An Internet-based literature search was performed using the MEDLINE electronic database between January 1990 and March 2010. The literature search was confined to studies published in the English and German language. The keywords "paraesophageal hiatal hernia," "mesh," and "laparoscopy" were used in all possible combinations in order to identify relevant articles. If there was any suggestion of the data looked for, the full texts of relevant articles were retrieved for further in-depth review. A second-level search included manual search of the reference lists of the retrieved articles. The literature search, study selection, and data extraction were performed by two independent authors.

Studies were considered for inclusion in this review, provided the following criteria were fulfilled: (1) they comprised a series of at least 20 patients having undergone mesh-reinforced hiatal hernia repair, (2) they documented a follow-up period of at least 6 months, (3) they reported on the outcome expressed by the hernia recurrence rate, and (4) they reported on type of mesh material, hiatal closure, and antireflux surgery.

Outcome measures and data abstraction

The following data were abstracted from each study (where available): study design (prospective/retrospective, randomized/nonrandomized), number of patients treated, material, shape and size of the mesh used, mesh placement, sac excision, hiatorrhaphy, application of fundoplication or gastropexy, follow-up period, hernia recurrence rate, and long-term dysphagia rate. Data extraction was performed from the text, tables, or graphs of the relevant studies. Primary outcome measure was recurrence rate, whereas secondary outcome measure was the incidence of postoperative dysphagia.

In view of the expected heterogeneity of data, no meta-analysis was planned. Instead, a critical review and analysis of available data was undertaken in order to apprize evidence for and against various surgical modalities in laparoscopic mesh-reinforced hiatal hernia repair.

Results

Search results

The literature search identified 105 articles. The majority of the studies included a wide spectrum of anatomical or physiological abnormalities as indications for hiatal mesh reinforcement, ranging from symptoms of GERD without hiatal hernia to type IV hiatal hernias. Twenty-three articles fulfilling the inclusion criteria were finally included in the analysis [3–27]. Reasons for exclusion were (Fig. 1): patients <20 (n=47), non-English or non-German articles (n=10), reviews (n=10), comments/letters to the editor (n=7), not related articles (n=5), animal study (n=1), pediatric study population (n=1), and inadequate operative data (n=1). Two further articles were excluded from the analysis due to overlapping study populations [26, 27]. The 23 qualified studies enrolled a cumulative number of 1,446 patients.

Study characteristics

A wide variation in the indications for mesh reinforcement was recorded; paraesophageal hernia alone was the indica-

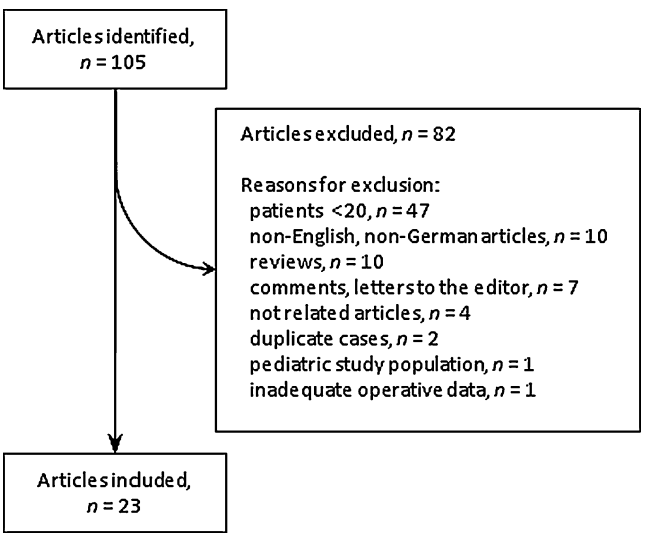

Fig. 1 Search history

tion for only five of the studies, while GERD and/or hiatal hernia was the indication for eight of the included articles. Six author teams performed a tailored mesh hiatoplasty according to the size of the hiatal defect, regardless of hernia type. Eleven of the 23 studies were prospective, including 2 randomized control trials; 8 were retrospective, whereas the study design was not specified in the remaining 4 studies (Table 1).

Intraoperative and postoperative data

Polypropylene (PP) was the most commonly used mesh material, utilized by 52% of the authors, followed by polytetrafluoroethylene (PTFE) or expanded PTFE (ePTFE) (26%), collagen- or titanium-coated PP (9%), porcine SIS (9%), human cadaveric dermis (9%), collagen-coated polyethylene (4%), and polyglactin 910 (Vicryl; 4%). Mesh shape and size varied significantly among different studies. The vast majority of the authors placed the mesh posterior to the esophagus, and 22% of them performed a "tension-free" hiatoplasty. Half of the authors preferred to excise the hernia sac in order to achieve adequate mediastinal visualization, while fundoplication was the most commonly used procedure following hiatal hernia repair (91%). Recurrence rates ranged from 0% to 38.5%, whereas the incidence of postoperative dysphagia ranged from 0% to 34.3% among the studies (Table 2).

Mesh material

The literature analysis demonstrated a wide range in the incidence of hernia recurrence following PP hiatoplasty between 0% and 22.7%, with a median of 1.9%. The largest available prospective study, which included 170 patients treated for reflux symptomatology, demonstrated a recurrence rate of 0.6% over a follow-up period of at least 12 months [6]. The highest recurrence rate (22.7%) was reported by Müller-Stich et al., who performed exclusively anterior gastropexy in their prospective series of 22 patients with mixed type I, II, and III hiatal hernias [22]. Interestingly, the lowest recurrence rate (0%) was achieved by Hawasli and Zonca, who also performed gastropexy in 25 of their 27 patients treated for paraesophageal hernias [3]. There were no significant differences in the technical and operative characteristics between the two study groups, except the choice for resection of the hernia sac by the latter surgical team.

The incidence of dysphagia after PP-reinforced hiatoplasty ranged from 0% to 21.7%, with a median value of 3.9%. The largest prospective series reporting on PP application demon-

Table 1 Characteristics of the included studies

Authors	Year	Type of study	No. of patients	Inclusion criteria
Hawasli and Zonca [3]	1997	NR	27	Paraesophageal hernia
Basso et al. [4]	2000	NR	70	GERD and/or hiatal hernia
Kamolz et al. [5]	2002	Prospective	100	NR
Granderath et al. [6]	2002	NR	170	GERD symptomatology, LESP <6 mmHg
Frantzides et al. [7]	2002	Prospective	36	Hiatal defect >8 cm
Champion and Rock [8]	2003	Retrospective	52	GERD symptomatology, hiatal defect >5 cm
Casaccia et al. [9]	2005	Retrospective	27	Paraesophageal hernia
Granderath et al. [10]	2005	Prospective	50	GERD
Gryska et al. [11]	2005	NR	135	GERD symptomatology, paraesophageal hernia, hernia recurrence
Oelschlager et al. [12]	2006	Prospective	51	Symptomatic paraesophageal hernia
Ringley et al. [13]	2006	Prospective	22	Hiatal defect >5 cm
Granderath et al. [14]	2007	Prospective	23	Symptomatic GERD
Kepenekci et al. [15]	2007	Prospective	164	GERD
Jacobs et al. [16]	2007	Retrospective	92	NR
Lubezky et al. [17]	2007	Retrospective	59	Primary or recurrent paraesophageal hernia
Zaninotto et al. [18]	2007	Retrospective	35	Type III hernia
Granderath et al. [19]	2008	Prospective	33	Hernia and symptom recurrence
Hazebroek et al. [20]	2008	Prospective	40	Large hiatal defects
Lee et al. [21]	2008	Retrospective	52	Hiatal defect >5 cm
Müller-Stich et al. [22]	2008	Prospective	22	GERD
Varga et al. [23]	2008	Prospective	26	Hiatal defect >6 cm, hernia recurrence
Soricelli et al. [24]	2009	Retrospective	138	Hiatal hernia
Zehetner et al. [25]	2010	Retrospective	21	Intrathoracic stomach

Table 2 Operative and postoperative data of the included studies

Authors	Material used	Shape	Sac excision	Hiatorrhaphy	Mesh placement	Fundoplication/ gastropexy	Follow-up	Recurrence	Dysphagia
Hawasli and Zonca [3]	PP	Oval 6×5 cm	Yes	Yes	C/A	Gastropexy	1–56 months	0 (0%)	0 (0%)
Basso et al. [4]	PP	Square 3×4 cm	Yes/no	No	P	Fundoplication	1 year	1 (1.8%)	NR
Kamolz et al. [5]	PP	Square 1×3 cm	NR	Yes	P	Fundoplication	1 year	1 (1%)	3 (3%)
Granderath et al. [6]	PP	Square 1×3 cm	NR	Yes	P	Fundoplication	>1 year (12–30 months, mean 16 months)	1 (0.6%)	7 (4.4%)
Frantzides et al. [7]	ePTFE	Oval 13×10 cm	No	Yes	C	Fundoplication	6 months–6 years, mean 3.3 years	0 (0%)	NR
Champion and Rock [8]	PP	Square 3×5 cm	No	Yes	P	Fundoplication	1 year	1 (1.9%)	2 (3.9%)
Casaccia et al. [9]	PP/PTFE	A-shaped 8×7 cm	No	Yes/no	P	Fundoplication	>6 months (6–46 months, mean 27 months)	1 (3.7%)	4 (14.8%)
Granderath et al. [10]	PP	Square 1×3 cm	NR	Yes	P	Fundoplication	1 year	4 (8%)	2 (4%)
Gryska et al. [11]	PTFE or ePTFE/ PTFE	Triangular or V-shaped	Yes	No	P	Fundoplication	>6 months (mean 64 months)	1 (0.8%)	21 (15.5%)
Oelschlager et al. [12]	SIS	Square 7×10 cm	Yes	Yes	P	Fundoplication	6 months	4 (9%)	NR
Ringley et al. [13]	HADM	U-shaped 4–8 cm	NR	Yes	P	Fundoplication	1 year	0 (0%)	1 (4.5%)
Granderath et al. [14]	PP, PPCC, PTFE	Various	NR	Yes/no	P	Fundoplication	>3 months (3–12 months, mean 6.3 months)	0 (0%)	2 (8.7%)
Kepenekci et al. [15]	PP	U-shaped 2×3 cm	NR	Yes	P	Fundoplication	>2 years	3 (1.8%)	1 (0.6%)
Jacobs et al. [16]	SIS	NR	No	Yes	P	87 fundoplication, 6 gastropexy	3.2 years (median)	3 (3.3%)	8 (8.6%)
Lubezky et al. [17]	PTFE, ePTFE or PECC	NR	Yes	Yes	NR	Fundoplication	>6 months (6–92 months, mean 28.4 months)	21 (35.6%)	7 (13%)
Zaninotto et al. [18]	ePTFE	Square 7.5×7.5 cm	Yes	Yes	C	Fundoplication	>1 year	2 (5.7%)	12 (34.3%)
Granderath et al. [19]	PP	Oval 15×10 cm	Yes	Yes	C	Fundoplication	5 years	2 (6.1%)	NR
Hazebroek et al. [20]	PPTC	NR	No	Yes	P	Fundoplication	1 year	1 (5.6%)	11 (21.7%)
Lee et al. [21]	HADM	U-shaped 4×7 cm	Yes	Yes	P	Fundoplication	>1 year (12–24 months,	2 (3.8%)	NR

Table 2 (continued)

Authors	Material used	Shape	Sac excision	Hiatorrhaphy	Mesh placement	Fundoplication/ gastropexy	Follow-up	Recurrence	Dysphagia
							median 16 months)		
Müller-Stich et al. [22]	PP	Circular 8 cm	No	Yes	C	Gastropexy	1 year	5 (22.7%)	NR
Varga et al. [23]	Teres ligament	NA	Yes	Yes	P	Fundoplication	1 year	10 (38.5%)	1 (3.8%)
Soricelli et al.[a] [24]	PP	Square 3×4 cm	Yes	Yes/no	P	Fundoplication	Mean 95.1 months	2 (2.4%)	NR
Zehetner et al. [25]	Polyglactin 910 with biogel	NR	No	Yes	P	Fundoplication	1 year	2 (9.5%)	NR

PP polypropylene, *PTFE* polytetrafluoroethylene, *ePTFE* expanded PTFE, *SIS* porcine small intestine submucosa, *PPCC* collagen-coated PP, *HADM* human acellular dermal matrix, *PECC* collagen-coated polyester, *PPTC* titanium-coated polypropylene, *P* posterior to the esophagus, *A* anterior to the esophagus, *C* circular periesophageal placement, *NR* not reported

[a] Two patient groups (primary hiatorrhaphy/tension-free hiatoplasty) with analytical data for each

strated an incidence of postoperative dysphagia of 4.4% [6]. The highest incidence was reported by Hazebroek et al. (21.7%), who utilized a titanium-coated PP mesh in 40 patients with large hiatal defects [20].

The retrieved studies selected for analysis used different mesh materials, which increases their heterogeneity and constitutes analysis of the outcome a difficult task. Frantzides et al. used a 13×10-cm oval-shaped ePTFE mesh in large hiatal hernias (>8 cm) and reported no recurrences in their study population for a mean follow-up period of 3.3 years (range, 6 months–6 years) [7]. Similar results were exhibited by Gryska et al., who used either PTFE or composite ePTFE/PTFE meshes in a triangular or V-formed shape [11]. The hiatoplasty was complicated with postoperative dysphagia in over 15% of their patients. In a well-conducted retrospective study, Zaninotto et al. reported on a homogeneous patient population with 35 repairs of type III hiatal hernia with an ePTFE patch and a follow-up time of more than 12 months [18]. Their results were similar to those of previous authors and showed an excessively high incidence of dysphagia (34.3%).

The application of Vicryl mesh with biologic glue for the treatment of intrathoracic stomach was recently evaluated in another study and was found to be associated with a recurrence rate of 9.5% at 12 months follow-up [25]. Further studies regarding the use of Vicryl in hiatal hernia repair are expected with interest.

Biologic implants represent an evolving field of investigation in hiatal hernia repair. Human acellular dermal matrix (HADM) and SIS are thought to produce minimal foreign material reaction at the hiatus due to their biocompatibility and thus minimize the risk of postoperative dysphagia. Oelschlager et al., in their prospective study, evaluated the use of SIS in 51 patients with symptomatic paraesophageal hernias and exhibited a recurrence rate as high as 9% [12]. The largest study is that of Jacobs et al., who reported on the application of SIS in hiatal reinforcement of 92 patients and achieved a recurrence rate of 3.3% and a dysphagia rate of 8.6% in a median follow-up of 3.3 years [16]. Data on the use of SIS in hiatal hernia repair are still scarce; however, no adverse effects have been reported for a cumulative number of 170 patients [28]. Current evidence on the results of HADM hiatal hernia repair is restricted to two studies only, which used similar inclusion criteria and operative techniques, enrolling a total of 72 patients. These studies demonstrated a cumulative recurrence rate of 2.7% [13, 21], whereas the incidence of postoperative dysphagia in one of these studies was 4.5% [13].

Mesh size

Data of studies having utilized a square-shaped 1×3-cm PP mesh exhibited a recurrence rate of 2% and a dysphagia

rate of 4% for a cumulative number of 320 patients with a follow-up of more than 12 months [5, 6, 10]. Similar results were provided by Kepenekci et al., who used a U-shaped 2×3-cm PP mesh in their prospective study of 164 patients and a follow-up of more than 2 years [15].

Mesh shape

Three main types of mesh shape used in hiatoplasty may be identified: square-shaped, oval- or circular-shaped, and U- or V-shaped meshes. Because several other factors, such as patient selection, prosthetic material used, and different operative techniques, might affect operative outcome, the effect of mesh shape is difficult to be evaluated. If we isolate studies utilizing PP mesh and performing routine fundoplication, the cumulative recurrence rate was 1.7% and the cumulative dysphagia rate was 3.8%. The largest prospective study utilizing a U-shaped PP mesh exhibited a recurrence rate of 1.8% and a dysphagia rate of 0.6% [15]. Furthermore, the application of a 15×10-cm oval-shaped mesh in a prospective study reporting on the treatment of 33 patients with symptom relapse or hernia recurrence resulted in a second recurrence in 6% of the patients [19]. Due to the heterogeneity of the data, no definite conclusions on the effect of mesh shape in operative outcome may be drawn.

Sac excision

Several surgeons prefer to excise the hernia sac, in order to achieve higher esophagus mobilization and thus eliminate traction into the mediastinum, which is thought to increase the risk of recurrence and contributes to postoperative dysphagia. In the lack of comparative data, this hypothesis cannot be confirmed. Studies by author teams performing fundoplication without excising the hernia sac and utilizing synthetic meshes achieved recurrence rates between 0% and 5.6%, with a median of 2.8%. The corresponding results of studies reporting excision of the sac were not substantially different (range 0–6.1%, median 2.4%).

Tension-free hiatoplasty

Since the primary factor for hernia recurrence is thought to be mechanical tension on the crural pillars, recent trends omit primary hiatorrhaphy and proceed directly to mesh application. The only study comparing tension-free and sutured mesh hiatoplasty from a retrospective database of 204 patients found no significant difference in recurrence between the two study groups in a mean follow-up of 95 months [24]. The range of recurrence rates of studies performing routine sutured mesh hiatoplasty ranged between 0% and 35.6%, with a median of 1.9%. Data of studies performing a tension-free hiatoplasty are scarce, with only three studies being available [4, 11, 24]. In these terms, a recurrence rate of 1.4% in a cumulative number of 284 patients was achieved.

Antireflux procedure

Management of the reduced stomach remains a matter of debate. It is generally accepted that the reduced fundus should be either plicated or anchored to the left hemidiaphragm or the anterior abdominal wall, following hiatal hernia repair. Proponents of the first trend argue that extended dissection of the stomach, the gastroesophageal junction, and the lower esophagus obliterate the physiological antireflux coordinates. Available data are extremely limited and controversial and do not allow any conclusions.

Discussion

Laparoscopic crural repair followed by an antireflux procedure is the optimal treatment for hiatal hernia, with the advantages of faster recovery, shorter hospital stay, and lower morbidity and mortality rates compared to open surgery [29]. Furthermore, there are sufficient data documenting the safety and efficacy of laparoscopic fundoplication [30, 31]. However, recurrence rates may reach 42% if simple suture hiatoplasty is performed in patients with paraesophageal hernias [1]. The evolution of a variety of mesh materials, the wide spectrum of surgical techniques, and different definitions of hernia recurrence (symptomatic, radiologic, endoscopic) and dysphagia (mild/severe, temporary/persistent/intermittent) have produced a profound confusion in the literature and render the evaluation of operative outcomes challenging.

Despite wide application of mesh hiatoplasty, there is currently no available evidence supporting a clear benefit with regard to recurrence rates for patients without hiatal hernia. Furthermore, indications for mesh reinforcement according to the type or the size of the hernia are poorly defined. Although several studies considered GERD as the sole inclusion criterion for mesh hiatoplasty, the study populations were an aggregate of patients with and without hiatal hernia, thus not allowing comparative evaluation of the clinical effect of mesh hiatoplasty in patient groups with specific hernia characteristics.

The main complications of mesh hiatoplasty include wrap migration or hernia recurrence, periesophageal mesh-induced fibrosis, and intraluminal mesh erosion. The common denominator of the above complications is a potential new-onset dysphagia, which usually persists for more than 1 year postoperatively [2]. The only identified risk factors for recurrence are vomiting and heavy lifting

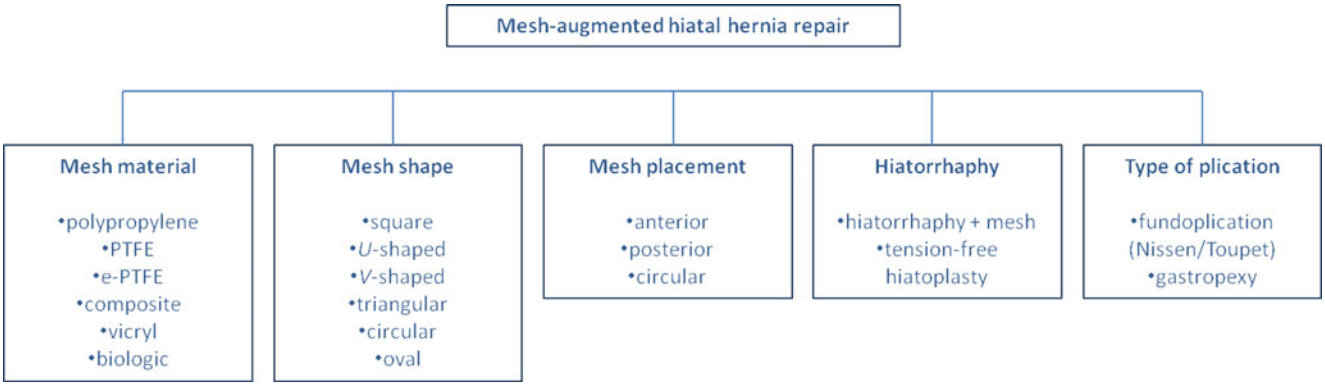

Fig. 2 Treatment options for mesh-augmented hiatal hernia repair

during the early postoperative period. Furthermore, there is no doubt that recurrence rates are highly dependent on the application of mesh hiatoplasty, as demonstrated by two randomized controlled trials and several prospective and retrospective studies [6, 7, 12, 16].

PP is the most commonly used prosthetic material for hiatal reinforcement. Its attribute of firmly attaching to the underlying crura and producing local fibrosis results in a steady mesh–tissue complex. However, concerns have been expressed as to whether the application of PP carries higher risks for dysphagia and esophageal stenosis due to foreign material reaction. Furthermore, several cases of PP erosion or migration into the esophagus have been reported. PTFE is considered to induce less fibrotic reaction than PP, while ePTFE and composite PP/ePTFE meshes seem to provide the advantage of encapsulation of the material and neo-mesothelialization of its abdominally exposed surface, thus becoming self-isolated from the esophageal and gastric tissue. Polyester collagen-coated mesh was designed to provide tissue in-growth on the polyester side and protect the contacting viscera on the other side. The evolution of several other combinations of synthetic and absorbable materials indicates the difficulty in eliminating mesh-induced reactions with their subsequent effects.

Intraluminal erosion represents one of the main concerns regarding mesh-reinforced hiatal repair. Although the associated incidence has been reported to be as low as 0–0.49%, operative management may be complex and often requires open surgery, gastrectomy, and/or esophagectomy [24, 32]. No risk factors for mesh erosion have been identified to date, while PP meshes are considered to be the most irritative to the exposed esophageal tissue. Furthermore, a trend towards esophageal stenosis for biologic materials in contrast to mesh erosion for PP and PTFE meshes has been demonstrated by raw retrospective data [2]. In the present review, only one mesh-related complication following PP-reinforced hiatoplasty was recorded (0.07%) in a cumulative number of 1,446 patients, but was not further specified [24]. However, due to the short follow-up of several studies of the present review, definite conclusions on the incidence of mesh erosion cannot be drawn. In spite of the existing concerns with regard to fibrotic reactions associated with PP meshes, the median dysphagia rate was as low as 3.9%, whereas PTFE and

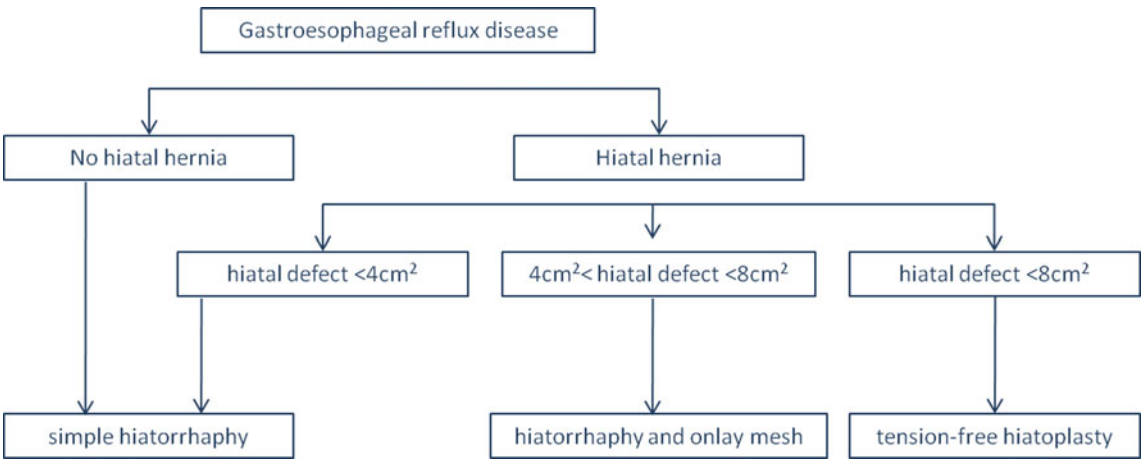

Fig. 3 Proposed protocol for surgical treatment of GERD

ePTFE meshes exhibited considerably higher dysphagia rates with acceptable recurrence rates.

Mesh engineering introduced four main types of biologic implants within the last two decades: SIS (Surgisis/Cook), HADM (Alloderm/LifeCell, FlexHD/Ethicon 360), porcine dermal collagen (Pelvicol and CollaMend/Bard, Permacol/Covidien), and acellular bovine pericardium (Tutomesh/Tutogen, Veritas/Synovis). SIS and HADM have been recently evaluated in hiatal hernia repair with satisfactory results. A trend toward lower dysphagia rates for HADM has been demonstrated compared to SIS. However, available data are limited and further cases need to be undertaken before definite conclusions can be made. Furthermore, our institution recently utilized a cross-linked porcine dermal collagen implant in a patient with hiatal hernia recurrence and a hiatal defect of 8 cm^2, without any symptom relapse or new-onset dysphagia having been reported at 8 months follow-up [28]. The main advantage of this implant is thought to be the cross-linking of its collagen fibers, which may render it resistant to natural tissue collagenases and subsequent degradation. However, a recent review of experimental studies evaluating the implant failed to demonstrate a significant advantage over other bioprosthetics in terms of inflammatory response and neovascularization, while the trend for adhesion formation was similar. Even though current evidence to support application of biologic implants in widespread clinical practice is insufficient, the existing results from clinical research are promising [28].

Technical details such as mesh size, mesh shape, mesh placement, sac excision, and primary or tension-free hiatoplasty vary considerably among surgical institutes (Fig. 2). A proposed treatment protocol includes mesh augmentation depending on the size of the hiatal defect (Fig. 3). In the lack of randomized studies, surgical modalities will remain empirical, guided by the surgeon's preferences, experience, and intuition. The laparoscopic surgeon ought to be familiar with the advantages and disadvantages of different techniques and tailor the surgical approach according to the underlying disease or anatomical defect. For example, tension-free hiatoplasty may prove advantageous in patients with an excessively widened hiatus and weak crural pillars. Similarly, meshes of smaller size may be sufficient for patients undergoing hiatoplasty for type I hiatal hernias with a large hiatal defect. Sac excision is a reasonable option for patients with brachyesophagus and/or intrathoracic stomach, where high esophagus mobilization is essential and mediastinal visualization is compromised.

Conclusion

In a constantly evolving research field, prospective cohort studies are expected to identify those prosthetic materials which induce minimum foreign body reactions and prohibit hiatal hernia recurrence. Current data support the use of PP in selected cases, as it results in low recurrence rates and acceptable incidence of postoperative dysphagia. The evolution of novel prosthetic materials may minimize mesh-related complications and improve postoperative dysphagia rates.

Conflicts of interest None.

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