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Review Article

A Reappraisal about the Use of Mesh for Hiatal Hernia Repair

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Abstract

Introduction: Hiatal hernia (HH) is a common anatomical disorder. Association with gastro esophageal reflux (GERD) is high, and HH act as a factor, accounting for the impairment and chronicity of GERD. Repair of HH and antireflux surgery are often done in the same surgical procedure by laparoscopy, being Nissen fundoplication the preferred anti-reflux surgery. Some key points to repair HH are extensive esophageal mobilization to bring down the gastroesophageal junction into the abdomen, complete sac dissection and tension-free closure of the hiatal crura. But tension-free closure of the hiatus is not always possible and if possible not guarantee that the tissue factor that induced hiatal defect, subside after repair, making recurrence possible.

HH repair has a high recurrence rate. 12% to 42% in some series, and up to 60% in others, which is unacceptable. To improve these bad results, prosthetic materials were introduced as an adjunct to the repair and have been reported to prevent recurrence. But occurrence of serious morbidity, in some patients, mainly strictures or erosions into the stomach or the esophagus, diminished the enthusiasm to use prosthetic materials. To date, there are no consensus about which cases need reinforcement, the best material, the shape of the mesh, or the proper technique of placement. It is advisable to think about HH not only as a simple hole, but as a complex problem in which tissue defect may be present, and learn from what we have known, mainly from inguinal hernia repair history.

Conclusion: Reinforcement the repaired hiatal area with mesh in some complex cases is under debate, but evidence indicate is useful to prevent recurrence. There is also no consensus about which is the best material or technique to place the mesh on the hiatus, but some technical points, as to avoid direct contact of the mesh with the esophagus and fix the mesh to the crura with suture to avoid displacement, make solid conclusions may be critical to avoid complications. More studies with emphasis on the technique and long follow-up are needed to make conclusions.

Keywords: *Hiatal Hernia (HH); Gastro Esophageal Reflux (GERD); Mesh Reinforcement*

Abbreviations

HH: Hiatal Hernia; GERD: Gastroesophageal Reflux Disease

Introduction

Hiatal hernia (HH) is a common anatomical disorder in which essentially, the upper part of the stomach moves up above the diaphragm into the posterior mediastinum through the esophageal hiatus [1,2]. In this condition, the sling-like opening of the right diaphragmatic

crus is abnormally dilated, and the anchorage given to the abdominal esophagus, mainly by the phrenoesophageal ligament which arises primarily from the endoabdominal (transversalis subdiaphragmatic) fascia, is weakened or lost [3-5]. But little is known about the structural morphology of the ligaments that normally support the gastro esophageal junction [6]. Strasberg and Silver were the first to emphasize the elastin-rich nature of the phrenoesophageal membrane, and studies have confirmed that it consists of loose connective tissue traversed by collagen fibers and well-formed elastic lamellae that have a substantial and deep insertion into the wall of the esophagus [6-8]. All or part of these attachments may be impaired in patients with HH.

Since the original description by Akerlund who proposed the term hiatus hernia, it is classified into different types [9]. If the hernia is small or type I, only a short portion of the cardia slides upward into the chest and is usually asymptomatic. When the esophageal length is maintained, and a portion of the stomach, usually the fundus, slide up alongside the esophagus through the esophageal hiatus into the chest, is named type II or paraesophageal hernia, and it may incarcerate. In type III, the esophagogastric junction and the gastric fundus migrates into the chest and can be variable in size. In this type, the herniated stomach may twist on itself and can become not only obstructed, but it can undergo strangulation, develop gangrene, and dead if it is not operated on emergency basis. In type IV, another organ, the spleen, colon, or pancreas may migrate to the chest along with the stomach [10]. As the size of hernia becomes bigger, the hiatal defect also increases, and other factors, as positive intraabdominal pressure and the negative intrathoracic pressure, pull the herniated content further up into the chest, worsening the condition.

Hiatal hernia and GERD

Patients who present HH, may experience symptoms such as regurgitation, heartburn, early satiety, and in extreme cases, respiratory compromise or visceral strangulation and ischemia. As Kahrilas pointed out many years ago, not all patients with HH have reflux disease, and not all patients with reflux esophagitis had concomitant hernias. The exact prevalence of hiatal hernia in patients with gastro esophageal reflux is unknown, but it has been reported from 50 to 94% [11]. Although hiatus hernia may or may not be an initiating factor at the inception of reflux disease, it clearly can act as a sustaining factor accounting for the frequently observed chronicity of GERD, and these two conditions are frequently encountered in the same patient. Repair of HH and antireflux surgery in many patients are done in the same surgical procedure [12]. Indications of surgery are well recognized: patients with heartburn with a satisfactory response to proton pump Inhibitors, patients with symptomatic type II-IV hernias, patients with esophagitis Los Angeles grade B or higher and patients with Barrett's esophagus or with other complications, are good candidates for surgery [13]. The major clinical significance of a Type I hernia is its association with proven gastroesophageal reflux disease, and these patients also benefit from surgery [14].

If surgery is considered, must be done on an individual basis. As there is decreased perioperative morbidity and mortality, less postoperative pain and better recovery with laparoscopic repair compared to open abdominal or transthoracic approach, the standard for repair is a minimally invasive procedure [15-19].

Surgical considerations

The goal for HH repair, is to pull the stomach down into the abdomen, and close the defect in the diaphragm to repair the herniation. Unfortunately, one of the main problems of this surgery is a high recurrence rate, being 12% to 42% in some large series, and in others is up to 60% [20].

This high recurrence rate must be considered unacceptable [21]. Many strategies have been proposed to improve these results, but until now, there is no consensus about the best surgical technique, and some authors even put the indication for surgery under debate, as the risk can be high in elderly patients with multiple comorbidities [22]. But undoubtedly, surgery benefit many patients with large hernias who are at risk, and patients with HH and symptoms of GERD that fail to subside with adequate medication or have complications of esophagogastric reflux. Nissen fundoplication is the preferred anti-reflux surgery, although in some patients, other types of antireflux valves may be chosen for different reasons [23-25].

Besides the selected method for correction of GERD, some key points have been proposed if the patient have a hiatal hernia, or the primary problem to be addressed. These key points are: extensive mediastinal esophageal mobilization to bring the gastroesophageal junction at least 2 to 3 cm. into the abdomen without tension, complete sac dissection to release the tethering of the esophagus, and tension-free closure with suture of the hiatal crura to decrease hernia recurrence [26-29]. But tension-free primary closure of the hiatus is not always possible, because the size of the defect or the debilitated structure of the crura. On the other hand, tension-free closure, not always guarantee that the tissue factor that induced primary hiatal defect subside with repair, making recurrence possible. To improve the results of HH repair, it is advisable to think about it, not only as a simple hole, but as a complex problem in which tissue defect may be present, and learn from what we have known, mainly from inguinal hernia repair history.

Hiatal hernia and metabolic considerations

Raymond Reads' early scientific work in 1970, postulated a systemic disease leading to groin herniation, and performed systematic analyses to confirm his point, but his findings were neglected by the surgeon's scientific community for long time [30]. Wagh, later demonstrated that patients with inguinal hernia had a deficiency in hydroxyproline (polymeric collagen) [31]. He proved that patients with inguinal hernia had a lower rate of fibroblast proliferation in their tissues, and that incorporation of proline into collagen was defective, suggesting that patients with direct inguinal hernia have ultrastructural and biological alterations in their tissues [32]. Bellon and others, also found structural abnormalities in tissues from patients with indirect and recurrent hernias [33]. Thus, the existence of metabolic causes, in at least some of the patients with hernias, is more than evident. Read's idea of an individual patient-related biological approach may have fundamental implications for improvement in the hernia field and these may be addressed also to some patients with HH as has been suggested by some authors [34].

Considering that tissue defect may play a roll in the genesis of inguinal hernia, some surgeons considered to reinforce the involved tissues with prosthetic materials. This idea dates back to 1832 with the use of fish swimming fins in patients with inguinal hernia. Since then, different materials were used, but the turning point in hernia surgery was the discovery of synthetic polymers by Carothers in 1935. And was Lichtenstein who took advantage of this discovery describing a tensionless technique to strengthen the posterior wall of the inguinal canal with Marlex mesh. He reported more than 1,000 operations without recurrence in 5 years after surgery, and following this revolutionary information, many techniques in inguinal hernia repair since then, include mesh to reinforce the inguinal wall to reduce the recurrence rate [35,36]. If recurrence is compared in inguinal hernia when prosthetic material is not used for repair, it becomes up to 33%, over a period of 10 years. A reduction in recurrence has been shown up to 50% with the use of synthetic mesh, compared to conventional surgery [37].

History of complex inguinal hernias may also provide a warning about the possibility to develop not only a bilateral hernia defect, but also a concurrent HH [38].

Felix proposed the term complex hernias which was later modified by our group, to include patients who have one or more of the following facts: family history of hernia, known recurrent or bilateral hernia in the patient or his family, or patients with multiple hernia defects. In all these cases, special attention must be paid to explore all possible sites of herniation including HH [39,40].

Mesh reinforcement of HH repair

Incorporation of mesh for HH repair is much more recent. The proliferation of innovative prosthetic materials encouraged surgeons to use them at the diaphragmatic hiatus, to reduce recurrence. But the hiatus is different from the inguinal area, because in the former, prosthetic material may damage the esophagus or the stomach due to close contact with them. But as recurrence rate is unacceptable high, prosthetic materials were introduced as an adjunct to the repair and have been reported to be useful to prevent hernia recurrence. The first mesh-reinforced cruroplasties used nonabsorbable materials like polypropylene or polytetrafluoroethylene (PTFE) [41]. But oc-

currence of serious morbidity, in some patients, after nonabsorbable mesh placement, mainly erosions into the stomach or the esophagus, some of which required esophagectomy were reported, and the enthusiasm to use prosthetic material began to shrink [42].

Many reports about mesh reinforced HH repair have been done since, without categorical evidence. A study of 628 patients comparing the results utilizing PTFE patch versus simple cruroplasty for large hernia repair, reported a recurrence rate of 22% with simple cruroplasty, as opposed to none in the PTFE group [43]. As reported by Petersen in 2014, reinforcement of the hiatus with permanent mesh, resulted in an improvement of GERD symptoms as well as patient satisfaction [44]. Müller-Stich made a long-term follow-up in patients with laparoscopic paraesophageal hernia repair, in whom biological mesh reinforcement was performed in 79% of the patients, suggesting a protective benefit of crural reinforcement with mesh, with a reduction in recurrence rates from 35% to 18% [45].

According to the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), the use of mesh for reinforcement of large hiatal hernia repair, decreases recurrence rates, but to date, there is still inadequate long-term data to make strong recommendations either for, or against it [46]. There is no consensus about the best prosthetic material, although some studies suggest that mesh should be non-resorbable [47]. In 2012, Antoniou., *et al*. made a review on postoperative dysphagia and recurrence, related to the type of mesh used. He concluded that polypropylene mesh seemed to be associated with 1.9% recurrence and 3.9% dysphagia rates, with higher dysphagia rates after polytetrafluoroethylene and expanded PTFE (15.5 - 34.3%) mesh hiatoplasty [48]. Studying the impact of mesh on esophageal motility, Granderath., *et al.* made a prospective randomized trial, with forty patients with GERD who underwent laparoscopic "floppy" Nissen fundoplication, comparing esophageal motility after simple sutured of the crura, versus prosthetic material to reinforce the closure. They found that laparoscopic Nissen fundoplication with prosthetic reinforcement, didn't impair postoperative esophageal motility compared with simple hiatal closure, although the former was associated with a higher rate of short-term dysphagia [49].

Most of the current published studies pay more attention on the type of mesh used, than in the technique of placement, which may be as important as the material itself. Soricelli., *et al.* in 2009 reported a 15-year retrospective series, with 297 patients who underwent antireflux surgery. 113 of them were treated with polypropylene mesh placement with a mean follow-up of 117.6 ± 18 months. Only two patients (1.8%) presented hiatal hernia recurrence, concluding that polypropylene mesh seems to be effective to reduce hernia recurrence, with a very low incidence of mesh-related complications [50].

Technical considerations about mesh placement

In many papers, technique of placement is not described. In 2004, Targarona., *et al.* performed a meta-analysis on HH repair, and different surgical techniques with or without tension were recorded. Tension techniques described were, simple crural closure, reinforcement of the closure using a polypropylene strip along the crura to hold the stitches, or a piece of polypropylene mesh covering both edges of the pillars. In the tension free group, some surgeons used a triangular piece of mesh to occlude the anterior segment of the hiatus, secured with staples or stitches fixing the stomach to the abdominal wall. Another technique fixed the mesh occluding the posterior segment of the hiatus, and a third technique tailored a keyholed mesh for the passage of the esophagus, similar as the technique we use since more than a decade with good results. From the analysis, they concluded that the use of mesh in laparoscopic hiatal repair is safe, and prevents hernia recurrence, but should be used selectively. They mentioned however, that long-term results were lacking and infrequent but severe complications, may arise [51]. Use of mesh may induce complications, such as aortal bleeding [52], prosthetic esophageal erosion [53,54] and dysphagia [55] to name some. Many of these reports associate complications to the type of mesh used, but few associate them to the technique itself. In a study by Stadlhuber, after prosthetic reinforcement of hiatal closure in 26 complicated patients, he retrieved operative details concerning mesh size; shape and implantation technique, concluding that in his series no apparent relationship between mesh type and configuration was encountered [56].

Some authors intend to avoid esophageal stricture using a U-shaped mesh as Lee, who reported reinforcement of the cruroplasty with a U-shaped AlloDerm® patch in 52 patients with a recurrence rate of 3.8% [57] but to date, no technique has been proposed as the

best. A web-based survey was made to 165 European surgeons to evaluate their current opinion on the use of mesh in large HH repair. It was routinely applied by 14.5% of the respondents, selectively by 77.6% and never used by 6.7%. Regarding the type of mesh, 52% used polypropylene mesh, polyester 15.6%, PTFE 7.8%, ePTFE 31.8% and biomesh 27.9%. There were 20% esophageal erosions reported and 20.6% esophageal stenosis due to fibrosis. U-shape mesh was preferred by 44.8% of the surgeons, V-shape by 19.5% and square with a keyhole for the passage of the esophagus by 13%. The mesh was placed posterior to the esophagus by 46.8% of the surgeons, and 66.9% used non-absorbable sutures for its fixation. An antireflux procedure was added to hiatal hernia repair by 83.6% of the respondents, and 9.1% add a fundoplication only in selected cases. Nissen fundoplication was the most applied antireflux procedure (70.9%) [58]. In 2010, Frantzides., *et al.* made another survey among SAGES members, searching for the indications of mesh use, the type of mesh, and placement technique. A total of 1,192 questionnaires were ground-mailed. 275 surgeons responded, and 261 of the surveys were analyzed. The most common indication was the size of the hiatal defect, with 5cm being the most common threshold. The most common mesh types were biomaterial 28%, PTFE 25%, and polypropylene 21%. Suture was the most common fixation technique 56%, followed by tacks 23.9%. The techniques recorded were also multiple: onlay 39.1%, inlay 7.36%, anterior 13.6%, posterior 34.2%, U shape 3.74%, non-circumferential 34.1% and circumferential 9.86%. Overall failure rate was 3% (more with biomaterial 5%); stricture 0.2%, and erosion 0.3%. The authors finally state, that no firm recommendation on the use of mesh at the esophageal hiatus could be made, although they favor the repair with circumferential placement of a lightweight coated, non-biologic mesh anchored to the diaphragm, as we did in our series [59].

Since we started to use mesh for repair twenty years ago for large (more than 5cm width) or recurrent HH, we have used different types of mesh. Since 2005, we use polypropylene coated on one side with a layer of oxidized cellulose (Proceed®; Ethicon, Inc.) because this mesh is easy to handle, tailor and fix to the pillars with stitches, and the oxidized cellulose side theoretically protects the esophagus.

After the hernia has been reduced, and the crura closed with 00 non-absorbable polyester (Ethibond®; J&J) stitches, we tailor the mesh (Figure 1). We make a key-hole in the center for the esophagus open one of the sides, and fix it with the same kind of stitches, one over the closed crura, one on the right and another on the left pillar, taking care that the edge of the mesh doesn't touch the esophagus, and avoid displacement of the mesh (Figure 2 and 3).

Figure 1: *Tailored (Proceed®; Ethicon, Inc.) mesh, opened straight in the middle inferior part , with the keyhole in the center.*

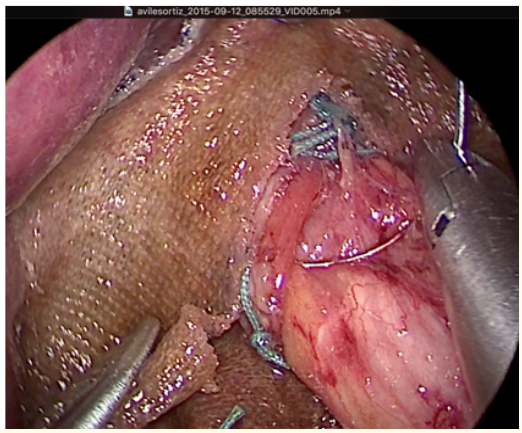

Figure 2: *Securing the mesh to the right crura, avoiding direct contact with the esophagus.*

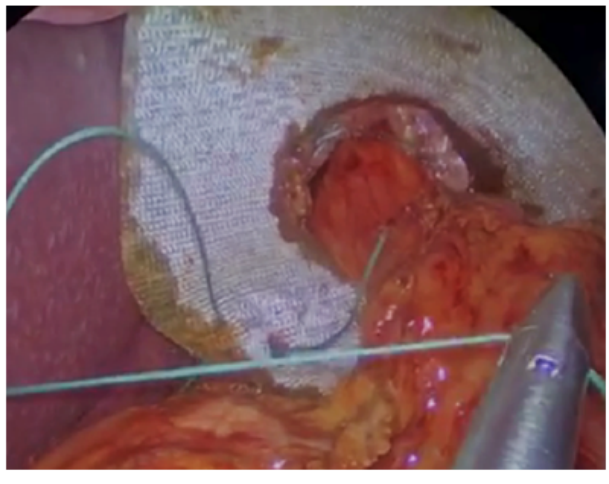

Figure 3: *Securing the mesh to the right crura, avoiding direct contact with the esophagus.*

The fundoplicated stomach will cover the esophagus, avoiding contact with the mesh. We think that a good anchoring of the circular mesh with sutures to the closed hiatus not only prevent recurrence, but also avoid complications if the esophagus is not in contact with the mesh. In 2017 we reported 36 patients with large or recurrent hernias treated with this technique without strictures or erosions. Since then, we have increased the series with good results and no mesh related complications [60].

The debate about the use of mesh in hiatal repair is still ongoing, mainly because possible complications. It must be taken into account that use of prosthetic material always entails possible complications. In inguinal hernia, the debate about mesh complications continues, because possible association with inguinodynia and other problems related. Here again, mesh placement played an important roll. But no matter the debate, mesh is still used for inguinal hernia repair.

Laparoscopic repair of large hiatal or recurrent hernias are technically demanding procedures. They require significant experience in advanced foregut surgery. Management is complex and should be decided on a case-by-case basis and is currently one of the most debated subjects in contemporary surgery, but it should be considered that some patients may have a metabolic tissue defect that must be addressed to avoid recurrence. Reinforcement the repaired hiatal area with mesh in some complex cases is reasonable and should be considered to reduce recurrence, but some technical points, as to avoid direct contact of the mesh with the esophagus as suggested by Wassenar [61] and fix the mesh to the crura with suture to avoid displacement, may be critical to avoid complications. More studies with emphasis on the technique and long follow-up are needed to make conclusions.

Conclusion

The use of prosthetic material in cases of hiatal hernia is still under debate, but the current evidence indicate that seems to be safe and useful to prevent recurrence. There also no consensus about which is the best material or technique to place the mesh on the hiatus, but possibly avoiding contact of the mesh with the esophagus may avoid complications. More controlled studies with longer follow-up are needed to draw valid conclusions.

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