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TITLE:

Laparoscopic Repair of Para-Esophageal Hernia Using Absorbable Biosynthetic Mesh

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KEYWORDS:

para-esophageal, hiatus hernia, biosynthetic, mesh, glue, fundoplication

SUMMARY:

Presented here is a protocol of para-esophageal hernia repair. Use of absorbable biosynthetic mesh avoids the risk of erosion through the esophagus whilst reinforcing the repair. Glue fixation is preferred to avoid the risk of trauma such as bleeding or cardiac tamponade, which are associated with stitches or tacks.

ABSTRACT:

Para-esophageal hernia repairs are challenging procedures and there is no consensus on the optimal approach to repair. Mesh reinforcement has been associated with lesser hernia recurrence when compared to the primary suture repair. The type of mesh that is most appropriate is still debatable. Synthetic and biosynthetic materials have been studied in the literature. It is well documented that a synthetic mesh is associated with esophageal erosion and migration into the stomach. Though there are limited long-term data on biosynthetic mesh, the short-term results are excellent and promising.

This paper illustrates how a biosynthetic prosthesis can be safely used with fibrin glue fixation and anterior Dor fundoplication to repair any para-esophageal defect. The absorbable biosynthetic mesh has been shown to produce good long-term patient satisfaction outcomes and low recurrence rates compared to conventional methods including repair with synthetic mesh. This technique also avoids the risk of esophageal erosion whilst strengthening the repair. Tacks that are still widely used to secure the mesh can be abandoned due to the associated risk of developing cardiac tamponade, or other disastrous consequences. This repair method, also, highlights how the prosthesis can be fashioned into a V-shape and easily placed in an onlay fashion behind the esophagus. The protocol demonstrates an alternative and safer method for mesh fixation using fibrin glue.

INTRODUCTION:

The most recent meta-analysis review on para-esophageal hernia repair concluded that mesh reinforcement was superior and was associated with lower recurrence rates compared to the suture repair[1]. However, the preferred type of mesh remains controversial due to the study heterogeneity. Some included in the review had inconsistent definitions not only of para-esophageal hernias (which were either determined pre-operatively or intra-operatively) or hernia recurrences (which were based, either on symptoms or investigations), but also unspecified loss to follow-up. This manuscript highlights successful repair of a large hiatus hernia using biosynthetic mesh.

The most common biosynthetic mesh used is composed of 67% polyglycolic acid and 33% trimethylene carbonate. This prosthesis is gradually absorbed over 6 months and is replaced by the vascularized soft tissue and collagen. This biosynthetic mesh has been studied in 395 patients and in this large study, 16.1% of them experienced recurrent symptoms at 24 months (range, 2-69 months) and 7.3% had objective recurrence[2]. Only one patient had a major post-operative complication (esophageal stenosis) that required percutaneous endoscopic gastrostomy tube insertion and subsequently, re-operation with no recurrence at 44 months. Similar smaller studies reported symptom recurrence rates ranging from 0%-9%, objective recurrence rates 0.9%-25%, and re-operations ranging from 0%-10%[4-8]. None of the studies reported mesh-related complications.

The protocol detailed below was performed on a 68-year-old female who presented with a one-year history of severe reflux symptoms unresponsive to medical treatment and iron deficiency anemia, in the setting of previous *Helicobacter pylori* gastritis and NSAID-induced gastric ulcer. Pre-operative gastroscopy demonstrated Cameron lesions, large linear erosions in the gastric body and a 10 cm rolling hiatus hernia (compared to 4 cm in the previous gastroscopy one year earlier). Chest CT-scan confirmed the diagnosis of intra-thoracic para-esophageal hernia.

PROTOCOL:

The protocol follows the guidelines of the authors' institution's human research ethics committee (South-Western Health District).

1. Pre-operative preparation

1.1. Place the patient on low calorie high protein nutritional diet for a week to reduce the liver size and facilitate improved access to the hiatus hernia.

1.2. Under general anesthesia, place the patient in lithotomy and reverse Trendelenburg position.

1.3. Intra-operatively, prescribe first-generation cephalosporin prophylactic (2 g) intravenous antibiotic and anticoagulation for deep vein thrombosis prophylaxis.

2. Surgery

2.1. Prepare the sterile field by shaving the patient's abdomen, applying antiseptic solution to the skin and draping the patient. Ensure that the first surgeon stands between the patient's legs and the assistant is on the left side.

2.2. Establish Pneumoperitoneum of 12 mm Hg via a left subcostal Veress needle at Palmer's point[9] (3 cm below the subcostal margin in the left mid-clavicular line). Using a direct bladeless optical access entry system, insert the ports which is supra-umbilical, one hand-span from the costal margin and to the left of the midline, for the camera.

2.3. Elevate the left lobe of the liver with a Nathanson liver retractor through a small left para-xiphoid incision.

2.4. Place two further 5 mm ports under direct vision alongside the camera port: one at the level of the right mid-clavicular line, the second port on the left anterior axillary line. Insert a 10 mm port that is more cephalad at the left mid-clavicular line to create an ideal working triangulation.

NOTE: See **Supplementary Figure 1** for port placement.

2.5. At this stage ensure that most of the stomach will be herniating into the mediastinum. Therefore, pull the incarcerated stomach back into the abdominal cavity with continuous traction from the assistant to view the gastro-esophageal junction.

2.6. Enter the lesser curvature at the level of the *pars flaccida* of the gastrohepatic ligament, and progressively dissect, reduce and excise the hernia sac using cauterization. This will lead to the gradual exposure of both diaphragmatic crura. This is made of the inferior vena cava and the caudate lobe of the liver in relation to the right crus.

2.7. Mobilize the esophagus circumferentially by dividing all the congenital peri-esophageal adhesions within the hiatus. Continue mobilizing the hiatus hernia off the bilateral crura to assist in retracting the hernia sac into the abdominal cavity. Identify and preserve the vagus nerves and both pleurae.

2.8. Create a window posteriorly between the esophagus and thoracic aorta and place a tape around the distal esophagus to allow gentle traction.

2.9. Mobilize the distal esophagus proximally (≥10 cm distance), until there is adequate intra-abdominal esophageal length (3-4 cm) and so the esophagus lies free of tension.

2.10. Approximate the diaphragmatic crura with 3 or 4 interrupted 1.0 non-absorbable braided sutures and reinforce the repair with a pre-shaped biosynthetic mesh that is introduced behind the esophagus in an onlay fashion.

NOTE: The right edge of the mesh should slide under the caudate lobe of the liver. If necessary, divide the left triangular ligament to accommodate the mesh. No pledgets are required if the quality and the tension of the crura is adequate. The extent of the crural closure should not cause narrowing or compression on the lower esophagus. A rough guide to adequate closure is being able to pass a grasper through the remaining gap.

2.11. Secure the biosynthetic mesh with 4 mL of fibrin glue.

2.12. Perform a modified 180˚ anterior Dor fundoplication using 2.0 non-absorbable braided sutures by suturing the gastric fundus to the left crus, then sequentially fixing the folded greater curvature of the stomach anteriorly to the diaphragm, and all the way to the proximal right crus. Four sutures are usually required. Incorporate the mesh into the first suture. Take care not to injure the pericardium during the fundoplication. A bougie is not used.

2.13. Insert a closed-suction drain.

2.14. Close skin with subcuticular 3.0 synthetic, absorbable and monofilament sutures.

3. Post-operative procedures

3.1. Post-operatively, elevate the patient's head to 30˚ to avoid aspiration.

3.2. Perform early chest X-ray in recovery to exclude possible pneumothorax or atelectasis.

3.3. Commence the patient on clear fluids on day one. Give regular anti-emetics for the first 24 h. Commence the patient on daily anticoagulation for deep vein thrombosis (DVT) prevention as per the hospital protocol.

3.4. Commence the patient on puree diet on day two. Remove the drain on day two.

3.5. Continue puree diet for four to six weeks. Afterwards, place the patient on to a more solid but soft diet for three weeks.

3.6. Continue DVT prophylaxis until the patient goes home. Extended course can be given at the surgeon's discretion if deemed necessary.

3.7. Follow-up the patient at 2 and 6 weeks for routine surgical review.

3.8. Perform repeat gastroscopy at 4 and 12-months post-operative.

REPRESENTATIVE RESULTS:

Post-operatively the patient remained symptom free. Routine gastroscopies at 4 and 12 months respectively showed that the cardio-esophageal junction remained at 38 cm from the dental arcade with no evidence of early recurrence or reflux esophagitis. There was mild gastritis of the

antrum.

This technique has been performed in 23 patients using this absorbable biosynthetic mesh. Only one patient reported complication (**Table 1**).

FIGURE AND TABLE LEGENDS:

Table 1: Summary of Patient Cases. ^Both were greater than 7 cm. *This patient had a recurrent type III hiatus hernia and this was a difficult dissection. Post-operatively she was initially quite well and was able to tolerate fluids for the first 48 h. She then unexpectedly rapidly decompensated from an unrecognized cardiac tamponade.

Supplementary Figure 1: **Port Placement.** (**1**) Camera port: 10 mm supra-umbilical, one hand-span from the costal margin and to the left of the midline incision. (**2**) Liver retractor: left para-xiphoid incision. (**3**) Working port: 5 mm left mid-clavicular incision. (**4**) Working port: 10 mm right mid-clavicular incision. (**5**) Working port: 5 mm left anterior axillary incision.

DISCUSSION:

The key steps in para-esophageal hernia repair include port placement, total excision of the hernia sac, intra-abdominal esophageal lengthening, identification of both vagus nerves, atraumatic mesh reinforcement of the crus, and anterior fundoplication with gastroplasty.

This protocol highlights a 4-port method (one camera, three working ports) which uses only one assistant. Safe insufflation is achieved through a Veress needle inserted at Palmer's point. An optical bladeless access system is used to place the camera port, which is inserted via a left para-median incision that is one hand-span from the costal margin. This position offers optimal vision of the hiatus hernia anatomy. An optical entry device is preferentially used to avoid potential injury to the superior epigastric artery or underlying visceral structure. A left para-xiphoid incision is used solely for the retractor to retract the left lobe of the liver and expose the esophageal hiatus. Hiatal dissection is facilitated by the triangulation of two 5 mm ports (right mid-clavicular; left anterior axillary) and a 10 mm port (cephalad to the two 5 mm ports, and in mid-clavicular line). The technique works with two 5 mm ports as the size of the port correlates with the tendency to develop port site hernias[10].

Total hernia sac dissection and excision reduces recurrence rates[11]. Hernia sac excision is generally more difficult on the right side of the patient than on the left, as it corresponds to the territory of the left gastric vessels that should be reduced into the abdomen to prevent injury[11]. Sac excision also includes division of the phreno-esophageal and gastro-hepatic ligaments. Sac excision can be particularly more difficult due to adhesions around the stomach or due to large hiatal hernias[11,12].

Adequate esophageal lengthening prevents recurrence. This protocol highlights that the extension of esophageal mobilization in the mediastinum depends on ensuring that 3 to 4 cm of the distal esophageal length remains in the abdomen tension-free. Dissection of the fat-pad off

the gastro-esophageal junction is also helpful. In the rare cases where esophageal lengthening may not be possible, some authors suggest Collis gastroplasty, particularly in those with massive hernias[12]. We believe that a short esophagus can generally be dissected more proximally into the mediastinum, and that this is enough to avoid this extra step of the procedure. In our latest experience of over 50 large para-oesophageal hernia repairs, we did not have to perform a Collis gastroplasty.

In patients with dense intra-abdominal adhesions, conversion to laparotomy may be the safest option in order to reduce the entire stomach, completely excise the sac, or to minimize the risk of further complications such as iatrogenic esophageal perforation[13]. Vagal nerve injury has been reported to be at least 5% in the literature. This is usually in the context where the vagus nerve is adherent to the hernia sac. Also, tension on the fat pad from the posterior esophagus tends to pull the posterior vagus up and this can inadvertently lead to nerve injury[12]. Vagal nerve injury can lead to delayed gastric emptying.

Failure of para-esophageal hernia repair has been attributed to weak crus of the diaphragmatic hiatus[14]. Biosynthetic mesh has been used in large hernias for several years with growing interest, as outlined in a recent large retrospective study[2]. The authors showed that biosynthetic mesh was associated with long-term patient satisfaction outcomes and acceptable low rates of symptomatic recurrence. Like Olson et al[2], this manuscript shows a posterior cruroplasty that is reinforced with absorbable biosynthetic mesh previously re-fashioned into a V-shape before being delivered behind the esophagus in an onlay fashion. Mesh use reduces crural tension and reinforces the crural repair. The crura is re-approximated posteriorly using 3 or 4 size 1/0 non-absorbable braided sutures depending on the size of the defect. This aims to place the cruroplasty as close as possible to the esophagus, but without creating any narrowing.

This technique is a highly technical procedure and should be performed by experienced surgeons. Otherwise, no real limitations exist with this technique.

This manuscript highlights how the mesh can be easily fixed using non-traumatic fibrin glue instead of tackers or sutures. This technique, which can be performed quickly and safely, has been previously reported in the literature[15]. As an alternative, non-absorbable sutures have also been used to secure the biosynthetic mesh with no mesh-related complications, as demonstrated in Asti's observational cohort study[16]. However, the nature of the biosynthetic mesh thickness can make it difficult to be sutured onto the crura. Conversely, tackers have been associated with severe potential life-threatening risk of cardiac tamponade[3]. We, therefore, strongly advise against it.

Fundoplication in para-esophageal hernia repair buttresses the repair to reduce risk of recurrence and to prevent post-operative gastro-esophageal reflux[11,17,18]. This case highlights the benefit of anterior Dor fundoplication used as opposed to the Nissen technique as it is associated with lower incidences of dysphagia and gas-related symptoms in the long-term[19]. However, patients with severe reflux symptoms prior to surgery are more likely to experience residual mild reflux after Dor repair compared to Nissen fundoplication[18]. Furthermore, as the stomach is

strongly secured to the diaphragm and crura with the Dor approach, there is a lower risk of hernia recurrence, whereas in the Nissen technique the stomach is only secured to the esophagus and theoretically more likely to migrate back into the chest.

The next phase of this technique for laparoscopic hiatus hernia repair with mesh is to trial a different biosynthetic mesh that is thinner and therefore easier to apply on the crus. This new mesh has a delayed reabsorption time of 18 months compared to 6 months.

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DISCLOSURES:
The authors have nothing to disclose.

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No Figures for the manuscript.

Table 1. Summary of patient cases

Number of cases using this technique
Median Follow-up
Gender
Median Age
Hiatus Hernia Types
Recurrence
Complications

^Both were greater than 7cm.

*This patient had a recurrent type III hiatus hernia and th
tolerating fluids for the first 48 hours. She then unexpect

23
15 months
5 Male; 18 Female
69
2 Type I^ 17 Type III (3 recurrent) 4 Type IV
1
1 Mortality*

is was a difficult dissection. Post-operatively she was initially quite well and
edly rapidly decompensated from an unrecognized cardiac tamponade.

Table of Materials

Click here to access/download;Table of Materials;JoVE_Table_of_Materials (3) (1).xlsx

Name of Material/Equipment	Company	Catalog Number	Comments/Description
1.0 non-absorbable suture			
10 mm port			
3.0 absorbable suture			
5mm port			
Biosynthetic mesh	GORE BIO-A		
Bladeless optical access entry system	Kii		
Drain			
Fibrin glue	Tiseel		
Laparoscopic grasper	Ethicon		
Laparoscopic harmonic scalpel	Ethicon		
Nathan liver retractor			
Sling			
Veress needle			

23/8/19

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The authors would like to express their appreciation for the feedback on the submission. The authors have modified the manuscript and re-taped the video to meet your requirements.

Your sincerely,

Dr My Pham
Dr Ruben Cohen-Hallaleh
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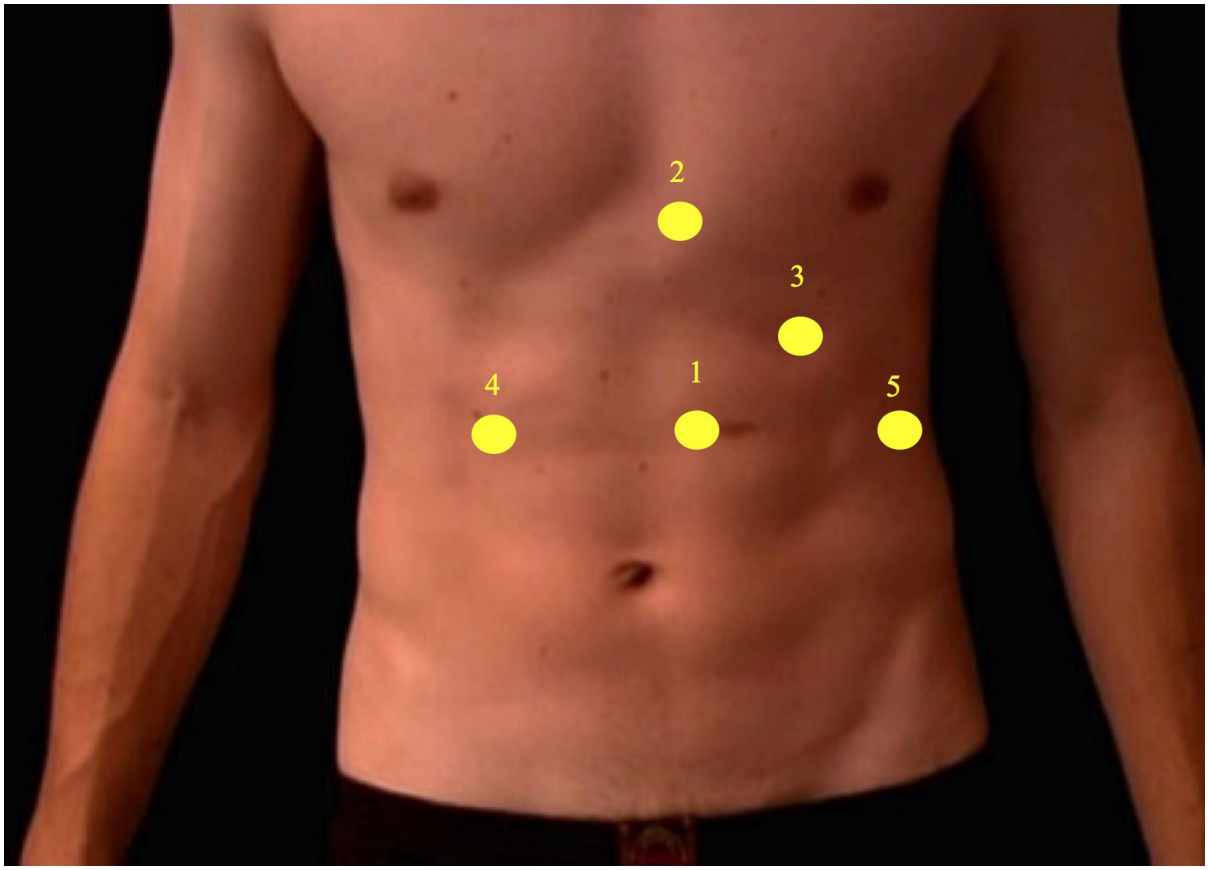

Figure

1. Camera port: 10mm supra-umbilical, one hand-span from the costal margin and to the left of the midline incision.
2. Nathanson liver retractor: left para-xiphoid incision.
3. Working port: 5mm left mid-clavicular incision.
4. Working port: 10mm right mid-clavicular incision.
5. Working port: 5mm left anterior axillary incision.

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