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Falciform Ligament Plug in Laparoscopic Hiatus Hernia Repair

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ABSTRACT

Background: A prospective and retrospective collected databases to identify outcome in Laparoscopic para-esophageal hiatal hernia repair is a challenging procedure. The falciform ligament is used as an autologous onlay flap to achieve tension-free closure of the crural defect of a para-esophageal hernia (PEH).

Aim of the work: To assess the use of Falciform ligament for hiatus hernia repair and to evaluate the outcomes results.

Patients and Methods: From December 2015 to august 2018, a total of 24 patients with para-esophageal hiatus hernia were conducted; Hernias were diagnosed with esophago-gastroscopy, barium contrast X-ray study and esophageal manometry.

Results: twelve patients underwent falciform ligament plug repair while twelve patients underwent crural approximation and fundoplication repairs. The classical traditional procedure time for repairs was significantly longer (p=0.004). Hospital stays, resting lower esophageal sphincter pressure, and mean contraction amplitudes were similar between groups. Discussion: The well documented advantages of laparoscopic hiatal hernia repair less pain; shorter hospital stays, and faster recovery and the rates of failure are higher in patients had open repairs.

Conclusion: Use of falciform ligament as a vascularized autologous onlay flap is a safe and effective procedure to close the crural defect of para-esophageal hiatus hernia.

Keywords: Hiatal hernia, Gastro-esophageal reflux, Laparoscopy, Falciform ligament plug.

INTRODUCTION

The classic definition of para-esophageal hernia (PEH) is a protrusion of the gastric fundus through the diaphragmatic hiatus while the lower esophageal sphincter remains in its normal anatomic position (type II hiatal hernia). More frequently, both the fundus and the lower esophageal sphincter are herniated into the thorax (type III hiatal hernia)[(1)].

Laparoscopy was introduced in the late 1980's and was quickly adopted by esophageal surgeons as opportunity to provide operative repair without the morbidity of the open procedures. Since that time, the feasibility and safety of a laparoscopic approach to giant para-esophageal hernia repair was established [(2)].

At present, laparoscopy is accepted as the standard approach for the surgical treatment of gastroesophageal reflux disease, and it is also widely used for repair of PEH. Although technically demanding, this approach provides better exposure of the surgical field than open trans-abdominal procedures and adds the known general advantages of laparoscopy in terms of reduced morbidity, shorter hospital stay, rapid recuperation, and decreased pain medication requirements. These advantages may be especially valuable in the PEH population because most patients are elderly and have multiple comorbid conditions. Because a high percentage of recurrent PEHs are initially asymptomatic, contrast imaging is necessary to accurately detect recurrences[(3-5)].

Reconstruction of the esophageal hiatus by re-approximation of the left and right hiatal crurae with interrupted sutures (posterior hiatoplasty) often results in significant tension on the repair. Failure of the posterior hiatoplasty is known to be the most common cause for hernia recurrence[(6,7)].

Several surgical techniques were suggested to decrease the rate of recurrence, including efforts at creating a tension-free repair by the use of synthetic and biological mesh[(8)].

Synthetic meshes, however, were associated with serious complications at the hiatus, such as fibrosis, esophageal stricturing, erosion, and gastric fibrosis[(9)].

Biologic mesh materials were proposed as an alternative to plastic mesh in hopes of avoiding these potentially catastrophic complications while achieving a robust permanent repair[(10)].

In theory, these materials cause less foreign body reaction and instead act as a temporary matrix for native tissue ingrowth and remodeling. Several investigators found that hiatal hernia reinforcement with biologic mesh is associated with low objective recurrence rates of 0–11% [(11)].

When perioperative outcomes are compared directly with open techniques, post-operative morbidity and mortality, blood loss, and hospital length of stay are significantly reduced for the laparoscopic approach[(12)].

Use of the falciform ligament as a vascularized autologous flap for tension-free repair of a large hiatal defect is an attractive option for obtaining tension-free repair of a PEH without the risks associated with prosthetic materials or the substantial cost of biologic mesh. There is some variation in anatomy; the blood supply to the falciform ligament comes mainly from branches of the left hepatic and left inferior phrenic arteries which anastomose to form an arcade as well as from smaller perforators from the parietal peritoneum. It is

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important to maintain the integrity of the arterial arcade during mobilization of the ligament and this is best ensured by keeping the line of dissection as close to its attachment to the anterior abdominal wall as possible [(13)].

Primary repair failure results from the poor quality of the crus and the diaphragm, which means that the tissue does not hold suture well and tears easily. Also, the defects are usually long-standing and large, and the primary closure of the hernia is always under tension. These factors make the recurrence of the hernia more likely and may be associated with symptom recurrence including dysphagia[(14)].

PATIENTS AND METHODS

From December 2015 to august 2017, a total of 24 patients with para-esophageal hiatus hernia underwent falciform ligament onlay flap and hiatus plug at General Surgery Department, Al-Azhar University Hospitals. Preoperative assessment was performed, including history, examination, gastroesophageal reflux evaluation with esophago-gastroscopy and esophageal manometry and barium contrast X-ray study, full laboratory study, and abdominal ultrasonography. Patients were divided randomly into: group I (Falciform ligament repair), group II (crural approximation with or without fundoplication).

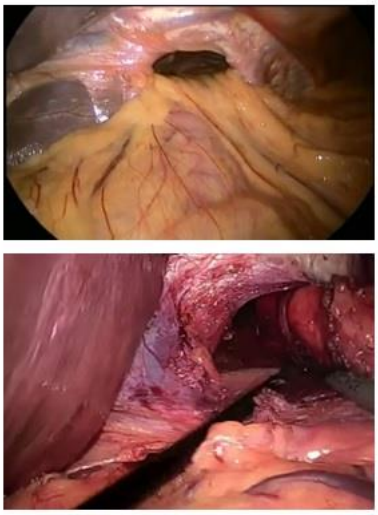

Figure (1): Para- esophageal Hiatus Hernia

All patients were subjected to follow-up barium contrast study, esophagogastroscopy and abdominal ultrasonography (US) at 3, 6, and 12 months postoperatively **Figure (1)**.

Ethical approval: All the patients provided informed consent to participate in the retrospective review of the prospectively collected data before initiation of the study, and Hospital Ethical Committee approval was obtained for the protocol of the study.

Eligible patients were between 20 and 46 years of age. The patients underwent a complete preoperative workup for both the surgical pathology and any medical co-morbidity relevant to undergoing a general anesthetic and hiatus hernia repair.

Preoperative Assessment

Laparoscopic repair of para-esophageal hernia begins with a careful preoperative evaluation. We obtained a careful history, including assessment of typical symptoms of gastroesophageal reflux (heartburn and regurgitation) and dysphagia. Additional symptoms that are common included chest or epigastric pain, recurrent aspiration with or without associated pneumonia, cough, shortness of breath, and dyspnea on exertion. Signs of compromised blood flow to the herniated stomach may be subtle, such as iron-deficiency anemia. Patients often reported knowledge of a "hiatal hernia" for many years.

Next, we obtained a radiographic evaluation by barium swallow. Abnormal esophageal motility was often evident on barium swallow in patients with para-esophageal hernia. Barium swallow was useful for identifying the location of the gastroesophageal junction (GEJ), and assessing the degree to which the stomach is herniated into the chest. Because the esophagus was often tortuous and placement of a manometry catheter across the lower esophageal sphincter into the stomach could be difficult, we rarely performed a complete motility study.

Laboratory studies included assessment of the hemoglobin for occult anemia (present in up to 1/3 of patients) and serum albumin levels for evaluation of nutritional status. We obtained pulmonary function testing in patients with a complaint of shortness of breath to determine whether the breathing difficulties were due to restriction of lung function due compression of adjacent lung by herniated stomach or to co-existing intrinsic lung disease, which may in fact be related to long-standing reflux, aspiration, and lung injury.

Surgical Procedures

Patient Preparation, Positioning, and Port Placement:

Our preferred position of the patient is supine, in reverse Trendelenburg position. Patients received 5,000 IU of heparin subcutaneously prior to induction of anesthesia[(15)].

Pneumoperitoneum was established via insertion of a Veress needle to insufflate the abdomen to a pressure of 12–15 mmHg. A 10 mm 30° laparoscopic telescope was then introduced under direct visualization via a vise port, approximately one third to one half of the distance between the umbilicus and xiphoid process. All further ports were placed under direct visualization. A 5 mm port is placed at the xiphoid process to facilitate retraction of the left lobe of the liver, 5 mm working ports were placed in the left and right hypochondria, and a 5 mm assistant's

port was placed in the left flank just inferior to the left costal margin.

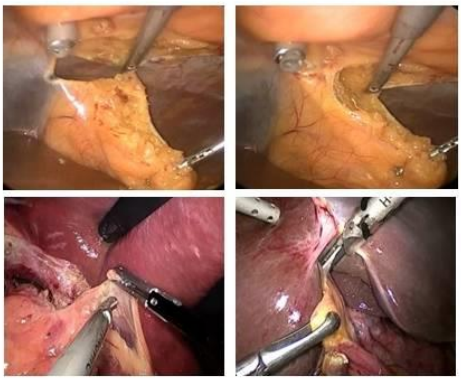

Figure (2): Division of vascularized falciform ligament.

Care was taken to avoid dissection into the falciform ligament. Because of the extensive dissection within the mediastinum, this port must be placed in the upper third of the abdomen [16].

Surgical Technique

The hernia contents were reduced by gentle traction. The gastro-splenic ligament and short gastric vessels were divided with harmonic scalpel or the ultrasonic shears; this allows access to the areolar attachments of the hernia sac to the mediastinal structures. Care was taken to identify both the anterior and posterior vagi, and re-establishing adequate intra-abdominal esophageal length. Great care was taken not to cause an iatrogenic esophageal injury at this point.

Division of vascularized falciform ligament

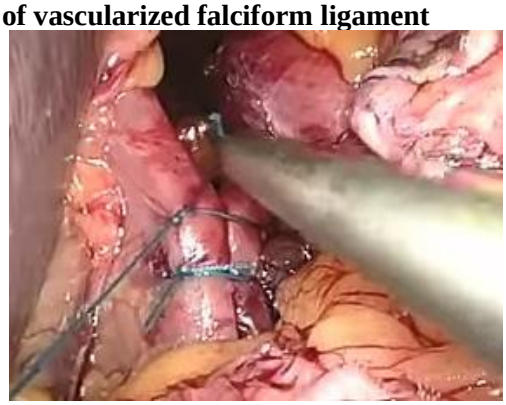

Figure (3): Approximation of two crura.

After mobilization of the anterior and left sides of the esophagus, attention was turned to the lesser omentum. The pars flaccida was divided, and the base of the right crus was identified.

Strict attention to maintaining the integrity of the peritoneal lining over the crura was critical for the success of primary closure. Without this lining, the crural musculature has no intrinsic strength and, therefore, would not hold suture sufficiently to prevent dehiscence of the crural repair. We assessed the location of the GEJ for adequate intra-abdominal length in a neutral resting position in the abdomen [17].

Approximation of two crura

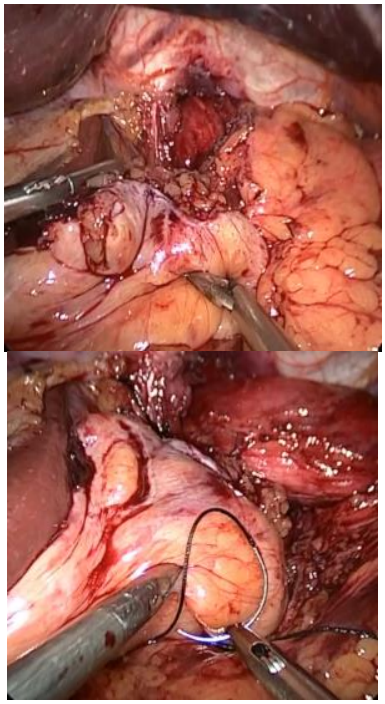

Figure (4): Falciform ligament plug fixation.

A Penrose drain was passed around the esophagus and was used for gentle retraction to expose the base of the a suture approximation of the crurae, a falciform flap was developed and used as an onlay mesh to achieve a tension-free closure of the defect and the tip of the flap were rolled upon itself to plug the rest of esophageal hiatus.

We repaired the hiatus in all patients regardless of the decision that was made to re-approximate the crura by one or two stitches of 2-0 proline, anterior to the aorta.

Falciform ligament plug fixation

The falciform ligament was mobilized at the level of its attachment to the anterior abdominal wall starting just superior to the umbilicus and continuing superiorly and anterior of the liver with harmonic scalpel dissection through the left flank port and retracted with a traumatic grasper via the port in the left hypochondrium.

The falciform flap was guided under the lateral segment of the left lobe of the liver and maneuvered to cover the hiatal defect.

A 54-Fr bougie was introduced trans-orally and advanced into the stomach under laparoscopic visualization. The bougie was used as a guide to prevent excessive narrowing of the hiatus and plug the flap on the posterior wall of the esophagus.

Postoperative Care

Following completion of the operation, the patient was typically extubated and transferred to the

recovery room and admitted to the intensive care unit (ICU) for post-operative observation. We routinely performed barium swallow prior to discharge to document sub-diaphragmatic positioning of the fundoplication wrap and look for unrecognized esophageal or gastric injury.

The median postoperative length of hospital stay was 3 days.

Routine follow-up, including barium esophagram and symptom assessment with validated measures for gastroesophageal reflux disease health-related quality of life[18].

All patients were seen 2 weeks after surgery and again 3, 6 months and 1 year after surgery. Barium esophagram was performed 1 year after surgery and then at 2-year intervals.

Symptoms of Hernia Recurrence

Common postoperative complaints include dysphagia, heartburn, gas bloat, and diarrhea were recorded.

Statistical Analysis

Data are presented as mean ± SD. Chi-square/Fisher exact tests were used for comparison of discrete variables and the two-tailed t test for continuous data. Significance was defined as $P < 0.05$.

RESULTS

All cases in the study were scheduled as elective procedures.

Nissen fundoplication performed in 10 patients, two patients had no fundoplication.

An esophageal lengthening procedure (Collis gastroplasty) was not performed in study groups.

Mean operative time was 100 minutes in group I (Falciform ligament repair), with average (100 to 180 minutes), while in group II (crural approximation with or without fundoplication) 132.9 minutes with average (120 to 220 minutes).

Post-operative hospital stay ranged from 1 to 8 days with an average stay of 3 days (Table 1).

Post-operative follow-up exceeded 6 months, in group I (Falciform ligament repair) of these 10 patients, 7 (75%) had no esophageal symptoms. Heartburn was the most common complaint and was present in 2 patients (20%). Dysphagia was observed in 2 patients (20%); one of them present with ingestion of solids only and in the other after liquids as well. Chest pain was present in one patient (10%).

Post-operative physiologic assessment (manometry, 24-hour pH tests) and endoscopy were not performed routinely. Contrast barium esophago-grams were obtained routinely at 6 to 12 months after surgery and/or to assess symptoms during follow-up (Table 2).

Pre-and post-operative symptoms were compared, marked improvement was noted in all symptoms evaluated (P, 0.001). A significant decrease in the use of antacids medications from pre-operative (77%) to post-operative (11%) evaluation was also observed (P, 0.001).

For data analysis, chi-square/Fisher exact tests were used for comparison of discrete variables and the two-tailed t test for continuous data. Significance was defined as P, 0.05. Summary data are presented as mean SD. Analysis of pre-operative parameters, including age, sex, number, surgical approach and hernia size, to assess their influence on post-operative recurrence showed no statistically significant association between these variables and recurrence (P . 0.05).

The classical cases group took > 50 min longer than falciform ligament cases group (190±84.7 vs. 132.9±40.4 min, p=0.004) (Table 2).

Despite the higher complexity of cases and longer operative times, patients in the falciform ligament group had uncomplicated initial post-operative courses and were discharged from the hospital at similar times to their non-falciform ligament counterparts (day 2.26±0.94 vs. 2.24±0.90, p=0.94).

Table (1): Presenting Features.

Common presentation	Average	P value
Age (yr.)	24	(SD ±13)
Symptom duration (mo.)	12	(SD ±43)
Presenting Symptoms (%): Heartburn: Chest pain: Dysphagia: Asthma: Cough: Vomiting: Anemia/gastro-intestinal bleeding:	 16 7 18 2 17 3 11	 (0.015) (0.034) (0.013) (0.12) (0.014) (0.08) (0.02)
Pre-operative Evaluation: Hernia size (cm.): Endoscopic esophagitis (%): Hypotensive lower esophageal sphincter (%)	 6 (3–14) 18/24 13/24	 (SD±2) (0.013) (12)

Table (2): Characteristics of the study groups.

Point of difference	Group I (falciform plug)	Group II (classical repair)	P value
Number	12	12	P=0.1
Gender	M: 9 (75%); F: 3 (25%)	M: 11 (91.6%); F: 1 (8.3%)	
Approach	Laparoscopic: 12 (100%)	Laparoscopic: 12 (100%)	
Conversions to Open Approach	0	0	
Mean Operative time (minutes)	±132.9	140	P=0.004
Estimated bleeding (mL)	14.7 (0 - 100)	14.7 (0 - 100)	P=0.1
Hospital stay (days)	3 (1 - 8)	3 (3 - 10)	
Incidence of recurrence	0 (0%)	2 (16.6%)	P=0.008

Falciform ligament cases were seen on post-operative day 24.9±10.7 and the non- falciform ligament patients followed up on day 23.0±17.0 (p=0.57).

Overall, during this second visit, non- falciform ligament patients had more symptom complaints; they had significantly more chest pain, abdominal pain, and complaints of inability to belch to relieve discomfort.

Non- falciform ligament patients had higher heartburn scores than patients who had their hiatal hernias bio-mesh repair.

Falciform ligament patients tend to complain more of solid food dysphagia and bloating, but the differences did not reach significance.

Esophageal manometric testing was routinely performed at the 6-month visit. While the resting LES pressure was the same for both hernia repair groups the residual pressure was significantly higher in the patients who had a mesh repair (13.7±6.6 vs. 1.7±5.8 mmHg, p=0.0001).

Barium esophagograms were obtained in 6 (37.5%) of the 24 patients with more than 6 months of follow-up. The remainders have either refused to participate in the study or have not been evaluated in the office for more than 6 months post-operatively.

Recurrent hiatal hernias were observed radiographically in 2 patients (8.3% overall or 16.6% of those undergoing contrast x-ray evaluation) (Table 3).

Table (3): Symptomatic outcome in study group:

	Pre-operative	Post-operative	P value
Symptoms present	8 (66.6%)	2 (16.6%)	(P . 0.05)
Dysphagia: Solids only.	8 (66.6%)	1 (8.3%)	(p. 0.94)
Liquids and solids	3 (25%)	2 (16.6%)	(p.0.0001)
Heartburn	4 (33.3%)	2 (16.6%)	(p. 0.94)
Chest pain	6 (50 %)	1 (8.3%)	(p. 0.94)
Response to Medication	9 (75 %)	11 (91.6%)	(P . 0.05)

DISCUSSION

The results of a vascularized falciform ligament flap technique can be used to both re-inforce a completed hiatoplasty and, more uniquely, bridge a defect when the crura cannot be re-approximated and provides a barrier to egress of bowel or other abdominal contents into the mediastinum and the motivation for developing the technique when no other means of hiatal closure was available. Biologic meshes cannot be used to span a defect, and non-absorbable meshes should not be used to span a hiatal defect.

Varga et al. the ligamentum teres was used in 26 patients both laparoscopically and open, to re-inforce the hiatal closure. Their results demonstrated the technique to carry low morbidity (11 %) and mortality (0 %) with a radiologic recur-rence of 15 % at a mean of 3 years follow-up [(19)].

Once Biological mesh implanted, they are eventually replaced by host collagen and blood vessels. While showing great promise in a few select applications, their role in supporting long-term durable hiatal repairs is far from established [(20)].

The radiological recurrence rate, following laparoscopic suture repair of a PEH, has been reported as high as 42%. It is understood that radiologic evidence of failure of a HH repair does not necessarily correlate with clinical evidence of failure. Consequently, patients who have undergone repair of GPEH can be found to have anatomic evidence (to varying degrees) of hernia recurrence without clinical evidence or return of symptoms [(21)].

CONCLUSION

The novel technique of laparoscopic falciform flap and plug repair of PEH and prevent gastro-esophageal reflux. The falciform flap technique of repairing a PEH allows the GIT surgeon option to bridge an otherwise “unclosable” hiatal defect with patient’s own tissue, avoiding the risks, complications, and costs inherent in the use of currently available meshes.

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