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Benefit of Laparoendoscopic Repair of Hiatal Hernia in the Presence of Aberrant Left Hepatic Artery

Medhat Y. Fanous, MD, FACS

ABSTRACT

Background and Objectives: An aberrant left hepatic artery (ALHA) limits the already confined operative field of laparoscopic antireflux surgery (LARS) and laparoscopic hiatal hernia repair (LHHR). The aim of this study is to provide a safe laparoendoscopic technique for hiatal hernia repair in the presence of an ALHA.

Methods: We conducted a retrospective chart review of patients who underwent LARS or LHHR between March 2016 and March 2018. We reviewed clinical and laboratory data and operative reports and images. Follow-up data included gastroesophageal reflux disease (GERD) questionnaire results and the results of esophagogastroduodenoscopy (EGD) and upper gastrointestinal studies.

Results: One hundred thirty-one LARS and LHHR procedures were performed by a single surgeon. Eight (6.1%) patients had an ALHA. There were 6 female and 2 male patients. The average age was 54.5 (±10.4) years, and the average body mass index was 28.1 (±5.5) kg/m^2. The duration of their GERD symptoms was 16.6 (±6.9) years. Patients underwent LHHR followed by transoral incisionless fundoplication. Hiatoplasty was performed with extracorporeal sliding arthroscopic knots. The ALHA was preserved in all cases. There was no intraoperative bleeding, mortality or postoperative complications. All antireflux medications were discontinued with significant improvement of GERD questionnaires. All patients had EGD at 3 months postoperatively with no recurrence of hiatal hernia. Five patients who had the surgery longer than 1 year ago had an upper gastrointestinal study without evidence of hiatal hernia recurrence.

Conclusion: The laparoendoscopic technique of hiatal hernia repair, using extracorporeal arthroscopic sliding knots and concomitant transoral incisionless fundoplication, is safe, preserves an ALHA, and allows proper surgical techniques in a confined operative field.

Key Words: Aberrant left hepatic artery, Hiatal hernia repair, Crural repair, Extracorporeal sliding arthroscopic knot tying, Transoral incisionless fundoplication.

INTRODUCTION

An aberrant left hepatic artery (ALHA) usually originates from the left gastric artery and runs through the pars condensa of the lesser omentum.[1] The reported incidence of ALHA in various anatomical and radiological studies and laparoscopic findings is 3% to 34% in adults.[2–4] The presence of an ALHA creates a significant challenge in foregut surgery, as it limits an already confined operative field.

In the case of laparoscopic hiatal hernia repair (LHHR) or laparoscopic antireflux surgery (LARS), an ALHA prevents unobstructed access to the right diaphragmatic crus. This can result in an inadequate hiatal dissection and suboptimal fundoplication, both of which are the essence of antireflux surgery.[5,6] To deal with this operative scenario, several operative strategies are used. The first strategy is to operate away from the aberrant vessel starting at the left crus. The reported operative bleeding of this approach is 4.1%.[3] The second strategy is to increase the operative space by dissecting around the ALHA. However, it is reported that this increases operative bleeding to 5.3%.[5] The third operative strategy is to divide the ALHA and take the minimal risk of necrosis of the left lobe of the liver. This approach should be considered only as a last resort, especially when operating on pediatric patients.[6]

Department of Surgery, Aspirus Iron River Hospital and Clinics, Iron River, Michigan, USA.

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Address correspondence to: Medhat Fanous, MD, FACS, Department of Surgery Aspirus Iron River Hospital and Clinics, 1400 West Ice Lake Road Iron River, MI 49935, USA. Telephone: 906-265-0499 Fax: 906-265-1244 Email: medhat.fanous@gmail.com

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In the current study, we preserved the ALHA by dissecting the diaphragmatic hiatus using a left-to-right approach. We used extracorporeal sliding arthroscopic knots (ESAKs) because of their ability to be navigated around anatomical obstacles. We then performed endoscopic fundoplication for the antireflux component of the surgery.

METHODS

Institutional review board approval was obtained for a retrospective evaluation. Between March 2016 and March 2018, all patients who underwent LHHR or LARS were evaluated for the presence of an ALHA. Its presence was documented by intraoperative images and operative reports.

Diagnostic workup included upper gastrointestinal (UGI) study, esophagogastroduodenoscopy (EGD), and wireless pH study. Esophageal manometry was selectively used for dysphagia or abnormal UGI findings.

On-table endoscopy was performed initially on patients who did not undergo EGD by the operating surgeon. As our program evolved, we performed on-table EGD on all patients. Endoscopic examination was performed after LHHR to obtain the measurements for transoral incisionless fundoplication (TIF) and at the conclusion of the procedure. The difference between the endoscopic measurement of gastroesophageal junction (GEJ) before and after LHHR was used as a surrogate of the length of esophageal mobilization. We used the typical laparoscopic 5-port technique (camera, liver retractor, 2 working ports, and assistant port). All of them were 5 mm except the left upper quadrant (LUQ) main port, which was 11 mm. We commenced the hiatal dissection at the left diaphragmatic crus, moving toward the right crus. Meticulous mediastinal dissection was undertaken. We did not divide the short gastric vessels. Once 3 cm or more of intra-abdominal esophagus was obtained, attention was then directed toward performing the hiatoplasty. Simple crural repair was performed by using interrupted permanent sutures with the use of an Endostitch™ (Covidien, CT, USA). Both ends of the suture were pulled through the main laparoscopic port and tied externally with ESAKs

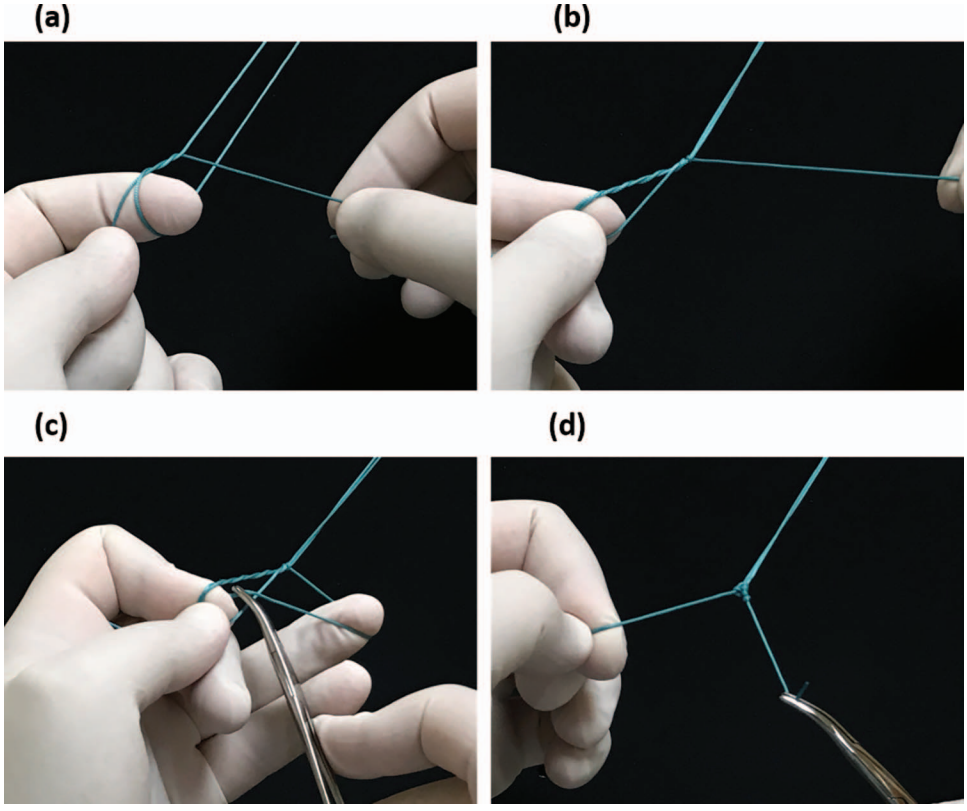

Figure 1. Formation of modified Duncan Loop. (**a**) Create a loop as if you are performing 2-handed knot tying and place 2 half-knots on the side of index finger. (**b**) Place 3 winds around both limbs. (**c**) Pass the free end into the loop around the index finger. (**d**) Tension the knot. Reproduced from Fanous et al.[16]

such as Weston or Roeder's knots or a modified Duncan Loop. **Figure 1** illustrates the steps to perform a modified Duncan Loop.[7] These knots do not unravel and require a knot pusher to be advanced. We precisely placed the knots between the posterior aspect of the right crus and the inferior vena cava (IVC) to evert the crura. One unique aspect of ESAK is the ability to advance the knots farther. For this reason, we leave a long crural stitch tail to allow further cinching. **Figure 2** shows that the second posterior crural stitch became loose after placement of the third crural stitch. It was then cinched with a side knot pusher.

The pneumoperitoneum was deflated and the laparoscopic portion was concluded. We then used the Esophyx HD® device (EndoGastric Solutions, Redmond, WA, USA) to perform a standardized TIF.[8] Postoperative objective testing included EGD at 3 months and UGI study at or after 12 months.

RESULTS

One hundred thirty-one LHHR and LARS procedures were performed by a single surgeon duing a 2-year period. Eight (6.1%) patients had an ALHA. There were 6 female and 2 male patients. The average age was 54.5 (±10.4) years. The average body mass index was 28.1 (±5.5) kg/m^2. The duration of the patients' gastroesophageal reflux disease (GERD) symptoms was 16.6 (±6.9) years. Proton pump inhibitors (PPIs) were used by 6 (75%) of 8 patients, with average duration of 13.2 (±9.4) years.

The average DeMeester score obtained off antisecretory medications was 41.6 (±21.2). Patients had a median American Society of Anesthesiologists classification of 2.3 (range 2 to 3). Operative data showed an average duration of 132 (±14.9) minutes. The relevant characteristics of this cohort are listed in **Table 1**.

All patients underwent LHHR followed by TIF. There were no conversions to open procedures. The difference between the endoscopic distance of the GEJ from incisors, before and after hiatal hernia repair, provided an indication of the length of intra-abdominal esophagus. The distance ranged between 3 and 4 cm. There was no intraoperative or postoperative bleeding. There were no incidents of 90-day mortality or morbidity. All patients were

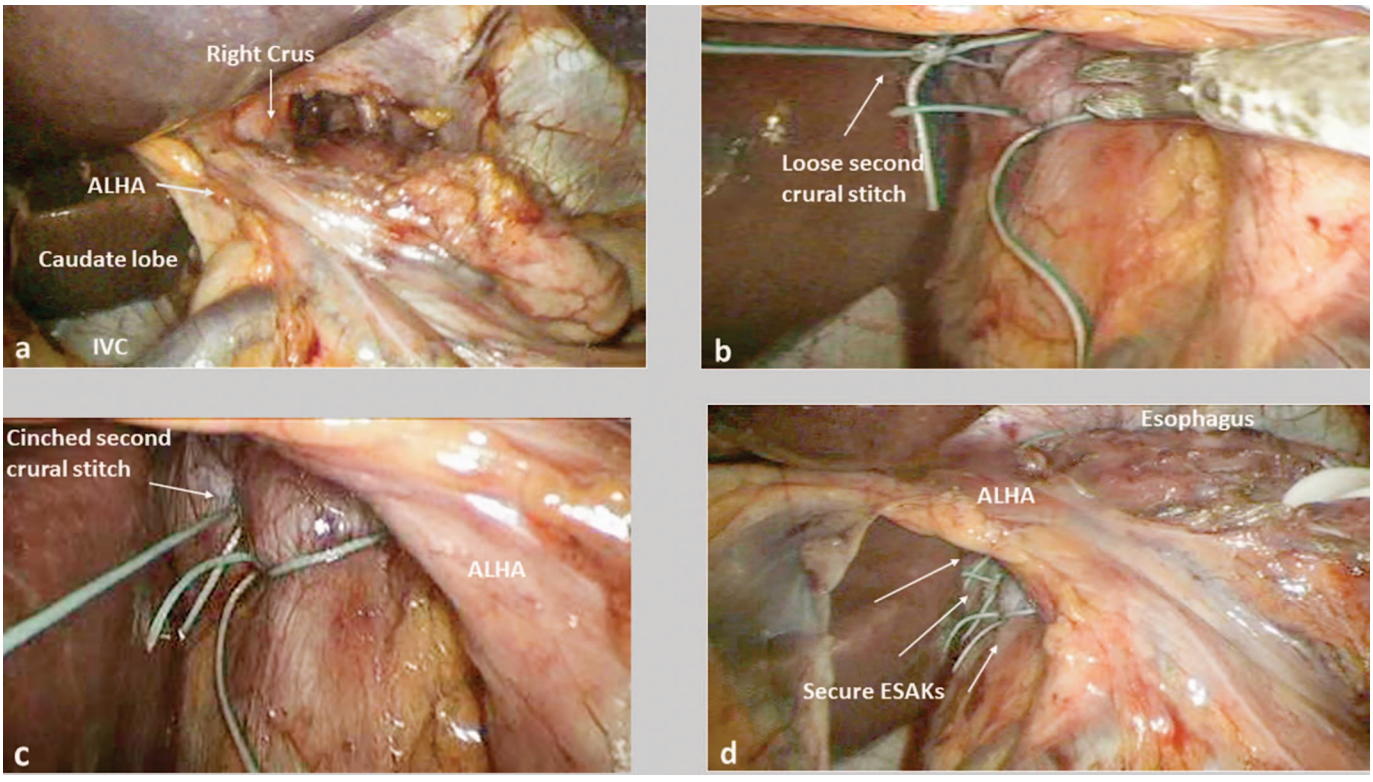

Figure 2. Characteristics of extracorporeal sliding arthroscopic knots (ESAKs). (**a**) Laparoscopic view of an ALHA obscuring most of the right crus. (**b**) Second crural stitch becomes loose after placement of third stitch. (**c**) Loose stitch cinched. (**d**) Side view showing location and security of ESAK.

Table 1
Characteristics of the Study Population

Characteristic	Mean ± SEM or n
Demographics	
Age (years)	54.5 ± 10.4
Male: female	2: 6
Body mass index (kg/m^2)	28.1 ± 5.5
GERD	
Duration (years)	16.6 ± 6.9
Symptoms	
Heartburn	8/8 (100%)
Regurgitation	7/8 (87.5%)
Dysphagia	4/8 (50%)
PPI use	
Number of patients	6/8 (75%)
Duration (years)	13.2 ± 9.4
Combination with H2 blockers	4/6 (66.6%)
Response	
Complete	0%
Partial	100%
Diagnostic studies	
EGD	
Hiatal hernia sliding component (cm)	2.7 ± 0.4
Hiatal hernia width (cm)	3.3 ± 0.8
DeMeester score	41.6 ± 21.2
Esophageal manometry	
Number of patients	6/8 (75%)
Intact peristalsis	4/6 (66.6%)
Ineffective esophageal motility	2/6 (33.3%)
Lower esophageal sphincter (LES)	
Complete relaxation	6/6 (100%)
Normotensive LES	3/6 (50%)
Hypotensive LES	3/6 (50%)
Operative	
ASA	2.3 (2–3)
Duration (minutes)	132 ± 14.9
Degree of fundoplication	
330	1/8 (12.5%)
300	6/8 (75.0%)
270	1/8 (12.5%)
Postoperative	
Length of stay (days)	1
Discontinuation of PPI	6/6 (100%)

discharged the day after surgery. Their liver function tests were normal. Patients were seen in the clinic and successfully weaned off PPIs. The median follow-up was 12 (±6.7) months. Preoperative versus postoperative GERD questionnaires are listed in **Table 2**. We used GERD-Health Related Quality of life, Heartburn Score, Regurgitation Score, Reflux Symptom Index, and GERD Symptom Score.

Objective testing at 3 months with EGD for all patients showed no recurrence of hiatal hernia. Five patients had their procedures performed more than 1 year ago. They had UGI studies at or after 12 months that showed no recurrence of hiatal hernia.

DISCUSSION

When present, an ALHA usually poses a significant challenge to the foregut surgeon. It reduces the operative space, which is already limited. It impairs crural dissection in almost one third of cases and results in failed Nissen fundoplication in 6% of patients.[5,6] Operative bleeding is reported to be 4.1%, which rises to 5.3% when the surgeon dissects around the aberrant vessel.[3,5]

In the current study, when the presence of an ALHA limited the access to the right side of the operative field "box," a left-to-right crural dissection was undertaken. This was followed by tying outside the box using ESAKs. Finally, we used endoscopic fundoplication to wrap outside the box.

The use of ESAKs has been shown to be beneficial in confined operative foregut fields. The knots can navigate anatomical obstacles and require a single insertion of a knot pusher, which reduces the risk of injuring an ALHA. ESAKs can be precisely placed between the posterior aspect of the right crus and the IVC to evert the crura. Fanous et al[7] described the steps of formation, characteristics, and advantages of ESAK in LARS. This is the only suturing technique currently available that allows for cinching earlier crural stitches when subsequent stitches rendered them loose. This technique saves the time normally required for redoing the loose crural stitches, which is challenging as the diaphragmatic hiatus is partially closed.

This laparoendoscopic approach of LHHR with concomitant TIF was first reported by Ihde et al in 2011.[9] The TIF procedure creates a 2- to 3-cm, 270° to 330° esophagogastric partial wrap through a natural orifice by using the Esophyx device. It is worth noting the misnomers when combining LHHR and TIF. Clearly, TIF here is not inci-

Table 2
GERD Questionnaires (Mean Values)

GERD-Related Questionnaires (median follow-up of 12 ± 6.7 months)	Preprocedure	Postprocedure	*P*
GERD-Health Related Quality of life (HRQL)	33.6	4.9	.001
Heartburn Score	17.3	3.5	.001
Regurgitation Score	11.0	0.4	.001
Reflux Symptom Index	23.4	6.5	.001
GERD Symptom Score	22.0	3.3	.001

sionless. In fact, TIF should more accurately be called transoral incisionless cardiaplication because it uses the cardia of the stomach, not the fundus, to create the wrap. The retroflexed endoscopic views before and after LHHR are illustrated in **Figure 3a** and **3b**. It is also shown that the reconstructed gastroesophageal valve has approximately 330° of wrapping, which is maintained 3 months postoperatively (**Figure 3c** and **3d**).

There are multiple advantages to this laparoendoscopic approach. First, it preserves the angle of His, which is essential to the antireflux mechanism. Second, it produces a partial wrap, which reduces the incidence of the side effects of dysphagia and gas bloat syndrome.[10] Third, TIF is performed transorally, thus avoiding a confined operative field. Fourth, this approach preserves the short gastric vessels and their contribution to the gastric blood supply. It also avoids potential bleeding related to their division or from splenic capsular tears. Fifth, multiple studies have shown the safety, efficacy, and durability of the TIF procedure.[11–13] Finally, this technique does not burn bridges for revisional antireflux surgery as the cardia is used for the wrap and the fundus is spared. Performing laparoscopic Nissen fundoplication after TIF was reported to be safe without additional operative morbidity.[14] The dissection required for Nissen fundoplication is more extensive than in the laparoendoscopic approach because the proximal stomach is adequately mobilized, the short gastrics are divided, and the fundus is used for the wrap. Additional stitches might be used to secure the laparoscopic wrap to the diaphragmatic crura. Revisional antireflux operations after Nissen fundoplication are difficult and would be even more challenging in the presence of an ALHA.

TIF has been shown to be effective, but good outcomes require accurate measurement of hiatal hernia.[11] TIF is indicated when the craniocaudal extent of the hiatal hernia is 2 cm or less. Our midterm data demonstrates the efficacy of the laparoendoscopic approach as it repairs larger hiatal hernia laparoscopically to enable endoscopic performance of TIF. This approach was shown to be effective in normalizing postoperative pH scores.[15]

CONCLUSION

The laparoendoscopic technique of hiatal hernia repair, using extracorporeal arthroscopic sliding knots and concomitant TIF, is safe, preserves an ALHA, and allows proper surgical techniques in a confined operative field.

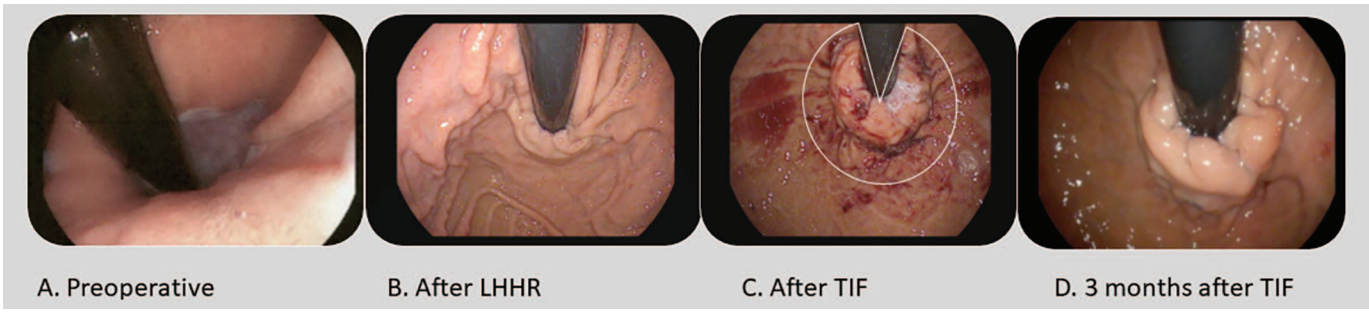

Figure 3. Endoscopic retroflexed views.

These midterm data show its effectiveness in the discontinuation of PPIs. Longer follow-up is required to evaluate the durability of this technique.

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