

10 Critical Steps of Hiatal Hernia Repair and Anti-Reflux Surgery: An Expert Consensus and Literature Review

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Abstract

Background: There is significant variability in the treatment of hiatal hernias, which has led to various perspectives regarding the proper manner of dissection, repair, and reconstruction. We sought to evaluate and analyze expert opinions, survey data, and the literature to define the critical steps in hiatal hernia repair.

Methods: A focus group (*focus*) of expert foregut surgeons defined and agreed upon a sequence of critical steps of a hiatal hernia repair. Using the data from the focus group, an anonymous survey was compiled and distributed to members of the American Foregut Society (AFS). The survey data (*survey*) was then compared to the *focus* for agreement. The compiled *focus* and *survey* data was interpreted as expert recommendation (*expert*). A literature review (*literature*) was then conducted and compared to *expert* data for agreement and evaluation of discordance. This was used to define the critical steps of hiatal hernia repair.

Results: Of the 10 identified critical steps, there was agreement on 9 of 10 steps between *focus* and *survey*. The 1 step with discordance was supported by the *literature*.

Conclusions: Ten critical steps have been identified to help produce a succinct and reproducible approach to hiatal hernia repair. It is believed that adherence to these steps will allow the surgeon to achieve a safe and successful hiatal repair.

Keywords

hiatal hernia, laparoscopic, anti-reflex, bougie, foregut

Key Learning Points

- Close attention should be paid to the surgical plane when performing a minimally invasive hernia repair.
- Preservation of the anterior and posterior vagus nerves is crucial.
- This 10-step process can ensure an efficient and safe procedure.

Introduction

Gastroesophageal Reflux Disease (GERD) is a gastrointestinal disorder with high prevalence across the world, and the presence of a hiatal hernia is a large risk factor for the development of GERD.¹ A hiatal hernia repair followed by anti-reflux surgery is the most common surgical intervention for this disease.² Regarding the procedure,

guidelines established by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) state that all symptomatic paraoesophageal hernias should be surgically repaired, and the use of a laparoscopic approach is preferred due to a markedly decreased morbidity rate and shorter hospital length of stay.³ Thus, while the laparoscopic approach is now considered the gold standard, there still remains great variability in procedural technique.

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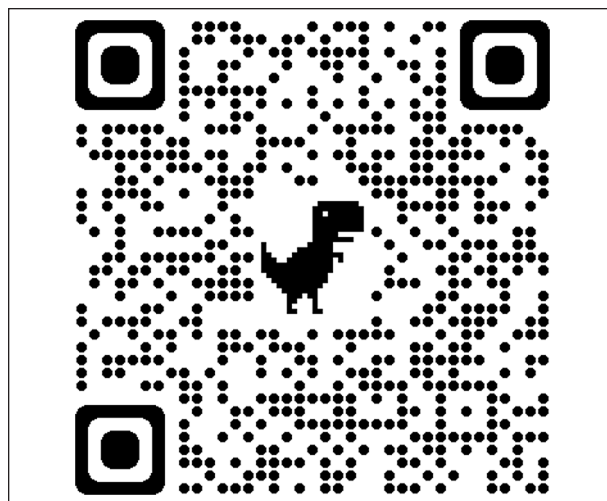
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Currently, there are various methods of both hernia repair and anti-reflux surgery that can be found throughout the literature and clinical practice. It is crucial to study and understand this procedure to produce the safest and most effective technique and to maximize positive outcomes for the patient. To do so, we set out to study both expert opinion via a focus group and assessment and utilization of survey data from the American Foregut Society. This was then compared to a review of the literature to identify reproducible steps for a safe and efficient way to repair the hiatus.

Methods

Institutional Review Board approved the study for the use of survey data. A focus group (*focus*) of 3 surgeons who received specialized training in foregut surgery, with two of them having more than five years of experience in foregut surgery in tertiary care center(s), identified a set list of critical steps to hiatal hernia repair. The *focus* agreed upon 10 critical steps that should be performed in a specific order. These agreed-upon steps were then compiled into a survey, which was placed on the monthly Foregut newsletter in July and August of 2022. This newsletter is sent routinely every month to all AFS members. Twenty-two foregut surgeons completed the survey. Survey recipients anonymously answered questions about these 10 critical steps and other techniques for hiatal hernia repair. The AFS survey data (*survey*) was then compared to the *focus* for agreement. Agreement was set at >75%, or when 18 of the 22 *survey* surgeons were to agree with the *focus*. While all expert opinions were considered equally, agreement was set to >75% to allow for recognition of differences between opinions at our tertiary care medical center and the broader population of expert foregut surgeons. *Focus* and *survey* data was interpreted as the expert recommendation regarding clinical practice (*expert*).

A literature review (*literature*) was conducted to examine each step of the operation, evaluating if *expert* aligned with current literature. Literature included PubMed peer review and standard surgical text. Search terms included “hiatal hernia repair,” “foregut surgery,” “gastroesophageal reflux disease” OR “GERD,” “antireflux surgery,” “paraesophageal hernia,” “Collis gastroplasty,” “bougie,” and “fundoplication.” Articles between 1965 and 2023 were included. All articles relevant to the 10 critical steps decided upon were reviewed. This allowed for examination regarding agreement and discordance between *current* and *literature*. A final recommendation based on *expert* and *literature* was analyzed to formulate each of the 10 critical steps. Additionally, a video of the procedure was recorded by the *focus*, and the link is included in the QR code below.



[Link to Video](#)

Results

Focus opinion was compared to data from the *survey*. This yielded agreement between nearly all critical steps of hiatal hernia repair (Table 1).

Step 1) Division of the gastrohepatic ligament and phrenoesophageal membrane (Figures 1-6). There was 100% agreement between the *focus* and *survey* regarding this step of the operation. *Literature* supports division of both the gastrohepatic ligament and the phrenoesophageal membrane.

Step 2) Initial exposure of mediastinum with vagal nerve preservation. Eighty-two percent of *survey* surgeons agreed with the *focus* that the anterior and posterior branches of the vagus nerves should be visualized and preserved. *Literature* supports this but is not conclusive.

Step 3) Dissection of the left and right crus (Figures 7-10). Here, 86% of *survey* surgeons agreed that full dissection of both crural pillars is required, which is in agreement with *focus*. Again, this is supported in the *literature*.

Step 4) High mediastinal dissection (Figures 11 and 12). Again, 82% of *survey* surgeons agree that a complete mediastinal dissection to the level of the inferior pulmonary vein is critical. The *literature* strongly supports full dissection of the hiatal hernia into the mediastinum.

Step 5) Reduction of the hiatal hernia sac. *Focus* and *survey* were in complete agreement that the hernia sac must be reduced, and this is supported in the *literature*.

Step 6) Appropriate abdominal esophageal length (Figures 13-15). The *focus* recommended at least 3 cm of intra-abdominal length, while the *survey* data showed that 25% of surgeons felt <3 cm was required, 45% felt 3 cm was required, and 30% felt >3 cm was required. Compiling the data, 75% agreed that at least 3 cm of abdominal length was required and agreed with *focus*. *Literature* supports at least of 2 to 3 cm of abdominal length.⁴⁻¹⁰

Step 7) Placement of bougie (Figures 16 and 17). Only 10.5% of *survey* surgeons felt that a bougie was needed

Table 1. Agreement and Disagreement of Steps of Hiatal Hernia Repair and Anti-Reflux Surgery; Agreement is Considered >75%.

Step	Survey compared to Focus	Literature
Division of the gastrohepatic & phrenoesophageal membrane	Agree 100%	Agree
Initial Exposure of the Mediastinum, Vagal nerve preservation	Agree 82%	Agree
Dissection of both crus	Agree 86%	Agree
High Mediastinal Dissection	Agree 82%	Agree
Reduction of the Hiatal Hernia	Agree 100%	Agree
Abdominal Esophageal length	Agree 75%	Agree
Bougie Placement	Disagree 89.5%	Agree/Neutral
Perform Collis Gastroplasty if GE junction is within the chest	Agree 95%	No conclusion
Crural Repair and use of mesh	Agree 82%	Agree
Creation of anti-reflux surgery/fundoplication	Agree 100%	Agree

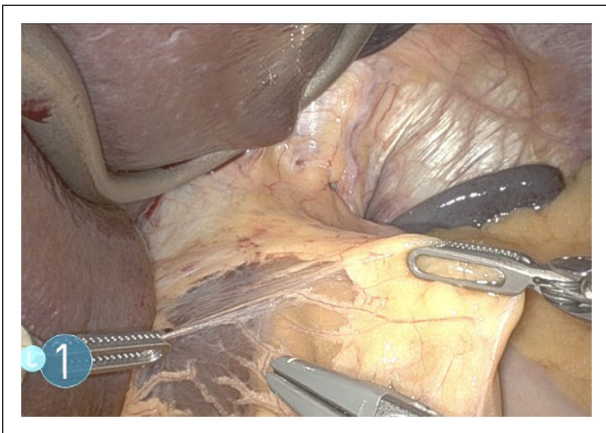


Figure 1. Division of the gastrohepatic ligament during a small hiatal hernia repair.

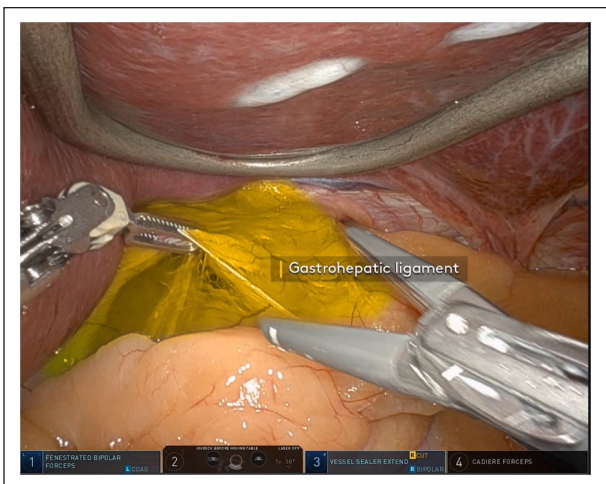


Figure 2. Division of the gastrohepatic ligament during a large hiatal hernia repair.

during hiatal hernia repair, while the *focus* group felt this was a critical step. The *literature* showed that bougie usage

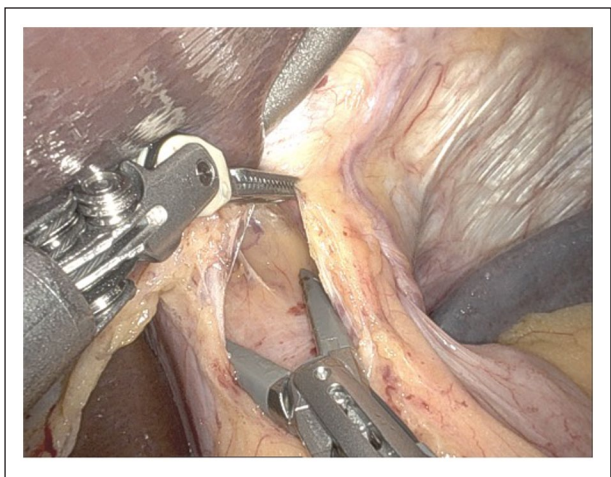


Figure 3. Division of the phrenoesophageal membrane along the superior aspect of the right crus during a small hiatal hernia repair.

either resulted in a positive or neutral finding but did not show a negative finding during hiatal repair. Thus, with the support of *focus*, and the positive finding in the *literature*, this was left as a critical step. Thus, this is an area of quality improvement in hiatal repair and warrants further discussion, study, and education on the potential value of bougie placement during hiatal hernia repair.

Step 8) Ensure the GE junction has returned to the abdominal cavity, and if not, perform a Collis Gastroplasty. Ninety-five percent of *survey* surgeons perform a Collis Gastroplasty if the GE junction is in the mediastinum, while 5% of *survey* surgeons state they never perform a Collis Gastroplasty. The *literature* on Collis Gastroplasty was not conclusive, with poor study designs, mixed results, and no definitive conclusion.

Step 9) Crural repair and use of mesh (Figures 18-20). The *focus* supports both an anterior and posterior repair regardless of size. Eighty-two percent of *survey* surgeons agreed with this, while 18% of surgeons only performed a posterior repair. No surgeon reported performing an anterior repair only. This is a clinical practice change that should be highlighted, as the historic dogma called for a posterior closure

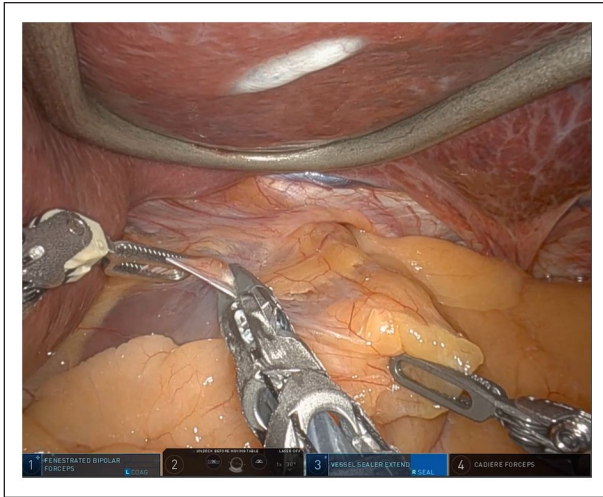


Figure 4. Division of the phrenoesophageal membrane along the superior aspect of the right crus during a large hiatal hernia repair.

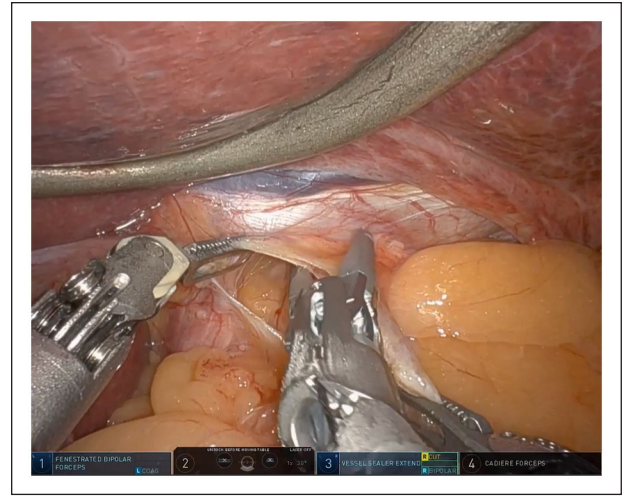


Figure 6. Division of the phrenoesophageal membrane along the left crus during a large hiatal hernia repair.

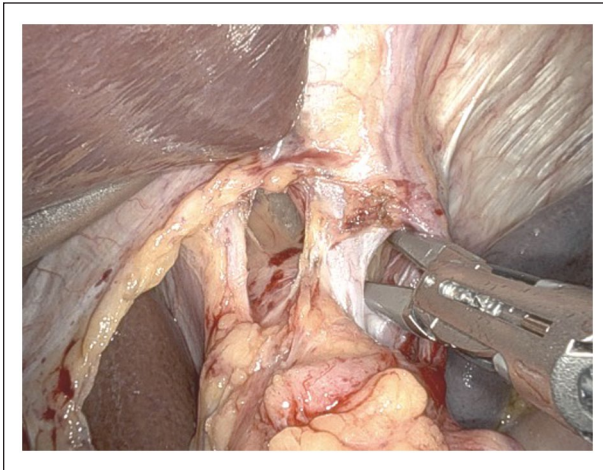


Figure 5. Division of the phrenoesophageal membrane along the left crus during a small hiatal hernia repair.



Figure 7. Dissection of the right crus during a small hiatal hernia repair.

only. Regarding mesh, there was complete, 100% agreement between *focus* and *survey* that synthetic mesh should not be used in the hiatus. The *literature* supported both coverage of the anterior and posterior repair, while also supporting the use of either biologic or bioabsorbable mesh and is conclusive that synthetic mesh is contraindicated in the hiatus.

Step 10) Anti-reflux procedure (Figures 21-23). There is complete agreement between *focus* and *survey* that an anti-reflux procedure should be performed in conjunction with hiatal hernia repair. Regarding the specific type, the *literature* opted for Toupet, while *survey* results were as follows: Toupet (11/19=57.9%), Nissen 4/19 (21.1%), and Watson

3/19 (15.8%), with no reported utilization of Dor for anti-reflux surgery. *Literature* supports anti-reflux surgery in the setting of hiatal hernia repair but is not conclusive regarding the specific procedure.

A Deeper Examination of the Additional Topics Where Literature Review is Inconclusive

Intraoperative endoscopy. The *focus* endorsed the use of endoscopy in all hiatal hernia repairs for the endoscopic evaluation of the GE junction and inflation of the stomach for functional evaluation of the fundoplication. Only 51% of *survey* surgeons believe there must be clear identification of the GE junction. While 63% of surgeons evaluate the

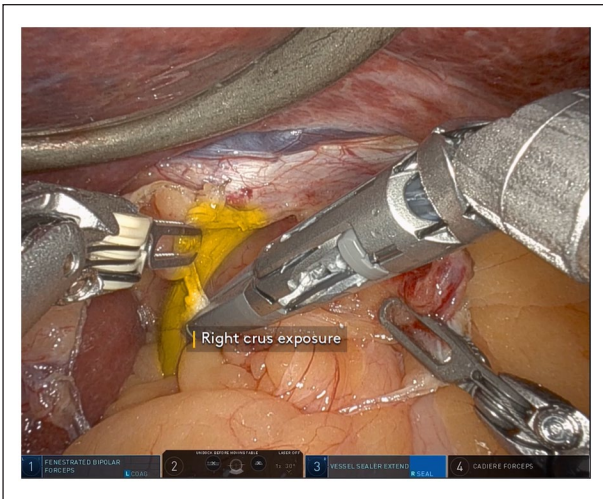


Figure 8. Dissection of the right crus during a large hiatal hernia repair.

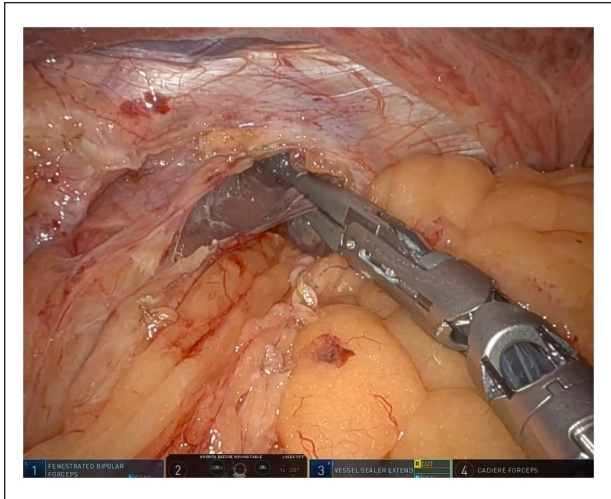


Figure 10. Dissection of the left crus and angle of His during a large hiatal hernia repair.

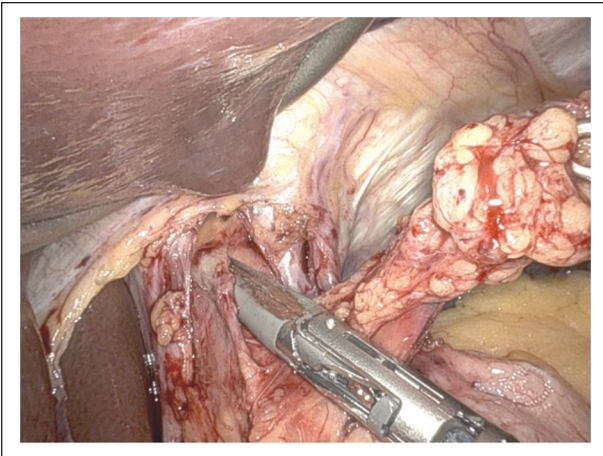


Figure 9. Dissection of the left crus and angle of His during a small hiatal hernia repair.

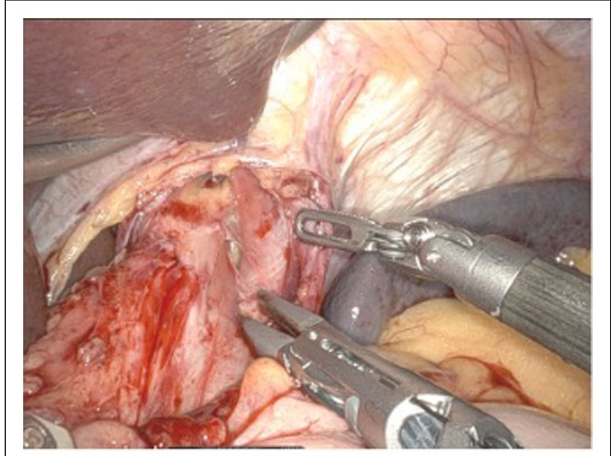


Figure 11. Blunt dissection of the hiatal hernia during a small hiatal hernia repair.

fundoplication with an endoscope, 10% evaluate with an endoFLIP™, and 26% do no additional evaluation.

Suture to use in hiatal hernia. While both the *focus*, *survey*, and *literature* support the use of permanent sutures, the type of sutures varied. The *focus* all use braided sutures, while 30% of *survey* surgeons use a barbed suture, 10% use a monofilament suture, and 60% use a braided suture.

Buttress material. The *focus* uses pledgets in all cases, while the *survey* group reported that 70% do not use pledgets.

Mesh configuration. The *focus* uses mesh in a keyhole fashion, while *survey* reported other mesh configurations,

with 56% using “reverse C,” 33% using keyhole, and 11% using a starburst.

Discussion

This work used expert focus group opinion (*focus*), survey data (*survey*) from the American Foregut Society, and a literature review (*literature*) to compile the 10 critical steps to a hiatal hernia repair. Each step was evaluated for agreement between *focus* and *survey*, which represented current expert recommendation (*expert*). Agreement was found in all the critical steps except the use of a bougie during the operation. *Expert* was then compared to *literature* for agreement, where all steps were either supported by the literature or the literature was found to be neutral or not studied. There was no critical step supported by

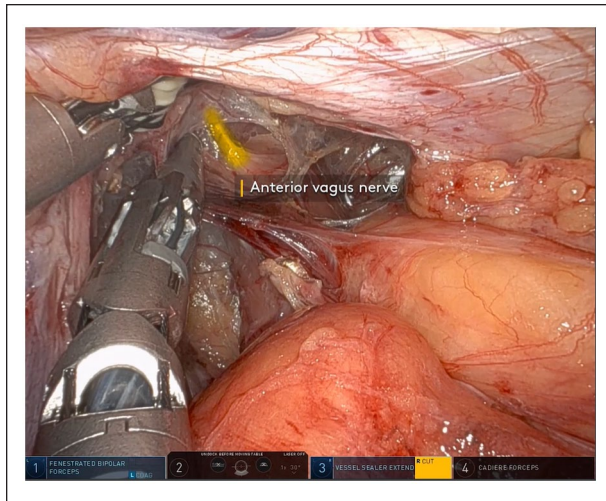


Figure 12. Blunt dissection of the hiatal hernia during a large hiatal hernia repair.

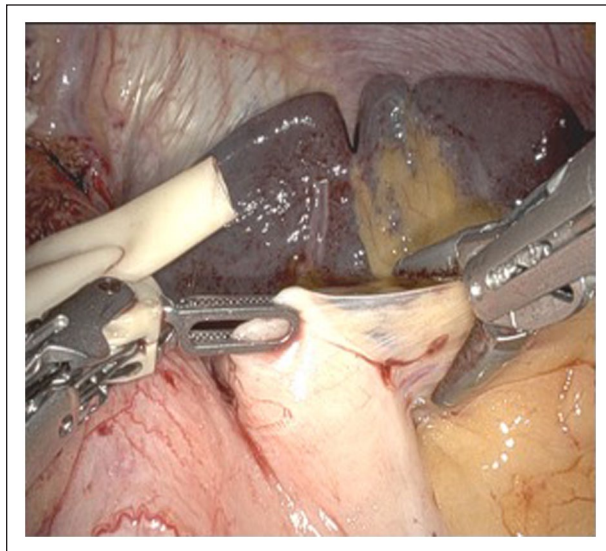


Figure 13. Take down of the short gastric during a small hiatal hernia repair.

expert where the *literature* was found to disagree. Thus, these 10 critical steps are proposed by *focus* with validity supported by both *survey* and *literature*.

Summary of Steps Supported by Focus and Survey With Review of the Literature

First Step: Division of the Gastrohepatic Ligament and the Phrenoesophageal Membrane

It has long been agreed upon that the gastrohepatic and phrenoesophageal ligaments should be dissected during

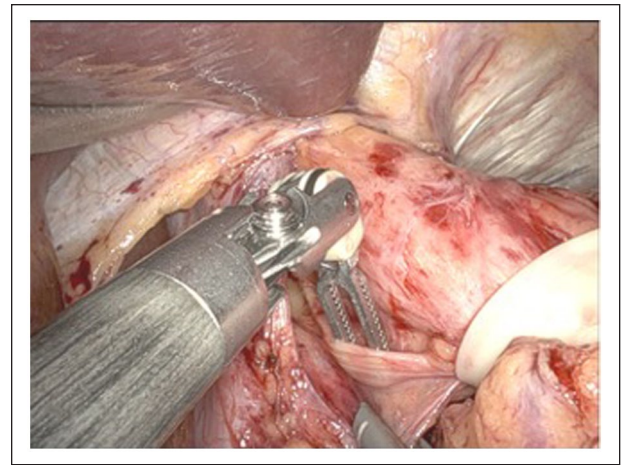


Figure 14. Hernia reduction during a small hiatal hernia repair.

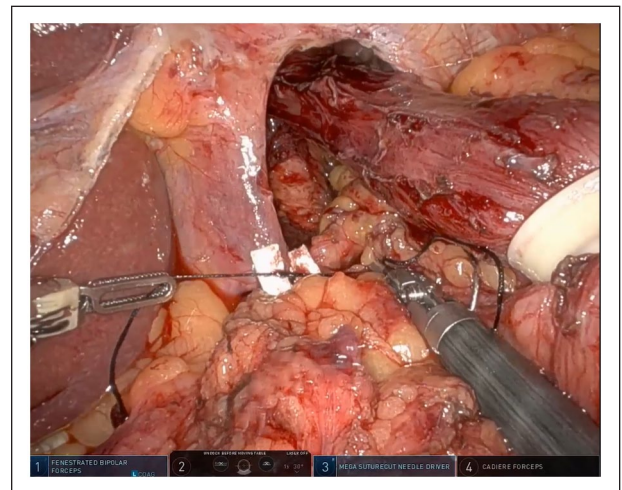


Figure 15. Hernia reduction during a large hiatal hernia repair.

the repair of a hiatal hernia to expose the hiatus.¹¹ Division of the phrenoesophageal membrane is necessary for exposure of the anterior hiatus.¹² There is a lack of recent research on this step, as it is collectively agreed upon that this dissection is critical for a successful surgery. There is no research on not dissecting the phrenoesophageal ligament.

Some potential complications to this step include the presence of an aberrant left hepatic artery (ALHA) crossing the gastrohepatic ligament, which can be found in 3% to 34% of adult patients,¹³ or the crossing of the hepatic branch of the vagus nerve over the gastrohepatic ligament. If an ALHA is present, surgeons can either operate away from the vessel, dissect the vessel to increase operative space, or divide the vessel, with the final option risking necrosis to the left lobe of the liver.¹³⁻¹⁶ This situation was not included in the *survey*, but *focus* recommends

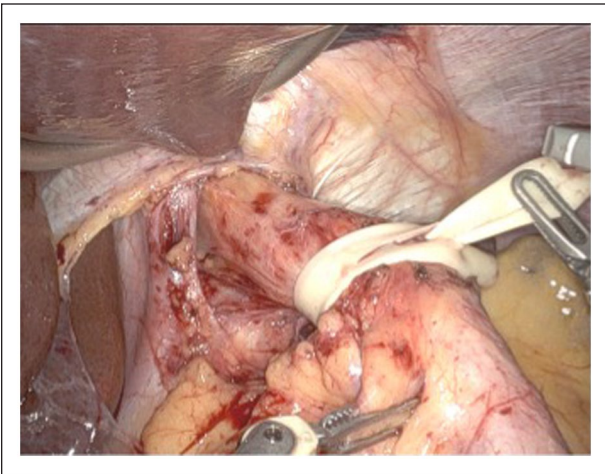


Figure 16. Bougie placement during a small hiatal hernia repair.

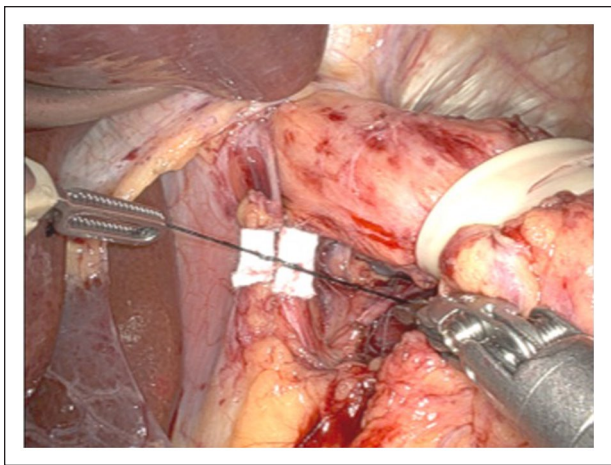


Figure 18. Crural repair during a small hiatal hernia repair.

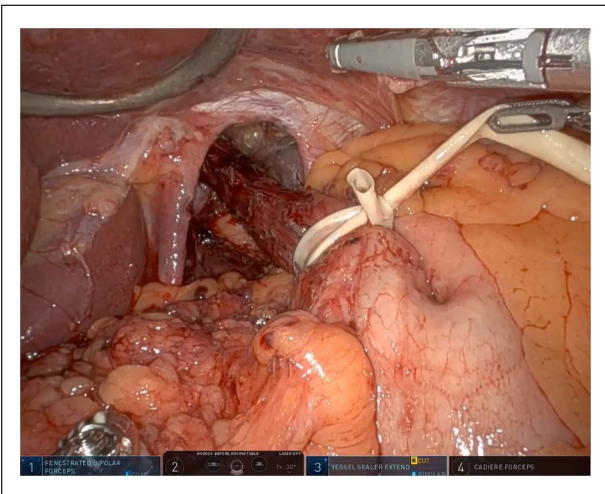


Figure 17. Bougie placement during a large hiatal hernia repair.

test clamping the vessel to see if there is a change to the liver parenchyma before proceeding with vessel division. The use of indocyanine green (ICG) for perfusion would also be of benefit in this scenario. The preservation of the hepatic branch of the vagus nerve was also not included in *survey*, but *focus* believes that this branch should be preserved if present with a large vessel but can be taken otherwise. A broader survey would need to be conducted to better understand current practices regarding this issue. Since we do not have *survey* data on these scenarios, we cannot comment on the broader opinion of foregut surgeons with regard to these situations.

It is recommended in the literature that blunt dissection begin at the right crus and caution be taken to avoid damaging the posterior vagus nerve.^{9,17} Some authors recommend dissection to begin at the left crus.¹⁸

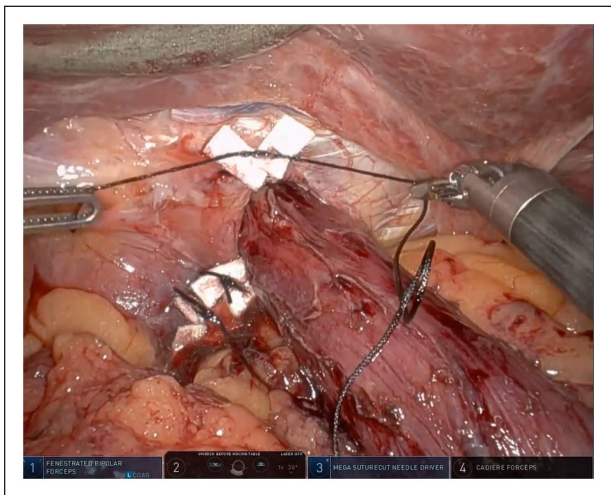


Figure 19. Crural repair during a large hiatal hernia repair.

Second Step: Initial Exposure of the Mediastinum and Vagus Nerve Preservation

The long-standing surgical dogma during hernia repair has been to avoid vagotomy if possible due to the increased risk of delayed gastric emptying and other gastrointestinal symptoms, such as diarrhea, cramps, bloating, nausea, vomiting, and dumping.¹⁹ In 2008, Oelschlager et al⁷ described the effective use of vagotomy as opposed to Collis Gastroplasty when mobilization of the esophagus does not provide sufficient esophageal length. In this study, patients who received a unilateral vagotomy did not have more severe symptoms of delayed gastric emptying when compared to patients who did not receive a vagotomy. Of note, the vagotomy was unilateral, and one of the nerves was always preserved.²⁰ Thus, it is believed that both vagus nerves should be preserved, however if this is not possible, as in the case with some

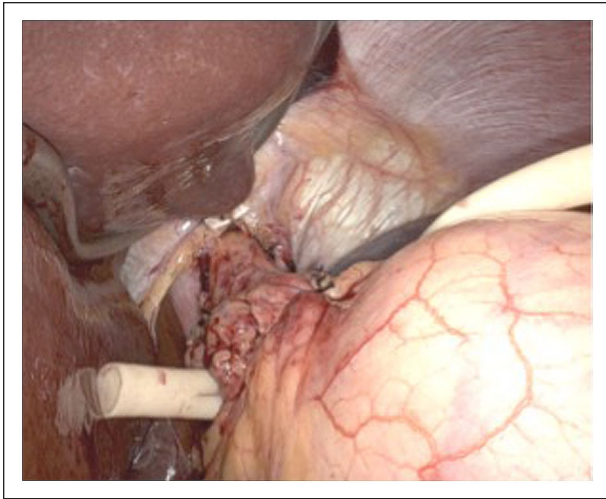


Figure 20. Creation of the fundoplication during a small hiatal hernia repair.

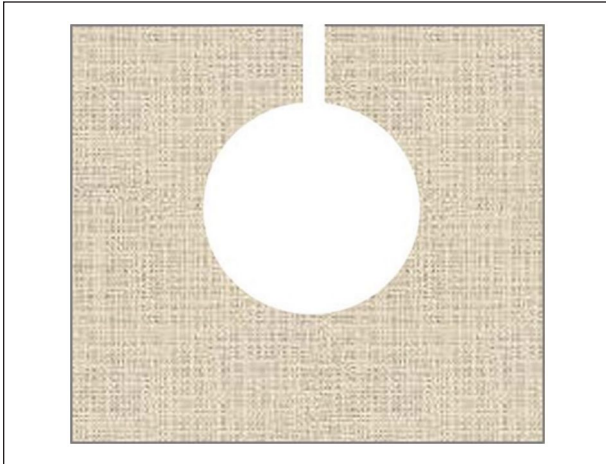


Figure 21. Keyhole mesh configuration.

massive paraesophageal hernias where the anterior vagus is displaced and attenuated, then one of the nerves, most likely the posterior, should be preserved to decrease the risk of gastroparesis.

Third Step: Dissection of the Left Crus and Right Crus With Exposure of Posterior Crural Confluence

Yang et al²¹ expresses that revealing both crura is the most important step in laparoscopic hiatal hernia repair in order to reduce the rate of recurrence. However, no literature was found comparing the efficacy of unilateral or no crural dissection versus bilateral crural dissection for hernia repairs. It is critical to dissect out both crura to their posterior confluence to ensure proper repair and approximation of the pillars.



Figure 22. Reverse C mesh configuration.



Figure 23. Starburst mesh configuration.

While dissecting out the crura, care must be taken to not denude the peritoneal layer covering the diaphragm. This is critical, as the diaphragm does not have a fascial layer; thus the “strength” layer of the muscle is missing. This is also why many Foregut surgeons will use either Teflon pledgets, as classically described by Dally and Falk., or biologic buttressing material.²²

Fourth Step: High Mediastinal Dissection

The literature supports extensive mediastinal dissection to above the level of the inferior pulmonary veins as a means of minimizing tension.^{14,18,19} Watson et al²⁰ compared the incomplete versus complete mediastinal

dissection, also evaluating for reduction and resection of hernia sac. A comparison of these methods showed that laparoscopic hiatal hernia repair was performed more successfully with complete mediastinal dissection.²⁰ Extensive mediastinal dissection can eliminate the need for an esophageal lengthening procedure, such as Collis Gastroplasty, which could decrease post-operative complications such as dysphagia, localized acid production, and progression to esophagitis that are common among esophageal lengthening procedures.⁶ Flores et al⁶ found that patients who underwent high mediastinal dissection had a statistically significant improvement in esophageal symptoms at 6 months postoperatively and beyond, endorsing the support for high mediastinal dissection.

Fifth Step: Reduction of the Hiatal Hernia Sac

The literature supports a complete reduction of the hiatal hernia.^{9,10} Comparison of outcomes between hiatal hernia repair with the sac left in place versus complete hernia sac excision showed that complete excision reduced the rate of recurrence, decreased the risk of transmural perforation or neurovascular injury, decreased the chance of symptomatic collection, prevented rises in intraabdominal pressure that could push the stomach back up into the chest, and allowed the esophagus to freely descend back to neutral position.¹⁰

Sixth Step: Intra-Abdominal Esophageal Length

With regards to esophageal length, no studies were found within the literature that compare outcomes when different lengths of esophagus are mobilized into the stomach; however, several papers recommend a specific length of esophagus be mobilized into the abdomen for a successful procedure. The literature recommends that 2 to 3 cm of esophagus be mobilized into the stomach during this step.^{4,10}

Seventh Step: Bougie Placement

The use of a Bougie has been shown to minimize long-term, post-operative dysphagia. Patterson et al²³ found that 31% of patients whose operation was performed without a Bougie, compared to 17% of patients whose operation was performed with a Bougie, had long-term post-operative dysphagia symptoms. However, use of a bougie is not without risk and can increase the risk of esophagogastric perforation.²⁴ Novitsky et al²⁵ discussed the safety and efficacy of not using a Bougie during fundoplication. In a tertiary care hospital, a retrospective study was performed using 102 patients undergoing a laparoscopic Nissen fundoplication without a Bougie. It

was found that long-term dysphagia associated with not using a Bougie was resolved either spontaneously or with the use of expectant management.²⁵ Overall, the literature describes positive or neutral views on the use of a Bougie during fundoplication. Further studies need to be conducted on the indications for Bougie use and pros and cons associated with this technique.

Eighth Step: Ensure the GE Junction Has Returned to the Abdominal Cavity, and If Not, Perform a Collis Gastroplasty

Collis Gastroplasty for esophageal lengthening is a procedure of much debate, as several complications have been reported in the literature, including recurrent hiatal hernia, esophagitis, pathologic esophageal acid exposure, and Barrett's Esophagus, with esophagitis and pathologic acid exposure occurring in 36% to 80% of patients post-operatively.^{26,27} Studies have also reported new distal esophageal body peristalsis in up to 43% of patients, as well as recurrent hernia in 17% of patients.^{25,26} Some of the literature supports extensive mediastinal dissection as an alternative to Collis gastroplasty to decrease the risk associated with additional esophageal length.⁶ Puri et al²⁸ discussed the risk-benefit analysis of hiatal hernia repair with a Collis esophageal lengthening procedure by looking at pre- versus post-operative symptoms of heartburn, dysphagia, regurgitation, chest pain, and nausea in patients who received an esophageal lengthening procedure versus those that did not.²⁸ The surgeons participating in this study endorse doing a Collis for an esophageal length less than 3 cm, and they did not find any significant differences in complication rate post-operatively between the esophageal lengthening group and non-esophageal lengthening group.²⁸ Other researchers have discussed an overall positive benefit with regards to Collis Gastroplasty in the literature.^{8,29} Overall, it appears that a conclusion about the use of Collis Gastroplasty for short esophageal length has not been reached, raising a need for further research into this technique.

Ninth Step: Crural Repair and Use of Mesh

The utilization of mesh in laparoscopic hiatal hernia repair has been extensively studied in the literature. Synthetic permanent mesh use is contraindicated, as reports of mesh erosion and shrinkage leading to dysphagia have discouraged the use of this mesh in hiatal hernia repair.³⁰ On the contrary, biological mesh has shown good results. A multi-center, prospective, randomized trial in 2006 demonstrated that the use of biologic mesh during large paraesophageal hernia repairs (LPEHR) decreases the rate of recurrence at 6 months post-operatively.³¹ After this study, it was advised that surgeons utilize biologic mesh in their practice.

Regardless of this evidence, the use of mesh in LPEHRs remains inconsistent. In 2017, analysis of 9590 laparoscopic paraesophageal hernia repairs from the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database looked at evidence published in the literature compared to practices done by ACS surgeons and found a lack of compliance with evidence-based medicine with regards to this topic, suggesting that the most up-to-date suggestions with regards to mesh usage for LPEHRs might not be what is executed in practice. Regardless of this discovery, this analysis compared procedures done with and without mesh and found no significant difference in 30-day postoperative morbidity and mortality.³² The current guidelines from SAGES strongly recommend the use of mesh for reinforcement of large hiatal hernias due to their correlation with decreased short-term recurrence.³ It is the practice of the *focus* to place mesh if the hernia is >5 cm, the BMI is >30 kg/m², it is a recurrent operation, or a diaphragm release is performed.

On the topic of diaphragm release, a release should be considered when the crural repair is under tension. Consider releasing the right crura prior to releasing the left, as the right sided crural release is far from the phrenic nerve. If a crural release is performed, it will need to be covered with mesh.

When mesh is utilized, comparison of Keyhole, Starburst, and Reverse C (Figures 21-23) configurations has been studied in the literature, but not extensively. Our team has studied the differences in efficacy and complication rate between the Starburst pattern and Keyhole pattern, noting that the Starburst pattern allows the edges of the hiatus to be completely covered with mesh, decreasing the rate of recurrence.³³

The results of the survey for suture placement do not fully align with the data presented in the literature. Obeid et al³⁴ describes that patients receiving posterior only or anterior and posterior sutures had longer OR times, and patients with posterior only sutures had a longer overall length of stay. There was not a significant difference in complication rate within 30 days between the anterior only, posterior only, and anterior and posterior groups. The group that received both anterior and posterior sutures had a 0% reoperation rate at 4 years post-operation. This study presented that anterior and posterior sutures is the best technique to prevent reoperation, but there were no significant differences between anterior only or posterior only sutures in this study; however, none of the surgeons in the survey utilized an anterior only suture placement.³⁴ Of note, when recurrences do occur, the vast majority are anterior, thus necessitating an anterior stitch.

Pledgets are used as a support system for the hiatal closure and to protect the crural tissue from being

severed.³⁵ The literature supports the use of pledgets due to decreased short-term complications,³⁶ as well as long-term complications.³⁷ Based on current literature, the use of pledgets shows promise in decreasing recurrence rates, but further research is needed to compare this data to other methods.

Tenth Step: Creation of Anti-Reflux Surgery/ Fundoplication

There are varying opinions in the literature regarding the best type of fundoplication, but it appears that most literature can agree that the Toupet fundoplication warrants fewer post-operative side effects and complications; however, the Nissen fundoplication may provide better reflux control, at the expense of more side effects in the post-operative period.

There are several meta-analyses by Broeders et al³⁸⁻⁴⁰ comparing Nissen and Toupet for recurrent pathological acid exposure/reflux control, esophagitis, dysphagia, dilatation for dysphagia, heartburn, and reoperation rate. These analyses have concluded that Toupet fundoplication led to lower rates of post-operative dysphagia, dysphagia after 1 and 5 years, dilatation for dysphagia, reoperation, gas-related symptoms, and overall post-operative side effects, providing level 1a evidence for using Toupet over Nissen fundoplication.

In another meta-analysis from 2010 comparing several types of wraps, dysphagia rates and reflux recurrence were examined for Toupet, Nissen, and anterior fundoplications.⁴¹ While there was some variability in the ways the surgeries were performed, this analysis revealed that Nissen fundoplication may provide better reflux control, but patients experienced more dysphagia and gas bloat than with the Toupet or anterior fundoplication.⁴¹ Different papers included in this meta-analysis found varying results with advantages and disadvantages to each technique. The various wrap techniques for fundoplication prove difficult to study and compare due to variability across surgeons in the way they are performed with regards to the Bougie used, fixation of the wrap, etc., proving the need for a standardized, long-term outcomes study on these methods.

Regarding gastropexy, a protocol for an ongoing randomized controlled trial has been published. The trial involves comparing anterior gastropexy to no anterior gastropexy in paraesophageal hernia repair.⁴² After the conclusion of the reconstruction, the use of endoscopy is recommended to detect the presence of any abnormalities, such as esophagitis or resistance to endoscope passage, and check for sufficient fundoplication integrity, such as location of the wrap relative to the diaphragmatic hiatus, location of the squamocolumnar junction greater than 1 cm proximal to the wrap zone, and an intact wrap.⁴³

Jobe et al⁴⁴ created 10 criteria that would define a successful fundoplication and should be checked for using endoscopy at the end of the reconstruction. The literature supports post-fundoplication evaluation; however, there is no literature that compares evaluation with an endoscopy versus endoFLIP™.

Limitations

There are limitations to this review. The survey respondents only represent a small group of foregut surgeons, and therefore, their opinions may not represent the opinions of the entire population. The final recommendation based on the *focus*, *survey*, and current *literature* typically had overwhelming evidence to support; however, where there was discordance, the final recommendation was decided on by the whichever group, *focus or survey*, corresponded with the literature. It would be important to analyze the viewpoints of a larger sample size to ensure support.

Summary

This study evaluates the critical steps of hiatal hernia repair for consensus between an expert focus group, a survey of AFS foregut surgeons, and the literature.

By analyzing survey results of expert surgeons and current literature, as well as comparing the results to the opinions of the focus group, we were able to compose final recommendations for the critical steps of hiatal hernia repair. By following these 10 critical steps when performing laparoscopic hiatal hernia repair, the procedure should progress in an efficient and safe manner which is reproducible and teachable.

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Supplemental Material

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