

Emergent Repair of Paraesophageal Hernias and the Argument for Elective Repair

Brian Shea, MD, William Boyan, MD, Jonathan Decker, DO, Vincent Almagno, MD, Steven Binenbaum, MD, Gurdeep Matharoo, MD, Anthony Squillaro, MD, Frank Borao, MD

ABSTRACT

Background and Objectives: A feared complication of large paraesophageal hernias is incarceration necessitating emergent repair. According to previous studies, patients who require an emergent operation are subject to increased morbidity compared with patients undergoing elective operations. In this study, we detail patients who underwent hernia repair emergently and compare their outcomes with elective patients.

Methods: A retrospective analysis was performed of the paraesophageal hernia repair operations between 2010 and 2016. Patients were divided into 2 groups: patients with hernias that were repaired electively and patients with hernias that were repaired emergently. Perioperative complications and follow-up data regarding morbidity, mortality, and recurrence were also recorded. A propensity analysis was used to compare emergent and elective groups.

Results: Thirty patients had hernias repaired emergently, and 199 patients underwent elective procedures. Patients undergoing emergent repair were more likely to have a type IV hernia, have a partial gastrectomy or gastrostomy tube insertion as part of their procedure, have a postoperative complication, and have a longer hospital stay. However, propensity analysis was used to demonstrate that when characteristics of the emergent and elective groups were matched, differences in these factors were no longer significant. Having an emergent operation did not increase a patient's risk for recurrence.

Conclusion: Patients who had their hernias repaired emergently experienced complications at similar rates as

those of elective patients with advanced age or comorbid conditions as demonstrated by the propensity analysis. The authors therefore recommend evaluation of all paraesophageal hernias for elective repair, especially in younger patients who are otherwise good operative candidates.

Key Words: paraesophageal hernia, emergent, repair, elective, hiatal, hiatus.

INTRODUCTION

Paraesophageal hernias occur when the diaphragm hiatus enlarges to allow a portion of the stomach or other intra-abdominal organs to migrate into the thoracic cavity.¹ Paraesophageal hernias comprise roughly 5% to 10% of all hiatus hernias,² and are distinguished from sliding hiatal hernias by their fixed component in the thoracic cavity. A major risk factor for the development of a paraesophageal hernia is advanced age, as previous series demonstrate the median age of patients undergoing elective repair to be in the seventh decade of life.^{3,4}

It is well established that symptomatic patients with paraesophageal hernias should undergo elective repair. Identifying patients with symptoms presents a challenge, as these patients often have slowly developing, vague symptoms with which they can live for many years prior to seeking therapy. A recent study conducted by Carott et al. identified symptoms in those individuals undergoing elective repair. In this study, 269 of 270 patients had a mean of four symptoms related to their hernia, and their symptoms included heartburn (65%), early satiety (50%), chest pain (48%), shortness of breath (48%), dysphagia (48%), regurgitation (47%), and anemia (41%).⁵

A feared complication of a large paraesophageal hernia is incarceration necessitating urgent repair. The approximate risk of requiring an emergent operation in a patient with a paraesophageal hernia is 0.7% to 7%.⁶ According to previous studies, patients who require an emergent operation are subject to increased rates of morbidity and mortality compared with patients undergoing elective operations.^{7,8}

Monmouth Medical Center, Department of Surgery, Long Branch, New Jersey (all authors).

Disclosures: none.

Conflicts of Interest: The authors have no conflicts of interest directly relevant to the content of this article.

Informed consent: Dr. Shea declares that written informed consent was obtained from the patient for publication of this study/report and any accompanying images.

Address correspondence to: Brian Shea, 350 Warren St, Apt 217, Jersey City, NJ 07302. E-mail: bshea423@gmail.com

DOI: 10.4293/JLS.2019.00015

© 2019 by JLS, *Journal of the Society of Laparoendoscopic Surgeons*. Published by the Society of Laparoendoscopic Surgeons, Inc.

In the present study, we discuss 30 patients who underwent emergent repair of paraesophageal hernias and compare their outcomes with those of 199 patients who underwent elective surgery. Additionally, we use a propensity analysis in an attempt to establish emergent operation as an independent predictor of unfavorable outcome. With this information, the authors hypothesize that morbidity and mortality in patients who undergo emergent repair is higher compared with elective patients and therefore should undergo surgical evaluation when a paraesophageal hernia is identified.

METHODS

We conducted a retrospective analysis of the operations performed between December 2010 and December 2016 by 4 surgeons who perform paraesophageal hernia repairs at a 537-bed community-based teaching institute. Patients were separated into 2 groups: those who had their hernia repaired electively and those who had their hernia repaired on an emergent basis. We first identified patients who had emergent procedures during the study period. “Emergent” procedures consisted of those that were performed on patients admitted to the hospital for hernia-related complications, such as gastric outlet obstruction, gastrointestinal bleeding, volvulus and ischemia. Indications for emergent operation are listed in **Table 1**. All patients who had their hernias repaired electively composed a comparison group. A propensity analysis was then used for comparison, using 21 patients from each group. Patients undergoing a simultaneous bariatric procedure were excluded from the study. Operative factors were also recorded for both groups, which included method of hernia repair (primary repair with or without mesh, with or without fundoplication). Postoperative outcomes were also recorded, including length of stay, perioperative and 30 day complications, and readmissions.

To compare the preoperative baseline demographic and clinical parameters of emergent patients with those of

elective patients, a propensity score for each patient was created using multivariate logistic regression that included the baseline variables with significant absolute standardized differences, including age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) class, tobacco use, and comorbidities (diabetes, hypertension, chronic obstructive pulmonary disease, hyperlipidemia, coronary artery disease, and gastroesophageal reflux disease). Baseline and demographic characteristics can be found in **Table 2**.

A 1:1 greedy matching technique was used to match emergent with elective patients according to their respective propensity scores. Standardized differences were used to compare baseline characteristics in the emergent and elective cohorts to assess for distribution of baseline covariates. Baseline characteristics according to procedure timing status were also compared using Pearson’s χ^2 test for categorical variables and analysis of variance (ANOVA) for continuous variables to provide a measure of significant statistical difference, reported as *P* values before and after matching.^{9,10}

Student’s *t* test and ANOVA were then used to compare outcomes of interest between elective and emergent groups. SAS (Version 9.2, SAS Institute, Cary, NC) was used for all statistical analyses. Continuous data are presented as mean \pm standard deviation values. Categorical variables are given numbers and percentages. Operative outcomes between groups can be found in **Table 3**.

Complications were scored using the Clavien-Dindo classification system,¹¹ and examples of these complications can be found in **Table 4**. According to this institution’s postoperative protocol, patients undergoing paraesophageal hernia repair remain NPO on the day of the operation. Postoperative pain is controlled with a transversus abdominus plane (TAP) block performed with liposomal bupivacaine while in the operating room, intravenous acetaminophen every 6 hours, and intermittent intravenous narcotics as needed. Patients then receive an upper gastrointestinal series on the first postoperative day, in which patients are first tested with gastrograffin followed by thinned barium. If the test demonstrates no leak and passage of contrast, the patient is advanced to a noncarbonated clear liquid diet. As long as the patient maintains adequate hydration on liquids and pain is controlled with oral medications, the patient is stable for discharge. Any deviation from this postoperative protocol was recorded as a complication.

Patient follow-up data were then recorded, including any hospital readmissions or reoperations. The patient

Table 1.

Emergent Indications

Indication	n (%)
Volvulus and/or ischemia	14 (46.7)
Gastrointestinal bleed	5 (16.7)
Gastric outlet obstruction	6 (20)
Cardiopulmonary decompensation	4 (13.3)
Aspiration pneumonia	1 (3.3)

Table 2.
Baseline Demographic and Clinical Characteristics Before and After 1:1 Propensity Score Matching

	Before Matching			After Matching		
	Emergent (n = 30)	Elective (n = 199)	<i>P</i> value	Emergent (n = 21)	Elective (n = 21)	<i>P</i> value
Age (y)	74 ± 13	66 ± 13	.002	67 ± 13	69 ± 12	.512
Sex (male)	24 (80)	150 (75)	.574	15 (71)	17 (81)	.468
BMI (kg/m ²)	29 ± 6	28 ± 5	.349	29 ± 8	29 ± 4	.996
ASA class (n) (%)						
II	7 (23)	78 (39)	.015	6 (29)	6 (29)	.492
III	20 (67)	119 (60)		14 (67)	15 (71)	
IV	3 (10)	1 (1)		1 (5)	0 (0)	
V	0 (0)	1 (1)		0 (0)	0 (0)	
History of (n) (%)						
Diabetes	4 (13)	21 (11)	.657	3 (14)	4 (19)	.678
Hypertension	19 (63)	102 (51)	.214	13 (62)	12 (57)	.753
COPD	2 (7)	13 (7)	.978	3 (14)	1 (5)	.283
Hyperlipidemia	8 (27)	34 (17)	.225	3 (14)	4 (19)	.678
CAD	1 (3)	22 (11)	.139	1 (5)	0 (0)	.235
GERD	13 (43)	129 (65)	.026	12 (57)	13 (62)	.753
Tobacco use	6 (20)	44 (22)	.792	4 (19)	5 (24)	.706
Type of hernia (n) (%)						
I	0 (0)	30 (15)	<.001	0 (0)	5 (24)	.003
II	0 (0)	3 (2)		0 (0)	0 (0)	
III	20 (67)	140 (70)		7 (33)	13 (62)	
IV	10 (33)	26 (13)		14 (67)	3 (14)	
Use of mesh (n) (%)	30 (100)	174 (87)	.006	21 (100)	18 (86)	.036
Con. procedure (n) (%)						
Partial gastrectomy	7 (23)	13 (7)	.007	5 (24)	2 (10)	.208
Gastrostomy tube	4 (13)	2 (1)	.002	1 (5)	5 (5)	1.000

BMI, body mass index; ASA, American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease; CAD, coronary artery disease; GERD, gastroesophageal reflux disease; Con, concomitant.

record was also examined for any studies that a patient received postoperatively that imaged the hernia repair, regardless of whether the imaging study was obtained for purposes related to the repair. A radiographic recurrence was defined as the presence of the gastroesophageal junction 2 cm above the hiatus. If a radiographic recurrence was noted, the patient record was examined to determine if the patient was having symptoms related to a recurrent hernia. Patients were then noted to either have symptomatic or asymptomatic recurrences.

Operative Technique

The patient is positioned supine on the operating room table with both arms outstretched. After induction of general anesthesia, the patient is positioned in 1 of 2 ways according to surgeon preference. The patient can be positioned supine with a footboard to allow steep reverse Trendelenberg position, and the operating surgeon stands on the patient's right side with the assistant standing on the patient's left side. Alternatively, the patient can be placed in stirrups such that the patient is in chair-like

Table 3.
Operative Outcomes Before and After 1:1 Propensity Score Matching

	Before Matching			After Matching		
	Emergent (n = 30)	Elective (n = 199)	<i>P</i> value	Emergent (n = 21)	Elective (n = 21)	<i>P</i> value
Length of stay (d)	7 ± 6	3 ± 3	<.0001	67 ± 13	69 ± 12	.512
Any complication (n) (%)	14 (47)	39 (20)	<.001	8 (38)	7 (33)	.113
Comp. grade (n) (%)						
I	1 (3)	20 (10)	<.001	0 (0)	3 (14)	.113
II	6 (20)	15 (8)		5 (24)	3 (14)	
III	2 (7)	1 (1)		2 (10)	0 (0)	
IV	2 (7)	3 (2)		1 (5)	1 (5)	
V	3 (10)	0 (0)		0 (0)	0 (0)	
Recurrence (n) (%)	5 (17)	25 (13)	.959	1 (5)	4 (19)	.141
Readmission (30 d) (n) (%)	1 (3)	7 (4)	.959	1 (5)	1 (5)	1.000
Reoperation (n) (%)	0 (0)	14 (7)	.044	0 (0)	2 (10)	.091

Table 4.

Examples of Complications

Grade I	Delayed advancement of diet due to persistent nausea
Grade II	Arrhythmia requiring administration of cardiac medications, administration of supplemental oxygen for low saturation.
Grade III	Reoperation for a crural closure that was too tight, chest tube for capnothorax
Grade IV	ICU stay for ventilatory support
Grade V	Death

position when placed in steep reverse Trendelenberg, and the operating surgeon stands between the legs of the patient with the assistant standing to the patient's left. The ports are then placed in the following locations: 2 right subcostal 5-mm ports in the midclavicular and anterior axillary lines, a right paramedian 12-mm port, and 2 left subcostal 5-mm ports in the anterior axillary and midclavicular lines. The lateralmost right 5-mm port is used to place a Mediflex liver retractor to retract the left lateral segment of the liver. The operating surgeon uses the right midclavicular and paramedian ports, the angled laparoscope is placed through the left midclavicular port, and the assistant uses an instrument through the left anterior axillary port.

The procedure starts with identifying the pars flaccida of the gastrohepatic ligament over the caudate lobe of the

liver. This is divided, revealing the right diaphragmatic crus. The hernia sac is then separated from its attachments to the right crus, progressing anteriorly to the phrenoesophageal ligament, which is then incised. The gastrotocolic and gastrosplenic ligaments are then divided using an energy device, and the left diaphragmatic crus is exposed. Blunt dissection posterior to the stomach is used to create space to accommodate a Penrose drain, which is placed around the stomach to provide traction. The hernia contents are then reduced into the abdominal cavity from the posterior mediastinum with gentle traction. Adhesions between the mediastinal pleura and hernia sac are divided using a combination of blunt and sharp dissection. The vagus nerves are identified and preserved.

Once all hernia contents are reduced into the abdominal cavity, the repair is initiated. The diaphragmatic hiatus is closed using braided polyester nonabsorbable suture in an interrupted fashion. Once the crural closure is complete, a biologic mesh is placed to reinforce the repair in most cases. The mesh most commonly used is an acellular mesh derived from porcine liver. The mesh is cut and shaped to cover the crural closure and around the esophageal hiatus in a U pattern. Mesh placement is at the discretion of the surgeon. A Nissen fundoplication is then completed after division of the short gastric vessels using an energy device and is typically 2.5 cm in length. The procedure concludes with a TAP block with liposomal bupivacaine under direct visualization.

RESULTS

During the study period, 229 patients underwent paraesophageal hernia repair. Thirty of these cases were identified as emergent, and 199 are identified as elective. Elective patients having a concomitant bariatric procedure were excluded from the study. The most common emergent indication was gastric volvulus with evidence of ischemia, based on imaging or endoscopic findings. Other indications included gastric outlet obstruction, gastrointestinal bleeding, and cardiopulmonary decompensation.

Baseline patient characteristics were recorded for each group. Emergent and elective cases and their respective age, sex, and comorbidities were compared. These characteristics are outlined in **Table 2**. Patients with an emergent presentation tended to be older than the patients in the elective population (74 vs 66 y; $P = .002$) with a higher-grade hernia (100% of emergent cases grade III or greater vs 83% of elective cases) and tended to have more medical comorbidities, as reflected by a slightly higher ASA score (2.83 vs 2.63). When propensity matching was performed, there was no significant difference between groups noted. It is important to note that all patients with emergent operations had an “E” designation added to their ASA score, denoting an increased risk.

Differences between groups were analyzed for statistical significance using chi square analysis. Patients undergoing emergent operations were more likely to either have a partial gastrectomy (23% vs 7%; $P = .007$) or gastrostomy tube placement (13% vs 1%; $P = .002$). However, propensity matching demonstrated these differences to no longer be significant. Mesh repair was used in most cases but was used in significantly more patients undergoing emergent repair even after propensity matching (21 vs 18; $P < .036$).

Postoperative complications were then recorded for the emergent and elective groups. Examples of these complications can be found in **Table 3**. When comparing emergent and elective patients, emergent patients were more likely to have a longer hospital stay (6.63 vs 2.79 d; $P = .002$) and postoperative complications (44.8% vs 19.4%; $P = .002$). These complications also tended to be more severe, as emergent patients had more grade III (6.9% vs 0.5%; $P = .043$), IV (6.9% vs 1.5%; $P = .12$), and V (6.9% vs 0.5%; $P = .043$) complications. There was no statistically significant difference in readmission rates between the 2 groups (3.7% vs 3.5%; $P = .22$). It is important to note that these differences are no longer significant after propensity matching.

Recurrence data were then recorded for all groups. A hernia recurrence was classified as symptomatic or asymptomatic. Follow-up imaging after hernia repair, apart from the initial upper gastrointestinal series performed with the index operation, is not routinely ordered unless the patient with thought to be symptomatic from a possible hernia recurrence. Therefore, not all patients having imaging available to review to determine whether there is a recurrence. A total of 94 (41.3%) of patients underwent imaging, after their initial hernia repair. In total, 30 recurrences were documented. Of these 30 patients, 10 were noted to be symptomatic, and 20 were diagnosed incidentally in asymptomatic patients. Only 1 of these recurrences was noted on a postoperative upper gastrointestinal series, and that patient underwent prompt reoperation. Of the remaining 199 patients who have no documented recurrence, only 32.5% underwent imaging that visualized the repair and have no documented recurrence. The remaining patients are presumed to have no symptoms to warrant further investigation with imaging.

DISCUSSION

This study examines patients who undergo emergency repair of paraesophageal hernias and compares their perioperative and long-term outcomes with both an age- and a comorbidity-matched cohort, as well as all patients who undergo the procedure electively. Patients who underwent surgery electively were patients who most often underwent endoscopy for evaluation of gastroesophageal reflux disease and were found to have a hiatus hernia. Patients were then sent for surgical evaluation, and their diagnosis of a paraesophageal hernia was confirmed on an upper gastrointestinal series. Other patients had long-standing vague complaints of retrosternal chest pressure or dysphagia, and still others had undergone several previous hospital admissions for aspiration pneumonia. Patients previously admitted typically received a chest computed tomography (CT) scan, which identified a large paraesophageal hernia.

Patients who had their paraesophageal hernias repaired on an emergency basis presented in a different fashion compared with elective patients. Patients with an emergent complaint would often have a history of vague chest pain and occasional dysphagia but would present to the emergency department with varying levels of chest pain, shortness of breath, and hemodynamic instability. Chest CT is often obtained in the emergency department, on which the most common findings or gastric outlet obstruction and organoaxial volvulus. In our study, 5 patients had

undergone endoscopy for gastrointestinal bleeding and identified Cameron's ulcers necessitating repair.

When patients have paraesophageal hernias fixed on an emergency basis, the repair proceeds in a similar fashion to those patients who have hernias repaired electively. In patients who are initially hemodynamically unstable, reduction of the hernia often improves hemodynamics. However, when the hernia is reduced, emergent patients often have additional comorbidities that need to be addressed. For example, our surgeons have encountered very large atonic stomachs, partial necrosis of the stomach, and large defects in the hiatus that are difficult to close without tension.

Often, the stomach is large and atonic from years of chronic incarceration and low-grade gastric outlet obstruction that has acutely worsened. In cases of volvulus, a portion of the stomach has usually become necrotic. In both instances, a partial gastrectomy is performed. Patients with large, atonic stomachs benefit from partial gastrectomies because the result of the procedure increases intragastric pressure and promotes emptying. Patients with large paraesophageal hernias can be at risk for delayed gastric emptying following repair as well. A recent study by Tog et al. identified 102 patients who underwent large paraesophageal hernia repair, of which 18.6% suffered delayed gastric emptying following their procedure. Risk factors for developing this complication based on their multivariate analysis included division of short gastric vessels and revisional surgery.¹²

Decreasing gastric volume as a measure to promote gastric emptying is also supported by previous studies in morbidly obese patients undergoing sleeve gastrectomy. In a study by Shah et al., 67 patients were evaluated for gastric emptying half-time. It was found that patients who underwent sleeve gastrectomy had a significantly shorter gastric emptying half-time compared with lean controls.¹³ Another study performed by Braghetto et al. used scintigraphy to measure emptying of solids and liquids in 20 patients who underwent sleeve gastrectomy compared with 18 controls. They found that emptying of solids and liquids was faster in the patients who underwent sleeve gastrectomy.¹⁴ Although increasing intragastric pressure to promote emptying, these patients may have worsening reflux symptoms or be at increased risk for persistent reflux symptoms.¹⁵ A large, atonic stomach was more commonly found in our emergent patients, but there were patients in the elective population with large para-

esophageal hernias in which a partial gastrectomy was used.

After addressing the stomach and performing the appropriate fundoplication, attention is turned to the crural closure. The technique used by the surgeons in the present study is posterior reapproximation using interrupted permanent suture. Anterior stitches are rarely used. To augment the closure, a biologic mesh is used. This practice of placing a biologic mesh is supported by previous studies, which demonstrate decreased early recurrence without added morbidity or complications,^{16,17} although this benefit appears to decrease over time.¹⁸ At times during the very large paraesophageal hernias, more commonly in emergent patients, the crural closure could not be reapproximated to the extent to prevent a recurrence without undue tension. A biologic mesh is often used in these patients, but a gastrostomy tube is also placed to tether the stomach in the abdominal cavity. This procedure has been mentioned in previous reports and is used as a technique of last resort to maintain an intra-abdominal stomach.¹⁹ When the stomach has healed to the abdominal wall (typically 3 mo after the operation), the gastrostomy tube is removed. The authors of this study do not advocate the use of synthetic mesh in paraesophageal hernia repair, as previous reports have demonstrated erosion of the mesh into nearby structures.²⁰ Additionally, synthetic mesh used in a case in which devitalized tissue is present may serve as a nidus for future infection.

Although all patients in this study were able to undergo successful hernia repair at the time of their presentation, patients do not always present to centers where experienced foregut surgeons are present. While repair of the hernia is optimal if the patient's condition permits, alternative strategies may need to be used in unstable patients. Principles of management should include relief of the obstruction in cases of volvulus and debridement of devitalized tissue if present. Techniques for purposes of relief of obstruction have been described to temporize and stabilize patients with gastric volvulus. A case report of endoscopic detorsion details an elderly gentleman that presented with multi-organ system failure and gastric volvulus, which was treated with endoscopic detorsion and subsequent hernia repair 1 week later when the patient's clinical condition improved.²¹ An additional approach can include simple laparoscopic detorsion and gastropexy, which can serve as a temporizing measure and bridge to definitive repair.²² There is currently no data to suggest that conversion from an emergent to elective procedure improves outcomes. The data from this study, however,

suggest that there may not be additional benefit of converting an emergent procedure to an elective one in experienced hands, as propensity analysis demonstrates similar outcomes between emergent and elective patients.

Recent literature has suggested that watchful waiting may be an appropriate strategy for some patients with giant paraesophageal hernias. Jung et al.²³ used a microsimulation decision analysis model and used quality-adjusted life months to determine the superior strategy for the approach to giant paraesophageal hernias. The authors from that study concluded that patients with asymptomatic paraesophageal hernias are more likely to achieve health benefit with a watchful waiting strategy compared with elective paraesophageal hernia repair.

The results of this study are supported by the results of previous studies that suggest patients undergo emergent repair of paraesophageal hernias have worse outcomes when compared with patients who undergo emergent operations. A study performed by Tam et al. used propensity-adjusted analysis to determine if an emergent operation was an independent predictor of poor outcome. The authors analyzed 980 patients at a single institution, and found that even when accounting for baseline patient characteristics, emergent repair was associated with worse outcomes when compared with elective repair.²⁴ Similarly, a study by Jassim et al. surveyed a nationwide inpatient sample, and found that emergent repair was associated with higher rates of morbidity and mortality when compared with elective patients.⁷

In the present study, though, there was an increased risk of complications in older patients as evidenced by the propensity analysis. This information supports the notion that this operation can be safely carried out in the elderly population to mitigate the risk of an emergent presentation, and to alleviate symptoms. Research conducted by Spaniolas et al. examined the NSQIP database for all patients undergoing laparoscopic paraesophageal hernia repair in a 2-y period and determined that elective repair in patients over 80 y of age was not associated with significant differences in mortality or major morbidity when compared with younger patients.²⁵ El Lakis et al. had similar findings in their study, which examined patients who underwent paraesophageal hernia repair over a 16-y period at a single institution. They found that paraesophageal hernia repair is safe in physiologically stable patients regardless of age and that although complications were slightly increased in their oldest patients

(>80 years old), complication severity and mortality rates were similar to younger patients.²⁶

It should be noted in our study that the statistically significant differences in complications between elective and emergent cases was no longer significant when comparing emergent and propensity-matched cohorts. This could indicate that the complications experienced by the emergent group may be owed to their comorbidities rather than the emergent nature of the operation. Augustin et al. used the NSQIP database to examine whether an emergent operation was independently associated with worse outcomes. On initial analysis, emergent patients had a longer length of stay and a mortality rate 10 times that of elective patients. However, on adjusted analysis, they found that the emergent surgery was no longer independently associated with increased mortality.²⁷ The results of the present study reinforce the results of this study; patients undergoing emergent operations tended to be older with more medical comorbid conditions, and significant differences between emergent and elective patients were no longer present when propensity matched.

In terms of recurrence, data for this study were limited, as not all patients had radiographic studies performed after their operation. Routine imaging is not typically performed on all patients. Those who are symptomatic following their operation undergo imaging to identify the presence or absence of recurrence. With imaging obtained for a reason unrelated to the paraesophageal hernia, no significant difference in recurrence rate was noted between elective and emergent patients. Patients who were symptomatic ultimately underwent reoperation. The present study had a reoperation rate of 5% in elective patients, which is consistent with previous studies.²⁸

It is important to note that data regarding previous evaluations for paraesophageal hernias on patients who presented on an emergency basis are lacking. The authors could not find evidence of previous surgical evaluation for a paraesophageal hernia in the medical record for all patients and therefore cannot comment on whether a patient in the emergent population was evaluated for a paraesophageal hernia when younger and potentially healthier. Information regarding previous evaluations before a subsequent emergent presentation may be helpful in the decision-making process in patients with identified paraesophageal hernias.

CONCLUSION

This study demonstrates the performance of an emergent paraesophageal hernia repair is associated with

worse outcomes compared with an elective operation. However, propensity matching demonstrated outcomes to not be statistically significant when comparing emergent and elective patients. This indicates that older patients with more comorbidities are at increased risk for complications, regardless of whether they are having an emergency operation. And in experienced hands, complication rates of emergency operations appear to approach those of elective patients when matched for baseline characteristics. The authors therefore recommend that all patients with paraesophageal hernias be evaluated for repair when a hernia is identified, as advanced age increases the likelihood of emergent presentation and complications. Preferably, patients presenting with emergent indications for repair should be evaluated if possible at high-volume centers, where complication rates of emergency operations appear to approach those of elective repair.

References:

1. Kahrilas PJ, Kim HC, Pandolfino JE. Approaches to the diagnosis and grading of hiatal hernia. *Best Pract Res Clin Gastroenterol.* 2008;22:601–616.
2. Hyun JJ, Bak YT. Clinical significance of hiatal hernia. *Gut Liver.* 2011;5:273–277.
3. Luketich JD, Nason KS, Christine NA, Pennathur A, et al. Outcomes after a decade of laparoscopic giant paraesophageal hernia repair. *J Thorac Cardiovasc Surg.* 2010;139:395–404.
4. Matar SG, Bowers SP, Galloway KD, Hunter JG, et al. Long-term outcome of laparoscopic paraesophageal hernia repair. *Surg Endosc.* 2002;16:745–749.
5. Carrott PW, Hong J, Kuppusamy M, Koehler RP, et al. Clinical ramifications of giant paraesophageal hernias are underappreciated: making the case for routine surgical repair. *Ann Thorac Surg.* 2012;94:421–428.
6. Silhvo EI, Salo JA, Rasanen JV, Rantanen TK. Fatal complications of adult paraesophageal hernia: a population based study. *J Thorac Cardiovasc Surg.* 2009;137:419–424.
7. Jassim H, Seligman JT, Frelich M, Goldblatt M, et al. A population-based analysis of emergent versus elective paraesophageal hernia repair using the Nationwide Inpatient Sample. *Surg Endosc.* 2014;28:3473–3478.
8. Polomsky M, Jones CE, Sepesi B, O'Connor M, et al. Should elective repair of intrathoracic stomach be encouraged? *J Gastrointest Surg.* 2010;14:203–210.
9. Bergstralh E, Kosanke J. *Computerized matching of cases to controls. Technical report serial no. 56.* Rochester, MN: Mayo Clinic Section of Biostatistics: 1995.
10. Austin PC, Mamdani MM, Stukel TA, et al. The use of the propensity score for estimating treatment effects: administrative versus clinical data. *Stat Med.* 2005;24:1563–1578.
11. Dindo D, Demartines N, Clavien PA. Classification of surgical complications. *Ann Surg.* 2004;240:205–213.
12. Tog C, Liu DS, Lim HK, Stiven P, et al. Risk factors for delayed gastric emptying following laparoscopic repair of very large hiatus hernias. *BJS Open.* 2017;1:75–83.
13. Shah S, Shah P, Todkar J, Gagner M, et al. Prospective controlled study of effect of laparoscopic sleeve gastrectomy on small bowel transit time and gastric emptying half-time in morbidly obese patients with type 2 diabetes mellitus. *Surg Obes Rel Dis.* 2010;6:152–157.
14. Braghetto I, Davanzo C, Korn O, Csendes A, et al. Scintigraphic evaluation of gastric emptying in obese patients submitted to sleeve gastrectomy compared with normal subjects. *Obes Surg.* 2009;19:1515.
15. Carter PR, LeBlanc KA, Hausmann MG, Kleinpeter KP, et al. Association between gastroesophageal reflux disease and sleeve gastrectomy. *Surg Obes Rel Dis.* 2011;7:569–572.
16. Oelschlager BK, Pellegrini CA, Hunter JG, Soper N, et al. Biologic prosthesis reduces recurrence after laparoscopic paraesophageal hernia repair: a multicenter, prospective, randomized trial. *Ann Surg.* 2006;244:481–490.
17. Müller-Stich BP, Kenngott HP, Gondan M, Stock C, et al. Use of mesh in laparoscopic paraesophageal hernia repair: a meta-analysis and risk-benefit analysis. *PLoS ONE.* 2015;10:e0139547.
18. Oelschlager BK, Pellegrini CA, Hunter JG, Brunt ML, et al. Biologic prosthesis to prevent recurrence after laparoscopic paraesophageal hernia repair: long-term follow-up from a multicenter, prospective, randomized trial. *J Am Coll Surg.* 2011;213:461–468.
19. Pierre AF, Luketich JD, Fernando HC, Christie NA, et al. Results of laparoscopic repair of giant paraesophageal hernias: 200 consecutive patients. *Ann Thorac Surg.* 2002;74:1909–1916.
20. Tatum RP, Sherene S, Oelschlager BK, et al. Complications of PTFE mesh at the diaphragmatic hiatus. *J Gastrointest Surg.* 2008;12:953–957.
21. Kulkarni K, Nagler J. Emergency endoscopic reduction of a gastric volvulus. *Endoscopy.* 2007;39:E173.
22. Palanivelu C, Rangarajan M, Shetty AR, et al. Laparoscopic suture gastropexy for gastric volvulus: a report of 14 cases. *Surg Endosc.* 2007;21:863–866.
23. Jung JJ, Naimark DM, Behman R, Grantcharov TP. Approach to asymptomatic paraesophageal hernia: watchful waiting or elective laparoscopic hernia repair? *Surg Endosc.* 2017.

24. Tam V, Luketich JD, Winger DG, Sarkaria IS, et al. Non-elective paraesophageal hernia portends worse outcomes in comparable patients: a propensity-adjusted analysis. *J Gastrointest Surg.* 2017;21:137–145.
25. Augustin T, Scheider E, Aladeen D, Kroh M, et al. Emergent surgery does not independently predict 30-day mortality after paraesophageal hernia repair: results from the ACS NSQIP database. *J Gastrointest Surg.* 2015;19:2097–2104.
26. Spaniolas K, Laycock WS, Adrales GL, Trus TL. Laparoscopic paraesophageal hernia repair: advanced age is associated with minor but not major morbidity or mortality. *J Am Coll Surg.* 2014;218:1187–1192.
27. El Lakis MA, Kaplan SJ, Hubka M, Mohiuddin K, et al. The importance of age on short-term outcomes associated with repair of giant paraesophageal hernias. *Ann Thorac Surg.* 2017; 103:1700–1709.
28. Andujar JJ, Papasavas PK, Birdas T, Robke J, et al. Laparoscopic repair of large paraesophageal hernia is associated with a low incidence of recurrence and reoperation. *Surg Endosc.* 2004; 18:444–447.