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Resolution and recurrence of anemia following repair of paraesophageal hernias

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Abstract

Background Iron deficiency anemia is a common paraesophageal hernia (PEH) symptom and may improve after repair. When present, anemia has also been proposed to be associated with an increase in length of hospital stay, morbidity, and mortality after PEH repair. This study aimed to determine anemia-related factors in patients with PEH, the rate of anemia resolution after PEH repair, and the risk of anemia recurrence when repair failed.

Methods We included patients who received a PEH repair between June 2019 and June 2020 and had 24 months of post-operative follow-up. Demographics and comorbidities were recorded. Anemia was defined as pre-operative hemoglobin values < 12.0 for females and < 13.0 for males, or if patients were receiving iron supplementation. Anemia resolution was determined at 6 months post-op. Length of hospital stay, morbidity, and mortality was recorded. Logistic regression and ANCOVA were used for binary and continuous outcomes respectively.

Results Of 394 patients who underwent PEH repair during the study period, 101 (25.6%) had anemia before surgery. Patients with pre-operative anemia had larger hernia sizes (6.55 cm ± 2.77 vs. 4.34 cm ± 2.50; $p < 0.001$). Of 68 patients with available data by 6 months after surgery, anemia resolved in 36 (52.9%). Hernia recurred in 6 patients (16.7%), 4 of whom also had anemia recurrence (66.7%). Preoperative anemia was associated with a higher length of hospital stay (3.31 days ± 0.54 vs 2.33 days ± 0.19 $p = 0.046$) and an increased risk of post-operative all-cause mortality (OR 2.7 CI 1.08–6.57 $p = 0.05$). Fundoplication type ($p = 0.166$), gastropexy, or mesh was not associated with an increased likelihood of resolution (OR 0.855 CI 0.326–2.243; $p = 0.05$) (OR 0.440 CI 0.150–1.287; $p = 0.05$).

Conclusions Anemia occurs in 1 out of 4 patients with PEH and is more frequent in patients with larger hernias. Anemia is associated with a longer hospital stay and all-cause mortality after surgery. Anemia recurrence coincided with hernia recurrence in roughly two-thirds of patients.

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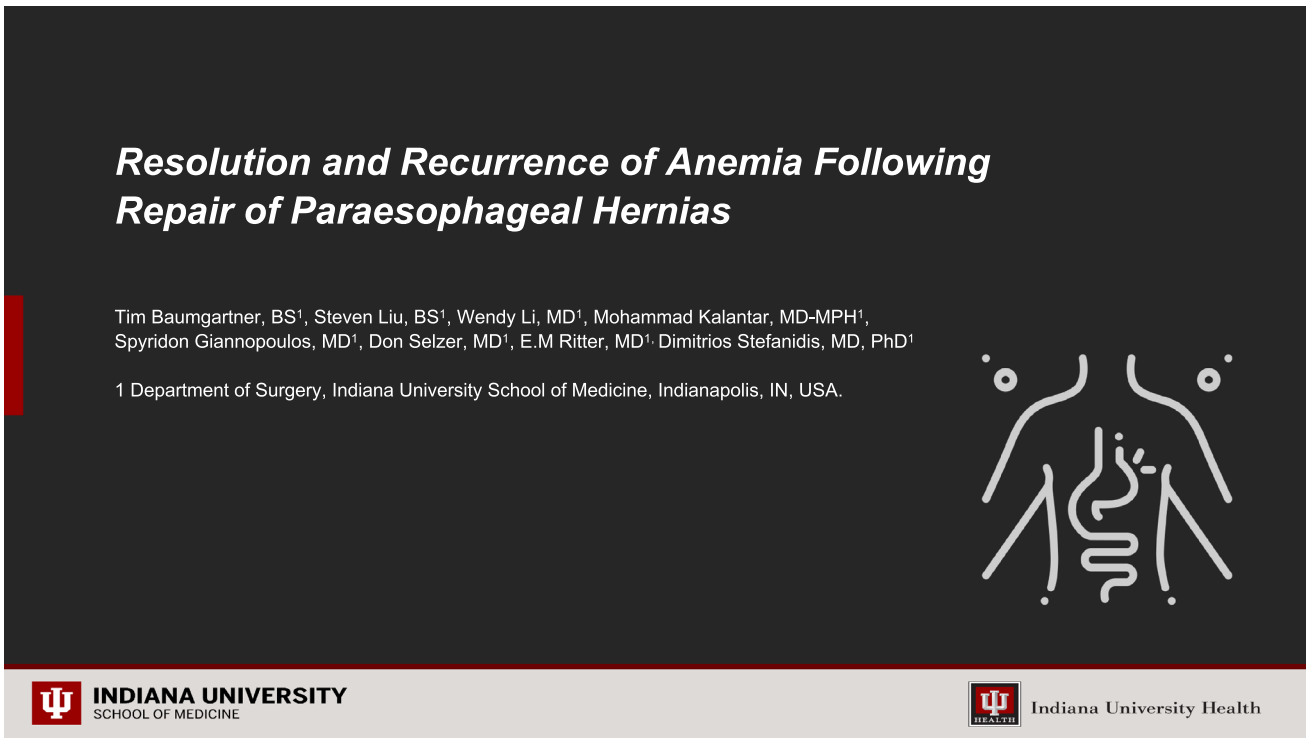
Graphical abstract



Keywords Paraesophageal hernia · Anemia · Repair · Surgical techniques · Gastropexy · Fundoplication · Perioperative outcomes

Paraesophageal hernia (PEH) is a relatively common condition with a prevalence ranging from 0.8 to 2.9% [1]. Large PEHs have been associated with iron deficiency anemia (IDA) reaching up to 42%, with a higher incidence among females and older adults [2–4]. Up to half of these patients experience significant symptoms related to anemia [5]. It is thought that one consequence of PEHs is erosions on the mucosa of the herniated tissue leading to chronic gastrointestinal hemorrhage and subsequently to IDA.

Linear ulcerations, called Cameron lesions (CL), are diagnosed with EGD, and found in 3–5% of patients with PEH. The presence of CL seems to be positively associated with hernia size, occurring in 10–20% of PEH larger than 5 cm. Although the exact pathology behind this phenomenon is unknown, it is hypothesized that mechanical traction forces at the hiatus during respiration and the damage of the mucosal surface from gastric acid may play a role in IDA development. Microscopic lesions in tissue with smaller hernia defects are also suspected causes of chronic anemia when other sources are ruled out [6].

Although nonsurgical treatment may improve IDA in PEH patients, there is strong evidence that surgical correction dramatically reduces the need for PPI, sucralfate, and iron supplements [1, 7]. This favorable outcome has been demonstrated to be important in patients with and without prominent esophageal lesions on endoscopy [4]. In fact, paraesophageal hernia repair (PEHR) may lead to the resolution of CL and return of hemoglobin levels to normal. The effect of PEH recurrence on the IDA prevalence in this patient population is, however, not very well established by the available data. Therefore, this study aimed to determine the anemia resolution rate following PEHR, technical parameters associated with an increased likelihood of anemia resolution, and the risk of anemia recurrence in the event of recurrent PEH.

Methods

We performed a retrospective review of a prospectively maintained database at a single academic institution of patients who underwent PEHR between 2019 and 2020. Institutional Review Board approval and written consent were not needed for the completion of this project (Figs. 1, 2). We identified adult patients with evidence of PEH (types II, III, IV) on preoperative imaging who subsequently

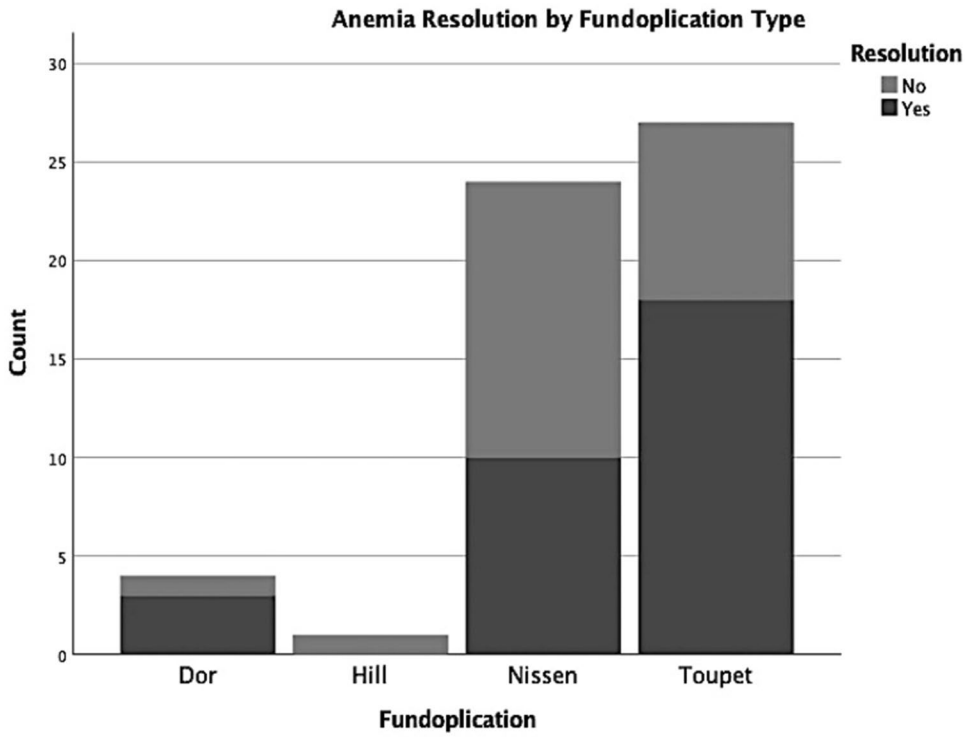


Fig. 1 Relative frequency of anemia resolution shown among patients receiving fundoplication in addition to primary PEHR. Data not significantly different between groups, and use of fundoplication did not significantly improve rate of anemia resolution at p = 0.166

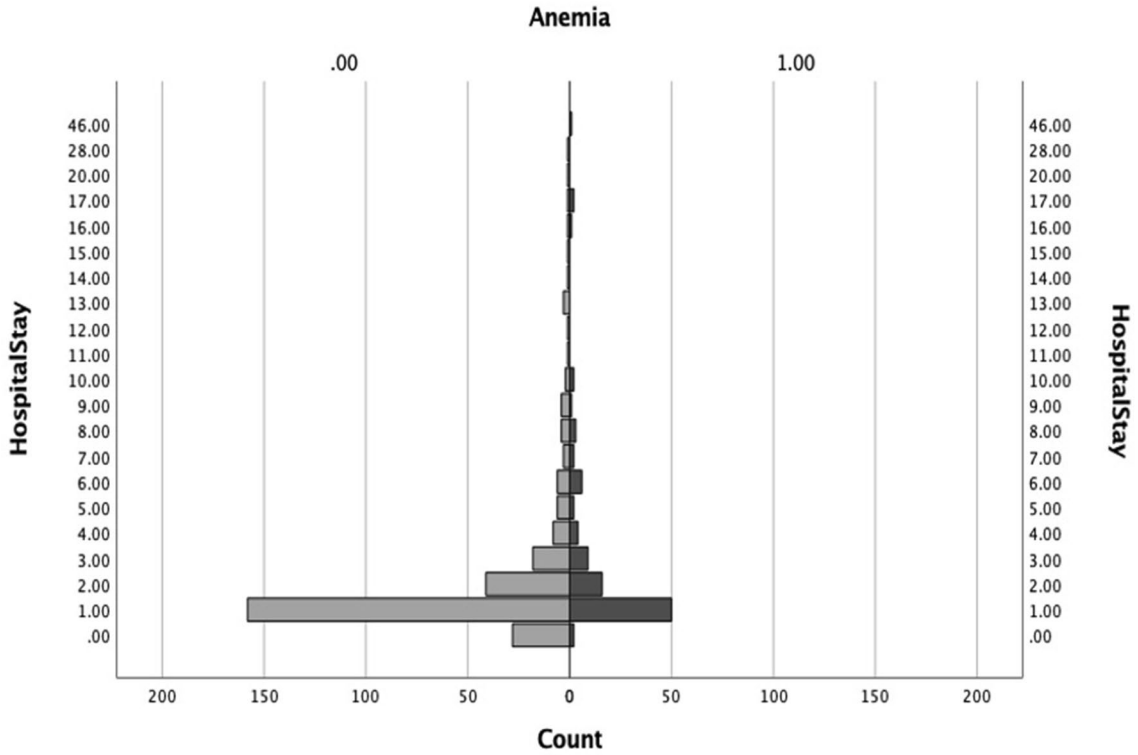


Fig. 2 Length of hospital stay (days) compared between patients with/without preoperative anemia before surgery. Anemic patients had significantly longer hospital stays p = 0.046

received laparoscopic or robotic surgical repair. Patients with a previous PEHR or concurrent procedures during the PEHR were excluded.

The presence of PEH was diagnosed preoperatively using barium swallow studies, upper endoscopy, or CT scan. Patient demographics, medical history, pre-operative and post-operative lab results, technical characteristics of the procedure, and imaging (hernia size and type) were recorded. Specifically, patient baseline characteristics consisted of age, sex, ASA score, body mass index (BMI), smoking status, and medical comorbidities. The procedural approach and other intraoperative technical characteristics, such as the creation of a fundoplication or gastropexy in addition to PEHR, the use of mesh, and the conversion rate to open, were captured. Perioperative outcomes were recorded, including the length of hospital stay and all-cause mortality. A control group was formed from all patients without pre-operative anemia. Our data suggests an average post-operative time to hernia recurrence is approximately 15 months with most recurrences occurring within 2 years after surgery. A paper by Jones et al. showed that more than half of recurrences found on follow-up imaging occurred by 2 years [8]. Therefore, patient follow-up for this study extended up to 24 months following the operation to determine if hernia or anemia recurrence had occurred.

Further, anemia was defined as hemoglobin values of < 12.0 g/dL for females and < 13.0 g/dL for males or if patients were actively receiving iron supplementation for a known IDA diagnosis. Patients with an identifiable source of anemia unrelated to the hernia were excluded. In contrast, anemia resolution was defined as the return to normal hemoglobin levels or cessation of supplementation by 6 months post-operatively. The primary outcome of the study was anemia resolution at 6 months. Secondary outcomes consisted of the effects of intraoperative techniques on 6-month anemia resolution, anemia recurrence with hernia recurrence, and impact of anemia on perioperative morbidity and mortality.

Binary variables were presented as absolute or relative frequencies and compared using Chi-square and Fisher's exact tests as appropriate. All continuous variables were presented as means ± standard deviations and compared with the independent sample T tests. Linear regression models (multivariate, univariate) and Kruskal–Wallis (non-parametric ANOVA) test were used to identify the association between gastropexy, fundoplication, and mesh and anemia resolution; preoperative anemia and length of hospital stay and all-cause mortality; and preoperative anemia risk and size of hernia. For all tests, $p < 0.05$ was considered significant. All analyses were performed using IBM SPSS Statistics vs 28.0 (IBM Corp., Armonk, NY, USA).

Table 1 Data are expressed as *n* (%) unless indicated as mean ± standard deviation

	Preoperative anemia *n* (%)	Control *n* (%)	p value
Patients (n)	101 (25.6%)	293 (74.4%)	
Female	70 (69.3%)	224 (77.2%)	0.155
Age (years)	64.62 ± 11.96	61.48 ± 13.29	0.037
BMI (kg/m^2)	31.13 ± 7.68	31.19 ± 6.15	0.940
ASA	2.76 ± 0.53	2.65 ± 0.55	0.073
Smoker	5 (4.9%)	23 (7.9%)	0.328
DM	19 (18.8%)	38 (13.1%)	0.150
CAD	13 (12.9%)	27 (9.3%)	0.570
COPD	16 (15.8%)	30 (10.3%)	0.131
OSA	9 (8.9%)	35 (12.1%)	0.404
GERD	89 (88.1%)	254 (87.6%)	0.777
HTN	50 (49.5%)	131 (45.2%)	0.404
Lap/Rob	92 (91.1%)	273 (93.2%)	0.509

p value was calculated using Independent Samples T test for continuous and Fischer's Exact Test for binary variables

BMI body mass index, *DM* diabetes mellitus, *CAD* coronary artery disease, *COPD* chronic obstructive pulmonary disease, *OSA* obstructive sleep apnea, *GERD* gastroesophageal reflux disease, *HTN* hypertension

Table 2 Data are expressed as *n* (%)

	Anemia anemia	No Anemia
Conversion to open	0 (0%)	1 (0.6%)
Gastropexy	35 (44%)	46 (23%)
Mesh	26 (33%)	37 (18%)
Fundoplication	64 (81%)	167 (82%)

Results

Of 394 patients who underwent PEH repair during the study period, 101 (25.6%) had anemia before surgery. Patient demographics are summarized in Tables 1, 2. Use of diagnostic imaging prior to surgery is summarized among the groups in Table 3, with some of them having completed multiple studies.

There was no significance difference in hernia size between pre-operative studies, but patients with pre-operative anemia had larger hernia sizes (6.55 cm ± 2.77 vs. 4.34 cm ± 2.50; $p < 0.001$). Patients with types 3 and 4 PEH were more likely to have anemia before surgery (OR 8.59, CI 3.51–21.02; $p = 0.05$). Roughly ¼ of all patients had documented follow-up visits after the 6-month post-operative period for additional work-up or management of symptoms. Of 68 patients with available data by 6 months after surgery,

Table 3 Data are expressed as *n* (%) unless indicated as mean

	n (%)	Avg hernia size (cm)
CT	103 (26%)	5.30
Barium	61 (15%)	6
Endoscopy	60 (15%)	5.26
Upper GI	57 (14%)	*

anemia resolved in 36 (52.9%). Hernia recurred in 6 patients (16.7%), 4 of whom also had anemia recurrence (66.7%).

After controlling for age, sex, and comorbidities, preoperative anemia was associated with a higher length of hospital stay (3.31 days ± 0.54 vs 2.33 days ± 0.19 p = 0.046) and an increased risk of post-operative all-cause mortality (OR 2.7 CI 1.08–6.57 p = 0.05). There was no significant difference in anemia resolution with concurrent fundoplication (p = 0.166), gastropexy (OR 0.855 CI 0.326–2.243; p = 0.05) or use of mesh (OR 0.440 CI 0.150–1.287; p = 0.05) during the hernia repair.

Discussion

This study aimed to investigate the effect of PEHR on IDA resolution and whether PEH recurrence was related to anemia recurrence. We found the rate of anemia resolution after PEH repair to be roughly 33%, and not related to surgical technique nor additional intraoperative procedures (fundoplication, gastropexy, mesh placement). We found that anemia recurrence coincided with hernia recurrence in every 2 out of 3 patients.

Although previous studies have examined the subject of PEH repair and anemia resolution (with findings to support a strong relationship) this study is unique in that it examined the incidence of anemia in patients with PEH recurrence. Hayden and Jamieson discussed this subject in their 2005 paper, but the study was limited by sample size (n = 11) and none of the patients had anemia recurrence by 24 months [9].

Cheverie et al. showed that PEH repair can benefit patients with preoperative anemia with or without Cameron lesions. Half of patients with Cameron lesions found on preoperative endoscopy had anemia resolution after PEH repair, and greater than 70% of patients without identifiable lesions had significant resolution of anemia [4]. Conversely, a paper from Haurani et al. suggests that resolution is more likely in anemic patients with identifiable lesions (88% vs 50%). Though we did not focus on preoperative endoscopic findings in this study, we found that 52.9% of all patients with preoperative anemia had resolution by 6 months after surgery which is in line with these prior studies.

Our findings did not support the use of fundoplication in anemic patients to increase the chance of resolution. Verhoeff et al. showed that surgery for anemic patients with PEH is superior to medical management, and that most patients with anemia resolution had received a fundoplication [10]. It is not yet clear that fundoplication has a positive impact on anemia resolution, but if it does it may be related to reflux control (lower risk of erosive esophagitis that may contribute to anemia). Ruhl et al. found that patients with larger hiatal hernias were more likely to require hospitalization and treatment for IDA than patients with esophagitis alone [11]. While there is ample evidence that incorporating fundoplication into a PEHR significantly improves reflux related symptoms in patients, it does not reduce the risk of hernia recurrence [12, 13]. In studying the use of gastropexy during PEHR, Allman et al. found that it reduced risk of recurrence and importantly the rate of PPI use after surgery, however they did not assess the impact on anemia [14]. Though mesh use is recommended for larger hernias, which are more likely associated with anemia, we are not aware of prior studies that have directly assessed the effect of mesh use on anemia resolution.

There is some evidence suggesting patients with PEH and anemia pre-operatively have worse outcomes post-operatively. Guillame et al. showed that anemic patients have a 2.6 increased risk of complications and were more likely to be admitted to the ICU following PEHR [15]. They argued for the importance of managing anemia prior to operation to reduce these risks. Clark et al. found preoperative anemia to be associated with longer hospital stay, and increased morbidity and mortality [16]. Our results mirror these findings and suggest that anemic patients may experience longer admissions and an increased risk of post-operative all-cause mortality. Importantly, some of our anemic patients were receiving treatment (supplementation) prior to their operations. This could explain minor differences in findings and support an argument for pre-operative management of anemia in patients.

Our study is not without limitations. We did not determine rates of esophageal lesions in our patient population, nor did we explore other causes for IDA. Our high anemia resolution rate suggests, however, that IDA was related to the PEH in many of the patients. Additionally, we included only symptomatic PEH recurrences in our analysis as we did not formally assess every included patient for a hernia recurrence. As such, patients may have had hernia or anemia recurrence that went undiagnosed. Finally, the results from our high-volume foregut center may not be broadly applicable to all surgeons or surgical centers.

In conclusion, we found that 1 out of 4 patients with PEH also had IDA. Anemia is more frequently found in patients

with larger hernias. Preoperative anemia was associated with a longer hospital stay after PEH repair and a significant effect on all-cause mortality during the 24-month follow-up period. Fundoplication, gastropexy, and mesh use did not influence rate of anemia resolution. Interestingly, 2 out of every 3 patients with hernia recurrence also had anemia recurrence further supporting the close relationship of these two clinical entities.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00464-023-10302-8.

Author contributions The authors confirm contribution to the paper as follows: DS—Study conception and design; WL, TB, SL—Data collection; TB, SL, DS—Analysis and interpretation of results; TB, SG, DS—Draft preparation; TB, SG, MK, DS—Critical content revision.

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Declarations

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