



Paraesophageal hernia recurrence following repair: making the case for reoperative surgery in a propensity-matched cohort

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Abstract

Background Paraesophageal hernia repairs (PEHRs) have high rates of radiographic recurrence, with some patients requiring repeat operation. This study characterizes patients who underwent PEHR to identify the factors associated with postoperative symptom improvement and radiographic recurrence. We furthermore use propensity score matching to compare patients undergoing initial and reoperative PEHR to identify the factors predictive of recurrence or need for reoperation.

Methods After IRB approval, patients who underwent PEHR at a tertiary care center between January 2018 and December 2022 were identified. Patient characteristics, preoperative imaging, operative findings, and postoperative outcomes were recorded. A computational generalization of inverse propensity score weight was then used to construct populations of initial and redo PEHR patients with similar covariate distributions.

Results A total of 244 patients underwent PEHR (78.7% female, mean age 65.4 ± 12.3 years). Most repairs were performed with crural closure (81.4%) and fundoplication (71.7%) with 14.2% utilizing mesh. Postoperatively, 76.5% of patients had subjective symptom improvement and of 157 patients with postoperative imaging, 52.9% had evidence of radiographic recurrence at a mean follow-up of 10.4 ± 13.6 months. Only 4.9% of patients required a redo operation. Hernia type, crural closure, fundoplication, and mesh usage were not predictors of radiographic recurrence or symptom improvement ($P > 0.05$). Propensity weight score analysis of 50 redo PEHRs compared to a matched cohort of 194 initial operations revealed lower rates of postoperative symptom improvement ($P < 0.05$) but no differences in need for revision, complication rates, ED visits, or readmissions.

Conclusions Most PEHR patients have symptomatic improvement with minimal complications and reoperations despite frequent radiographic recurrence. Hernia type, crural closure, fundoplication, and mesh usage were not significantly associated with recurrence or symptom improvement. Compared to initial PEHR, reoperative PEHRs had lower rates of symptom improvement but similar rates of recurrence, complications, and need for reoperation.

Keywords Paraesophageal hernia · Hiatal hernia · Hernia recurrence · Reoperative surgery

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Type II-IV hiatal hernias, commonly called paraesophageal hernias (PEHs), are estimated to comprise 5–15% of all diagnosed hiatal hernias and can be associated with decreased quality of life and potentially life-threatening complications [1]. Paraesophageal hernia repair (PEHR) is indicated for symptomatic cases of PEH and is generally associated with low rates of morbidity and mortality [1]. However, radiographic recurrence following PEHR remains a major concern, with one long-term multicenter prospective study documenting recurrence rates as high as 50% in 2 years [2]. While there exists considerable variation in intraoperative technique, limited evidence is available as to the relationship between factors including hernia type, fundoplication usage

and type, mesh usage, crural closure, and clinically important outcomes such as radiographic recurrence, resolution of symptoms, rate of complications, and need for revisional surgery [3].

Recent meta-analyses and systematic reviews on variations in PEHR technique have yielded mixed evidence on several points of controversy, with individual surgeon preference guiding intraoperative decision-making. The most updated guidelines issued by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) provide a weak recommendation in favor of fundoplication during paraesophageal hernia repair as a means of preempting postoperative GERD and preventing recurrence but acknowledge that no high-level evidence has been produced to support routine fundoplication [4]. A recent systematic review on the necessity of fundoplication during PEHR accordingly concludes that evidence remains lacking as to whether fundoplication is effective in reducing recurrence rates and the possible superiority of any particular fundoplication technique [5]. With respect to mesh placement, a recent meta-analysis of randomized controlled trials comparing PEHR with mesh repair to suture repair alone concludes that mesh usage is not associated with reduced long-term recurrence, reoperation rates, or increased intraoperative complications [6, 7].

Despite high rates of reported hernia recurrence, as few as 6% of patients undergo subsequent reoperative PEHR to address unresolved symptoms [8]. In retrospective studies, reoperative PEHR has been found to be associated with low morbidity and mortality, similar to initial PEHR, though few direct comparisons of initial and reoperative PEHR outcomes have been reported in the literature [8, 9]. There are no defined patient or operative factors that currently serve as predictors for PEH recurrence. A more robust understanding of preoperative factors that put patients at risk for symptomatic hernia recurrence requiring reoperation would be helpful with preoperative patient counseling and developing protocols for the optimal management of PEH patients. The primary goal of our study was to determine if there are predictive patient or operative characteristics associated with postoperative symptom improvement. We furthermore utilize propensity matching to compare initial and reoperative PEHR patients to identify the factors associated with failure to improve, risk for radiographic recurrence, and need for subsequent reoperations.

Methods

Study design

Following approval by the University of Pennsylvania Institutional Review Board, a retrospective review was performed to assess patient factors, perioperative characteristics, and

outcomes of paraesophageal hernia repairs (PEHR) conducted between January 2018 and December 2022 at a tertiary care center. The electronic medical record of three hospitals within the University of Pennsylvania Health System was queried for all patients ≥ 18 years of age who underwent primary or revisional repairs of hiatal hernias preoperatively classified as Type II, III, or IV during this time frame. After 386 PEHR patients were identified, a total of 244 primary and revisional operations were included in the study. Patients were excluded (142 patients) from analysis if they did not undergo a formal crural closure (i.e., gastropexy only). Patient demographics, baseline characteristics, perioperative imaging, operative findings, and immediate postoperative outcomes including 30-day complications, emergency department visits, readmissions, and long-term postoperative outcomes were reviewed. Radiographic recurrence was determined via the subjective judgment of a radiologist as documented in a postoperative imaging study.

Statistical analysis

Data were analyzed using STATA version 17 (StataCorp, College Station, TX, USA). Descriptive and univariate statistics were used to characterize perioperative outcomes and included means and standard deviations for continuous variables or counts and percentages for categorical variables. To compare initial and reoperative paraesophageal hernia repairs, a computational generalization of inverse propensity score weight was used to create populations with similar covariate distributions with age, weight, BMI, length-of-stay, sex, race, operative approach, and ASA score used for matching. Propensity-weighted groups were compared using two-sided t-tests and Wilcoxon–Mann–Whitney tests for continuous variables and two-sided Chi square and Fisher's exact tests for categorical variables, with a significance threshold of $P \leq 0.05$ in all cases. Odds ratios with 95% confidence intervals were calculated to compare the propensity-weighted groups along the following measures: postoperative symptom improvement, 30-day complications, late (after 30 days) complications, 30-day emergency department visits, 30-day readmissions, 30-day mortality, and repeat operations.

Results

A total of 244 patients were identified who underwent paraesophageal hernia repair (PEHR) during the specified time (Table 1). The cohort has majority of female ($n = 192$, 78.7%) with a mean age at the time of the operation of 65.4 ± 12.3 years. Operations were performed by one of thirteen surgeons at a tertiary care center. Baseline patient characteristics included a mean BMI of 29.8 ± 4.9 kg/m²

Table 1 Patient characteristics for all patients undergoing PEHR

	<i>n</i> = 244
Sex	
Male	50 (20.5%)
Female	192 (78.7%)
Other	2 (8.2%)
Mean pre-procedure BMI (kg/m ²)	29.8 ± 4.9
Median ASA Score	3 (IQR 2–3)
Hernia type	
Sliding hiatal hernia (type 1)	33 (13.5%)
Type 2	55 (22.5%)
Type 3	129 (52.9%)
Type 4	14 (5.7%)
Common preoperative symptoms	
Heartburn	118 (48.4%)
Abdominal pain	89 (36.5%)
Dysphagia	87 (35.7%)
Nausea/vomiting	69 (28.3%)
Chest pain	61 (25.0%)
Patients with prior PEHR	50 (20.1%)

and median ASA score of 3 (IQR of 2–3). Most patients (*n* = 194, 79.5%) were undergoing initial paraesophageal hernia repair. Surgical repairs were primarily performed for patients with type III (52.9%) and type II (22.5%) hiatal hernias, with fewer patients undergoing repair for type IV (5.7%) hernias. A subset of patients was observed to have a type I hiatal hernia intraoperatively (13.5%). The most common presenting symptoms prior to repair were heartburn (48.9%), abdominal pain (36.5%), dysphagia (35.7%), nausea and/or vomiting (28.3%), and chest pain (25.0%). A small subset of patients had evidence of volvulus on preoperative imaging (11.9%) and 2.8% cases presented with acute volvulus with obstruction and were emergent operations.

Operative characteristics (Table 2) demonstrated that the vast majority were completed using a minimally invasive operative approach (93.0%) with few open procedures (6.9%). Most repairs were conducted with fundoplication (73.0%). Of these fundoplications, 42.7% were Nissens, 21.3% were Toupets, and 34.3% were another type (i.e., Dor, Belsey-Mark, etc.). Only 14.2% of patients had mesh placed during the operation, and this was more common in redo operations. All repairs were performed using permanent sutures: polyester sutures (66.4%), silk sutures (23.0%), and polyester sutures with PTFE coating (5.3%). Postoperatively, patients generally noted subjective improvement of postoperative symptoms (76%) (Table 2). In particular, patient-reported outcomes included a substantial reduction in heartburn (48.4% to 11.1%), nausea/vomiting (28.3% to 11.1%), and shortness of breath (29.9%

Table 2 PEHR procedural characteristics and outcomes

	<i>n</i> = 244
Mean operative time (minutes)	132.1 ± 55.9
Operative approach	
Minimally invasive	227 (93.0%)
Open	17 (6.9%)
Crural closure	200 (82.0%)
Fundoplication	178 (73.0%)
Nissen	76 (42.7%)
Toupet	38 (21.3%)
Other fundoplication	61 (34.3%)
Permanent suture type	
Polyester	162 (66.4%)
Silk	56 (23.0%)
Polyester with PTFE coating	13 (5.3%)
Other type	1 (0.4%)
Mesh	35 (14.3%)
Emergent repairs	3 (1.23%)
Subjective improvement of symptoms	189 (77.4%)
Patients with follow-up imaging	155 (63.5%)
Radiographic recurrence	83 (53.5%)
Mean follow-up time (months)	10.0 ± 13.6
30-day outcomes	
Complications	22 (9.0%)
Readmissions	9 (3.7%)
ED visit	18 (7.4%)
Mortality	3 (1.2%)
Required reoperation for recurrent PEH	13 (5.3%)

to 3.3%) in comparisons of preoperative and postoperative symptoms (Fig. 1, Panel A).

The average patient followed up with a surgeon or gastroenterologist for 10.4 ± 15 months after their procedure. For the 155 patients for whom postoperative imaging was available, 53.5% were observed to have radiographic hernia recurrence as defined in the radiology report. However, of the patients with documented radiographic recurrence, 61.4% also reported subjective improvement in symptoms.

A minority of patients experienced adverse outcomes during the immediate postoperative period with 30-day outcomes including a complication rate of 9.0% (*n* = 22), readmission rate of 3.7% (*n* = 9), emergency department visit rate of 7.4% (*n* = 18), and mortality of 1.2% (*n* = 3). Most complications (81%) were classified as grades I–III on the Clavien–Dindo scale with fewer grade IV and V complications observed. Of the three mortalities, one was unrelated to the procedure and two involved postoperative gastric necrosis related to confirmed or suspected gastric perforations and leading to septic shock. Only 13 patients in the cohort of 244 patients (5.3%) required reoperation for paraesophageal hernia during the follow-up period. Hernia type, crural closure,

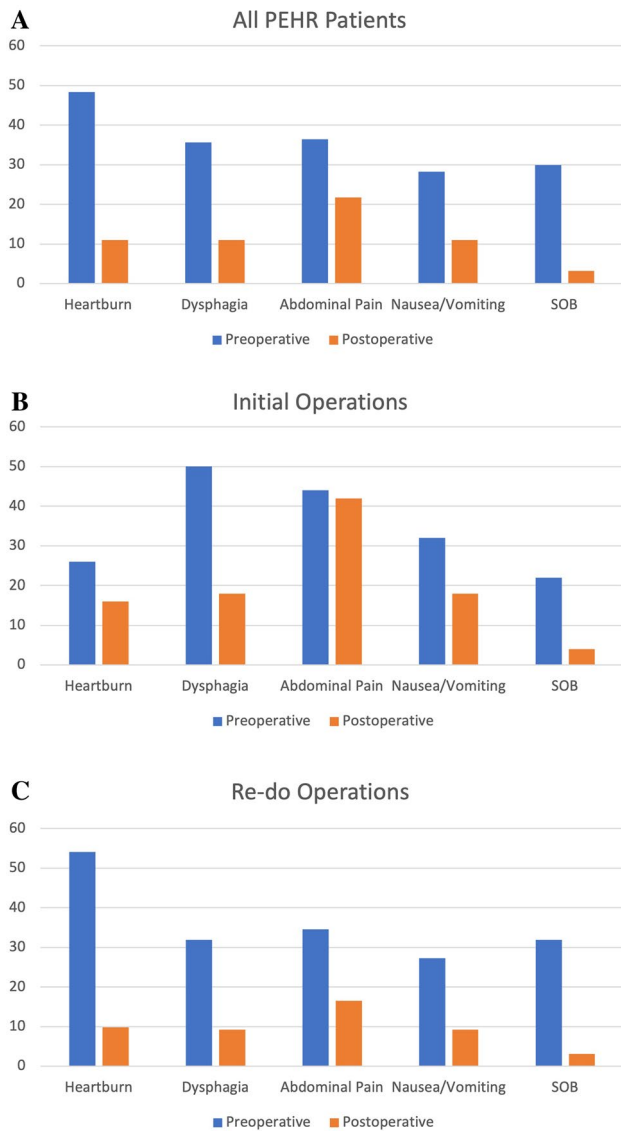


Fig. 1 Comparison of pre- and postoperative symptoms reported by PEHR patients. Symptoms as percent of patients in cohort. (Panel A: all patients, Panel B: initial operations; Panel C: redo operations). All preoperative-postoperative differences are statistically significant ($P \leq 0.05$) except abdominal pain in Panel B

fundoplication type, and mesh usage were all found to be not significantly associated with either postoperative radiographic recurrence or symptom improvement ($P > 0.05$).

Among the total cohort of patients undergoing PEHR, 50 were identified as undergoing reoperations. A weighted propensity score analysis comparing initial and revisional operations included 194 initial cases and 50 reoperative cases (Table 3) was completed. The matched cohorts were balanced across covariates including age, BMI, race and ethnicity, length of hospital stay, and type of surgery. The reoperative cohort, similar to the initial procedure cohort, was majority female (80%), with a mean age of 64 ± 11.06 years,

Table 3 Comparison of baseline patient characteristics for initial and reoperative pehr propensity-matched cohort

	Reoperation ($n=50$)	Initial ($n=194$)	<i>P</i> value
Mean age (SD)	64 (11.06)	65.82 (12.62)	$P=0.32$
Mean BMI (SD)	28.6 (5.06)	30.07 (4.8)	$P=0.07$
Sex			$P=0.47$
Male	9 (18%)	41 (21%)	
Female	40 (80%)	152 (78%)	
Other	1 (2%)	1 (1%)	
Hiatal hernia type			$P=0.07$
I	2 (4%)	1 (1%)	
II	4 (8%)	9 (5%)	
III	11 (22%)	31 (16%)	
IV	32 (65%)	151 (79%)	
ASA category			$P=0.06$
1	1 (2%)	0 (0%)	
2	22 (44%)	97 (50%)	
3	26 (52%)	96 (50%)	
4	1 (2%)	0 (0%)	
Race/Ethnicity			$P=0.21$
Caucasian	42 (84%)	170 (89%)	
Black	3 (6%)	14 (7%)	
Hispanic/Latino	1 (2%)	4 (2%)	
Asian	4 (8%)	4 (2%)	

and mean BMI of 28.6 ± 5.06 kg/m². Type IV (65%) and Type III (22%) hernias were most common in the reoperative cohort, similar to the cohort undergoing their primary PEHR.

A comparison of postoperative outcomes for the matched cohorts of reoperations and initial operations (Table 4) was performed, with odds ratios reported (95% confidence intervals). Reoperations were less likely to have successful postoperative symptom improvement (OR 0.245, 95% CI 0.1–0.55, $P=0.007$). The findings of reoperations having a higher likelihood of 30-day complications (OR 3.47, 95% CI 0.86–14.05, $P=0.32$) and need for further reoperation

Table 4 Comparison of outcomes of initial and reoperative pehr in propensity-matched cohort

Outcome	Odds ratio [95% CI]	<i>P</i> value
Postoperative symptom improvement	0.245 [0.1–0.55]	$P=0.007$
30-day complications	3.47 [0.86–14.05]	$P=0.08$
Late complications (after 30 days)	0.37 [0.05–2.66]	$P=0.32$
30-day ED visits	0.83 [0.24–5.84]	$P=0.83$
30-day readmissions	0.74 [0.09–5.75]	$P=0.77$
30-day mortality	1.01 [0.09–11.29]	$P=1.01$
Repeat operation	2.12 [0.49–9.25]	$P=0.31$

(OR 2.12, 95% 0.49–9.25, $P=0.31$) were not statistically significant. There were no significant differences between initial and repeat operations in 30-day mortality, 30-day readmissions, or long-term complications.

Discussion

In this retrospective study, we examine a cohort of 244 patients who underwent PEHR at a single institution, finding no significant association between hernia type, crural closure, fundoplication type, and mesh usage in relation to both postoperative radiographic recurrence and lack of symptomatic improvement. In this propensity-weighted cohort of initial and reoperative PEHR patients, we found that patients undergoing repeat operations were less likely to report subjective improvement of symptoms but otherwise had similar outcomes compared to patients without prior history of PEHR.

Studies of PEHR outcomes have documented high rates of radiographic recurrence, at times approaching or exceeding 50% of patients during long-term follow-up (> 2 years). It is unclear what role radiographic recurrence plays in clinical management as most of these patients do not go on to need reoperation. It should also be noted that assessments of radiographic recurrence involve subjective variation and do not yield perfect correspondence with the true anatomic picture; recurrent hernia size greater than 2 cm has been proposed in the literature as a standardized threshold for documenting recurrence [10]. In this study, not all patients underwent routine postoperative radiologic studies and varied due to surgeon preference. Of the patients who did have routine radiographic studies performed, the radiographic recurrence rate was 53.5% for 155 PEHR patients with the results of imaging studies available over a mean follow-up time of 10.4 ± 14 months. These findings are similar to other retrospective series in the literature. Lidor et al. report a 27% rate of recurrence within 1 year [11], Oelschlager et al. report 57% recurrence at 5 years of follow-up, and Dallemagne et al. report 66% recurrence at a median follow-up of 118 months (9.8 years) [12, 13]. In addition, there is no standard for routine postoperative imaging among surgeons in our health system, so a subset of the postoperative imaging was obtained in the setting of patients remaining symptomatic, and this rate is likely not entirely reflective of the entire cohort. This additionally begs the question if routine imaging should be obtained in the absence of clinical symptoms especially if it will not alter clinical or surgical management.

Despite common radiographic recurrence after PEHR, clinical management of recurrent paraesophageal hernia does not require reoperative surgery in most cases due to maintained resolution of symptoms. Similar to previous

studies of PEHR such as Carrot et al.'s single-center retrospective review in which 270 patients experienced symptom improvement in the range of 67%–93% across various preoperative symptoms (dyspnea, early satiety, regurgitation, dysphagia, and heartburn), we find subjective improvement in symptoms in 76% of the patients in this study [14]. Given high rates of symptom resolution reported by patients, it is unsurprising that reoperation rates for our cohort remained low, with only 4.9% of all patients requiring redo PEHR. Other studies have found similarly low rates of redo PEHRs performed after an initial repair, largely due to lack of symptomatic recurrence [9].

To address the causes of lack of symptom improvement and PEH recurrence, several studies have examined the contribution of intraoperative variations in surgical technique, including the routine usage of fundoplication in all PEH patients, type of fundoplication, placement of mesh, and crural closure. Our analysis contributes to this literature, finding no association between fundoplication type and postoperative radiographic recurrence or lack of symptom improvement, with 73.0% of the cohort receiving some form of fundoplication (most commonly a Nissen fundoplication). Other perioperative and patient factors, including mesh usage, crural closure, and hernia type, were also not predictive of radiographic recurrence or lack of symptom improvement, leaving major controversies in the management of paraesophageal hernia unresolved. Other studies have similarly yielded limited evidence for or against any particular approach. A meta-analysis performed by Andolfi et al., for example, reports no statistically significant difference between total (Nissen), partial (Toupet and Dor), and no fundoplication altogether in preventing postoperative reflux and avoiding dysphagia despite widespread usage of fundoplication for all patients in practice [15]. Huerta et al. provide a further comparison of subjective patient satisfaction following laparoscopic Nissen and Toupet fundoplication during the repair of Type III and IV hiatal hernias, finding no significant difference in patient-reported outcomes between the two approaches [16].

Although few patients will require revisional surgery after an initial PEHR, redo operations are indicated in some cases. While reoperative PEHR has been thought to carry additional risks of complications, elective revisional surgery is now well established as safe and effective. Addo et al., in a retrospective review of laparoscopic revisional PEHR at a single institution, report low overall morbidity and mortality rates of 15.8% and 1.1%, respectively, with 6.3% of patients requiring an additional revisional operation [8]. Such figures compare favorably to outcomes of initial PEHR, suggesting that redo PEHR is a viable option to address failed initial operations and reemergence of preoperative symptoms with radiographic recurrence. Our propensity score match analysis contributes to this literature, providing for the first

time a direct comparison of initial and redo PEHR to investigate potential predictors of failure to improve and need for reoperation in both groups. There are no differences between initial and repeat operations in 30-day mortality, 30-day readmissions, or long-term complications. A slightly higher odds ratio of reoperations and 30-day complications was observed for the redo group relative to the initial PEHR group, although these findings do not reach the threshold for statistical significance. There is, however, a lower reported postoperative symptom improvement in the redo cohort (OR 0.245, 95% CI 0.1–0.55, $P=0.007$), suggesting that preoperative counseling of these patients and their expectations for postoperative symptom improvement are important. For these complex patients, optimizing medical management prior to considering reoperation may also provide some improvement compared to a repeat operation.

This study has several limitations. First, generalizability may be limited due to the single-institution nature of the data. Protocols regarding such factors as preoperative CT, barium upper GI series, esophagogastroduodenoscopy, 24-h pH monitoring, and esophageal manometry may vary between surgeons and influence patient selection criteria for PEHR. Furthermore, this study utilizes a subjective definition of radiographic recurrence, relying on a radiologist's judgment as documented in postoperative imaging reports. It is therefore possible that some radiologists were more or less permissive in their identification of recurrent paraesophageal hernias. There were also no standardized patient-reported outcomes, and symptom determination was based on documentation within the electronic medical record. This study may also be underpowered to detect a difference between the initial and reoperative paraesophageal hernia cohort, although balancing the covariates may help adjust this analysis. Additionally, the choice to pursue a reoperation is dependent on clinical decision-making, and practice patterns may vary by surgeon, which limits this as a standardized outcome. Individual surgeon preferences may vary regarding operative approach and justifications for the use of a particular technique are often absent from available documentation. Finally, our matching strategy can only balance observable covariates, leaving open the possibility of unobserved variation between the initial and redo PEHR groups including patient-level factors that may not be documented in the medical record.

Ultimately, several directions for future study may be encouraged by our findings. Patient selection, particularly in the case of redo PEHR, will be an important focus of future research. Identifying additional patient or hernia characteristics, combined with objective data, and patient outcomes may further help identify better candidates for operative intervention. This study encourages foregut surgeons to employ additional objective metrics for evaluation before and after surgery to collect standardized data. Operative

variation in technique may also account for the lack of standardized improvement, and it may be useful to create criteria for selection of certain operations and approaches by using an evidence-based guidelines approach.

Conclusions

Perioperative factors and operative technique were not predictive of postoperative radiographic recurrence or symptom improvement following PEHR. While radiographic recurrence was documented in over half of all PEHR patients, symptom improvement was reported in over 75% of cases with approximately 5% of patients requiring reoperation. In comparison with initial PEHR, repeat operations were less likely to have postoperative symptom improvement but no significant differences were observed with respect to need for reoperation, 30-day complications, ED visits, readmissions, and mortality, and late complications.

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Declarations

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