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# Comparison of Dor and Nissen fundoplication after laparoscopic paraesophageal hernia repair

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ABSTRACT

*Background:* Fundoplication is performed routinely during laparoscopic repairs of a paraesophageal hernia, but the degree of fundoplication remains controversial. The purpose of this study is to assess postoperative dysphagia and reflux after a Dor versus a Nissen fundoplication in patients undergoing laparoscopic repair of giant paraesophageal hernias.

*Methods:* We performed a retrospective cohort study of all patients undergoing laparoscopic repair of giant paraesophageal hernias with Nissen or Dor fundoplication between January 2012 and December 2017 at a high-volume center, excluding revisional and emergency cases. Primary outcomes were reflux and dysphagia at 1 and 6 months. Severe dysphagia was defined as intolerance to liquids. Balanced cohorts were created using coarsened exact matching.

*Results:* A total of 106 patients were included, and 87 were matched (Dor = 48, Nissen = 58). Baseline characteristics were well balanced between matched groups. Mean follow-up duration was 17.7 months (standard deviation 16.4). The incidence of severe dysphagia at 1 month was less in the Dor group (0 of 48 vs 8 of 58, $P = .02$) with similar reflux symptoms. There was no difference in severe dysphagia and reflux symptoms at 6 months and at the latest visit.

*Conclusion:* Dor fundoplication is associated with less severe, early postoperative dysphagia. Future studies assessing the relative importance of dysphagia and reflux on quality of life should be conducted to tailor the operative technique and optimize patient satisfaction.



## Introduction

Fundoplication is performed routinely during laparoscopic repair of paraesophageal hernias (PEH) with the intent to prevent postoperative gastroesophageal reflux and potentially to reinforce the repair to prevent recurrence.[1,2] The optimal choice of fundoplication technique, however, remains an area of controversy, and a balance must be achieved between adequate control of reflux and the incidence of postoperative dysphagia.[3,4]

In patients with a giant PEH, the use of preoperative manometry in the diagnosis of esophageal dysmotility disorders is unreliable. Given the distorted anatomy, the placement of the manometry catheter across the lower esophageal sphincter and below the diaphragm is difficult and may adversely affect the pressure measurements.[2] Furthermore, deranged intrathoracic pressures owing to the PEH may also complicate interpretation of the measurements of esophageal contractility.[2] In addition, previous studies have suggested a high incidence of esophageal dysmotility in this patient population, further complicating decision-making in the appropriate technique of reconstruction of the lower esophageal sphincter.[5,6]

Complete 360-degree (Nissen) fundoplication is associated with the greatest risk of postoperative dysphagia, compared with techniques of partial fundoplication, and is thus not recommended when a preoperative diagnosis of esophageal dysmotility is established.[7]

Some experts advocate for partial fundoplication in all patients undergoing repair of a giant PEH to minimize the risk of postoperative dysphagia, but data are limited.[8] There exists an

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important need to identify differences in patient-reported outcomes to better individualize the use of the various techniques of fundoplication. Therefore, the aim of this study is to assess short- and long-term rates of postoperative dysphagia and reflux after a Dor compared with a Nissen fundoplication in patients undergoing laparoscopic repair of giant PEH at a high-volume, specialist referral center.

## Material and methods

### *Data source and study population*

We conducted a retrospective cohort study at a single, high-volume, specialist referral center, where 5 specialized surgeons perform laparoscopic PEH repair with fundoplication. All adult patients undergoing elective laparoscopic repair of giant PEHs with Nissen (complete) or Dor (partial) fundoplication from January 2012 to December 2017 were included. Patients who underwent Toupet fundoplication were not included in this study because there were too few cases during the study period to allow for meaningful analysis. A giant PEH was defined as more than 50% of the stomach herniated above the diaphragm as described by the surgeon in the operative report. Emergency and revisional cases were excluded from this study as were patients with less than 1-month follow-up duration.

We reviewed electronic medical records and office charts. Patient characteristics collected were age, sex, comorbidities defined using the American Society of Anesthesiologists score, and hernia type as determined from preoperative imaging studies. The most bothersome symptom was used to catalogue surgical indication, and these were then grouped according to symptom type as follows: reflux (which comprised regurgitation, esophagitis, changes in voice, and acid reflux); obstruction (which included postprandial chest pain, vomiting, early satiety, weight loss, or imaging demonstrating partial volvulus or obstruction); and bleeding (including otherwise asymptomatic patients presenting with occult or overt upper gastrointestinal hemorrhage with Cameron's ulcers found on endoscopy). The type of fundoplication performed (Dor or Nissen) was determined from operative reports. The technique of fundoplication was chosen by the treating surgeon at the time of the procedure, and a bougie (54-56 Fr) was used routinely for Nissens and selectively for Dors. Fundoplications were made short and loose, between 2 to 3 cm in length, and sutured to the crura. During the study period, an increasing proportion of partial fundoplications were performed each year in favor of Nissens owing to changes in surgeon preferences. In addition, a same-day surgery approach was adopted at our center, leading to an increase in same-day discharges over the past 5 years, such that currently ~80% of benign hiatal cases are treated without hospital admission.[9]

### *Outcomes*

The primary outcomes were incidence of postoperative dysphagia and reflux at 1 and 6 months postoperatively and at the latest follow-up visit. The severity of dysphagia was measured using a Likert score (0 = no dysphagia, 1 = dysphagia to solids, 2 = dysphagia to semi-solids, 3 = dysphagia to liquids, and 4 = dysphagia to saliva); severe dysphagia was defined as intolerance to liquids or any dysphagia complaint requiring invasive diagnostic or therapeutic intervention. Dysphagia was recorded preoperatively and at each follow-up visit. Symptoms of reflux were measured as a dichotomous variable based on the presence or absence of reflux symptoms preoperatively and at each follow-up visit. Preoperative manometry and pH testing are not performed routinely at our institution. Secondary outcomes included perioperative variables (duration of hospital stay, 30-day postoperative complications defined using Clavien-Dindo score, 30-day emergency room visits, and readmissions), radiologic recurrence, and need for reoperation or endoscopic dilation. Recurrence was defined as $\geq$2 cm gastric herniation above the diaphragm as recorded from postoperative imaging or endoscopy reports. Practice at our center includes a routine upper gastrointestinal study performed at 6 to 8 months postoperatively and endoscopy performed selectively.

### *Statistical analysis*

Coarsened exact matching (CEM) was used to account for differences in patient-level factors between those undergoing Nissen and Dor fundoplication that may have introduced a selection bias with regard to the choice of procedure and to create balanced cohorts for comparison. This statistical method was used preferentially to limit bias between groups in lieu of multivariate analysis owing to the low frequency of primary outcomes in each group. CEM is similar to other matching methods, such as propensity score matching, and is used to decrease imbalance in covariates between groups. In this study, CEM was used to account for baseline differences in age, sex, comorbidities, type of hiatal hernia, and surgical indication. CEM creates proportionality among possible confounding variables that are hypothesized to affect the exposure and the outcomes of interest based on a priori knowledge. This strategy of matching has the advantage of being able to balance comparison groups while minimizing the confounding effects of individual variables. It also avoids the need for the process of iterative balance checking that may introduce error as in propensity score matching while still maintaining a relative level of similarity between observations.[10] In CEM, subjects are divided into distinct strata and then are matched based on assigned, stratum-specific weight proportional to the number of subjects in each stratum. When compared directly with propensity score matching, CEM has been shown to result in less variance and bias.[11]

Data are presented as median (interquartile range) or mean (standard deviation) for continuous variables and $n$ (%) for categorical variables. Statistical significance between means was determined using the 2-tailed Student's $t$ test or Wilcoxon rank-sum test for continuous variables and Fisher exact test for categorical variables for both the unmatched and matched cohorts. Given variable durations of follow-up, patients who were followed <6 months were only included in the comparison of 1-month symptoms and excluded from the analysis at 6 months. Subgroup analysis excluding patients with anatomic recurrence was conducted. Statistical analysis was performed using Stata 12.1 (Stata Corp, College Station, TX).

## Results

Over the 5-year study period, 276 patients were screened, of whom 213 were reviewed and 106 cases met inclusion criteria for analysis (Fig 1). Forty-eight patients underwent Dor and 58 Nissen fundoplication. The most common indication for operative repair in either group was the presence of obstructive symptoms (Table I). Mean age was statistically significantly greater in patients undergoing a Dor fundoplication. A total of 87 patients were matched using coarsened exact matching including 35 in the partial fundoplication group and 52 in the complete fundoplication group. After matching, baseline characteristics (including age) were well balanced. Baseline characteristics of unmatched and matched cohorts are presented in Table I.

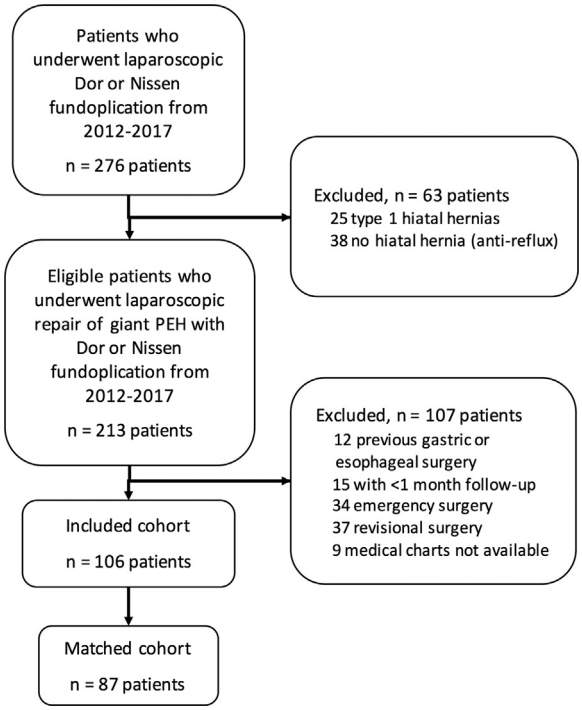


**Fig 1.** Flow chart of study population.

Operative characteristics, duration of stay, and 30-day postoperative outcomes are summarized in Table II and were similar between matched groups. Of note, all repairs were performed without mesh. The length of stay was less in the Dor group, reflecting recent changes in institutional practice.[9] The mean duration of follow-up in the matched cohort was 17.7 months, but Dor patients had a significantly lesser mean duration of follow-up than the Nissen patients. Sixty-seven patients (77%) underwent routine upper gastrointestinal study at 6 to 8 months postoperatively, of whom 14 (21%) were found to have an anatomic recurrences and 4 (6%) required reoperation. Incidence of anatomic recurrence, need for endoscopic dilation, and reoperation were similar between groups as shown in Table III.

At 1 month postoperatively, the incidence of any dysphagia was statistically significantly less in the Dor group with no difference in the presence of reflux symptoms (Figs 2 and 3). No patients in the Dor group reported severe dysphagia at 1 month in comparison to 8 patients (20%) in the Nissen group. At 6 months and at the latest follow-up visit, the incidence of severe dysphagia and reflux were low, and similar rates of each were reported in both groups (Figs 2 and 3). The incidence of postoperative dysphagia decreased over time (Fig 2). Subgroup analysis of patients without anatomic recurrences revealed similar results.

## Discussion

Fundoplication is often performed concomitantly during PEH repair; however, there is currently no high-level evidence to support the ideal choice of the type of fundoplication in the management of a giant PEH.[3] Although multiple studies have evaluated patient-reported outcomes with different fundoplication techniques in anti-reflux surgery, there is a lack of comparative evidence in patients undergoing giant PEH repair.[3] The underlying etiology of dysphagia is difficult to diagnose accurately in this patient population, and the decision to perform one fundoplication technique over another needs to consider the trade-off between optimal control of reflux and wrap-induced dysphagia.[3] Furthermore, because patients with a giant PEH are often elderly, striking the optimal balance between long-term durability of control of reflux versus the risk of immediate and clinically relevant postoperative dysphagia is often a difficult clinical question. Most evidence comparing Dor and Nissen fundoplications was reported in the context of primary gastroesophageal reflux disease (GERD).[12] Therefore, previously published results are not generalizable to patients with a giant PEH. The present study adds to the current body of literature by focusing on this patient population in whom a less constrictive fundoplication technique may be an adequate alternative to a full Nissen fundoplication given their greater risk of dysmotility and unreliable and inaccurate preoperative assessment.[2,5,6]

In the present study, a Dor fundoplication was associated with less early postoperative dysphagia when compared with a Nissen fundoplication but with no difference at 6 months. Complete fundoplication may result in more early postoperative edema at the level of the lower esophageal sphincter (LES) causing partial obstruction and dysphagia. Because postoperative inflammation resolves over time, this finding may explain why the increase in severe dysphagia was no longer observed at 6 months. In addition, several patients underwent endoscopic dilation, which may have contributed to the observed improvement in patient-reported outcomes over time as shown in Fig 2. Our results are consistent with previous studies of patients undergoing anti-reflux surgery in which Dor patients experienced less dysphagia to solid food and were more likely to express satisfaction with the clinical outcome compared with the Nissen group.[7,13]

In addition, there were no differences in the incidence of short- and long-term, self-reported symptoms of reflux nor the proportions of patients using proton pump inhibitors between groups. The mean duration of follow-up, however, was less in the Dor group owing to our recent institutional changes in practice, and it is unclear whether results would differ if follow-up between groups was similar. Previous studies have suggested that the majority of patients with a large PEH have an incompetent LES and may thus benefit from reconstruction of the LES.[14] It is unclear, however, whether symptoms of reflux in patients with a large PEH are due primarily to the abnormal location of the LES, resulting in lack of support from the diaphragmatic crura, the pressure effects from the large intrathoracic stomach itself, or due to partial obstruction provoking stasis of ingested food and regurgitation. Because patients often present with several symptoms that can have overlapping etiologies, a detailed history and dynamic imaging investigation are often necessary to determine more clearly the mechanics causing symptoms. In our study, the most common indication for repair of a giant PEH was the presence of obstructive symptoms as has been reported elsewhere; thus the technique of fundoplication ideally should be chosen to minimize postoperative dysphagia.[15] Because preoperative manometry is unreliable in the context of a giant PEH, developing a tailored approach to individual patients remains challenging.[2,16]

Quality of life studies have reported that patients with dysphagia have the greatest burden of global symptoms, whereas reflux does not impede the quality of life to the same degree.[17] Despite the theoretical risk of increased reflux with partial fundoplication, the avoidance of even temporary severe postoperative dysphagia in patients with a large PEH can be expected to result in improved quality of life. Furthermore, medical treatments can be offered to patients with GERD symptoms, whereas noninvasive therapeutic options are very limited for patients with dysphagia. For elderly patients who comprise the majority of those with giant PEH, postoperative dysphagia can result in considerable disability and exacerbate frailty.[18] Furthermore, the role of control of reflux in

**Table I**
Baseline characteristics

| Variables | Whole Cohort $N = 106$ | | | Matched Cohort $n = 87$ | | |
|---|---|---|---|---|---|---|
| | Dor $n = 48$ | Nissen $n = 58$ | *P* value | Dor $n = 35$ | Nissen $n = 52$ | *P* value |
| Mean age, y (SD) | 71.7 (1) | 67.2 (10) | .030 | 68.6 (10) | 67.5 (9) | .607 |
| Male sex | 16 (33) | 12 (21) | .142 | 9 (26) | 9 (17) | .343 |
| ASA | | | | | | |
| 1 | 2 | 1 | .321 | - | - | .591 |
| 2 | 26 (54) | 40 (69) | | 23 (66) | 37 (71) | |
| 3 | 19 (40) | 17 (29) | | 12 (34) | 15 (29) | |
| 4 | 1 | 0 | | - | - | |
| Hernia type | | | | | | |
| 2 | 0 | 2 | .168 | 0 | 2 (4) | .292 |
| 3 | 31 (65) | 43 (74) | | 23 (66) | 38 (73) | |
| 4 | 17 (35) | 13 (22) | | 12 (34) | 12 (23) | |
| Surgical indication | | | | | | |
| Dysphagia | 38 (79) | 47 (81) | .474 | 27 (77) | 46 (89) | .345 |
| Reflux | 7 (15) | 5 (9) | | 6 (17) | 5 (10) | |
| Bleeding | 3 (6) | 6 (10) | | 2 | 1 | |
| Preoperative baseline dysphagia* | | | | | | |
| No dysphagia | 13 (32) | 13 (27) | .918 | 12 (40) | 10 (23) | .305 |
| Mild dysphagia | 21 (51) | 25 (52) | | 14 (47) | 25 (58) | |
| Severe dysphagia | 8 (19) | 10 (21) | | 4 (13) | 8 (19) | |
| Preoperative PPI use | 21 (72) | 18 (78) | .629 | 18 (82) | 17 (85) | .782 |

Data presented as *n* (%), unless otherwise specified.
*ASA*, American Society of Anesthesiologist; *PPI*, proton pump inhibitor; *SD*, standard deviation.
* Mild dysphagia = dysphagia score 1–2, Severe dysphagia = dysphagia score ≥3.

the prevention of Barrett's esophagus and esophageal cancer may not be of crucial importance in this patient population because the development of malignant lesions secondary to reflux typically takes many years.[19]

In our study, fewer recurrences were seen with Dor fundoplication, which may be related to the technique itself or to the shorter follow-up duration in that group, but this difference did not reach statistical significance. In addition, the clinical importance of radiologic recurrence is questionable in the absence of symptoms because most asymptomatic recurrences generally do not require reoperation.[20] Currently, there is insufficient evidence to suggest any added benefit from either fundoplication technique in the prevention of recurrence.

The results of this study should be interpreted in light of several limitations. First, the presence of reflux symptoms was measured from the retrospective chart review and was not scored prospectively using a validated questionnaire. Although concerns may be raised about the sensitivity of a retrospective chart review to measure the outcomes of interest compared with objective measures, previous studies have reported a moderate to good agreement between patient and observer or physician ratings of symptoms of dyspepsia.[21] In addition, despite the existence of different validated questionnaires to measure gastrointestinal and dyspepsia-related quality of life, previous studies have shown that a strict endpoint, such as the absence of heartburn and sufficient control of heartburn, may be a suitable outcome measure.[22] Therefore, the presence or absence of reflux symptoms recorded in the present study appears appropriate.

In addition, our sample size was small and resulted in a low power to detect statistically significant differences that may be clinically relevant. In this cohort, the technique of fundoplication was chosen by the treating surgeon and may have resulted in a selection bias regarding the choice of procedure. We attempted to minimize the impact of such selection bias by matching on patient-level factors that could potentially influence a surgeon's choice of procedure. Although surgeons at our institution have performed Dor fundoplication over Nissen preferentially in most recent years, the fundoplication techniques themselves for both Dor and Nissen fundoplications have not changed meaningfully over time. Owing to the small sample size, however, we were unable to perform a

**Table II**
Perioperative outcomes, duration of hospital stay, and duration of follow-up

| Variables | Matched Cohort $n = 87$ | | |
|---|---|---|---|
| | Dor $n = 35$ | Nissen $n = 52$ | *P* value |
| Median duration of stay, days (IQR) | 1 (0–1) | 1 (1–2) | .01 |
| 30-day complications | | | |
| Any | 2 | 3 (6) | .99 |
| Severe (Clavien-Dindo ≥ 3) | 2 | 1 | .34 |
| Superficial SSI | 0 | 2 | .24 |
| Organ space SSI | 1 | 1 | .78 |
| Venous thromboembolism | 0 | 1 | .41 |
| 30-day emergency department visits | 2 | 3 (6) | .99 |
| 30-day readmissions | 2 | 0 | .08 |
| 30-day reoperations | 1 | 1 | .78 |
| Mean follow-up duration, months (SD) | 12.6 (12) | 21.0 (18) | .02 |

Data presented as *n* (%), unless otherwise specified.
*IQR*, interquartile range; *SD*, standard deviation; *SSI*, surgical site infections.

**Table III**
Secondary outcomes

| Variables | Matched Cohort $n = 87$ patients | | |
|---|---|---|---|
| | Dor $n = 35$ | Nissen $n = 52$ | *P* value |
| Anatomic recurrence | 4 (12) | 13 (27) | .09 |
| Endoscopic dilation | 1 | 3 (9) | .65 |
| Reoperation for recurrence | 1 | 4 (8) | .35 |

Data presented as *n* (%), unless otherwise specified

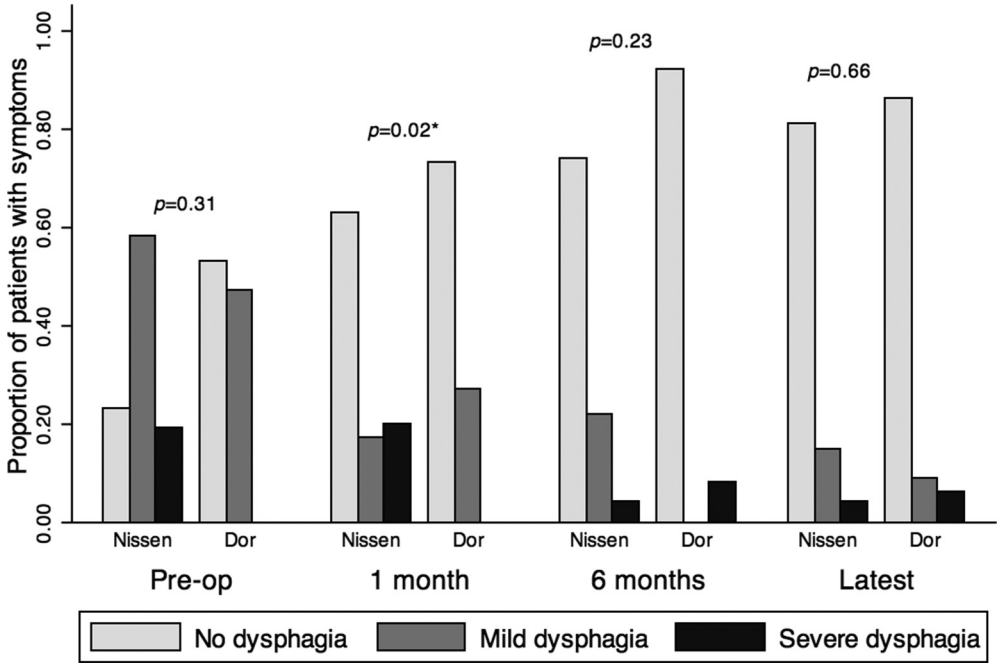


**Fig 2.** Proportion of patients with mild and severe postoperative dysphagia over time from day of operation.

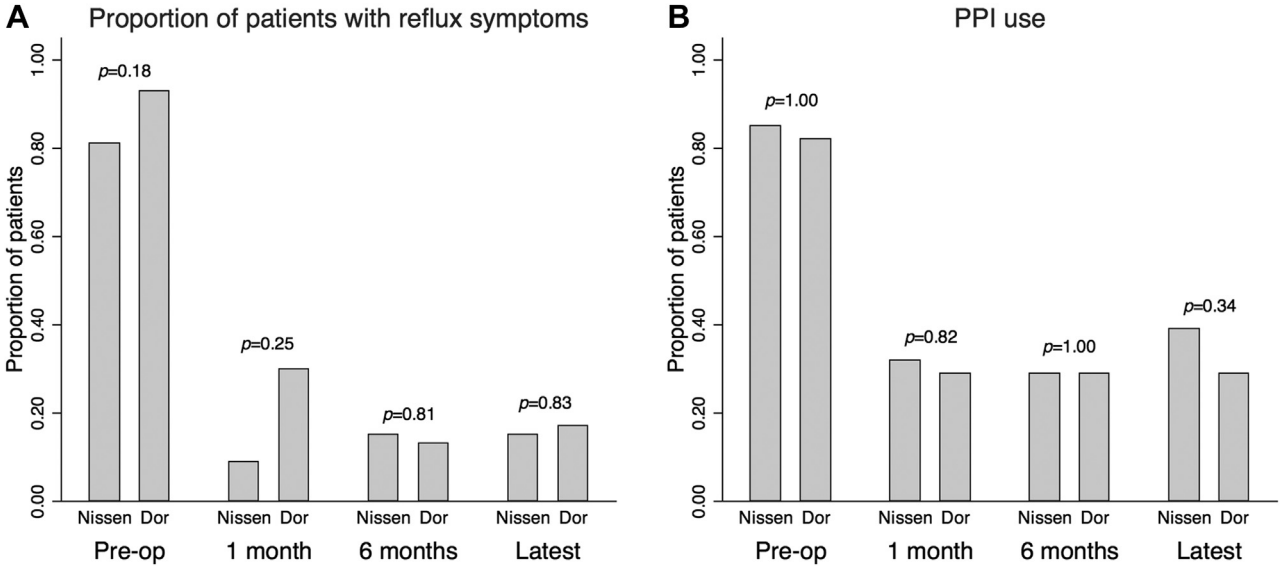


**Fig 3.** Proportions of patients with reflux symptoms and proton pump inhibitor use over time from day of operation.

time-varying analysis to further explore the effect of practice variation on outcomes.

Furthermore, given that very few patients experienced the events of interest, our numbers did not allow for a multivariate analysis to adjust for possible confounders. The technique of patient matching that we used, however, has been shown to be beneficial to adjust for confounders in small datasets (when there are 7 or fewer events per confounder variable), where they clearly appear less biased, more robust, and more precise than standard multivariable methods.[23]

In addition, given the benign nature of the disease, long-term follow-up was limited. It is unclear whether differences between the types of fundoplication would become more or less apparent with greater follow-up because some randomized controlled trials in GERD patients have shown persistent differences, whereas others have not.[24,25] To address these issues, a follow-up study involving administration of validated questionnaires of symptoms and quality of life for all patients in this cohort is planned.

In conclusion, in patients undergoing primary, elective repair of a giant PEH, Dor fundoplication was associated with less severe early postoperative dysphagia and similar reflux rates compared with Nissen fundoplication. Future studies assessing the relative importance of dysphagia and reflux from the patient's point of view should be conducted to better tailor the choice of the type of fundoplication and to optimize patient satisfaction.

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**Conflict of interest/Disclosure**

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**References**

1. Walther B, DeMeester T, Lafontaine E, Courtney J, Little A, Skinner D. Effect of paraesophageal hernia on sphincter function and its implication on surgical therapy. *Am J Surg*. 1984;147:111–116.
2. Swanstrom L, Jobe B, Kinzie L, Horvath K. Esophageal motility and outcomes following laparoscopic paraesophageal hernia repair. *Am J Surg*. 1999;177:359–363.
3. Kohn G, Price R, Demeester S, et al, and the SAGES Guidelines Committee. Guidelines for the management of hiatal hernia, 2013. Board of Governors of the Society of American Gastrointestinal and Endoscopic Surgeons. Available at: https://www.sages.org/publications/guidelines/guidelines-for-the-management-of-hiatal-hernia/. Accessed January 10, 2019.
4. Mark LA, Okrainec A, Ferri LE, Feldman LS, Mayrand S, Fried GM. Comparison of patient-centered outcomes after laparoscopic Nissen fundoplication for gastroesophageal reflux disease or paraesophageal hernia. *Surg Endosc*. 2008;22:343–347.
5. Conrado LM, Gurski RR, da Rosa AR, Simic AP, Callegari-Jacques SM. Is there an association between hiatal hernia and ineffective esophageal motility in patients with gastroesophageal reflux disease? *J Gastrointest Surg*. 2011;15:1756–1761.
6. Patti M, Goldberg H, Arcerito M, Bortolasi L, Tong J, Way L. Hiatal hernia size affects lower esophageal sphincter function, esophageal acid exposure, and the degree of mucosal injury. *Am J Surg*. 1996;171:182–186.
7. Watson D, Jamieson G, Pike G, Davies N, Richardson M, Devitt P. Prospective randomized double-blind trial between laparoscopic Nissen fundoplication and anterior partial fundoplication. *Br J Surg*. 1999;86:123–130.
8. Watson A, Jenkinson L, Ball C, Barlow A, Norris T. A more physiological alternative to total fundoplication for the surgical correction of resistant gastro-esophageal reflux. *Br J Surg*. 1991;78:1088–1094.
9. Molina JC, Misariu AM, Nicolau I, et al. Same day discharge for benign laparoscopic hiatal surgery: a feasibility analysis. *Surg Endosc*. 2018;32:937–944.
10. Blackwell M, Iacus S, King G, Porro G. CEM: coarsened exact matching in Stata. *Stata J*. 2009;9:524–546.
11. Wells A, Hamar B, Bradley C, et al. Exploring robust methods for evaluating treatment and comparison groups in chronic care management programs. *Popul Health Manag*. 2013;16:35–45.
12. Stefanidis D, Hope W, Kohn G, et al, and the SAGES Guidelines Committee. Guidelines for surgical treatment of gastroinstestinal reflux disease (GERD), 2010. Available at: https://www.sages.org/publications/guidelines/guidelines-for-surgical-treatment-of-gastroesophageal-reflux-disease-gerd/. Accessed January 10, 2019.
13. Walther B, Jamieson G, Lally C, et al. Multicenter, prospective, double-blind, randomized trial of laparoscopic Nissen vs anterior 90° partial fundoplication. *Arch Surg*. 2004;139:1160–1167.
14. Fuller C, Hagen J, DeMeester T, Peters J, Ritter M, Bremmer C. The role of fundoplication in the treatment of type II paraesophageal hernia. *J Thorac Cardiovasc Surg*. 1996;111:655–661.
15. Myers G, Harms B, Starling J. Management of paraesophageal hernia with a selective approach to antireflux surgery. *Am J Surg*. 1995;170:375–380.
16. Landreneau RJ, Del Pino M, Santos R. Management of paraesophageal hernias. *Surg Clin North Am*. 2005;85:411–432.
17. Reddy CA, Patel A, Gyawali CP. Impact of symptom burden and health-related quality of life (HRQOL) on esophageal motor diagnoses. *Neurogastroenterol Motil*. 2017;29.
18. Saito T, Hayashi K, Nakazawa H, Yagihashi F, Oikawa L, Ota T. A significant association of malnutrition with dysphagia in acute patients. *Dysphagia*. 2018;33:258–265.
19. Lagergren J, Bergstrom R, Lindgren A, Nyren O. Symptomatic gastroesophageal reflux as a risk factor for esophageal adenocarcinoma. *N Engl J Med*. 1999;340:825.
20. Oelschlager B, Petersen R, Brunt L, et al. Laparoscopic paraesophageal hernia repair: defining long-term clinical and anatomic outcomes. *J Gastrointest Surg*. 2012;16:453–459.
21. Madsen LG, Hansen JM, Gronvold M, Bytzer P. The validity of a symptom diary in ratings of dyspepsia measured against a detailed interview: do patients and clinicians agree in their assessment of symptoms? *Aliment Pharmacol Ther*. 2007;26:905–912.
22. Bytzer P. Assessment of reflux symptom severity: methodological options and their attributes. *Gut*. 2004;53:iv28–iv34.
23. Cepeda MS. Comparison of logistic regression versus propensity score when the number of events is low and there are multiple confounders. *Am J Epidemiol*. 2003;158:280–287.
24. Spence G, Watson D, Jamiesion G, Lally C, Devitt P. Single center prospective randomized trial of laparoscopic Nissen versus anterior 90 degrees fundoplication. *J Gastrointest Surg*. 2006;10:698–705.
25. Cai W, Watson D, Lally C, Devitt P, Game P, Jamieson G. Ten-year clinical outcome of a prospective randomized clinical trial of laparoscopic Nissen versus anterior 180 (degrees) partial fundoplication. *Br J Surg*. 2008;95.

# Discussion


**Dr Maude Trepanier:** To answer the first question, we have five different surgeons at our institution that have a very similar practice, and they have moved away over the recent years to perform more Dor fundoplications. They all use Bougies for Nissen fundoplication, and the size is 54 French, and usually 2 to 3 cm.

We did not do a time variant analysis just because of our sample size. Also, our study period was 5 years, so by year we have 87 patients, divided by 5…it's very small numbers, so we did not address that.

With regards to the reflux, that's a very good point. That is probably the main limitation of our study. We are currently doing a follow-up study including more prospective patients and measuring reflux using a validated questionnaire. For this cohort of patients, we will be conducting a follow-up study calling patients, filling out questionnaires to assess their reflux symptoms.

We have a very large catchment area at our institution so we tend to lose patients who are asymptomatic after 6 months. Although we have longer-term follow-up in our study, we felt that if we assess reflux at a year, a year and a half, we would only capture patients who kept being followed because they were symptomatic, so that's why we did not do that in our study. But that is a very good point.

For the last question, at our institution we moved away and performed more Dors, and I think the goal of our study was to assess whether this is a reasonable change in practice, and I think with our data we do show adequate alternatives, but for sure we do have to look into reflux and long-term symptoms.

**Dr L. Michael Brunt** (St. Louis, MO): Very nice study. Thanks for your contribution to the ongoing debate about partial versus full fundoplication.

I have a question about manometry, because at our institution, we do it routinely and are successful in a high percentage of these patients. The most common reasons that we'll do a partial fundoplication is if the patient has almost no peristalsis because some of these elderly patients with huge hernias and relative obstruction

over the years will get or inadequate contraction reserve. So my question to you is, did you use manometry at all in any of these patients to help guide your approach?

My second question relates to the dysphasia. Certainly we see it, not all that uncommonly, but in my experience, more postprandial pain, discomfort, or anemia from Cameron's erosions are some of the more common ways in which these large paraesophageal hernias present. Please comment on those.

**Dr Maude Trepanier:** To address your first question, at our institution we do not always use manometry preoperatively. We have one gastroenterologist who is very specialized and doing manometry. For this type of patient, we don't always get manometry. The choice of fundoplication has more to do with the frailty of the elderly patients with dysphagia symptoms, then we will do a Dor fundoplication or the posterior Nissen. If they do have severe reflux symptoms, and that's why they are presenting to us, then at that point we consider doing a Nissen fundoplication.

For your second question, we basically grouped the obstructive symptoms all together. We focused on postoperative dysphasia because of the retrospective nature of our study. That's really what's well documented in the charts. But we do have the data on postprandial chest pain, and basically the results are similar when we look at postprandial chest pain.

Nissen patients had more obstructive symptoms in general with dysphagia and postprandial chest pain than the Dor patients.

**Dr Jose Velasco** (Chicago, IL): As has been mentioned, indications for repair of paraesophageal hernia have evolved from the mere presence to really other indications. I notice 77% of your cases have dysphagia. In relation to the first question, how about the other ones? Was there a difference in the incidence or the prevalence of dysphasia of one to the other?

The second question relates to indication. You included any hernia that at least 50% of the stomach was in the chest. Not all of them are the same. Some of them had to do with extended mediastinal.

Did you see a difference between those cases, or really the incidence of dysphagia, irrespective of the indication? The reason for that is because the more we work on the area, the more information we create, the more likely it is transient, and after a month, in most cases will resolve, and also the incidence of vagal nerve injury at the time of repair. I think all of us have been exposed to that.

**Dr Maude Trepanier:** To answer the first question, for the small number of patients who did not have primary dysphagia and had surgery for reflux, we didn't do a subgroup analysis because of a numbers issue again.

To answer your second question, because of the retrospective nature of our study again, it was hard to determine if they had extensive mediastinal dissection.

We did look at length of the proxy measure of the complexity of the case or the length of the dissection and that was similar between groups as well. So we don't think that confounded the results in terms of dysphagia. But, again, we need larger studies to really adjust for that in the analysis.