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Forgoing Preoperative Manometry for Minimally Invasive Hiatal Hernia Repair

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ABSTRACT

Introduction: Hiatal hernia commonly occurs in adults. Although most patients are asymptomatic, some experience reflux symptoms or dysphagia. These patients are frequently managed with acid suppression and lifestyle changes. However, medical management does not provide durable relief for some patients; therefore, surgical repair is considered. Routine preoperative investigations include esophagoscopy, esophagography, and manometry. We investigated the role of preoperative motility studies for the management of these patients when partial fundoplication is planned.

Methods: We performed a retrospective review of 185 patients who underwent elective minimally invasive hiatal hernia repair with partial fundoplication between 2014 and 2018. Patients were divided into two groups based on whether a preoperative motility study was performed. The primary outcomes were postoperative dysphagia, complications, postoperative interventions, and use of proton pump inhibitors.

Results: Ninety-nine patients underwent preoperative manometry and 86 did not. The lack of preoperative manometry was not associated with increased postoperative morbidity, including leak rate, readmission, and 30-d mortality. The postoperative dysphagia rates of the manometry and nonmanometry groups were 5% (5/99 patients) and 7% (6/86 patients) ($P = 0.80$), respectively. Furthermore, seven of 99 (7%) patients in the manometry group and 10 of 86 (12%) ($P = 0.42$) patients in the nonmanometry group underwent interventions, mainly endoscopic dilation, postoperatively owing to symptom recurrence.

Conclusions: Forgoing preoperative manometry was not associated with significant adverse outcomes after minimally invasive hiatal hernia repair. Although manometry is reasonable to perform, it should not be considered a mandatory part of the preoperative assessment when partial fundoplication is planned.

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Introduction

Hiatal hernia is quite common in adults, with an approximate incidence of five per 1000 patients.[1] Furthermore, hiatal hernia tends to affect the elderly population, with a median age range of 65-75 y at presentation.[2] Most patients are asymptomatic. However, the management of symptomatic patients includes acid suppression and lifestyle changes. Symptoms include chest pain, heartburn, reflux, dysphagia, and atypical symptoms, such as cough and dyspnea. When patients do not experience relief with medical management, surgical intervention is considered. The preoperative workup for these patients generally includes contrast studies (barium esophagram), upper endoscopy, and motility studies.

Preoperative manometry is strongly recommended for patients who plan to undergo hiatal hernia repair.[3] There is a concern that hiatal hernia repair with fundoplication in patients with undiagnosed motility disorders will worsen postoperative dysphagia; therefore, high-resolution manometry (HRM) is considered a valuable diagnostic tool before surgical repair.[4] Additionally, the previous literature has questioned the utility of performing preoperative manometry for patients with a large paraesophageal hernia.[1] However, the value of preoperative manometry on a wide variety of hiatal hernias with multiple predominant symptoms is unclear. Additionally, whether forgoing preoperative manometry affects postoperative complications, postoperative dysphagia, or quality outcome measures is uncertain.

This study aimed to evaluate the role of preoperative manometry in the management of patients scheduled to undergo minimally invasive hiatal hernia repair with partial fundoplication. We examined postoperative outcomes, including dysphagia, reintervention, and quality indicators for patients who did or did not undergo manometry, before minimally invasive hiatal hernia repair.

Material and Methods

Patient population

We performed a retrospective review of 185 patients who underwent elective minimally invasive hiatal hernia repair between 2014 and 2018. Minimally invasive techniques included laparoscopic, robotic SI, and robotic XI platforms. Two surgeons performed most of the procedures. Patients were divided into those who did (manometry group, $n = 99$) and did not (nonmanometry group, $n = 86$) undergo preoperative manometry. The institutional review board approved the retrospective study design, and a specific waiver of consent was obtained. The primary outcomes of interest were postoperative complications, including dysphagia, reintervention, and 30-d hospital readmission. The secondary outcomes were objective quality outcome data, which included symptom recurrence and proton pump inhibitor (PPI) use at 1 y. Patients who presented with gastric volvulus were excluded from this study.

Preoperative workup

Clinical evaluations and subsequent procedures were performed by two surgeons. For most patients, the preoperative workup included esophagogastroduodenoscopy, barium swallow esophagram, and plain chest radiography or computed tomography. Additionally, patients with sliding type I hernia underwent pH testing. When patients who had not undergone HRM presented to the clinic, one surgeon ordered HRM before surgery and the other surgeon generally proceeded to surgery without HRM. Furthermore, a subset of patients underwent manometry before surgical consultation. Additionally, a group of patients were unable to tolerate manometry because of the size of the hernia. Chart reviews were performed for patients with abnormal motility. The manometry reports were individually reviewed to confirm the results. The data included motility parameters that mirrored the contemporaneous Chicago classification (version 3.0) at the time of surgery. None of the patients had achalasia, including the three subtypes.

Surgical technique

All patients included in the study underwent a minimally invasive hiatal hernia repair with partial fundoplication. After the reduction of the hiatal hernia, mediastinal dissection was performed to ensure an adequate intra-abdominal esophageal length. Partial fundoplication using either a posterior Toupet or an anterior Dor was performed at the discretion of the attending surgeon. Patients who underwent Nissen fundoplication, Roux-en-Y reconstruction, or the LINX procedure were excluded from this study.

Statistical analysis

Categorical variables in the data (such as differences in primary outcome, categorical demographics, symptoms, and proportion of patients using PPIs at 1 y) were compared using the Chi-square test. Continuous variables (such as age, body mass index, and hospital length of stay) were tested for normality using the Shapiro test. The distribution of all continuous variables was non-normal unless otherwise specified. Any continuous variables non-normally distributed were compared using the Wilcoxon rank sum test. Any continuous variables normally distributed were compared using the *t*-test. All components of statistical analysis were performed using the R statistical programming language (version 4.2.2).

Results

A total of 185 patients underwent elective hiatal hernia repair between 2014 and 2018. Their median age was 60 y, their median body mass index was 29, and 8% of patients were diagnosed with chronic obstructive pulmonary disease (Table 1). Furthermore, 8% of these patients underwent redo hiatal hernia repair. The overwhelming majority of patients

Table 1 – Patient demographics.

General characteristics	N = 185 (%)
Redo	15 (8)
Manometry	99 (54)
Recurrence	38 (21)
Median age, y*	60 [47, 67.25]
Body mass index*	29 [25, 32]
Surgeon 1	93 (50)
Surgeon 2	92 (50)
Smoker	38 (21)
Chronic obstructive pulmonary disease	15 (8)
Myocardial infarction	2 (1)
Abnormal motility	45 (24)
Ineffective esophageal motility	22
Absent peristalsis	1
Esophagogastric junction outflow obstruction	8
Hypercontractile esophagus	6
Hypotensive lower esophageal sphincter	7
Premature contractions, not otherwise specified	1
Type of hiatal hernia	
I	59 (32)
II	4 (2)
III	112 (60)
IV	10 (5.4)
Morbidity	
Reoperation	3 (2)
Leak	0
In-hospital 30-d mortality	0
Median length of stay, d*	2 [1,2]
Readmission within 30 d	8 (4)
Median number of days before presentation after surgery	7 [1,16]

*25th and 75th percentiles given in brackets.

Table 2 – Characteristics of patients who did and did not undergo preoperative HRM.

Patient characteristics	Manometry N = 99 (%)	No manometry N = 86 (%)
Median age, y*	58 (46.5, 64.0)	63 (61.0, 71.0)
Repeat	11 (11)	4 (5)
Surgeon 1*	76 (77)	17 (20)
Surgeon 2*	23 (23)	69 (80)
Body mass index, median	29.00 (25.00, 31.00)	29.00 (25.00, 32.25)
Smoker	19 (19)	19 (22)
Chronic obstructive pulmonary disease	9 (9)	6 (7)
Myocardial infarction	2 (2)	0
Abnormal motility	45 (45)	–
Mesh	92 (93)	75 (87)
Intrathoracic stomach %	–	–
<30%*	46 (46)	12 (14)
30%-49%	23 (23)	21 (24)
50%-74%	18 (18)	21 (24)
75%-99%	12 (12)	32 (37)
Type of hiatal hernia		
I	44 (44)	15 (17)
II	1 (1)	3 (3)
III	52 (53)	60 (70)
IV	2 (2)	8 (9)
Preoperative symptoms		
None	0	1 (1)
Hoarseness	9 (9)	4 (5)
Pain	47 (47)	35 (41)
Heartburn	57 (58)	40 (47)
Dysphagia*	17 (17)	29 (34)
Reflux	67 (68)	52 (60)
Dyspnea	16 (16)	18 (21)
Bloating	3 (3)	4 (5)

*Statistically significant differences were observed for age ($P < 0.01$), surgeon 1 *versus* surgeon 2 ($P < 0.01$), distributions of the intrathoracic stomach percentage ($P < 0.01$), and presence of dysphagia ($P < 0.01$).

underwent mesh reinforcement of the crural repair, and all patients underwent partial fundoplication.

Patients in the nonmanometry group were statistically significantly older than those in the manometry group (63 y *versus* 58 y, respectively). However, baseline characteristics, such as body mass index, smoking status, and a diagnosis of chronic obstructive pulmonary disease, and operative characteristics, such as the use of crural mesh, were not significantly different between the two groups (Table 2).

Based on the preoperative imaging (computed tomography, chest radiography, or esophagram) results, the estimated intrathoracic stomach percentage was inversely correlated with preoperative manometry. Preoperative manometry was more likely to be performed when the estimated intrathoracic stomach percentage was less than 30% (46/99 patients [46%] *versus* 12/86 patients [14%]; $P < 0.01$). In contrast, preoperative manometry was less likely to be performed when the estimated intrathoracic stomach percentage was 75%-99% (12/99 patients [12%] *versus* 32/86 patients [37%]; $P < 0.01$). These trends were statistically significant. The patients' predominant preoperative symptoms were noted. Interestingly, patients who predominantly reported dysphagia were less likely to undergo preoperative manometry (17/99 patients [17%] *versus* 29/86 patients [34%]; $P = 0.01$); this difference between groups was significant.

More motility studies were performed by surgeon 1 (76/99 patients; 78%) than by surgeon 2 (23/99 patients; 23%; $P < 0.01$). Abnormal motility was noted in 45% of patients who underwent manometry. During preoperative manometry, achalasia was not observed; therefore, no patients with achalasia were included in this study. Of the 45 patients with abnormal

manometry findings, 22 had ineffective esophageal motility. Although manometry indicated that one patient had absent peristalsis, other findings of achalasia, such as incomplete relaxation of the lower esophageal sphincter and esophageal pressurization, were not present. Furthermore, 67% of patients with a type I sliding hiatal hernia underwent pH testing, with a median DeMeester score of 23 [7.5, 42.9].

The primary outcomes of this study are shown in Table 3. The postoperative dysphagia rates associated with the non-manometry and manometry groups were 6.98% and 5.05%, respectively; however, this difference was not statistically significant. The postoperative morbidity rates of these groups were also noted. There were no associated differences in the rates of postoperative emergency department presentation (9/99 patients [9%] *versus* 10/86 patients [12%]; $P = 0.75$) or 30-d hospital readmission (3/99 patients [3%] *versus* 5/86 patients [6%]; $P = 0.57$) among patients who did and did not undergo HRM. Additionally, the median hospital length of stay was slightly longer for patients who did not undergo preoperative manometry (1 d *versus* 2 d; $P < 0.01$).

Seven patients who underwent manometry had an associated reintervention. Of those seven patients, three required endoscopic dilation and four required repeat hiatal hernia repair. Among the patients who did not undergo manometry, 10 had an associated reintervention. Of those 10 patients, seven required endoscopic dilation and three required repeat hiatal hernia repair. However, these differences were not statistically significant (Table 3).

Secondary outcomes such as the postoperative recurrence rate and quality indicators such as PPI use at 1 y were evaluated. Overall recurrence was defined as the development of symptomatic recurrence, radiographic (esophagogastroduodenoscopy, computed tomography, esophagram) recurrence, or recurrence requiring intervention. Forgoing preoperative manometry was not associated with an increase in overall recurrence rates (19/99 patients [19%] *versus* 19/86 patients [22%]; $P = 0.76$). PPI use at 1 y was strikingly similar in both groups. Twenty-five (25%) patients who underwent manometry and 25 (29%) patients who did not undergo manometry ($P = 0.25$) resumed PPIs, attributed to symptomatic recurrence.

Table 3 – Complications, recurrence rates, and quality-of-life outcomes.

Outcomes	Manometry $N = 99$ (%)	No manometry $N = 86$ (%)
Complications/Morbidity		
Emergency department presentation after surgery	9 (9)	10 (12)
Median time after surgery, d (Q1, Q3)	2.00 (1.00, 13.00)	11.00 (4.00, 19.00)
Median length of stay* (Q1, Q3)	1.00 (1.00, 2.00)	2.00 (1.00, 2.00)
Readmission within 30 d	3 (3)	5 (6)
Endoscopic dilation	3 (3)	7 (8)
Reoperation	4 (4)	3 (3)
Quality of life		
Postoperative dysphagia	5 (5)	6 (7)
Overall recurrence	19 (19)	19 (22)
Symptomatic recurrence	19 (19)	15 (17)
Radiographic recurrence	8 (8)	9 (10)
Required reintervention	7 (7)	10 (12)
PPI use at 1 y	25 (25)	25 (29)

A statistically significant difference was observed for the median length of stay ($P < 0.01$). No statistically significant differences were observed for recurrence rate or type of recurrence ($P = 0.76$), reintervention rates ($P = 0.42$), endoscopic dilation rate ($P = 0.23$) and postoperative dysphagia ($P = 0.81$).

Discussion

Forgoing preoperative manometry is a safe and viable option for patients scheduled to undergo elective symptomatic hiatal hernia repair with planned partial fundoplication. There was no association between postoperative dysphagia rate and the use of preoperative manometry. Additionally, there were no differences in the rates of postoperative complications, including postoperative morbidity and 30-d hospital readmission. For a small subset of patients, preoperative manometry was not associated with differences in postoperative endoscopic dilation rates or operative reintervention rates. Symptomatic, radiographic, and overall recurrence rates were explored, and our results demonstrate that forgoing preoperative manometry was not associated with increased recurrence.

In clinical practice, we favor partial fundoplication during minimally invasive hiatal hernia repair. Postoperative dysphagia and gas bloat associated with complete fundoplication are troubling postoperative symptoms that affect patient recovery and satisfaction.[5] Additionally, patients with persistent symptoms require further testing and endoscopic dilation for relief. Furthermore, regardless of esophageal dysmotility, Broeder *et al.* found that short-term dysphagia and reintervention rates associated with postoperative dysphagia were higher for patients who underwent complete fundoplication.[6] To avoid postoperative setbacks and preoperative manometry, we performed partial fundoplication on our patients. Nissen fundoplication (complete) as the standard wrap is dogmatically considered to result in dramatically lower rates of PPI use. However, multiple studies have shown that the rate of PPI use is close to 30%, thus weakening the argument for Nissen fundoplication over Toupet fundoplication.[7,8]

Our study is not the first to question the utility of preoperative esophageal manometry. A recent study by Wirsching *et al.* demonstrated similar symptomatic outcomes among patients with abnormal manometry results and those with normal manometry results.[1] Furthermore, the findings of Wirsching *et al.* raised questions regarding whether esophageal dysmotility had any effect on postoperative outcomes, thus precluding the need to perform manometry.

Additionally, a recent study by Zevin *et al.* included fewer patients and excluded patients with sliding hiatal hernias; however, they demonstrated that preoperative manometry did not impact the surgical plan and was not associated with a difference in postoperative recurrence rates.[1,9] Although these two studies questioned the use of preoperative manometry, the findings of both firmly reinforced the assertion that preoperative manometry remains an important aspect of the preoperative workup.

In contrast to these two studies, our study aimed to question the role of esophageal manometry in the workup of patients with a hiatal hernia who underwent repair with partial fundoplication. The use of manometry for giant paraesophageal hernias, which comprise a large proportion of the intrathoracic stomach, has been abandoned because of catheter coiling in the stomach and the patients' inability to tolerate the procedure.[4] However, our results showed no association between forgoing preoperative manometry and adverse outcomes of patients with moderate intrathoracic stomach involvement (30%-75%). Additionally, even among patients with predominant preoperative symptoms of dysphagia, a higher percentage did not undergo manometry. These findings question the premise that patients with predominant dysphagia symptoms should undergo preoperative manometry.

Most patients with moderate-to-large paraesophageal hernias will experience significant dysphagia caused by the structural defect of the lower esophageal sphincter.[10] In this clinical scenario, performing preoperative manometry based solely on a history of dysphagia will not optimize the operative plan and is not associated with changes in postoperative outcomes. Additionally, most patients with a large paraesophageal hernia who undergo manometry have underlying dysmotility caused by pressure changes reflective of abnormal anatomy. Although controversial, performing complete fundoplication for patients with a large hiatal hernia creates the risk of exacerbating postoperative dysphagia.[6] Partial fundoplication complements two critical aspects of the operative plan, namely, performing complete cruroplasty and obtaining an adequate intra-abdominal esophagus (>2.5 cm). Partial fundoplication obviates the need to perform preoperative manometry to identify unlikely patients with a concomitant paraesophageal hernia and a severe primary esophageal motility disorder.[11] Based on our results and experience, the main objectives of managing hiatal hernia include reducing the hernial sac, fixing the diaphragmatic defect, and obtaining adequate intra-abdominal esophageal length. To limit unchecked and clinically harmful reflux, partial fundoplication is performed.[12] The decision to proceed with complete 360° fundoplication when symptoms are mainly attributed to a structural hiatal hernia should be made with caution.

Interestingly, the lack of motility studies was not associated with increased dysphagia rates, recurrence rates, or rates of PPI use at 1 y. The overall and symptom recurrence rates of approximately 20% were comparable, if not better, than those reported previously.[13] Reasonably positive outcomes were obtained by this study population. For patients who undergo hiatal hernia repair with partial fundoplication, the addition of preoperative manometry appears to contribute little to postoperative outcomes.

Our study had some limitations. First, this study was a single-institution, nonblinded, retrospective review of two known patient groups. Second, although this study recognized the minimally invasive nature of surgical repair, there were separate groups of patients who underwent laparoscopic and robotic procedures, and these patients were not controlled for in the overall data. For the purposes of this study, we considered it reasonable to treat robotic and laparoscopic repairs as a single minimally invasive entity. Further studies are needed to elucidate the differences between these two operative approaches for this patient population. Because of the retrospective nature of this study, our practice was not standardized according to that of the two aforementioned surgeons. The differences in manometry utilization by those surgeons introduced bias; therefore, they represent a significant limitation. Additionally, ordering manometry before surgical consultation was not a standard procedure across the patient population. Finally, regarding the EndoFlip device, most surgeries were performed before the widespread use of this device to evaluate preoperative motility. Therefore, further investigation of the EndoFlip device and its impact on hiatal hernia repair should be performed.[14]

Our study did not include patients who underwent complete fundoplication. The question of whether partial or complete fundoplication should be performed was not addressed because it is our practice to perform a partial wrap. Further investigation of the degree of partial fundoplication (180° *versus* 270°) based on preoperative manometry results is required. Another limitation was that we excluded patients with acute obstruction who presented to the emergency department; therefore, these results cannot be applied to this patient population. Finally, we were unable to reasonably address the specific predictors of failure for patients who required postoperative endoscopic dilation or reintervention because the absolute number of patients who required postoperative procedures was too low.

Conclusions

Forgoing preoperative manometry for patients with symptomatic hiatal hernia should be considered before repair. Our results provide evidence that proceeding without preoperative manometry is not associated with increased rates of postoperative dysphagia or need for operative reintervention among patients who undergo a minimally invasive hiatal hernia repair with partial fundoplication. Although reasonable in certain clinical scenarios, manometry should not be deemed a mandatory portion of the preoperative assessment when partial fundoplication is planned.

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Andrew G. Marthy: Writing – review & editing, Writing – original draft, Validation, Supervision, Investigation, Formal analysis, Data curation. **Patrick Nguyen:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Emily Su:** Data curation. **Molly Mounsey:** Formal analysis, Data curation. **Erin Sahm:** Formal analysis, Data curation. **Olatoye Olutola:** Data curation, Conceptualization. **Tejinder Paul Singh:** Validation, Data curation, Conceptualization. **Thomas Fabian:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization.

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