



Surgical Management of Gastroesophageal Reflux Disease in Patients with Severe Esophageal Dysmotility

Priscila R. Armijo¹ · Dietric Hennings^{1,2} · Melissa Leon¹ · Akshay Pratap^{1,2} · Austin Wheeler³ · Dmitry Oleynikov^{1,2} 

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Abstract

Background Gastroesophageal reflux disease (GERD) and esophageal dysmotility are often disqualifying criteria for fundoplication due to dysphagia complications. A tailored partial fundoplication may improve GERD in patients with severe esophageal motility disorders. We evaluate this approach on GERD improvement in non-achalasia esophageal dysmotility patients.

Methods A single-institution prospective database was reviewed (2007–2016), with inclusion criteria of GERD, previous diagnosis of non-achalasia esophageal motility disorder, and laparoscopic partial fundoplication. Diagnosis of previous achalasia diagnosis or diffused esophageal spasm was excluded. Motility studies, pre- and post-upper gastrointestinal imaging (UGI), esophageal symptom scores, antacid, and PPI use were collected pre-op, 6 months, 12 months, and long-term (LT). Statistical analysis was made using SPSS v.23.0.0, $\alpha = 0.05$.

Results Fifty-two patients met the inclusion criteria. A total of 17.3% had esophageal body amotility, 79.6% had severe esophageal dysmotility. A total of 65.9% women (mean age 64 ± 15.7), mean peristalsis $45.3 \pm 32.6\%$, and failed peristalsis $36.0 \pm 32.2\%$. Mean LES residual pressure was 15.0 ± 18.0 mmHg, and 40.7% had hypotensive LES. Mean follow-up time was 25 months [1–7 years], with significant improvement in symptoms and reduction in PPI and antacid use at all time-points compared to pre-op. A total of 74% had UGI studies at 12 months; all showed persistent dysmotility. Six patients had radiographic hiatal hernia recurrence, with only one being clinically symptomatic postoperatively. Three required dilation for persistent dysphagia.

Conclusions A tailored partial fundoplication may be effective in symptom relief for non-achalasia patients with esophageal motility disorders and GERD. Significant symptom improvement, low HHR, and PPI use clearly indicate this approach to be effective for this population.

Keywords Esophageal dysmotility · GERD · Anti-reflux surgery · Laparoscopic partial fundoplication

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✉ Dmitry Oleynikov
doleynik@unmc.edu

¹ Center for Advanced Surgical Technology, University of Nebraska Medical Center, 986246 Nebraska Medical Center, Omaha, NE 68198-6246, USA

² Department of Surgery, University of Nebraska Medical Center, 986245 Nebraska Medical Center, Omaha, NE 68198-6245, USA

³ College of Medicine, University of Nebraska Medical Center, 986245 Nebraska Medical Center, Omaha, NE 68198-6245, USA

Introduction

Nearly 20% of the US population has a diagnosis of gastroesophageal reflux disease (GERD).¹ Pharmacological therapy is a common treatment option for GERD, accounting for half of the total cost estimate for management of the disease.² Long-term use of high-dose acid suppression treatments can contribute to loss of medication efficacy and side effects.² However, surgical management provides an alternative treatment and may have a significant role in treating GERD.^{1,2} Patient surgical candidacy and choice of anti-reflux surgical technique vary according to several factors including patient symptomatology, previous treatment, response to medication use, and esophageal function.¹ Very often, GERD is associated with other disorders, such as gastroparesis, eosinophilic

esophagitis, and esophageal dysmotility. Therefore, a preoperative workup including symptom evaluation and esophageal testing must be performed to achieve the best possible results.¹

Esophageal motility disorders comprise a large variety of disease of the esophagus. While the majority of authors have exhausted the study of achalasia and its implications,^{3–6} there are limited data on other esophageal motility abnormalities and their relationship with GERD surgical treatment.⁷ Patients with GERD and esophageal dysmotility disorders are often told they are not candidates for fundoplication due to fears of worsening dysphagia.^{8–10} We hypothesized that a tailored partial fundoplication might improve symptoms in GERD patients who have severe esophageal motility disorders. This study aimed to evaluate the effectiveness of tailored partial fundoplication in the improvement of GERD in non-achalasia esophageal dysmotility patients.

Materials and Methods

Population

After receiving Institutional Review Board approval, a retrospective analysis of a prospectively collected database at a single-institution was performed. This database was queried for patients with a diagnosis of GERD, who underwent anti-reflux surgery between 2007 and 2016. Only adult patients with previous diagnosis of severe esophageal dysmotility, who had a primary surgery performed in a laparoscopic fashion, were included in this study. Inclusion criteria were based on Chicago Classification for amotility of the esophageal body or ineffective peristalsis seen in preoperative esophageal manometry.¹¹ The first group of patients underwent conventional line tracing manometry evaluation, whereas the second received high-resolution manometry. Patients with diffuse esophageal spasm (DES) or achalasia were excluded. The remaining patients studied had ineffective esophageal motility disorder (IEMD) which includes a wide variety of dysmotility. These patients were further divided into amotility and ineffective motility. Amotility was defined as manometric findings showing failed progression of peristalsis down the esophageal body (weak distal amplitude waveforms) with preserved LES function, or absence of peristalsis. Ineffective motility comprised manometric findings with adequate peristalsis of the esophageal body and frequent failed swallows leading to failed bolus clearance from the esophagus. All patients had a DCI lower than 500 mmHg-cm-s, an amplitude lower than 40 mmHg, and an IRP \leq 15 mmHg. All patients evaluated during the study period who had poor esophageal function and GERD were offered a partial fundoplication. Patients who had peristalsis \geq 80% and esophageal amplitudes between 10 and 30 were offered a total fundoplication.¹²

Surgical Technique

After proper and secure patient placement and induction of anesthesia, a Toupet fundoplication technique was performed. A clip marked the location on the greater curvature of the stomach that is 3 cm distal and posterior to the GEJ. The standard “shoeshine” maneuver was used in order to create a floppy fundoplication, and the wrap was secured approximately 2 cm apart to the esophagus. The Penrose drain was removed after the first suture, and the fundoplication was secured to the hiatus via stitches on both crura, taking bites of the wrap, esophagus, and diaphragm. At the completion of the procedure, a routine endoscopy was performed to confirm smooth entry into the stomach at the GEJ and to visualize the completed wrap to ensure symmetry on retroflexion. A hiatal hernia repair was performed when necessary, prior to the Toupet fundoplication.¹³

Outcomes Measured

Patient demographics, medical and surgical history, and medication use were collected. Intra-operative data included surgical approach, type of fundoplication, and performance of hiatal hernia repair at time of surgery. Preoperative esophageal studies included upper gastrointestinal imaging (UGI), esophageal manometry, and upper endoscopy (EGD). A preoperative pH study was performed in all patients, unless a large PEH (greater than 5 cm) was present, or esophagitis was seen on biopsy. UGI was also performed at 1 year postoperatively, or earlier if clinically indicated. Primary outcome of interest was esophageal symptoms score, which were assessed preoperatively and at 1-, 6-, and 12-month, and at long-term (LT) follow-up. LT was defined as follow-up greater than 15 months postoperatively.

The esophageal symptoms score questionnaire was used to indicate the frequency that the patients experienced esophageal reflux symptoms (heartburn, regurgitation, solid and liquid dysphagia, abdominal pain, belching, bloating, and nausea). Frequency symptom data was collected by the 0 to 4 algorithm: 0 = never, 1 = once per month, 2 = twice per week, 3 = three times per day, and 4 = several times per day.¹⁴ The presence of symptom was defined as a score of 1–4 and absence as a score of zero.

Statistical Analysis

Categorical data were reported as frequency percentage, and continuous data were reported as mean \pm standard deviation (SD) or median [interquartile range, IQR] according to normality of the data. Descriptive analysis, Chi-square Pearson test with Bonferroni correction, and univariate analysis of variance were used where appropriate. The improvement of symptoms at 6-month, 12-month, and LT follow-up compared

to the baseline was analyzed using the nonparametric sign test with Bonferroni correction.¹⁴ All statistical analysis was performed using IBM SPSS v.23.0, with a level of significance of 0.05. The significant α level cut-off was adjusted as appropriate.

Results

Among the 548 patients who underwent anti-reflux surgery during this period, 54 met the inclusion criteria. Two patients were further excluded for receiving a Dor fundoplication. Out of 52 patients included in this study, 65.4% ($N=34$) were women, all patients were Caucasian, mean age was 64 ± 15.7 years, and mean preoperative body mass index was 28.42 ± 4.86 kg/m² (Table 1). Diabetes was the most common preexisting comorbidity ($N=30$), followed by hypertension ($N=29$), and lung diseases ($N=15$). All patients underwent laparoscopic Toupet fundoplication and had a hiatal hernia repair done at the time of the anti-reflux surgery, with 59.6% ($N=31$) having a HH greater than 5 cm.

Esophageal manometry test analysis revealed that nine (17.3%) patients had amotility of the esophageal body, whereas 79.6% had ineffective peristalsis. Mean operative time was 188 ± 53.9 min, and blood loss was minimal. Majority of patients (86.5%, $N=45$) were discharged home within 48 h of the procedure. There were no surgical conversions. One patient had postoperative urinary retention requiring discharge with urinary catheter.

Mean overall follow-up time was 25 months [1–7 years], with mean LT follow-up being 35 months [15–87 months]. There was a significant improvement in esophageal symptoms at 6-month, 12-month, and LT follow-up, compared to pre-op (Table 2), with nearly 75% of patients reporting significant improvement of their dysphagia at LT (Table 3). In addition, there was a significant reduction in use of proton pump inhibitors and antacid after the surgery (pre-op vs 6 months, pre-op

vs 12 months, and pre-op vs LT), all $p < 0.001$ (Table 3). Sub-analysis according to manometric findings revealed similar patterns postoperatively, with significant improvement of dysphagia and a significant reduction in PPI and antacid use postoperatively, for both amotility and ineffective motility patients (Table 3).

Forty patients (74%) had UGI studies at 12 months, and all showed persistent dysmotility. Radiographic hiatal hernia recurrence was seen in six patients (11.1%), with only one showing clinical reflux. Three patients required postoperative EGD dilation due to persistent dysphagia. No reoperations were performed in this group.

Discussion

This case series of 52 patients revealed that partial fundoplication is an effective and safe approach for the GERD treatment in patients with non-achalasia and severe esophageal dysmotility. Nearly 85% of patients were discharged within 48 h of the procedure, and postoperative complication rate was found to be lower than 10%. At 12-month and long-term follow-up, our data showed a significant improvement of esophageal symptoms compared to the baseline, concomitant to a significant reduction in PPI use.

Several authors have published the effectiveness of a tailored fundoplication on clinical outcomes.^{14–17} We have previously published the long-term outcomes of patients after a total or partial fundoplication with a concurrent hiatal hernia repair, resulting in good symptoms control and low rates of PPI use.¹⁴ However, all patients with a preexisting diagnosis of GERD were included in that analysis, regardless of an association with another esophageal disorder. A randomized trial comparing 64 patients who underwent either a Dor or Nissen fundoplication demonstrated that the anterior partial fundoplication technique was as feasible and effective as its total counterpart, with similar improvement of esophageal

Table 1 Descriptive of patients grouped according to manometric findings

		Amotility $N=9$	Ineffective motility $N=43$
Age—years (mean \pm SD)		64 ± 15.2	64 ± 15.2
Gender— N (%)	Male	1 (11.1%)	17 (39.5%)
	Female	8 (88.9%)	26 (60.5%)
Race— N (%)	Caucasian	9 (100%)	43 (100%)
BMI—kg/m ² (mean \pm SD)		28.4 ± 5.6	28.4 ± 4.8
Smoker— N (%)		0 (0%)	2 (4.7%)
Comorbidities— N (%)	Diabetes	5 (55.5%)	25 (58.1%)
	Hypertension	4 (44%)	25 (58.1%)
	Lung diseases	2 (22%)	13 (30.2%)
	Hyperlipidemia	3 (33%)	7 (16.3%)
Hiatal hernia size— N (%)	> 5 cm	6 (66.7%)	25 (58.1%)

SD standard deviation

Table 2 Symptom improvement over time for all patients (N = 52)

Gastrointestinal	Preop prevalence N (%)	Improved symptom score compared to preoperative baseline					
		6 months, N = 43		12 months, N = 40		Long-term, N = 30	
		Improved patients N (% ^a)	p value*	Improved patients N (% ^a)	p value*	Improved patients N (% ^a)	p value*
Heartburn	40 (76.9%)	33/33 (100%)	< 0.001	30/30 (100%)	< 0.001	20/24 (83.3%)	< 0.001
Regurgitation	35 (67.3%)	27/29 (93.1%)	< 0.001	25/27 (92.6%)	< 0.001	18/19 (94.7%)	< 0.001
Solid Dysphagia	30 (57.7%)	23/25 (92%)	< 0.001	24/24 (100%)	< 0.001	14/16 (87.5%)	0.115
Liquid Dysphagia	17 (32.7%)	12/12 (100%)	< 0.001	12/12 (100%)	< 0.001	9/10 (90%)	0.146
Abdominal pain	20 (38.5%)	12/16 (75%)	0.003	14/16 (87.5%)	0.001	8/8 (100%)	0.227
Belching	21 (40.4%)	15/17 (88.2%)	0.078	12/16 (75%)	0.035	9/10 (90%)	0.021
Bloating	20 (38.5%)	13/16 (81.3%)	0.049	12/13 (92.3%)	0.077	7/8 (87.5%)	0.344
Nausea	17 (32.7%)	12/13 (92.3%)	< 0.001	9/10 (90%)	0.065	7/9 (77.8%)	0.180

preop preoperative, N population size

*Significant alpha level cut-off of 0.017 is used instead of 0.05 due to multiple comparisons

^a Percent improved calculated using the number of patients who replied and were symptomatic preoperatively

symptoms, quality of life, and DeMeester scores in a mid-term follow-up.¹⁸ A similar finding was seen in our study, although the authors used a slightly different scale for the calculation of symptom frequency, and there was no information on preoperative esophageal function. In a randomized clinical trial of outcomes 17 years following laparoscopic Nissen fundoplication, 49% of patients reported dysphagia, with 9% being severe, whereas 43% and 25% reported mild or severe heartburn and regurgitation, respectively.¹⁶ In that same cohort, 42% were found to be on acid suppressing medications at long-term, although 65% of patients who were on PPI at 10-year follow-up had no objective pathological clinical exposure

to acid. Still, overall satisfaction level was greater than 75%. A double-blind randomized control trial of GERD patients with normal motility found similar improvement of GERD symptoms and reflux control in patients at 12 months after receiving Toupet and Nissen fundoplication.¹⁷ Our current findings support similar results for a specific population of patients with severe dysmotility who undergo anti-reflux surgery, with 12-month postoperative rates of heartburn and regurgitation of 20% and 7.5%, respectively.

Despite the comprehensive knowledge accumulated, the effects of fundoplication in patients with severe dysmotility are still debatable. Early studies have demonstrated positive

Table 3 Dysphagia prevalence over time, and comparison of follow-up versus baseline, for overall patients and according to manometric findings

		Preop		6-mo		12-mo		LT	
		N = 51		N = 43		N = 40		N = 30	
OVERALL									
Dysphagia	Yes	30	58.8%	4 ^a	16.3%	4 ^a	10%	8 ^a	26.7%
PPI use	Yes	49	94.2%	11 ^a	29.7%	11 ^a	30.6%	7 ^a	23.3%
Antacid use	Yes	42	80.8%	10 ^a	26.3%	10 ^a	27.8%	4 ^a	13.3%
Amotility		N = 9		N = 8		N = 7		N = 6	
Dysphagia	Yes	5	55.6%	2	25%	1	14.3%	2	33.3%
PPI use	Yes	9	100%	3 ^a	42.9%	2 ^a	33.3%	2 ^a	33.3%
Antacid use	Yes	9	100%	3 ^a	42.9%	3	50%	2 ^a	33.3%
Ineffective Motility		N = 42		N = 35		N = 33		N = 24	
Dysphagia	Yes	25	59.5%	5 ^a	14.3%	3 ^a	9.1%	6 ^a	25%
PPI use	Yes	40	90.3%	8 ^a	26.7%	9 ^a	30%	5 ^a	20.8%
Antacid use	Yes	33	76.7%	7 ^a	22.6%	7 ^a	23.3%	2 ^a	8.3%

*Only one patient had GERD diagnosed in the UGI at long-term follow-up

Preop preoperative, 6-mo 6-month follow-up, 12-mo 12-month follow-up, LT long-term follow-up, UGI upper gastrointestinal imaging, N population size

^a p value < 0.017, compared to the baseline

Significant alpha level cut-off of 0.017 was used instead of 0.05 due to multiple comparisons

outcomes of patients with esophageal dysmotility after Nissen fundoplication.^{19–23} In a case series of 31 patients with dysmotility, 90% reported satisfaction scores greater than 8, on a 10-scale, with significant decrease of dysphagia after a total fundoplication.¹⁹ We have previously compared outcomes between partial and total fundoplication among patients with dysmotility and have shown a significant improvement in heartburn and dysphagia, with high rates of acid reflux resolution after Nissen fundoplication.²⁰ However, those studies were performed in the era of conventional manometry.^{19–23} Esophageal dysmotility was then defined as peristalsis greater than 60%, or amplitude ≥ 30 mmHg, and this esophageal testing used to classify the patients had a low sensitivity. In the current study, majority of patients had a HRM performed preoperatively, and the criteria for dysmotility used was DCI lower than 500 Hg-cm-s, amplitude lower than 40 mmHg, with IRP ≤ 15 mmHg. Moreover, 17% of our patients had no motility preoperatively, with the remaining presenting with severe dysmotility. We believe that patients who were classified as having defective peristalsis in those earlier studies would actually be considered to have a normal peristalsis or very mild dysmotility on HRM, since they presented with amplitude averages of 30 mmHg, and body peristalsis mainly of 60–80%. Therefore, a total fundoplication could be offered to those patients, and indeed would result in good outcomes, as reported in those previous studies. Still, earlier comparisons between Nissen and Toupet outcomes also revealed the later to provide improved rates of dysphagia, lower DeMeester scores, and improved manometric parameters in those patients postoperatively.^{20,21}

Few authors have examined the association of GERD with concomitant dysmotility, and its impact in quality of life after anti-reflux surgery, and the results vary widely throughout literature.^{24–27} Postoperative LES pressure has been reported to be higher in patients receiving a total fundoplication versus its partial counterpart.^{24,28,29} Evidence exists that partial fundoplication can be as effective for GERD as Nissen.^{24,30} A 5-year follow-up study of 50 patients revealed a significant decrease in DeMeester scores, and esophageal symptoms after both total and partial fundoplication³⁰. Likewise, similar rates of postoperative pathologic reflux seen in endoscopy (3.4% vs 5.6%) and pH testing (6.9% vs 10.9%).²⁴ In fact, patients reported higher reflux recurrence in the Nissen group.²⁴

Herbella et al. evaluated 71 patients who underwent anti-reflux surgery and compared the manometric findings between the partial and total fundoplication groups.²⁵ Conversely, the authors found that although there was an increase of LES pressure and distal amplitude after both fundoplication techniques, a higher rate of normalized peristalsis was seen among Nissen patients (86%).²⁵ Another study comparing patients with normal versus poor esophageal body motility, who underwent Nissen and Toupet fundoplication, respectively, revealed that the latest group

experienced lower rates of dysphagia postoperatively, with 91% of patients reporting overall improved symptoms. On the contrary, a study performed in Germany found a significant increase in mean amplitude of esophageal contraction in 11 patients with hypomotility following a total fundoplication.²⁷ Yet, the authors did not evaluate symptom resolution or freedom of medication, and their follow-up time was only 6 months.

After following patients for 3 years, Simic et al. described rates of postoperative dysphagia ranging from 38 to 57% among patients with reflux esophagitis who underwent open Nissen surgery, depending on the subset of ineffective esophageal motility present preoperatively.²⁸ In contrast, Fibbe et al. reported that the esophageal motor function of patients with dysmotility remained unchanged after receiving fundoplication.²⁹ Moreover, the authors stated that postoperative dysphagia was directly related to type of fundoplication offered, rather than to preoperative esophageal function.²⁹ Strate et al. also found that Nissen fundoplication resulted in higher rates of dysphagia among patients with preexisting dysmotility compared to those undergoing Toupet fundoplication.²⁴ A meta-analysis from 2016 revealed similar findings, with equivalent benefits resultant from Toupet and Nissen. Interestingly, there were lower rates of postoperative dysphagia in the Toupet overall, but no difference in the rates between the two fundoplication types for patients with preoperative esophageal dysmotility.³¹

Due to the controversial data existent in literature, authors have looked for alternatives to surgical treatment of GERD in patients with poor motility. Roux-en-Y gastric bypass has been shown to significantly improve GERD symptoms, with lower recurrence rates postoperatively, although it has been indicated for patients with elevated body mass index.^{2,32} Yan et al. looked at a case series of 14 patients and found that all patients who received RYGB improved their symptoms of heartburn, regurgitation, and dysphagia, versus only 50% in the fundoplication group². However, they included both total and partial fundoplication in the latest group, which could have explained why half of the patients did not report similar improvement. Another group recommends laparoscopic RYGB for GERD patients who have a preoperative BMI greater than 35 kg/m.^{2,32} Nonetheless, patients included in our cohort had a mean preoperative BMI of 28 kg/m², and there is still lack of evidence on the benefits of the alternative surgical techniques for the studied population.

The current analysis revealed a prevalence of 26.7% ($N=8/30$) patients with dysphagia at LT, which is already lower than the rates previously published. Furthermore, a third of those patients rated its frequency to be once a month. Given the evidence in improved tangible and clinical outcomes of patients with GERD who underwent a tailored partial fundoplication, the findings of the current study emphasize the effectiveness of this surgical technique in controlling not

only objective GERD parameters, but also postoperative symptoms, including dysphagia.

Limitations of this study include its retrospective nature and the small sample size. Despite the expected decrease in follow-up rates over time, which could be due to complete resolution of symptoms and/or initial diagnosis,¹⁴ our median follow-up time was over 2 years. The lack of pH testing or esophageal manometry data at long-term postoperatively could also be a limitation, which was minimized by upper GI performed at 12 months of follow-up. Although we only included one group in this analysis, our objective was to evaluate the efficacy of performing a partial fundoplication in patients with severe esophageal dysmotility and the clinical outcomes of this specific population. The cause-effect of GERD and esophageal dysmotility disorders was also out of the scope of this study. Nonetheless, we feel confident that our analysis supports improvement in the quality of life of these patients, due to a decrease in esophageal symptoms and freedom of PPI medication postoperatively.

Conclusion

In conclusion, this study demonstrates the efficacy of tailored partial fundoplication in symptom relief including dysphagia for non-achalasia patients with severe esophageal motility disorder and GERD. Significant symptom improvement, low rate of hiatal hernia recurrence, and freedom from PPI illustrate that a tailored partial fundoplication is effective in patients with esophageal dysmotility and GERD.

Author's Contribution The contribution of each author, as defined by the ICMJE guidelines, is as follows: PRA: data acquisition, analysis, and interpretation; drafting and revision; final approval; accuracy and integrity; DH: data acquisition, analysis, and interpretation; drafting; final approval; accuracy and integrity; ML: data acquisition, analysis, and interpretation; revision; final approval; accuracy and integrity; AP: data acquisition, analysis, and interpretation; drafting; final approval; accuracy and integrity; AW: data acquisition, analysis, and interpretation; drafting; final approval; accuracy and integrity; DO: design of work, data acquisition, analysis, and interpretation; revision; final approval; accuracy and integrity.

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