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ORIGINAL ARTICLE

ESOPHAGEAL MOTILITY IN GASTROESOPHAGEAL REFLUX DISEASE BEFORE AND AFTER LAPAROSCOPIC NISSEN FUNDOPLICATION

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Abstract

Background and Aims: The aim of this study was to determine whether esophageal motor function changes after Laparoscopic Nissen Fundoplication (LNF) and whether esophageal dysmotility affects symptoms of Gastro-Esophageal Reflux Disease (GERD) or clinical outcome postoperatively.

Methods: This study included 200 patients with GERD who were operated upon by LNF in El-Mansoura Gastroenterology Surgical Center in the period between January, 2002 and March, 2008. All patients were subjected preoperatively to thorough clinical evaluation, upper endoscopy, barium study, esophageal manometry and 24-hour pH metry. Patients were stratified according to presence (24 cases) or absence of esophageal dysmotility (176 cases) and all underwent LNF. At postoperative follow-up (early within 6 months and late after 5 years from the date of surgery), preoperative tests were repeated,

Results: Mean Lower Esophageal Sphincter (LES) pressure improved from 10.9 mmHg to 22.3 mmHg ($p<.001$), while, the amplitude of peristaltic waves in different parts of the esophagus showed no significant change and the results were nearly similar to the preoperative values ($p>.05$). Esophageal dysmotility had no effect on the severity of reflux or the clinical outcome postoperatively ($p>.05$). All cases with preoperative esophageal dysmotility had postoperative normal body motility ($p<.001$).

Conclusions: The significant increase in basal LES pressure after LNF in patients with symptomatic GERD appears the most dramatic effect of fundoplication on esophageal physiology and should explain the efficacy of the surgical antireflux procedure. Esophageal dysmotility (1) does not reflect more severe disease; (2) does not affect postoperative clinical outcome; and (3) may improve with fundoplication.

Keywords: Esophageal Motility, GERD, Laparoscopic Nissen Fundoplication.

INTRODUCTION

It is accepted that in GERD, a functional defect of the LES is of major etiologic importance.[1]. However, the role of motor abnormalities of the esophagus body in the pathogenesis and clinical symptoms of GERD is poorly understood. In most patients with reflux disease, reflux seems to occur during transient, inappropriate (not induced by deglutition) LES relaxations.[2] It has been suggested that LNF prevents GERD by changes in the

mechanical properties and action of the gastroesophageal junction that result in incomplete abolition of the high-pressure zone during LES relaxation and reduced triggering of transient sphincter relaxations.[3]

Physiologically, primary esophageal peristalsis removes and neutralizes refluxed acid and is therefore crucial to prevent peptic esophagitis.[4] Impaired esophageal body motility is a common finding in GERD, with a prevalence of 25% in patients with mild disease and up to 50% in patients with severe disease,[5] but it is controversial whether esophageal dysmotility is a cause or consequence of the disease.[6] It has been suggested that reflux control may partially restore disturbed esophageal motor function.[7] However, it is uncertain whether surgery alters normal or impaired esophageal motility, or whether adjusting surgical techniques not only to anatomic defects but also to underlying motor disturbances (tailored concept) improves clinical outcome.[8]

The aim of this study was to determine whether esophageal motor function changes after LNF and whether esophageal dysmotility affects symptoms of GERD or clinical outcome postoperatively.

PATIENTS AND METHODS

This prospective study included 200 patients with GERD, who were operated upon by LNF in El-Mansoura Gastroenterology Surgical Center in the period between January, 2002 and March, 2008. 122 (61%) were males and 78 (39%) were females. Mean age was 36.1±9.5 years (range 18-64).

Preoperative Assessment: All patients were subjected to thorough clinical evaluation, upper endoscopy, barium study, esophageal manometry and 24-hour pH metry.

Clinical assessment: The typical reflux symptoms were analyzed. DeMeester's score was used for the assessment of the severity of these reflux symptoms.[9] Endoscopic assessment: For grading esophagitis, modified Savary-Miller classification was used.[10] Radiological assessment: Gastro-esophageal reflux was detected;(1) Mild, when induced by water-siphon test,(2) Moderate, when free reflux occurs in the recumbent position or(3) Severe when free reflux takes place in both recumbent and upright position. Esophageal manometry: Esophageal motility was evaluated using eight-lumen perfused manometric catheters. The recording catheter was introduced through the nose, after slight pharyngeal anesthesia, into the stomach. In this way, the distances from the incisors were comparable to endoscopic findings. The end-expiratory fundic pressure was taken as zero reference and all values were expressed in mmHg. The manometric characteristics of the LES were determined. The resting pressure was taken as the mean of the two slow pull-through measurements in each of the 4 catheters. Thoracic esophageal motility was evaluated by positioning three holes at 5, 10, and 15 cm proximal to the upper border of the LES. Ten wet swallows were assessed at each level. The mean values of these swallows were analyzed in each patient to evaluate proximal, mid, and distal esophageal body motility. The percentage of abnormal waves was recorded. 24- Hour PH Monitoring: Monitoring was performed over nearly 24 hours with the patient fully ambulant at hospital. Drugs known to affect gastroesophageal function were withheld for one week before and during this study. DeMeester (DM) score based on six reflux parameters (total percentage reflux time, erect percentage reflux time, supine percentage reflux time, total number of reflux episodes, number of reflux episodes > 5 min. and time for the longest reflux episode) was used.

Surgery: LNF was performed for all cases: after satisfactory hiatal dissection, the crura are closed behind the esophagus using 0-silk sutures. The fundus is wrapped around the lower end esophagus and is sutured to the anterior fundus on the right side of the esophagus using three sutures of 2-0 silk sutures placed approximately 1 cm apart. At least two of these sutures incorporate a partial-thickness bite of the esophagus. The fundoplication should be floppy and no longer than 2 cm.

Postoperative Assessment: All patients were asked to come for follow up visits at least twice; the first follow up visit was within the first 6 months after surgery (early follow up) and the second one at least after 5 years (late follow up). At the follow up visit, each patient was assessed in the same way of preoperative assessment, i.e., clinical evaluation, endoscopic examination, radiological study, esophageal manometry and 24-hour pH metry. All the patients were assessed clinically both early and late. 180 and then 160 cases underwent anatomical and physiological assessment both early and late respectively.

Statistical Analysis: Statistical analysis was done using SPSS statistical package for social science program, version 1999. Kolmogrov-Smirnov test was done to determine distribution of data whether parametric or none. The parametric data were presented in the form of mean, standard deviation and range. Student (t) test was done to compare between two groups. Paired (t) test was used to compare between two measurements of some groups. The non-parametric data were presented in the form of median and range. Mann Whitney (u) test was done to compare between each two groups. Significance was considered when p-value was < 0.05. Insignificance was considered when p-value was ≥ 0.05.

RESULTS

Total results of esophageal motility

Mean LES pressure improved significantly from

preoperative values. It had increased from 10.9 mmHg to 25.5 mmHg at early follow up and 22.3 mmHg at late follow up (p<.001). LES relaxation showed no significant difference (p>.05).

The amplitude of peristaltic wave in different parts of the esophagus showed no significant change and the results were nearly similar to the preoperative values (e.g. Distal amplitude was 74.2 preoperatively, 81.3 early postoperative and 80.2 late). The percentage of abnormal peristaltic waves had not improved after surgery (p>.05).

The late postoperative LES pressure was >10 mmHg in all cases except in 4 (2.5%) cases with wrap disruption; 2 were re-operated upon (one open and one laparoscopic) and the other 2 were managed medically and not submitted to re-operation because one had high liver enzymes and the other refused re-operation. The late postoperative esophageal body pressure was >35 mmHg in all cases. 4 cases had a percentage of abnormal peristaltic waves >20% preoperatively, but no one postoperatively (Table 1).

Table 1. Total results of esophageal motility.

Data	Pre-op. Mean value	Early post-op. Mean value	Late post-op. Mean value
LES Study			
-LES P (mmHg)	10.9±5.3	25.5±5.8	22.3±4.2
-LES R (%)	98.4±2.1	94.9±5.5	96.9±4.1
Body Study			
-Proximal Amplitude (mmHg)	45.1±21.6	49.4±18.3	47.9±14.8
-Proximal duration (sec)	2.1±0.6	2.1±0.5	2.1±.5
-Middle amplitude (mmHg)	54.9±28.6	55.2±19.3	52.9±19.4
-Middle Duration (sec)	2.36±0.5	2.4±0.5	2.3±0.5
-Distal amplitude (mmHg)	74.2±31.8	81.3±29.3	80.2±25.2
-Distal duration(sec)	2.6±0.6	2.8±0.7	2.8±0.7
-Velocity. (cm/sec)	3.9±1.8	3.5±1.1	3.4±0.9
-% Normal waves	95.2±3.9	96.2±7.6	96.7±4.4
-% Abnormal waves:			
→Simultaneous	2.1±2.1	2.4±6.4	1.4±2.7
→Non transmitted	1.9±3.1	1.0±2.7	1.4±2.6
→Retrograde	0.7±0.9	0.5±1.6	1.6±3.3
Total	**200**	**180**	**160**

On comparing preoperative with early and late postoperative results,
All p values were >.05 except for LESP.

Effect of defective les pressure upon GERD severity and surgery outcome

GERD severity

104 (52%) patients had LES pressure ≤10 mmHg, while the remaining 96 (48%) had pressure >10 mmHg. 92(88.5%) cases of the first group and 62 (64.6%) of the second group had severe heartburn (p<.05). This first group also showed a significant higher esophagitis grading (II, III&IV) in comparison with the other group (69.2:45.9% respectively) (p<.05) but with no difference as regard radiological reflux study. Pathological acid reflux score was also higher in this group (43.2:32.9 DM score respectively) (p<.05).

Surgery Outcome

Despite the clinical assessment of all cases in both groups, 82 cases of the first group and 78 of the second underwent the late anatomical and functional assessment.

Clinical Results

Clinical results were similar in both groups; 92(88.5%) cases of the first group and 86(89.6%) of the second showed heartburn relief, while 96(92.3%) and 92(95.8%) respectively had no regurgitation (p>.05).

Anatomical and functional results

Endoscopic and radiological results were nearly similar; 76 (92.7%) and 72 (92.3%) respectively had no endoscopic esophagitis, while 74 (90.2%) and 76 (97.4%) respectively showed no radiological reflux (p>.05). 14 cases had wrap problems; 12 in the first group (8 migrated up, 2 tight and 2 disrupted) and 2 in the second (disrupted) (p>.05).

Mean LES pressure was improved similarly (p>.05) in both groups (22.3 mmHg and 22.3 mmHg respectively), whereas mean pH scores dropped into 6.5 and 3.7 DM score respectively (p<.05). The four cases with postoperative defective LES pressure and positive pathological acid reflux (with disrupted wrap) were included 2 in the first group and 2 in the second (Table 2).

Table 2. Motility and PH metry results in patients with defective LES compared with normal ones.

Data	Pre-op.		Late post-op.	
	LES≤10	LES>10	LES≤10	LES>10
MOTILITY STUDY	MEAN	MEAN	MEAN	MEAN
-LES study				
-LESP (mmHg)	6.8±2.0	15.3±4.2	22.3±4.7	22.3±3.7
-LESR (%)	98.9±1.5	97.8±2.4	97.1±2.7	96.6±5.2
-Body study				
-Distal amplitude (mmHg)	71±29.3	77.7±33.9	78±24.7	82.4±25.8
-% Normal waves	99.3±4.1	95.1±3.9	96.4±4.5	96.9±4.4
PH METRY				
-%TR total	12.2±6.4	9.5±6.9	0.5±0.1	0.6±0.9
-DM score	43.2±23.1	32.9±22.9	6.5±1.5	3.7±1.9
Total	**104**	**96**	**82**	**78**

On comparing preoperative with early and late postoperative results,
All p values were >.05.
%TR =% time Reflux Total.

Effect of esophageal body dysmotility upon GERD severity and surgery outcome

GERD Severity

Patients with esophageal body pressure ≤35 were only 24(12%), while those with pressure >35 were 176(88%). Both groups were nearly similar as regard clinical, endoscopic, radiological, esophageal manometry and pH metry aspects (p>.05).

Surgery Outcome

All cases in both groups were reassessed clinically, but 20 cases of the first group and 140 of the second had the late anatomical and functional assessment.

Clinical Results

Clinical results were similar in both groups; 22 (91.7%) cases of the first group and 156 (88.6%) of the second documented heartburn disappearance, while 24 (100%) and 164 (93.2%) respectively had no regurgitation (p>.05).

Anatomical and functional results

Endoscopic and radiological results were similar; 18 (90%) cases and 130 (92.9%) respectively had no esophagitis, while 20 (100%) and 130 (92.9%) respectively showed no radiological reflux (p>.05). 14 cases had wrap problems; 2 in the first (disrupted) and 12 in the second group (8 migrated up, 2 tight and 2 disrupted) with no significant difference (p>.05).

LES pressure and esophageal exposure were improved similarly in both groups; Mean LES pressure was 21.8 mmHg in the first group and 22.3 in the second, whereas mean pH score was 4.4:5.7 DM score respectively (p>.05).

The 4 cases with postoperative defective LES pressure and positive pathological acid reflux (with disrupted wrap) were included 2 in the first group and 2 in the second (Table 3).

Table 3. Motility and PH metry results in patients with defective body motility compared with normal ones.

Data	Pre-op.		Late post-op.	
	Body≤35	Body>35	Body≤35	Body>35
MOTILITY STUDY	MEAN	MEAN	MEAN	MEAN
-LES study				
-LESP (mmHg)	9.8±3.1	11.0±5.6	21.8±2.9	22.3±4.4
-LESR (%)	98.9±1.5	98.4±2.1	94.8±9.2	97.2±2.8
-Body study				
-Distal amplitude (mmHg)	28.4±3.7	80.5±28.6	68.5±14.6	81.8±20.6
-% Normal waves	94.1±3.9	95.3±3.9	97.8±4.2	96.5±4.5
PH METRY				
-%TR total	8.6±1.9	11.2±6.7	1.0±0.9	0.5±0.2
-DM score	32.4±20.4	39.0±23.2	4.4±1.0	5.7±4.1
Total	**24**	**176**	**20**	**140**

On comparing preoperative with early and late postoperative results,
All p values were >.05.
%TR =% time Reflux Total.

DISCUSSION

Total results of esophageal motility

The main effect of the antireflux surgery is the significant increase in the LES pressure. This appears to be the most dramatic effect of fundoplication on esophageal physiology and should explain the efficacy of the surgical antireflux procedure.[11] Johnson et al, have shown that fundoplication decreases the occurrence of Transient LES Relaxations (TLESRs) induced by gastric dilatation; this mechanism could help explain efficacy of antireflux surgery in patients who do not have decreased LES pressure before surgery.[12]

Because TLESRs were not studied in our population, we can only speculate on the predominant mechanism (increase in LES pressure) to explain the efficacy of antireflux surgery. Mean LES pressure improved among our cases significantly from preoperative values. It had increased from 10.9 mmHg to 25.5 mmHg at early follow up and 22.3 mmHg at late follow up (p<.001).

Some authors documented that surgical treatment for GERD often improves esophageal motor function, indicating that body motility impairment may be the consequence rather than the cause of GERD.[13]

Our results do not support this concept. The amplitude of peristaltic wave in different parts of the esophagus showed no significant change and the results were nearly similar to the preoperative values (e.g. Distal amplitude was 74.2 preoperatively, 81.3 early postoperative and 80.2 late). The percentage of abnormal peristaltic waves had not improved after surgery (p>.05). From these results, it is clear that antireflux surgery has no major effect on esophageal body, at least on short-term follow up.

Effect of defective les pressure upon GERD severity and surgery outcome

GERD severity

Although low LES resting pressure (≤10 mmHg) has traditionally been considered the hallmark of GERD, it is now recognized that the majority of patients with reflux have a resting pressure greater than this value. In fact, in the studies of Kahrilas et al, only 12 of 65 patients with GERD had LES pressures ≤10 mmHg. It is also interesting to note that some patients in that study actually showed resting LES pressures that were >45 mmHg despite evidence of GERD.[14] A subsequent study has demonstrated that 5.2% of patients with GERD documented by abnormal acid exposure on 24-hour pH

monitoring had a hypertensive resting LES pressure.[15]

Although this phenomenon would appear to contradict previous concepts of LES pressure dynamics in patients with GERD, it is now becoming increasingly clear that this situation should not be unexpected. Since the studies of Dent et al, in 1980, the importance of TLESRs as the major mechanism by which reflux occurs has become generally accepted.[16]

In our study, 104 (52%) patients had LES pressure ≤10 mmHg, while the remaining 96 (48%) had pressure >10 mmHg. Severe heartburn was higher in patients with LES pressure ≤10; 92 (88.5%) cases of the first group and 62 (64.6%) of the second had severe heartburn (p<.05).

This group also showed a significant higher esophagitis grading (II, III&IV) in comparison with the other group (69.2:45.9% respectively) (p<.05) but with no difference as regard radiological reflux study. Pathological acid reflux score was also higher in this group (43.2:32.9 DeMeester (DM) score respectively) (p<.05). Despite the inability to elicit TLESRs our study, it is clear that defective LES pressure is a very important item, which is associated with severe form GERD.

Surgery Outcome

Many studies reported a significant increase in basal LES pressure after surgery in patients with symptomatic GERD and low LES pressure before surgery. This appears the most dramatic effect of fundoplication on esophageal physiology and should explain the efficacy of the surgical antireflux procedure.[17] Indeed, some authors have found that a decrease in LES pressure accounted for about 70% of GERD, increasing to 100% in patients with severe mucosal damage.[18] However, recent studies support the idea that TLESRs are responsible for the majority of gastro-esophageal reflux episodes in healthy humans and for a large proportion of these episodes in GERD patients.[19] Johnsson et al,[12] have shown that fundoplication decreases the occurrence of these relaxations induced by gastric dilatation: this mechanism could help explain efficacy of antireflux surgery, especially in patients who do not have decreased LES pressure before surgery.

Because TLESRs were not studied in our series, we can only speculate on the predominant mechanism (increase in LES pressure) to explain the efficacy of antireflux surgery. Clinical results were similar in patients with LES pressure ≤10 mmHg (104 cases) and those with LES pressure >10 mmHg (96 cases); 92 (88.5%) cases of the first group and 86 (89.6%) of the second showed heartburn relief (p>.05). Endoscopic and radiological results showed nearly similar results. Mean LES pressure was improved similarly (p>.05) in both groups (22.3 mmHg and 22.3 mmHg respectively), whereas mean pH scores dropped into 6.5 and 3.7 DM score respectively (p<.05).

Effect of esophageal body dysmotility upon gerd severity and surgery outcome

GERD severity

GERD is frequently associated with motor disorders of the esophageal body characterized by a hypermotility or, more frequently, by a hypokinetic pattern.[20] Whether these abnormalities are a primary phenomenon or occur as a consequence of acid injury is an area of controversy. The majority claimed that this peristaltic dysfunction is a primary alteration that precedes and contributes to severe forms of reflux injury.[21] Other authors, however, have demonstrated that surgical treatment for GERD often improves esophageal motor function, indicating that esophageal body motility impairment may be the consequence rather than the cause of GERD.[22]

Our results do not agree with the opinion that defective body pressure is usually associated with severe form GERD. In our series, patients with esophageal body pressure ≤35 mmHg were only 24 (12%), while those with pressure >35 were 176(88%). Both groups were nearly similar as regard clinical, endoscopic, radiologic, manometric and pH metric aspects (p>.05).

Surgery Outcome

Although the clinical significance has yet to be determined, total fundoplication causes partial obstruction at the Esophago-Gastric Junction (EGJ), so it is tempting to believe that this surgical procedure is prone to induce obstructive complaints in reflux patients with impaired motor function. Accordingly, it was recommended by many authors that patients with preoperative poor esophageal motility (distal esophageal body contraction amplitude ≤35 mmHg) be operated on with a partial fundoplication rather than a total fundic wrap to avoid adverse consequences of the operation.[23] Nevertheless, the idea has been challenged by the data from three studies that have a bearing on this clinical topic. Laws et al,[24] compared 23 patients having a laparoscopic complete wrap to 16 patients having a laparoscopic partial wrap. They concluded that a partial or a complete wrap, after Short Gastric Vessels Division (SGVD), offers effective therapy for reflux esophagitis with more than 90% patient satisfaction. They found that there is no clear advantage of one wrap (partial or complete) over the other. In a cross-sectional study, Mughal and coworkers[25] investigated 126 consecutive patients who had a floppy Nissen wrap irrespective of the preoperative manometric data. These authors concluded that preoperative esophageal studies, other than those required to make an accurate diagnosis, were of no value when designing the suitability of patients for surgical correction of GERD with a total fundic wrap. In another series of 345 consecutive patients operated upon with LNF, Baigrie et al,[26] found 31 patients who had disordered peristalsis preoperatively. These patients, with disordered peristalsis and possibly even absent

peristalsis, postoperatively reported clinical results similar to those in the larger group of patients with normal motor function of the esophagus, which suggested to the authors that weak manometric findings are not a contraindication to a Nissen's fundoplication. Therefore, these reports together with the study of Rydberg et al,[27] indicate that the principle of tailoring the type of fundoplication, based on the preoperative motor function of the esophagus, in chronic GERD patients lack firm scientific support. Consequently, information available to date does not allow a clear conclusion of the superiority of either operation.

Our results assured the efficacy of LNF in treatment of GERD patients with defective body motility. Clinical results were similar in patients with defective body pressure (24 cases) and in those with average pressure (176 cases); 22 (91.7%) cases of the first group and 156 (88.6%) of the second documented heartburn disappearance (p>.05). Endoscopic and radiological results were similar in both groups. LES pressure and esophageal exposure improved similarly in both groups; Mean LES pressure was 21.8 mmHg in the first group and 22.3 in the second, whereas mean pH score was 4.4:5.7 DM score respectively (p>.05). It is to be noted that cases with defective body motility had a postoperative great improvement (mean distal amplitude increased from 28.4 mmHg preoperatively to 86.5 postoperatively) (p<.001).

CONCLUSIONS

Defective LES pressure is a very important item, which is associated with severe form GERD. The significant increase in basal LES pressure postoperatively appears to be the most dramatic effect of fundoplication on esophageal physiology. However, LNF results are similar in patients with or without preoperative defective LES.

Our preoperative data were nearly similar in patients with or without defective body pressure. Total wrap in patients with defective body motility provides a similar symptomatic and physiologic outcome to those with normal motility.

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