The short esophagus: Intraoperative assessment of esophageal length

Sandro Mattioli, MD,^a Maria Luisa Lugaresi, MD, PhD,^a Mario Costantini, MD,^b Alberto Del Genio, MD,^c Natale Di Martino, MD,^d Landino Fei, MD,^e Uberto Fumagalli, MD,^f Vincenzo Maffettone, MD,^c Luigi Monaco, MD,^d Mario Morino, MD,^g Fabrizio Rebecchi, MD,^g Riccardo Rosati, MD,^f Mauro Rossi, MD,^h Stefano Santi, MD,^h Vincenzo Trapani, MD,^e and Giovanni Zaninotto, MD^b

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From the Division of Esophageal and Pulmonary Surgery Villa Maria Cecilia e San Pier Damiano Hospitals, University of Bologna^a; Department of Surgical Sciences and Gastroenterology, University of Padova^b; First Division of General and Gastrointestinal Surgery, II University of Naples^c; VIII Division of General Surgery and Gastroenterologic Physiopathology, II University of Naples^d; Unit of Gastrointestinal Surgery, School of Medicine, II University of Naples^e; Esophagogastric Surgery Unit, Istituto Clinico Humanitas, Rozzano, University of Milan^f; Minimally Invasive Surgery Centre, University of Turin^g; General Surgery IV, Regional Referral Centre for Esophageal Pathology, Department of Medical and Surgical Gastroenterology, AOU Pisana, Pisa, Italy.^h

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Address for reprints: Sandro Mattioli, MD, FECTS, FACS (Th), Università degli Studi di Bologna, Dipartimento di Discipline Chirurgiche, Rianimatorie e dei Organo, Via Massarenti 9—40138 Bologna, Italy (E-mail: sandro.mattioli@unibo.it).

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Objective: To define the frequency and predictors of short esophagus in a case series of patients undergoing antireflux surgery.

Method: An observational prospective study from September 10, 2004, to October 31, 2006, was performed at 8 centers. The distance between the esophagogastric junction as identified by intraoperative esophagoscopy and the apex of the diaphragmatic hiatus was measured intraoperatively before and after esophageal mediastinal dissection; a distance of 1.5 cm was arbitrarily determined to categorize cases as long (>1.5 cm) or short (≤1.5 cm).

Results: One hundred eighty patients were enrolled; the mean age of patients was 49.3 ± 15.3 years. At the first measurement (after isolation of the esophagogastric junction), the median distance between the esophagogastric junction and the apex of the hiatus was equal to or shorter than 1.5 cm in 68 (37.7%) patients; at the second measurement (after full mediastinal isolation), the measurement of the distance was still shorter than 1.5 cm in 34 (18.8%) patients and between 1.5 and 2.5 cm in 24 (13.4%) patients. The median length of the mediastinal esophageal dissection was 6 cm (range 1–12 cm). An esophageal lengthening procedure was performed in 26 (14.4%) patients. The duration of symptoms ($P = .047$), the General Health domain of the SF-36 questionnaire ($P = .001$), and an x-ray barium swallow ($P = .000$) are predictive factors for a “true” short esophagus.

Conclusions: True short esophagus is present in about 20% of patients undergoing routine antireflux surgery. Radiology, severity, and duration of symptoms are predictors of true foreshortening.

The diagnosis and treatment of short esophagus in gastroesophageal reflux disease (GERD) is a past controversy that has recently re-emerged.^{1,2} During the last 10 years, many thousands of laparoscopic antireflux operations have been performed in the world. For the majority of scientific articles reporting on laparoscopic antireflux surgery (often based on a large patient case series), cases of short esophagus were not mentioned.³⁻⁶ Likewise, only a minority of articles emphasized the preoperative and intraoperative diagnoses of a short esophagus and the need to cure this condition with dedicated surgical techniques.⁷⁻¹² In an attempt to definitively address the controversy on the existence, frequency, and predictors of short esophagus in patients undergoing antireflux surgery, a multicenter prospective study was devoted to the precise measurement of the distance between the apex of the diaphragmatic hiatus and the esophagogastric (EG) junction, as localized by intraoperative endoscopy during the surgical procedure.

Abbreviations and Acronyms

CRF	= case report form
EG	= esophagogastric
GERD	= gastroesophageal reflux disease

Patients and Methods

A multicenter observational prospective study was run by members of the European Society of Esophagology at 8 centers that have adequate expertise and patient volume in the field of GERD surgical treatment (more than 10 years of clinical/scientific experience in antireflux surgery, more than 100 open/minimally invasive procedures performed, and more than 20 cases performed per annum).

The study protocol was approved by the Ethics Committee for Clinical Studies of the proposing center. Among consecutive patients at the center's outpatient clinics, those who fit the protocol inclusion criteria and agreed to the surgical therapy for GERD were asked to enter the study. Informed consent was obtained from the patients before enrolment, according to the approval criteria of the ethics committee and to the ethical standards of the Helsinki Declaration of 1975. The study's inclusion criteria were adopted by each center, according to the international guidelines for the surgical therapy for GERD.¹³⁻¹⁵ Surgery was indicated for (1) patients with GERD who were not responding to medical therapy; (2) patients not compliant with long-term medical therapy; (3) patients requiring high dosages of drugs; (4) patients too young for lifetime medical treatment; (5) patients performing a particular type of job that does not allow drugs to be taken constantly; (6) patients with atypical GERD who opted for surgery; and (7) patients who decided, in the first instance, for the surgical treatment of typical GERD.¹³⁻¹⁵ Surgery was also indicated in patients with massive incarcerated (paraesophageal) hiatal hernia that was or was not associated with GERD.^{8,15} Exclusion criteria for the study were age younger than 18 years, association of GERD with epiphrenic esophageal diverticulum, collagenous diseases, primary esophageal motility disorders, redo antireflux surgery, and previous surgery on the thoracic and abdominal esophagus, stomach, or diaphragm. Data collection was structured into 12 case report forms (CRFs). CRFs 1–2 included the identifying card and the informed consent for each center. Data regarding follow-up (CRFs 11–12) have not been included in the present study. The full protocol is accessible at the following site: <http://www.fondazionevillamaria.it/gerdsurgery/index.htm>.

Clinical Evaluation (CRF 3)

Medical history, duration of symptoms related to GERD, and previous medical therapy were collected. Data regarding GERD symptoms and the general health of the patient were assessed according to the self-administrated SF-36¹⁶ and GERD-HRQL questionnaires.¹⁷

Instrumental Evaluation (CRFs 4, 5, 6, and 7)

The barium swallow was performed in the upright, supine, and prone positions, with and without gas powders, according to a protocol previously described.⁷ The radiologic classification is based on 6 different conditions, evaluated in the upright position⁷: normal EG junction, sliding hiatal hernia, hiatal insufficiency, concentric hiatal hernia, short esophagus, and massive incarcerated gastric hiatal hernia (Figure 1).

Upper gastrointestinal endoscopy, esophageal manometry, and ambulatory 24-hour esophageal pH recording were performed according to the international guidelines and the centers' current practice criteria that were adopted for the preoperative study of candidates for antireflux therapy. Esophageal pH recording was obligatory in the presence of nonerosive esophageal reflux disease.¹⁸

Reflux esophagitis was graded according to the Los Angeles classification, including nonerosive esophageal reflux disease.¹⁹ Biopsies were performed for the histologic confirmation of the diagnosis of Barrett esophagus or when dysplastic lesions were suspected; Barrett esophagus was categorized according to established criteria.²⁰

Surgery (CRFs 8 and 9)

Surgeons were free to adopt an open or a minimally invasive approach.

After 360° isolation of the EG junction and diaphragmatic pillars and resection of the hernia sac and the fat pad, if necessary, a fiberscope was inserted orally to the level of the proximal margin of the gastric mucosal folds. The EG junction was localized where the gastric folds disappear into the tubular esophagus.²⁰ A large hemoclip was applied at the level of the tip of the scope, as felt by the clip applier, to mark the position of the EG junction. Air insufflation was minimized, and after the maneuver, the scope was inserted into the stomach to deflate it. The instrument was retracted into the upper part of the esophagus and the light was turned off. The surgeon relieved any tension applied to the stomach and measured the distance between the clip marker and the apex of the hiatus (*first measurement* after isolation of the EG junction) and again after maximal isolation of the mediastinal esophagus (according to the surgeon's judgment; *second measurement*). The measurements were performed with a gauge instrument specifically designed for this study (laparoscopic L-branched ruler, designed by S.M.; Figure 2). The vertical branch of the L-branched ruler, at a right angle to the axis of the instrument, was positioned at the apex of the hiatus to measure the distance between the marker (clip) and the hiatus itself. During laparoscopy, the ruler was introduced into the abdomen through the right lower port to place the L-branched ruler as close to parallel to the esophagus as possible.

These measurements produced three types of data: (1) the distance between the EG junction clip and the diaphragm (in centimeters), as marked with a minus sign when the junction is placed below the diaphragm or a plus sign when the junction is placed above the diaphragm; (2) the length (in centimeters) of the isolated thoracic esophagus, from the top level of the mobilization to the apex of the hiatus; (3) an arbitrary categorization of cases as "long" or "short" when there was more than or less than 1.5 cm subdiaphragmatic esophagus, respectively. In fact, if the antireflux procedure is to be performed without undue tension, it is generally accepted that at least 2.5 cm of tubular esophagus should lie below the hiatus in the absence of tension on the stomach.^{1,8,9,10,11,21} The mediastinal dissection was extended and the antireflux technique (hiatoplasty and fundoplication) was chosen by the first surgeon, according to personal experience.

Training of the Research Groups

In January 2004, a meeting was held for the involved physicians to pool the common knowledge of the preoperative barium swallow and the intraoperative methodology of EG junction identification and measurements. Videos of the radiologic and surgical procedures were distributed among the centers.

Figure 1. Barium swallow. HH, Hiatal hernia; EGJ, = esophagogastric junction of the esophagus. *Black outline* is the esophageal wall; *white outline* is the gastric wall. *Normal esophagogastric junction:* the EGJ is located below the diaphragm, at the apex of the angle of His. *Sliding hiatal hernia:* the EGJ rises above the esophageal hiatus, together with a portion of the fundus of the stomach, while the patient is in a prone position and straining, although it recedes within the abdomen in the upright position. *Hiatal insufficiency:* in the upright position, the esophagus is straightened, the angle of His is widened, and the EGJ is at the level of the diaphragmatic hiatus (hiatal notch); the intra-abdominal esophageal segment has disappeared. *Concentric hiatal hernia:* in the upright position, the esophagus is straightened, the EGJ is located above the diaphragm, and the gastrocardial folds display a "tent-shaped" appearance. *Short esophagus:* in the upright position, the esophagus is straight and rigid, the EGJ is fixed far above the diaphragm and it may be stenotic; the intrathoracic stomach has a "funnel- or bell-shaped" appearance. *Massive incarcerated gastric hiatal hernia:* in the orthostatic position, a great portion of the stomach is fixed in the chest with a bottleneck appearance of the transhiatal portion; the esophagus may be straightened or curling. (From Figures 1 and 2 of Mattioli S, D'Ovidio F, Pilotti V, Di Simone MP, Lugaesi ML, Bassi F, Brusori S. Hiatus Hernia and Intrathoracic Migration of Esophagogastric Junction in Gastroesophageal Reflux Disease. *Dig Dis Sci.* 2003;48:1823-31. With kind permission of Springer Science and Business Media.)

Intraoperative and Postoperative Complications (CRF 10) and 6-month and 12-month Follow up (CRF 11 and CRF 12)

Further data were collected for the multicenter study that are not reported in the present article.

Statistical Analysis

The Villa Maria Foundation (Ravenna, Italy; <http://www.fondazionevillamaria.it/>) was identified as the independent group responsible for (1) the development of hardware and software for collecting the registered data, (2) study monitoring, and (3) structural analysis of the collected data.

The Mann-Whitney *U* test was used for comparisons of the ordinal qualitative variables, and the χ^2 test was used to evaluate the nominal qualitative variables. The Student *t* test for unpaired data was used for comparisons of the continuous quantitative variables. The comparison of the measurement of the distance between the diaphragmatic hiatus and the EG junction before and after esophageal mediastinal dissection was performed with the Wilcoxon signed rank test.

The logistic regression method was used to identify the predictive factors of foreshortened esophagus.

Results

Between September 10, 2004, and October 31, 2006, 180 consecutive patients were enrolled, 84 (46.6%) men and 96 (53.4%) women. The mean age of the patients was 49.3 ± 15.3 years.

Comorbidities were present in a mix of combinations in 99 patients. The median duration of GERD symptoms was 60 months, with a range of 3 to 360 months. Medical therapy had been previously administered to all patients either continuously or cyclically for a median period of 6 months (range 1–180 months).

At barium swallow, the EG junction was normal in 23 (12.8%) patients, a sliding hiatal hernia was present in 59 (32.8%), a hiatal insufficiency in 52 (28.8%), a concentric hiatal hernia in 22 (12.2%), a short esophagus in 2 (1.2%), and a massive incarcerated hiatal hernia was present in 22 (12.2%) patients. Other preoperative characteristics of the study population and indications for surgical therapy are shown in Table 1. In 55%, 22%, and 23% of patients, only 1, 2, or 3 or more indications were selected, respectively.

Figure 2. The ruler used for the intraoperative measurements of the distance between the marker (clip) and the hiatus consists of a stainless steel rod that is 5 mm in diameter and 45 cm long. The head of the instrument is graduated with notches every 5 mm and can be bent upward by 90°.

The surgical approach was minimally invasive in 175 (97.3%) patients and open (laparotomy) in 5 (2.7%). During minimally invasive surgery, the median pressure of the pneumoperitoneum was 12 mm Hg (range 10–14 mm Hg). Surgery was converted from laparoscopy to laparotomy in 2 (1.1%) patients.

At the first measurement, the median distance between the EG junction and the apex of the diaphragmatic hiatus was –2 cm (range –4 to +3 cm).

In 31 (17.3%) patients, the intra-abdominal esophagus was longer than 2.5 cm, and in 81 (45%) patients, it was equal to or less than 2.5 cm and longer than 1.5 cm. In 68 (37.7%) patients, the intra-abdominal esophagus was equal to or shorter than 1.5 cm. A histogram of the distribution of the measured data is shown in [Figure 3, A](#). The median length of the mediastinal esophageal dissection was 6 cm, with a range of 1 to 12 cm. At the second measurement, the median distance between the EG junction marker and the apex of the diaphragm was –3 cm, with a range of –5 to +3 cm.

In 122 (67.8%) patients, the intra-abdominal esophagus was longer than 2.5 cm, and in 24 (13.4%) patients, it was equal to or less than 2.5 cm and longer than 1.5 cm ([Figure 3, B](#)). In 34 (18.8%) patients, the intra-abdominal esophagus was still equal to or shorter than 1.5 cm ([Figure 3, B](#)); the mediastinal dissection in 16 (8.8%) patients was less than 6 cm; in 18 (10%) patients, it was longer than 6 cm.

In the comparison between the first and second measurements, statistically significant differences were observed ($P = .000$), suggesting that the esophageal mediastinal dissection significantly affected the final intra-abdominal esophageal length. The distance between the EG junction and the diaphragm before (first measurement) and after (second

measurement) the esophageal mediastinal dissection is shown in [Figure 4](#).

A standard fundoplication was performed in 154 (85.5%) patients, with 49 (27.2%) Nissen fundoplications, 103 (57.2%) Nissen–Rossetti fundoplications modified according to DeMeester (floppy Nissen), and 2 (1.1%) Toupet fundoplications. The mean length of the wrap was 2.2 ± 0.5 cm. A Collis gastroplasty was performed in 26 (14.5%) patients; of these, the length of the intra-abdominal tubular esophagus was –1.7 cm in 1 patient, –1.5 cm in 2 patients, and > -1.5 cm in 23 patients. The Collis procedure, associated with a 360° fundoplication, was performed by a laparoscopic approach in 7 (3.8%) patients, and a laparothoracoscopic approach was taken in 19 (10.6%). The mean length of the gastroplasty was 3.1 ± 0.8 cm.

The 2 groups of patients in whom at the second measurement the distance between the EG junction and the diaphragmatic hiatus was longer than 1.5 cm (long esophagus) or equal to or shorter than 1.5 cm (short esophagus) were statistically different according to age, preoperative duration of symptoms, role Physical and General Health domains of the SF-36 questionnaire, resting tone of the lower esophageal sphincter, and intrathoracic migration of the EG junction at the preoperative radiologic study (univariate analysis) ([Table 2](#)). The predictive factors for a “true” short esophagus were preoperative duration of symptoms, General Health domain of the SF-36 questionnaire, and the orad migration of the EG junction at the preoperative radiology (multivariate analysis; [Table 2](#)).

Discussion

In the last 15 years, the vast majority of articles on (laparoscopic) surgery for GERD have not reported on cases in which the esophagus was shortened, resulting in technical problems when fundoplication without tension was performed around an adequate segment of intra-abdominal esophagus.^{1–6} Some surgeons have noted that a short esophagus is not an infrequent result among patients undergoing antireflux surgery. Their attention is focused on the technical issues necessary to adequately correct this condition.^{7–12} What is the cause of these opposite positions? What is the source of the misunderstanding? A reasonable answer is that the recent reports are biased, probably more now than in the past, through methodological errors both in the subjective identification and assessment of the position of the EG junction and in the equally subjective quantification of the degree of esophageal shortening needed to reposition an “adequate” segment of the tubular esophagus into the abdomen.^{8–10} It is more difficult to precisely localize the passage from the tubular esophagus into the stomach in laparoscopy than in open procedures because, in the process of esophageal shortening, the angle of His disappears, and the proximal stomach tubularizes and assumes a funnel-like shape.^{8–10,22,23}

TABLE 1. Preoperative characteristics of the study population (180 patients)

	Mean $\pm$ SD	Range
Age (y)	49.3 $\pm$ 15.3	17–79
Preoperative duration of symptoms (mo)	83.56 $\pm$ 63.59	3–360
Score of the preoperative GERD HRQL	20.82 $\pm$ 8.72	0–43
SF-36 Physical Functioning	72.80 $\pm$ 24.13	5–100
SF-36 Role—Physical	59.06 $\pm$ 41.98	0–100
SF-36 Bodily Pain	62.90 $\pm$ 21.74	12–100
SF-36 Role—Emotional	57.89 $\pm$ 43.77	0–100
SF-36 General Health	50.56 $\pm$ 8.71	30–77
SF-36 Vitality	55.87 $\pm$ 18.05	5–95
SF-36 Social Functioning	61.11 $\pm$ 21.75	0–100
SF-36 Mental Health	60.35 $\pm$ 18.66	4–100
Manometric basal tone of the LES (mm Hg)	10.28 $\pm$ 5.31	2–35
Manometric length of the LES (cm)	3.37 $\pm$ 0.73	1.3–5
	No.	%
Reflux esophagitis according to the Los Angeles classification	A: 59	A: 32.7%
	B: 38	B: 21.2%
	C: 8	C: 4.4%
NERD	75	41.7%
Barrett esophagus	26	14.4%
Hypotonic LES	134	74.4%
Secondary motility dysfunction of the esophageal body	61	33.8%
24-Hour pH recording	64*	35.5%
% of total time with pH < 4	64	35.5%
Indications for surgery	No.	%
Patients not responsive to medical therapy	75	41.6%
Patients not compliant with long-term medical therapy	96	53.3%
Patients requiring high dosages of drugs	46	25.5%
Patients too young for lifetime medical treatment	52	28.8%
Patients performing a particular type of job that does not allow drugs to be taken constantly	7	3.8%
Patients presenting atypical GERD, who chose surgery	10	5.5%
Patients who decided in first instance for the surgical treatment of typical GERD	28	15.5%

GERD, Gastroesophageal reflux disease; HRQL, health-related quality of life; LES, lower esophageal sphincter; EG junction, esophagogastric junction; NERD, nonerosive esophageal reflux disease. *In 11 of 75 patients with NERD, the pH recording failed because of the presence of a massive incarcerated hiatal hernia.

The core aim of the present multicenter study was the objective measurement of the distance between the EG junction (marked with intraoperative endoscopy) and the apex of the diaphragmatic hiatus, after isolation of the mediastinal esophagus, in a series of patients undergoing surgical therapy for GERD. At the first measurement, the distance between the EG junction and the apex of the diaphragmatic hiatus was ≤ 1.5 cm in 68 (37.7%) patients; at the second measurement, performed after esophageal mediastinal dissection, the distance between the EG junction marker and the apex of the diaphragm was still ≤ 1.5 cm in 34 (18.8%) patients.

It is worth noting that great care was taken not to overestimate esophageal shortening. We assumed that the gastric folds and not the Z line (usually located 0.5 cm cranially) were the mark of the lower end of the esophagus, in part to overcome the problem of localizing the EG junction in the presence of a long Barrett esophagus.²⁰

The proximal mark point was the apex of the hiatus, which is located more cranially with respect to the confluence of the diaphragmatic pillars. Moreover, the shift of the hiatus toward the chest originated by the pneumoperitoneum, which apparently elongates the intra-abdominal esophagus,²² was not considered. Again, we point out that the 1.5-cm distance or less between the EG junction and the diaphragm was arbitrarily taken as the cutoff limit to categorize cases as having a “long” or “short” esophagus, although it is widely accepted that 2.5 cm of intra-abdominal esophagus is necessary to correctly perform the fundoplication.^{1,8-11,21}

The multivariate logistic regression analysis showed the predictive factors of “true” short esophagus: the duration of symptoms, the grade of symptom severity (as evaluated by the General Health domain of the SF-36 questionnaire), and the presence of intrathoracic migration of the EG junction at the preoperative radiologic examination. Others

Figure 3. Representation of (A) the first intraoperative measurement of the distance between the esophagogastric junction and the apex of the diaphragm and (B) the second intraoperative measurement, performed after esophageal mediastinal dissection. The *minus signs* indicates that the junction was placed below the diaphragm. In *parentheses* are indicated the absolute numbers.

have indicated different predictors for a short esophagus, such as the presence of peptic stenosis, Barrett esophagus, massive incarcerated hiatus hernia, and repeat surgery.^{9,21} We excluded the latter condition from our protocol to study only patients with an anatomy not modified by previous surgery; curiously, in the present series, we have not seen any cases of peptic stenosis, and long Barrett esophagus was associated with a true short esophagus only in 7 of 26 (26.9%) cases. We registered a significant decrease in peptic stenosis in a population of 170 patients undergoing antireflux surgery in the period 1992 to 2003 as compared with a population of 149 patients operated on between 1980 and 1991⁸; the cases of oral migration of the EG junction increased in the second period with respect to the first one. We speculate that proton

pump inhibitor therapy does not interfere with the elastic retraction of the esophagus, although it reduces the parietal inflammation and fibrosis induced by GERD, at least in the hiatal insufficiency and concentric hiatal hernia phases.⁸ The present study was ruled on 3 years ago in Italy, where proton pump inhibitor therapy is totally supported by the National Health Service; 100% of patients had undergone this therapy for long periods. It may be that our data do reflect a local condition. This observation implies a limitation for the study and suggests that further research is necessary, involving North American and North European centers. The barium swallow is a predictive factor as revealed by the multivariate analysis; this has not been proposed before. We would like to point out that in our study protocol, radiology was performed

Figure 4. Variation of the distance between the esophagogastric junction and the diaphragm before (first measurement) and after (second measurement) esophageal mediastinal dissection ($P = .000$).

TABLE 2. A comparison of patients with long and short esophagus (intraoperative measurement) according to preoperative clinical–instrumental parameters

	Long esophagus Mean	Short esophagus Mean	P value
Univariate analysis			
Age (y)	47.17	54.69	.012
Preoperative duration of symptoms (mo)	77.09	97.50	.049
SF-36 Role—Physical	64.92	40.62	.005
SF-36 General Health	51.99	44.56	.000
LES resting tone (mm Hg)	12.10	9.93	.043
	%	%	
Intrathoracic migration of the EG junction at the preoperative radiology	43.3	78.1	.001
Multivariate analysis			
	OR	95% CI	P value
Age	1.02	0.38–2.68	.966
Preoperative duration of symptoms	3.35	1.05–10.63	.040
SF-36 Role—Physical	1.90	0.74–4.84	.177
SF-36 General Health	5.62	1.92–16.44	.002
LES resting tone	1.21	0.45–3.19	.699
Intrathoracic migration of the EG junction at the preoperative radiology	6.42	2.06–20.05	.000

Statistically significant analyses are reported. *LES*, Lower esophageal sphincter; *OR*, odds ratio; *CI*, confidence interval; *EG junction*, esophagogastric junction.

and interpreted according to innovative guidelines.⁷ We believe that a preoperative radiologic examination should be part of the diagnostic workup of GERD patients, inasmuch as it provides information that is useful to discuss with the patient about the grade of severity of the disease; the therapeutic alternatives (whether medical or surgical), particularly in relation to a condition of permanent displacement of the EG junction across or above the diaphragm, which favors cardinal incontinence^{7,15}; and the risks and benefits of surgery in light of the complexity of the surgical procedure.

In conclusion, this study has shown that a significant foreshortening of the esophagus is present in about 20% of patients undergoing GERD surgery; this condition is more frequent in patients with longstanding and severe symptoms. Preoperative radiology, severity of symptoms, and duration of symptoms are clinical and instrumental predictors of a “true” short esophagus. The combined surgical–endoscopic procedure for the measurement of the distance between the EG junction and the diaphragm is a simple and objective method to precisely diagnose, in the operating room, the condition of “true” esophageal shortening and, consequently, to treat this condition according to the principles of the tailored surgery.^{8,12}

Limitations

The present study suffers from an unavoidable limitation: the measurements have been performed in anesthetized, paralyzed patients with a pneumoperitoneum. However, this is the scenario in which true short esophagus can and must be diagnosed.

Another limitation of the study is the arbitrary definition of true short esophagus that we have adopted. In fact, in 24 (13.4%) of 180 patients, the measured length of the abdominal esophagus after mediastinal isolation of the esophagus was equal to or less than 2.5 cm and longer than 1.5 cm., thus shorter than the length indicated in the literature (empirically) as optimal to perform the fundoplication. The follow up of the patients of this group who underwent a standard fundoplication will indicate whether the 1.5-cm length we assumed arbitrarily as the “cutoff” measure for the definition of true short esophagus is correct or not. At the present time, our practice (empirical, too) is to perform the Collis gastroplasty when the abdominal esophagus is equal to or less than 1.5 cm and also when it is shorter than 2.5 cm and longer than 1.5 cm in the case of obese patients or patients younger than 60 years.

Intraoperative endoscopy should become routine, at least in cases in which a short esophagus is likely. It is evident that the surgeons involved in this study behaved differently in terms of extension of the esophageal mobilization and in the choice of the antireflux technique, with respect to the length of the abdominal esophagus after the first and second measurements. The long-term follow-up of patients enrolled in this study and ideally further prospective studies, will provide more information about surgery for GERD, particularly in borderline conditions.

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